

HISTORY

"More Brazilian Than Cachaça": Brazilian Sugar-Based Ethanol Development in the Twentieth Century

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Today, Brazil has one of the most diverse energy systems in the world. The sugar-based ethanol industry plays a pivotal role in that achievement, yet scholars of energy development have focused little on ethanol. This article examines the history of the sugar-based ethanol industry from its beginning in the 1930s to the creation of the state-led program Proálcool (the National Ethanol Program) in 1975 and the ethanol-fueled car in 1979. This article demonstrates how federal and private actors connected nationalist goals of a modern, industrial Brazilian identity to ethanol in order to sustain the industry against the vagaries of the sugar market. Drawing from production data, the monthly sugar industry journal *Brasil Açucareiro*, newspapers, government funding applications for privately owned ethanol distilleries, and oral interviews, it highlights how the idea of a nationally developed technology and domestic industry etched a long-term place for the ethanol industry in the nation's energy strategy.

Hoje, o Brasil tem um dos sistemas de energia mais diversos no mundo. A indústria sucroalcooleira tem um papel central nessa conquista, mas acadêmicos em desenvolvimento de energia têm se concentrado pouco no álcool. Esse artigo se concentra na história da indústria desde seu início na década de 30 até a criação do programa estadual, Proálcool (o programa nacional do álcool), em 1975 e o carro a álcool em 1979. Esse artigo mostra como os participantes federais e privados conectaram as metas nacionalistas de uma identidade brasileira moderna e industrial com o álcool para manter a indústria contra as dificuldades do mercado açucareiro. Usando dados de produção, o diário mensal *Brasil Açucareiro*, jornais, aplicações para fundos governamentais para destilarias privadas do álcool, e entrevistas orais, esse artigo destaca como a ideia da tecnologia desenvolvida nacionalmente e a indústria doméstica estabelecerem um lugar no longo prazo para a indústria do álcool na estratégia energética nacional.

In 1986, a new agricultural magazine, *Revista Globo Rural*, provided a full account of the Brazilian sugar-based ethanol program, Proálcool, calling the industry and its necessary counterpart, the ethanol-fueled car, more Brazilian than the country's most famous sugarcane liquor, *cachaça*.¹ The journalist played on the fact that ethanol, known as alcohol in Brazil, is a subproduct produced from sugarcane just like *cachaça*. At the same time, the author illustrated how important the industry had become, not only to Brazil's economy in the mid-1980s but also to its psyche. That the ethanol industry emerged from a sugar sector considered fundamentally backward, extractive, and closely associated with the Northeast at the beginning of the twentieth century underlies the nationalist pride of the journalist's comparison. As promoter of an industry without technological equal in the world, Proálcool, established in 1975 and notably linked to the automobile industry, represented Brazil's uniquely agro-industrial and technological development.

This article explores the history of Brazilian ethanol development from the 1920s through the twenty-first century. I argue the ethanol industry emerged from a long-term development strategy in which federal actors, military interests, and private producers strategically used economic nationalist terminology to build a domestic alternative energy industry. In the shadow of a national search for domestic oil reserves,

¹ "Proálcool: O novo ciclo da cana," *Revista Globo Rural* 1, no. 9 (June 1986): 52.

officials began promoting ethanol production in the 1930s as a solution to both chronic overproduction in the sugar sector and dependence on foreign oil. Although ethanol became a part of the Brazilian energy matrix by midcentury, the discovery of domestic oil reserves secured petroleum's preferred role in modern energy development. However, with the oil shock of 1973, ethanol again emerged as a prominent energy option. Thereafter, the launch of the ethanol-fueled car, developed by Brazilian scientists and engineers, drove Proálcool's expansion. The program fit well within the dominant protectionist development strategy of the time, import-substitution industrialization (ISI), which sheltered domestic industries from foreign competition in order to grow. By 1985, over 95 percent of all new cars on the road ran exclusively on ethanol (Anfavea 2015). This incredibly rapid shift in fueling, though short-lived, cemented and expanded the industry's place in the national energy system.

Although ethanol production was a national endeavor, São Paulo was its leader. Beginning in the 1930s, the central government promoted ethanol production in order to industrialize the impoverished sugar-producing region of the Northeast. However, as São Paulo's urban industrial base expanded, the state also emerged as the country's agro-industrial center. While the Northeast historically had been the center of sugar production, industrialization of sugar production and proximity to the important São Paulo and Rio de Janeiro consumer markets quickly transformed São Paulo into the center of national sugar and ethanol production by midcentury.² Ribeirão Preto, home to some of the state's most advanced agricultural producers, became the largest ethanol-producing region in the country by the 1980s. In part through evidence from the Biagi family, a leading sugar and alcohol producer in Ribeirão Preto, this article reveals how local private producers also promoted ethanol's place in Brazil's national energy model.

As a nationally grown industry and technology, the ethanol industry represents a core development story closely linked to Brazil's struggle to represent itself as a modern developed nation in the twentieth century. Scholars have long debated the central government's role in Brazilian national development, particularly state-led development schemes that birthed state-owned corporations in oil, steel, and mining promoted by economic nationalist ideologies (Triner 2011; Dinius 2010; Wirth 1970; Gomes 1983). Moreover, scholars have questioned the role of the federal government in the formation of urban industries in which domestic private businessmen have become dependent on or been pushed out by multinationals in textiles, electric power, automobiles, and pharmaceuticals, among other industries (Eakin 2002; Evans 1979).³ More recently, Wolfe (2010) has explored the importance of the automobile to Brazilian ideas of a developed nation. Ethanol's place in these histories is secondary at best, despite the industry's historical position as a national energy industry successfully incubated by government support and intricately tied to Brazilian automobile history. Building on a well-established literature on the sugar sector (Rogers 2010; Ramos 1999; Nunberg 1986; Szmrecsányi 1979) and a very small history-focused literature of the ethanol industry (Demetrius 1990; Barzelay 1986; Santos 1984), I illustrate how the ethanol industry connected the traditionally divided urban industrial development to the agricultural rural sector to briefly become the country's most important fuel source in the 1980s.

Sugar's Place in Early Energy Policy

Sugar has been a key agricultural product throughout Brazilian history. By the early twentieth century, the sugar sector produced for both export and internal consumption, often in excess. The industry also manufactured numerous subproducts such as molasses and alcohol. Alcohol is distilled from any sugar or starch products such as potatoes, grapes, corn, or sugarcane itself. Upon fermentation, alcohol is chemically distilled. Lower-grade distillations make drinking alcohol, like the famous cachaça, but higher-grade distillations are potent enough to run engines (Szmrecsányi 1979, 41–53; Bernton, Kovarik, and Sklar 2010, 3–4). Many early internal combustion engines in France, Germany, and the United States ran on alcohol, not petroleum. As automobiles transformed from playthings of the supremely wealthy in the early 1900s into products for modern transportation, the Brazilian state looked to ethanol to supplement petroleum demand in a country that had yet to find domestic oil reserves. These early efforts laid the foundation for the larger-scale state program, Proálcool, founded in 1975, as a means of addressing both the energy crisis and the country's struggling sugar sector with private interests' support.

² On early Brazilian sugar production, see Freyre (1937).

³ Major trends in national development historiography have shifted from structuralism (Prebisch 1950), to dependency theory (Cardoso and Enzo 1979; Evans 1979), to neoliberalism (Haber 1997), and more recently, neo-institutionalism (Triner 2011). For an overview, see Ioris (2014).

State-sponsored Brazilian research in sugar-based ethanol formally began in the 1920s. In 1923, São Paulo engineer Eduardo Sabino de Oliveira conducted research on the potential energy source in collaboration with the engineer Heraldo de Souza Mattos and Professor Ernesto Lopes da Fonseca Costa at the São Paulo Polytechnic School and at the National Technology Institute in Rio de Janeiro under the Ministry of Agriculture's former Mines and Combustion Experimental Station. Testing both hydrated and anhydrous, or virtually waterless, ethanol, these early studies revealed that anhydrous ethanol could substitute for up to 20–25 percent of the oil-based fuel supply without requiring reforms to the standard engine. Sabino de Oliveira's work, later published in 1937, opened the door for the government to embrace the large-scale mixture of ethanol in the national fuel supply in the 1930s.

Getúlio Vargas and his provisional government formalized state interests in ethanol during the early 1930s as part of a sugar support initiative. Facing newly restricted international markets after the Great Depression, the provisory Vargas government looked to ethanol to address multiple pressing political and economic issues of the time. The ethanol industry bolstered an ailing sugar sector, created a domestic industry as part of a larger self-sufficiency agenda, and addressed a major trade balance issue.

The creation of an ethanol industry met both political and strategic development objectives in the 1930s. The collapse of world sugar prices pushed the government to refocus the export-oriented industry on domestic production. Northeastern and southern producers alike called for national support like that provided for coffee. Vargas had a particular interest in supporting Northeastern producers as a means to economically empower that political base and offset the influence of southern actors, particularly São Paulo coffee producers, under his new political rule (Buckley 2017, 132). Furthermore, the potential to create a domestic industry fit well in Vargas' budding economic agenda, focused on the "development of a self-sufficient, modern and industrial domestic economy" (Triner 2011, 80).

With the onset of the Great Depression, the international market for coffee, the country's major export and foreign-exchange earner, collapsed. Although Brazil was a small petroleum consumer, and international oil prices remained low in the 1930s, the alcohol option lowered petroleum imports and repurposed underpriced potential sugar exports to improve the growing trade deficit.⁴ This link between ethanol and national interests would remain a key element in Brazilian ethanol marketing throughout the century.⁵

Government promotion successfully pushed ethanol onto the national market in the 1930s. Federal promotion of ethanol first began with Decree 19.717 of February 20, 1931, which required that gasoline importers add a 5 percent minimum of domestically produced anhydrous alcohol to commercial gasoline (Pereira 1942, 6). Beyond the minimum mixture, the government also started marketing *álcool-motor*, also known as pink gasoline (*gazolina rosada*). This variety was made of various levels of alcohol, gasoline, kerosene, and other ingredients. Motor alcohol's success played an important role in lowering the trade balance in the 1930s and 1940s.⁶

After creating domestic demand, the government sought to encourage domestic alcohol production. Vargas explicitly connected the future of the sugar industry to the development of an ethanol industry with the creation of the formal Institute of Sugar and Alcohol (Instituto de Açúcar e do Alcool, IAA) in 1933. The institute, one of many Vargas-era organizations created to support agricultural commodities, had two objectives. First, to limit sugar production to domestic demands. Second, to construct and/or equip distilleries for the production of anhydrous alcohol (Szmrecsányi 1979, 180–185). Producers were slow to abide by IAA-imposed production limitations, continuing to produce sugar at previous export levels. Thus, the IAA encouraged redirecting excess sugar production into alcohol for fuel in the form of anhydrous alcohol and for industrial use in the form of hydrous alcohol. The IAA set the selling price of anhydrous alcohol delivered to private gasoline distributors and set a mandatory minimum mixture of 5 percent ethanol in the national fuel supply while encouraging gasoline vendors to aim for a 10 percent mixture.⁷

Yet, early production and distribution fell well short of the mandated fuel mixture levels, pushing more direct government intervention in the creation of an ethanol market. Despite ample sugar capacity, private

⁴ Coffee prices fell to a third of their average price from 1925 to 1929; foreign capital investment also dried up by 1932. This created a trade balance crisis as the country had an external debt of over US\$1.3 billion in 1931 (Baer 2014, 37).

⁵ Getúlio Vargas, "À nação," *A Noite*, May 14, 1932, 1–3; "Propaganda do álcool motor," *Brasil Açucareiro* (henceforth *BA*), August 1934, 374, 405; Getúlio Vargas, "A política açucareira do Brasil," *BA*, November 1934, 137.

⁶ Between 1936 and 1950, alcohol in motor alcohol sales saved the country over 515 billion cruzeiros (US\$27.3 billion) in imported gasoline (IAA, *Anuário Açucareiro 1950–1951*, 76).

⁷ Dr. Gercino de Pontes, "A indústria no Brasil, depois de 1928–1929," *BA*, September 1935, 21; "Gazolina rosada," *BA*, August 1936, 402.

producers fought IAA-mandated cuts in sugar production and refused to invest in costly distilling equipment.⁸ By 1936, production was not even half of the amount necessary to meet the nationally mandated mixture quota. For example, a São Paulo newspaper report claimed that statewide alcohol production sat around 6.5 million liters, when the capital alone would need 7.2 million liters to meet the 10 percent mixture rate promoted by the IAA.⁹ Of the alcohol produced, the more costly but preferred anhydrous variety represented only 4 million liters. The failure to reach national production goals encouraged more direct action by the IAA administration. In response, it created centralized state-financed distilleries near major markets, to which private sugar producers would direct a portion of their sugar supply (de Melo 1942, 50–53, appendix).¹⁰

Under international pressure of the war, ethanol became more than a solution to sugar overproduction, as it had seemed in the 1930s, but also a viable national energy alternative due to World War II fuel shortages.¹¹ Brazil only discovered its first domestic oil reserves in 1939 and had no production infrastructure in place. German submarines off the Brazilian coast caused a 40 percent reduction in oil imports from predominantly American and British refineries between 1938 and 1944.¹² In response, policymakers and military officials turned to alternative fuel sources to alleviate severe fuel rationing across the country. In October 1941, President Vargas established the National Commission for Fuels and Lubricants (Comissão Nacional de Combustíveis e Lubrificantes), which promoted increased ethanol production along with other fuel options, notably the wood- and charcoal-burning gasogene engines, to supply domestic energy demand. Accordingly, the IAA established price parity between alcohol and sugar in 1942 to encourage producers to expand ethanol production. And, with better price incentives, sugar producers responded. Ultimately, the national commission legitimized ethanol as a national security concern given the country's limited domestic petroleum reserves and increasing state interest in development and self-sufficiency goals (Wolfe 2010, 107).¹³

Despite increased incentives, alcohol production still fluctuated due to both internal and external factors. For fuel consumption, anhydrous alcohol was preferable over hydrous alcohol. Anhydrous alcohol required no manipulation of automobile engines while hydrous alcohol did. However, for sugar producers, anhydrous alcohol was costlier to produce. Anhydrous alcohol required additional processing inputs to properly dehydrate the alcohol. The most common input used was benzene, which had to be imported into Brazil and then purchased by producers. This directly affected production levels during World War II, when wartime blockades limited benzene imports to Brazil (Santos 1984, 112–123). Thus, anhydrous alcohol production decreased significantly between 1942 and 1944 while hydrous production gradually increased, as illustrated in **Table 1**.

Ethanol production steadily increased after the war, particularly in São Paulo, shifting the sugar production geography. As the Brazilian population rapidly shifted toward urban cities for industrial jobs after the war, demand for both sugar and fuel dramatically increased in the country's economic center, São Paulo, during the 1940s. In response, the IAA released production limits that had previously limited São Paulo producers in favor of Northeastern producers in 1946 (Szmrecsányi 1979, 214). New sugar and ethanol producers flooded the southern market thereafter. By 1951, São Paulo became the largest sugar producing state in the country and by 1954, the largest ethanol-producing state.¹⁴

The Brazilian government slowly diversified its energy market with the creation of the ethanol industry beginning in the 1930s. This new industry was the child of incentivizing policies to push private sugar producers toward ethanol production under the IAA. Even as state investment promoted the industry, domestic sugar producers were slow to respond to these incentives until the 1940s, when national security concerns buoyed the industry's importance. However, even as ethanol production expanded, oil became the desired path toward self-sufficiency, modernization, and, most notably, energy independence, eclipsing ethanol's initial promise with nationalist hopes for a modern, industrialized urban country built on domestic oil.

⁸ Producers pleaded with the IAA administration and Vargas himself to release sugar quotas as their individual profits diminished. See LAPA 459, Dept. 508, 1941, IAA Collection, National Archives: Rio de Janeiro (henceforth IAA: ANR). On alcohol equipment costs, see Pereira (1942, 51–52).

⁹ "Gazolina rosada."

¹⁰ See also "Associação dos Usineiros de São Paulo," *Correia da Manhã*, June 15, 1951, 10–11.

¹¹ The military played a central role in nation-state building in the twentieth century, first as a moderator of political transitions and more explicitly as a promoter of development after World War II. See Stepan (1971).

¹² "O problema do petróleo e as classes produtoras," *O Estado de São Paulo* (henceforth *ESP*), November 11, 1952, 15; Wirth (1970, 136).

¹³ Decree Law no. 3.755 was issued on October 24, 1941. The IAA reported on the first meeting of the commission in the December 1946 issue of *BA*. "A queda da importação da gasolina e o emprego do álcool-motor como seu sucedâneo," *A Manhã*, August 26, 1941; Agamenon Magalhães, "Álcool-motor," *BA*, August 1941, 38.

¹⁴ IAA, *Anuário Açucareiro* 18, 1953–56 (IAA: Rio de Janeiro), xiii.

Table 1: Ethanol production (in thousands of liters).

Year	Total	Anhydrous	Hydrous
1930	48.9	—	48.9
1931	43.8	—	43.8
1932	63.3	—	63.3
1933	55.1	0.1	55.0
1934	53.3	0.9	52.4
1935	51.3	5.4	45.9
1936	65.8	18.5	47.3
1937	59.1	16.4	42.7
1938	81.0	31.9	49.1
1939	96.7	38.2	58.5
1940	116.5	53.5	63.0
1941	133.2	76.6	56.6
1942	147.6	82.2	65.4
1943	121.5	50.2	71.3
1944	122.5	41.0	81.5
1945	108.5	22.8	85.7
1946	116.6	30.2	86.4
1947	126.5	50.5	76.0
1948	154.8	65.4	89.4
1949	153.7	56.9	98.8
1950	135.2	18.6	116.6
1951	168.0	38.0	130.0
1952	204.0	71.6	132.4
1953	269.0	137.2	131.8
1954	304.1	163.4	140.7
1955	290.3	177.8	112.5
1956	241.3	97.4	143.9
1957	367.4	214.0	153.4
1958	435.3	280.5	154.8
1959	480.9	341.5	139.4
1960	476.3	188.6	287.7
1961	419.5	181.5	238.0
1962	382.6	132.4	250.2
1963	387.5	111.2	276.3
1964	375.6	62.2	313.4
1965	559.1	305.9	253.2
1966	674.8	362.0	312.8
1967	765.7	432.6	333.1
1968	499.2	171.1	328.1
1969	459.7	98.4	361.3

(Contd.)

Year	Total	Anhydrous	Hydrous
1970	625.3	233.0	392.3
1971	624.7	394.5	230.2
1972	684.0	399.3	284.7
1973	652.8	319.7	333.1
1974	614.9	215.1	399.8
1975	580.1	220.3	359.8
1976	642.1	272.3	369.8
1977	1387.6	1087.9	299.7
1978	2359.1	1959.9	399.2
1979	3448.3	2830.0	618.2
1980	3676.1	2171.5	1504.7
1981	4206.7	1347.6	2859.1
1982	5618.2	3527.4	2090.7

Source: Santos 1993, 302.

Oil, Automobiles, Ethanol, and Brazilian Development in the 1950s and 1960s

By the end of the 1940s, Brazilian government officials, military interests, and private sugar producers had combined to create a uniquely Brazilian energy industry. However, oil quickly became the preferred domestic energy option. The founding and expansion of the Brazilian national oil industry shifted attention away from the fuel alternative in the 1950s. However, political and cultural transformations made ethanol's connection to the burgeoning automobile market all the more important. Ethanol lost public support in the 1950s, but private sugar producers and military officials alike continued to support the production and research for future large-scale use of the fuel in the 1950s and 1960s.

Petroleum emerged as a national security imperative and key element in Brazilian development in the 1950s. Military leaders famously transformed the oil issue into a public debate, spawning the popular movement to nationalize oil, known as "The Oil Is Ours" campaign, in the late 1940s. Advantageously connecting himself to the nationalist movement, Vargas returned to power in 1951 on the promise of establishing a national oil company. After much debate, Congress approved the creation of Petrobras in 1953. This solidified Brazil's obsession with petroleum as the key to development and quieted support for ethanol (Wirth 1970).

After Vargas's infamous suicide, Juscelino Kubitschek de Oliveira, the popular governor of Minas Gerais, successfully won the 1955 presidential election on the campaign promise of rapidly transforming Brazil into a modern country. He proclaimed he would achieve fifty years' worth of economic growth in his five-year presidential administration, known as "Fifty Years in Five" (Ioris 2014, 3). As world coffee prices and thus Brazil's balance of payments continued to fall, his administration focused on developing numerous aspects of the economy. The most popular was the establishment of a domestic automobile industry.

Kubitschek's administration specifically focused on rapidly creating a domestic auto industry as part of a "fast-paced national development" agenda. His strategy, known as the Targets Plan, focused on five main sectors of the economy: energy, transportation, agriculture and food supply, basic industries, and education. The establishment of a national auto-making industry received special attention as a key basic industry. The government used "favorable exchange rates, fiscal benefits, preferential credit terms, and market guarantees via tariff protection" to incentivize foreign auto companies to set up full production in Brazil. In exchange, foreign companies had to agree to increase the percentage of locally produced components used in production over a short period of time (Ioris 2014, 105–106).

Kubitschek's plan worked. Foreign companies, such as German Volkswagen and American Willys-Overland Motors, jumped at the incentives offered and quickly expanded Brazilian-based production in the mid-1950s (Wolfe 2010, 119–125). Brazilian auto parts and manufacturing expanded due to the domestic vehicle component requirements attached. Given São Paulo's earlier and more intense industrialization compared to the rest of the country, these firms remained notably concentrated in that state. Simultaneously, Kubitschek's

administration doubled petroleum production and tripled highway construction under its energy and transportation goals to accommodate growing demand for cars over the course of his administration (Wolfe 2010, 139; Ioris 2014, 34–35, 103). By the 1960s, Brazil had restructured its energy and industrial model to focus on oil-based economic growth.

The new petroleum-based auto industry significantly affected ethanol's place in the national energy model. The government's focus on fostering the auto industry supported future use of ethanol as a fuel alternative, despite the lack of specific government attention to the product's development. Scientists and engineers in Brazil's growing university research and education system pushed ethanol's adaptation as a full fuel replacement in cars in the 1950s. Professor Urbano Ernesto Stumpf of the federally funded Aeronautical Technology Institute (Instituto Tecnológico de Aeronáutica) spearheaded the effort. The engineering professor published his early research on alcohol-driven motors throughout the 1950s in various journals and magazines. These included the Institute of Sugar and Alcohol's *Brasil Açucareiro*, a monthly industry journal that distributed new policies and research to subscribing sugar producers (Silva and Fischetti 2008, 47–51). Stumpf's work, although known by and linked to military interests, remained peripheral to national policy and instead developed in the growing technical and scientific academic community.

At the same time, Brazilian sugar policy continued to support ethanol production in the 1950s. Ethanol had proven its strategic value during World War II, and policymakers extended support of the industry as a part of Vargas's national development agenda. The IAA issued Resolution 501 in 1951, which encouraged additional alcohol production despite the public shift toward oil-based products. It required all sugar mills to direct 10 percent of their overall sugar production to alcohol production and granted price parity between sugar, anhydrous alcohol, and hydrous alcohol produced directly from cane.¹⁵ In response, national alcohol production continued to increase, as noted in **Table 1**.

Despite the IAA's continued support of production, ethanol consumption eroded over the course of the 1950s. After the creation of Petrobras, the National Petroleum Council (Conselho Nacional do Petróleo, CNP), its ruling body, became increasingly and more publicly hostile toward the alcohol mixture requirement in the 1950s. Despite low oil prices worldwide in the 1950s, rising gasoline prices drew public ire in Brazil in the mid-1950s. Rather than point the finger at rising inflation linked to Kubitschek's development plan, the CNP repeatedly and directly blamed the alcohol mixture (Baer 2014, 427). In 1955, the CNP issued a memorandum to clarify the cause of rising gasoline prices, stating, "among the walls that constitute the 'structure' of the price of the sale of petroleum derivatives in our country ... is the quota relative to the required addition of anhydrous alcohol to regular gasoline."¹⁶ Indeed, climbing alcohol prices, buoyed by the IAA's established alcohol price parity with sugar, only bolstered the CNP's claim.¹⁷ Thus, the CNP shifted blame toward the national alcohol policy.

Ethanol entered a crisis. Many officials felt government support for ethanol should end as stock reserves increased. In 1958, CNP president Brigadeiro Henrique Fleiuss characterized the minimum 5 percent alcohol mixture in the fuel supply as a questionable sugar support initiative: "Really, this pretense [the alcohol mixture] exists for the Institute of Sugar and Alcohol."¹⁸ As **Table 1** illustrates, production of anhydrous alcohol, which exclusively served the fuel market, dropped but not faster than demand. The market for hydrous alcohol, which serviced light industrial markets like plastics, perfume, and pharmaceuticals, continued to grow. However, with the national government's revised fuel standards, unused anhydrous reserves stockpiled, particularly in São Paulo (Santos 1984, 145). By the 1960s, the alternative energy option was in dire straits.

All the while, São Paulo sugar producers distanced themselves from their Northeastern counterparts by shifting toward an agro-industrial production model that better fit with the national push for modernization during the Kubitschek era. The Biagi family in Ribeirão Preto exemplifies this trend. Maurilio Biagi, son of an Italian immigrant, purchased a small sugar mill, the Usina Santa Elisa, in 1936. During the 1940s, he mechanized the production and transportation process earlier than most other producers, using tractors and trucks to accelerate sugar production and making the Usina Santa Elisa a "reference point" of modern, industrialized plants. In collaboration with a local mechanic, Ettore Zanini, Maurilio Biagi also established a leading sugar and ethanol industrial equipment company, Zanini Ltd., in 1950. The Biagis also consolidated their production abilities, incorporating smaller, neighboring plants and their land into Santa Elisa's

¹⁵ "Política açucareira," *BA*, March 1951, 3, 10–19. The IAA supported this policy in subsequent harvest plans.

¹⁶ "Ocorrência do petróleo no estado de S. Catarina," *ESP*, October 15, 1955, 9.

¹⁷ Lower world petroleum prices in the 1950s made officials question the cost per barrel of adding ethanol. "Ocorrência do petróleo no estado de S. Catarina"; "Aumento no preço do combustível," *ESP*, November 9, 1952, 6.

¹⁸ "Unificação dos preços dos derivados do petróleo é antieconômica," *ESP*, May 7, 1958, 21.

holdings. Biagi's efforts at the Usina Santa Elisa and Zanini further promoted the Ribeirão Preto region as a leader in sugar and ethanol production by the 1960s (Eaglin 2015, 81–83; Hasse 1996).

Nationally, the IAA began shifting sugar policy objectives away from self-sustainable domestic market production, in which alcohol had been an important component of Vargas's support for industry, and toward export-oriented growth of sugar production in response to new export opportunities in the 1960s. New opportunity arose for sugar exports with the collapse of the US-Cuban sugar trade and expanded global demand for sugary packaged foods and sweeteners (Tucker 2000, 51–60). Sugar became an increasingly profitable, although erratic, international market. Global sugar prices peaked in 1963 and 1964 at over US\$ 100 per ton, before falling to below \$40 per ton between 1966 and 1968 (United States Department of Agriculture 2011). To capitalize, the IAA invested heavily in the agro-industrialization of the sugar sector.

São Paulo producers gained further influence amid the IAA's modernization efforts. Some São Paulo sugar producers, like the Biagis, had already begun modernizing their facilities. However, beginning in 1961, a series of government policies facilitated access to loans for equipment and favored land consolidation for large-scale production (Szmrecsányi 1979, 256). In São Paulo, the government encouraged struggling coffee producers toward sugar cultivation with federal funding for new equipment and higher production quotas. These policies accelerated the implementation of large-scale agro-industrial production in São Paulo faster than the Northeast, even as IAA policy intended to rebalance production and influence between the two regions (Hartzmark 2014, 275–277).

As large-scale industrial sugar and ethanol production grew in São Paulo, nationalist factions in Brazil's military, which had played such an important role in the development of Petrobras, regained political influence in the tumultuous 1960s. While immensely popular, Kubitschek's development programs dramatically increased public expenditures with foreign loans, drove up inflation, and left the national economy overstretched by the end of his term in 1961. In response to the economic crisis and increasing social conflict, a faction of the military led a coup in April 1964. The hardline faction established a new military dictatorship focused on driving industrial modernization for economic growth, while also suppressing political dissidents. The new dictatorship focused on nationalist, state-centered development interests (Skidmore 1988).

Sugar, not ethanol, held an increasingly important role in the new military dictatorship's focus on industrialization. The regime sought to mechanize sugar production to take advantage of the erratic but profitable world sugar market. Because of failed harvests in other sugar markets, market protections, high inflation, and the energy crisis, international sugar prices boomed in the early 1970s. In 1972, sugar exports earned Brazil US\$403.5 million, making it the second most important export next to coffee. In November 1974, sugar prices peaked at US\$1,440 per ton. Sugar exports earned over US\$1.2 billion for the year, displacing coffee as the top-earning Brazilian export.¹⁹

Over the course of twenty years, ethanol fell from public view. As petroleum-led development usurped ethanol's energy importance, the alternative fuel fell into the background of the sugar sector. National security implications had pushed government support of ethanol through the vagaries of the sugar market since the 1930s. Yet, the new military regime looked to sugar, not ethanol, for agro-industrial growth by the early 1970s. The traditionally maligned sugar industry, once dismissed as a major part of Brazil's "economy of desserts" by Vargas, became a central piece of the new military government's development agenda. However, global forces would push attention back to the alcohol option just as sugar's position crested and fell on the world market.

The Birth of the National Ethanol Program

In 1973, OPEC countries placed an embargo on oil to the United States and allied countries in retaliation for America's military support for Israel in the 1973 Arab-Israeli War. This sparked an oil shock that quadrupled petroleum prices in the span of just a few months. Despite dreams of self-sufficiency linked to the establishment of Petrobras, Brazil's oil reserves disappointed and the industry focused on refining imported oil by the 1970s. Brazil still depended on foreign imports to service over 80 percent of its demand, so the oil shock created a severe balance of payments crisis by 1974 (Baer 2014, 76). Just as it had in the 1930s, the Brazilian government looked to ethanol as a solution. Unlike in the 1930s, sugar producers used the government-financed modernization efforts of the 1970s to guide state support toward ethanol due to the increased economic importance of sugar exports. As the Biagi example illustrates, private São Paulo

¹⁹ Omer Mont' Alegre, "Das perspectivas de 1974 às perspectivas de 1975," *BA*, March 1975, 24–39.

producers were critical players in definitively shaping Brazil's response to the oil crisis with the creation of Proálcool (Programa Nacional de Álcool, the National Ethanol Program) in 1975.

As part of the sugar sector's accelerating agro-industrial development model begun in the 1960s, the government employed a series of sugar modernization policies to capitalize on rising sugar prices in the 1970s. The IAA formalized these efforts with the Special Export Fund and later the support program for the Sugar Agroindustry Program (Programa de Apoio à Agroindústria Açucareira, Funproçucar), officially founded in 1973 (Ramos 1999, 159). The program streamlined financial support to large-scale sugar producers, primarily through funds generated through the profits from sugar exports in the Export Fund and the Bank of Brazil, at deeply subsidized interest rates in order to encourage increased sugar production capacity for the agricultural export market. By 1974, the government had invested over US\$7.5 million, including \$6.6 million in 1974 alone, into the sector's modernization and expansion.²⁰

The oil shock of 1973 realigned the military government's interests toward a renewed diversified energy agenda. Assuming the presidency in the immediate wake of the crisis, General Ernesto Geisel (1974–1979), a former Petrobras president, focused his new development plan on expanding new energy opportunities in hydroelectricity, nuclear energy, and, less formally acknowledged, ethanol.²¹ In fact, the new president made little direct mention of ethanol in his famous Second National Development Plan, giving no indication that a national program would emerge. Instead, private producers shaped this large-scale intervention, anticipating the state's focus on energy independence and aligning their own interests in expanded ethanol production accordingly.

Private producers like Maurilio Biagi and his son, Maurilio Biagi Filho, used sugar's increased economic importance and heightened energy fears after the oil shock of 1973 to push the expanded government support of ethanol production both from within the sugar modernization program, Funproçucar, and outside of it. Biagi and Biagi Filho played a key role in drawing policy back to ethanol as a major alternative fuel option through Funproçucar even before Geisel emphasized diversifying energy options in his Second National Development Plan and the creation of Proálcool a year later. Father and son applied for Funproçucar financing just after the program began. IAA president General Álvaro Tavares Carmo approved Santa Elisa's application for Funproçucar funding on April 4, 1974, only three months after the oil shock set in and five months before Geisel announced his new development plan.²² Program incentives were meant to support increased sugar production capacity, but instead the Biagis redirected modernization funds toward increased ethanol production capacity. Indeed, the largest share of their Funproçucar financing went toward a new seventy-thousand-liter-per-day distillery rather than new sugar production equipment.²³

At the same time, the Biagis allied with other private producers to lobby for the expansion of an ethanol initiative in public debates. Biagi Filho revealed in an interview that he and his father, Maurilio Biagi Sr., were key contributors to an April 1974 anonymous report submitted to the CNP, outlining a large-scale alcohol program. The report, "Photosynthesis as Energy," first proposed the basic framework of the subsequent national initiative for financing the construction of autonomous distilleries for direct alcohol production and expanding the idle capacity of annexed distilleries on large-scale sugar complexes like those at the Usina Santa Elisa (Szmrecsányi 1979, 310–311).²⁴

The Biagis continued to aggressively lobby the IAA to support expanded ethanol production in their follow-up June 1974 Funproçucar request. Applying for financing of an additional ethanol distillery, Biagi Filho connected the distillery to national interests in energy independence, stating, "Given the global oil crisis, the Usina Santa Elisa believes that the production of ANHYDROUS ALCOHOL [*sic*] will be of great importance for the national economy."²⁵ While the IAA denied their request, the Biagis remained undeterred. In fact, so sure were they that alcohol should and would be part of a larger energy initiative

²⁰ Santa Elisa GEAT form of August 23, 1973, A6.06 Box 0393, IAA: ANR; "Relatório das atividades do Instituto do Açúcar e do Álcool em 1974," *BA*, February 1975, 10–11.

²¹ President Ernesto Geisel, statement at the Meeting of Ministers on September 10, 1974, in *Federative Republic of Brazil* (1974, 3–4 and 81–83).

²² Funproçucar approval letter from General Tavares Carmo to the Usina Santa Elisa on April 4, 1974. GPcT (Gabinete do Presidente do IAA) 515/74, A6.16 Box 0443, IAA: ANR.

²³ Funproçucar approval letter from General Tavares Carmo to the Bank of Brazil president Dr. Ângelo Calmon de Sá on April 4, 1974, GPO 324/74, A6.16 Box 0443, IAA: ANR; industrial contract between the Bank of Brazil and the Santa Elisa shareholders on May 6, 1974, and the annexed equipment budget of May 3, 1974.

²⁴ Maurilio Biagi Filho, interview by author, May 21, 2013. Szmrecsányi confirms this point. The report's authors were unknown at distribution in 1974. Biagi was one collaborator to later claim authorship.

²⁵ Funds request letter from Maurilio Biagi Filho to IAA President General Álvaro Tavares Carmo on June 17, 1974. A6.16 Box 0443, IAA: ANR.

that they sought, and received, approval from Funproçucar to build a self-financed additional 120,000-liter distillery in February 1975.²⁶

The collapse of world sugar prices in December 1974 further encouraged government officials to pursue a national ethanol program. An international agreement to end national quotas on sugar imports in 1973 sent the booming sugar market into free fall by late 1974, as artificially protected markets had encouraged global overproduction of sugar (Tucker 2000, 60). Indeed, monthly world raw sugar prices dropped from US 65¢ per pound in November 1974 to 38¢ in January 1975 and 13¢ in June 1975 (United States Department of Agriculture 2011). Private producers found themselves in crisis again with excessive investments pending in sugar equipment and lower prices to cover their debt. Expanded national incentives to support domestic alcohol production provided a means to offset these issues, just as they had in the 1930s.

The coinciding collapse of sugar prices has led some scholars, notably Michael Barzelay (1986, 44), to conclude that the ethanol program was just another sugar bailout. However, this explanation is incomplete. First, it diminishes the state's historical focus on energy independence that spurred the public-private development of the ethanol industry since the 1930s. Second, it ignores the strategic positioning private producers had already done to establish the ethanol industry as a viable large-scale energy industry through Funproçucar financing, as the Biagi example illustrates. Sugar producers had successfully tied the idea of increased national ethanol consumption to energy independence even before the price collapse. The importance of the sugar industry in the national economy only further encouraged the government to acquiesce to private producers' petitions for a large-scale program.

Sugar producers' lobbying was successful. President Geisel announced the foundation of a large-scale initiative on October 9, 1975, committing the country to a 20 percent mandated mixture of alcohol in the national fuel supply. This came along with a series of measures to address rising oil prices and their effect on the current balance of payments, including the controversial authorization of Petrobras to expand domestic oil exploration with foreign companies.²⁷ The Petrobras agreement incited questions about the continued status of the industry's state monopoly on petroleum, which had been so fiercely defended since the creation of the National Petroleum Council in 1938. Thus, sugar producers' call for a new national alcohol initiative controlled by a domestic industry as a national solution to the energy crisis became even more important symbolically given the opening of Petrobras.

On November 11, 1975, President Geisel instituted the National Ethanol Program (Programa Nacional do Álcool, Proálcool) with Decree no. 76.593.²⁸ The new alcohol program mirrored aspects of the initiative private producers proposed in the 1974 "Photosynthesis as Energy" report, supporting the construction of autonomous distilleries for direct alcohol production and expanding the idle capacity of annexed distilleries at established agroindustrial sugar complexes (Szmrecsányi 1979, 310–311). The program financed sugar producers' investment in ethanol production capacity and agricultural equipment at discounted rates, subsidized ethanol prices at the pump, and encouraged domestic producers' investment in machinery to execute this alcohol expansion.²⁹ The Bank of Brazil became the program's primary financier, and the state became the exclusive purchaser of alcohol. The National Petroleum Council (CNP) gained control of pricing. However, production expansion on sugar-ethanol complexes remained under the control of private producers.

In its initial phase, from 1975 to 1979, the government set a conservative goal of achieving 20 percent fuel mixture rates by expanding alcohol production from about a half billion to at least three billion liters of alcohol annually by 1980 (CENAL 1980, 5). The Biagis and other major sugar producers who had pushed the program's creation were already equipped to meet the mandated additional alcohol production requirement thanks to earlier state-financed but self-directed investments in ethanol production. IAA incentives since the 1930s, the extensive expansion of sugar production capacity ushered in through Funproçucar, and established producers' strategic redirection of state funds toward ethanol infrastructure drove initial production expansion. National production more than doubled in the first two years, and producers easily met the initial production goal by 1979, as illustrated in **Table 1**.

²⁶ Usina Santa Elisa Proálcool Application, Maurilio Biagi Filho to IAA President Tavares Carmo on February 13, 1976. National Alcohol Commission, Division of Assistance for Production N. SP06/76, February 12, 1976. A6.16 Box 443, IAA: ANR.

²⁷ Other measures included a 25 percent increase in the price of gasoline and a 10 percent increase in diesel oil prices. "Geisel autoriza contratos de risco, pais restringir consumo de importados," *ESP*, October 10, 1975, 1; "Geisel a Adalberto: Estou vivendo numa rodaviva," and "Um discurso histórico de 44 minutos," *Jornal do Brasil*, October 10, 1975, 12–13.

²⁸ Decree no. 76.593, *Diário Oficial*, November 14, 1975.

²⁹ "Meta: equilibrar o balanço," *ESP*, November 15, 1975, 30; "O plano, afinal," *Veja*, November 19, 1975, 120–121; Szmrecsányi (1979, 436–437).

Domestic sugar producers successfully guided state support of ethanol toward a national program. They used nationalist rhetoric about the national security value of the alternative fuel for the oil-dependent country to inspire large-scale state intervention. After Proálcool's implementation, producers quickly linked the industry to Brazilian national identity. One ad, pictured in **Figure 1**, by the Biagi-owned Zanini Ltd., called Proálcool the "best Brazilian cocktail" of anhydrous alcohol and gasoline, which reduced Brazilian imports by 20 percent. Indeed, the ad claimed that the initiative proved "Brazilians' creativity and technique. ... A true cheers to the health of the Brazilian economy." While Proálcool focused on the 20 percent mixture in its first four years, the second oil shock in 1979 ushered in a new, expanded phase of the program.

Rise and Fall of the Alcohol-Fueled Car

Private businessmen took advantage of the government's obsession with energy independence to successfully drive the federal government toward creating an import-substitution-inspired national program around the uniquely Brazilian sugar-based ethanol industry in 1975. The agroindustrial modernization of the sugar sector in the 1960s and 1970s supported producers' claim that the sugar sector could meet this expanded demand. Sugar producers quickly met program objectives in the first phase of the program. However, their

**Em Guaricanga
vamos preparar
o álcool para o melhor
coquetel brasileiro.
Tome nota da receita.**



É muito simples:
basta adicionar álcool anidro
à gasolina. Depois, é só
substituir 20% das importações
de petróleo, e pronto.

Você terá uma das
melhores receitas para
economizar milhões e milhões
de cruzeiros em divisas para o
nosso país. Essa receita faz
parte do Programa Nacional do
Alcool. Um dos projetos mais
importantes a que nosso governo
tem se dedicado nos últimos
tempos. Porque vai tornar possível
não só economizar gasolina, mas
também criar uma nova atividade.
Envolvendo novos capitais,
empresários, técnicos de alto nível,
indústrias e operários.

A Destilaria Guaricanga é um
bom exemplo. E uma grande contribuição para
o Programa Nacional do Alcool. Porque
vai produzir 120.000 litros de álcool anidro.
Diariamente.

Vai ser construída no Município
de Presidente Alves, em São Paulo.

Pelo consórcio Zanini-Conger.
Empresas especializadas
na fabricação e montagem de
equipamentos para destilarias
autônomas. Destilarias que
produzem o álcool anidro
diretamente da cana-de-açúcar.
Guaricanga vem mostrar
mais uma vez a criatividade
e a técnica dos brasileiros. Que
inventaram até um coquetel
diferente. Um verdadeiro brinde
à saúde da economia brasileira.

zanini
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Figure 1: New Proálcool Distillery Ad.

Source: Zanini, Conger, and Proquip ad, n/d. Box 193, Ribeirão Preto Municipal Archives.

role as energy producers significantly expanded in the 1980s, when the government retooled the program to become a full fuel replacement program beginning in late 1979.

Government officials, car producers, and sugar distillers restructured Proálcool from a fuel supplement to a fuel replacement program with the introduction of the domestically developed ethanol-fueled car in 1979, after the second oil shock the same year. The beginning of the Iranian Revolution in December 1978 sparked a 14.5 percent increase in OPEC prices and a cut in production, after which oil prices nearly doubled by the end of 1979 (Santos 1984, 360; Barzelay 1986, 174). Iran, as the second largest Brazilian oil supplier, left Brazilians particularly vulnerable to the new crisis. In the face of rising oil prices, officials focused on the expansion of the ethanol program to attend to the deepening energy crisis, and the new ethanol car buoyed national support for the program into the 1980s.

The national development of the ethanol-fueled engine by Brazilian engineers was a point of particular pride for President Geisel. The Brazilian engineer who had been working on the ethanol car since the 1950s, Urbano Stumpf, and a team of Brazilian engineers at the Aeronautical Technology Center (Centro de Tecnologia Aeronáutica, CTA) successfully developed the modifications necessary to run an engine exclusively on ethanol, which had eluded Sabino and his team in the 1920s and 1930s. Stumpf and his research team successfully adapted the gas turbines, compression ratio, carburation, ignition distribution, and the cold engine start system in the revised engines.

Geisel gave Stumpf the support to perfect the engine in 1975 and closely linked long-term future ethanol production goals to phasing in the ethanol car. Unlike the anhydrous alcohol fuel mixture in place since the 1930s, the new ethanol-fueled engine ran exclusively on hydrous alcohol. Volkswagen, the leading car producer in Brazil, quickly joined the effort to bring ethanol-driven cars to market in 1976. Ultimately, Brazilian scientists won the patent rights to the engine despite claims from Volkswagen engineers that their work was essential to the engine's market development. Austrian engineer Georg Pischinger of Volkswagen complained of Brazilians' fierce nationalist association with the ethanol car. Yet, for many, winning the royalties to the alcohol-fueled engine asserted Brazil's ability to compete technologically and commercially on an international scale. Its success quickly transformed the ethanol car into a symbol of uniquely Brazilian development (Bernton, Kovarik, and Sklar 2010, 145–154).³⁰

Even though Brazilians won the patent claim over the ethanol car, foreign manufacturers were central to the creation of a domestic ethanol car market. Like Volkswagen, other multinational manufacturers also recognized the ethanol car as a means to expand their share of the growing Brazilian car market as global car sales contracted due to the global oil crisis and subsequent recession of the 1970s. Fiat, in accord with the government of the state of Minas Gerais, opened a plant in 1976 specifically to produce ethanol cars (Wolfe 2010, 164). As a result, the CTA launched the first fleet of experimental alcohol-fueled cars for government use in 1977, and Fiat launched the first private model to the public in 1978.³¹ The North American automakers General Motors and Ford joined the market in 1979.

Domestic businessmen facilitated the relationship between multinational car manufacturers and the Brazilian government. For example, Mário Garnero, the president of the Associação Nacional dos Fabricantes de Veículos Automotores (National Automobile Producers' Association, Anfavea), lobbied the four major car companies (Ford, General Motors, Fiat, and Volkswagen) to enter the risky exclusively Brazilian production market with extensive market guarantees from the government.³² Shortly thereafter, President João Baptista de Oliveira Figueiredo and the Anfavea president Garnero signed an agreement in September 1979 committing the car industry to produce 250,000 alcohol-fueled cars over the next year.³³

The domestic launch of the alcohol-fueled car foregrounded the dramatic expansion of the ethanol program in the 1980s. Politically, President Figueiredo (1979–1985) explicitly made alcohol a central component of the country's response to the oil crisis.³⁴ The new engine and subsequent car models fostered the expansion of the hydrous alcohol supply, which more than doubled between 1979 and 1980 (see **Table 1**). At the same time, Proálcool's original target to increase the use of anhydrous alcohol in the national fuel supply to a 20 percent mixture rate continued. Thus, overall alcohol production exponentially expanded. Indeed, President

³⁰ "CTA diz que pode utilizar o Programa Álcool-Motor no país," and "500 veículos andam apenas com álcool," *Jornal do Brasil*, May 29, 1978, 15. For example, Lieutenant Colonel Sergio Ferolla, director of the Institute of Research and Development at the CTA, noted that Brazilian ownership of the alcohol motor patent provided the country "equal footing with international manufacturers." João Batista Olivi, "CTA ditará padrões para motor a álcool," *ESP*, April 27, 1979, 30.

³¹ Pedro Lobato, "Pronto o Fiat-Álcool," *Gazeta Mercantil*, September 4, 1978.

³² Mário Garnero, interview by author, December 11, 2013.

³³ "Um acordo com as fábricas para a produção de carros a álcool," *Gazeta Mercantil*, September 11, 1979.

³⁴ Paulo Sotero, "Figueiredo e o desafio dos anos 80," *Veja*, June 13, 1979, 93.

Figueiredo subsequently increased target alcohol production from the conservative initial goal of 3 billion liters to 10.7 billion liters by 1985 (CENAL 1980, 8).

Private producers, who had been so important to the program's creation, quickly seized the opportunity to support the ethanol-fueled car as a part of the program's expansion as well. For example, the Biagis equipped their facilities with ethanol-fueled cars. They promoted the program to local businesses and to consumers in the region as well, distributing hats and T-shirts with the motto "See this T-shirt, Choose alcohol" (Hasse 1996, 171). Even as the government expanded program objectives, private sugar producers remained at the center of this process, remarketing the ethanol option as a nationalist energy option.

While sugar producers promoted the car, consumer support was more mercurial. Initially, the public committed to the alcohol program and the alcohol car as the effects of the second oil shock spread to the pump. Nationally, new alcohol fueled car sales reached over 226,000 in 1980 alone, as referenced below in **Table 2**. However, early models of the new ethanol-fueled car faced myriad problems. Maurilio Biagi Filho, owner of the Usina Santa Elisa, recalls, "The first generation of motors was awful, the second, awful, the third, bad, the fourth, good."³⁵ Technical difficulties with the car plagued public support. Notably, engine corrosion and failure to start in cool temperatures (below 60 degrees Fahrenheit) because of fuel pooling at the bottom of the tank most vexed consumers. These technical problems quickly affected sales in the second year of mass production.³⁶ As a result, the government began to offer numerous incentives in the form of subsidized fuel prices and various reduced car taxes to rally consumer support.

Government financial support faltered. Program subsidies and financing also brought negative attention to the financial obligations attached to Proálcool amid deteriorating economic conditions in the early 1980s.

Table 2: The rise and fall of alcohol cars.

Year	Alcohol cars sold	Percentage of the automobile market
1979	3,120	.3%
1980	240,643	28.5%
1981	137,307	28.7%
1982	233,497	38.1%
1983	581,373	88.5%
1984	568,163	94.6%
1985	647,445	96%
1986	698,563	92.1%
1987	459,222	94.4%
1988	566,610	88.4%
1989	399,578	61.0%
1990	82,001	13.2%
1991	150,985	22.1%
1992	195,510	28.5%
1993	264,235	26.7%
1994	141,835	12.2%
1995	40,707	3.0%
1996	7,647	0.5%
1997	1,120	0.1%
1998	1,224	0.1%

Sources: Anfavea 2015; Cleide Silva, "Aumenta a procura por carros a álcool," *O Estado de São Paulo*, April 26, 1999.

³⁵ Maurilio Biagi Filho, interview by author, May 21, 2013.

³⁶ "Uma reação nas vendas de autos?," *ESP*, November 13, 1981.

The government had shifted to a debt-led development model in the 1970s to support economic growth, yet heavy investment in numerous domestic state development programs simultaneously contributed to a damaging surge in inflation.³⁷ By 1980, inflation hit 110 percent and kept rising. In response, President Figueiredo and his economic team attempted to impose macroeconomic policy reforms in the second half of 1980. They tightened the monetary policy and curtailed investments in state programs, including Proálcool. Despite private businessmen's production and propaganda efforts, Minister of Planning Delfim Neto suspended the program in June 1981. The government lifted the brief freeze on Proálcool project expansion in August 1981 with the help of a \$250 million World Bank loan (Baer 2014, 82–83; Santos 1984, 430 and 463). Still, the program suspension incited consumers' fears about the program's longevity, hurting alcohol car sales.

Government intervention again buoyed the program with a series of additional incentives to lure consumers back to the alcohol car market in 1983. Incentives included a guarantee that alcohol prices would not surpass 59 percent of the price of gasoline (per liter); a lowering of the IPI (industrial product tax) for alcohol cars to 28 percent (from 32 percent previously) while increasing gasoline cars' IPI to 33 percent (32 percent previously); a reduction in the price of the alcohol car to 2 percent below the gasoline car despite the fact that its production costs exceeded the gasoline car; and longer lease terms for new alcohol cars.³⁸ Behind these incentives, alcohol car sales quickly rebounded. However, concern about the alcohol program's long-term viability remained.

This concern was not limited to government actors. Public figures increasingly attacked both the program and sugar producers. Fernando Homem de Melo, professor of sociology at the University of São Paulo, was one of the more outspoken public critics. He directly identified sugar producers as the largest beneficiaries of the national program and consistently highlighted the social inequities produced by the program's growth, particularly in relation to rural labor. His rather acute and astute review of the program placed private producers on the defensive about the program's benefits. Indeed, national attention on rural labor protests in the sugar- and ethanol-producing region of Ribeirão Preto in 1984 further complicated public perception of Proálcool.³⁹

The increasingly controversial program still garnered a great deal of support in the late 1980s. By 1985, 96 percent of all new cars sold in the country ran exclusively on alcohol (see **Table 2**). The media and private producers touted the program's technological prowess to challenge critics. For example, Maurilio Biagi Filho asserts in his 1983 article, entitled "The Alcohol Is Ours," that "we ought to, indeed, defend our nationalist interests. The technology and labor are ours, we do not pay royalties [on the technology], on the contrary, we have an international market, that imports our technology."⁴⁰ Similarly, in 1986, the *Revista Globo Rural* made its comparison of the ethanol car to cachaça, the national alcoholic drink, to reiterate the nationalist value of the domestic development of the alcohol engine in 1978 and the ethanol cars' subsequent success.⁴¹

However, the economic, political, and environmental realities of the time hampered long-term nationalist support for the ethanol car. Brazil was deeply entrenched in a catastrophic debt crisis with a spiraling inflation rate. A series of failed economic plans further engulfed the country in economic crisis by the late 1980s. International oil prices collapsed in 1986. Additionally, a series of droughts deeply affected the program's ability to meet the rapidly growing ethanol fuel demand.⁴² By 1990, fuel shortages drove consumers to switch back to the cheaper gasoline cars. The ethanol market collapsed so quickly that democratically elected president Fernando Collor de Mello threatened to completely end the program in 1990 amid a stream of neoliberal economic reforms.⁴³

³⁷ Many of these programs focused on energy diversification. Government officials particularly targeted the ethanol program for its inflationary pressure on the economy; for example, "O Proálcool, inflacionário," *ESP*, January 6, 1981, 24.

³⁸ "A subida da montanha," *Veja*, March 31, 1982, 100–101; "Produtores de álcool acusam as montadoras," *Folha de São Paulo*, June 10, 1983.

³⁹ For example, Homem de Melo (1981, chapter 3); Fernando Homem de Melo, "Por que o álcool não é a melhor alternativa?," *Revista Exame* (São Paulo), July 28, 1982, 102. See also Eaglin (2015).

⁴⁰ Maurilio Biagi, "O álcool é nosso," *A Folha de São Paulo*, May 9, 1983. Indeed, Brazil exported ethanol and its technology to Japan, among other countries, by 1983.

⁴¹ "Proálcool: O novo ciclo da cana," *Revista Globo Rural* 1, no. 9 (June 1986): 52.

⁴² For example, "Seca agravará crise economia do Sul," *ESP*, February 16, 1986, 52; Flávio Nery, "As chuvas virão com atraso, atrase também o próximo plantio," *ESP*, July 27, 1988, 9.

⁴³ Collor focused on eliminating state monopolies in the production of goods and services, notably shutting down the IAA in the process.

Ethanol's connections to nationalist rhetoric and security concerns saved the program in the 1990s again, as they had so many times before. Politicians and the public decried the program as a model of an outdated state-centered development strategy in 1990, and President Collor admitted the limits of ethanol as a full fuel replacement.⁴⁴ However, the threat of rising foreign oil prices with the Persian Gulf crisis drove Collor to restructure program incentives and continue state support of ethanol as a fuel mixture. He focused on slowly transitioning the industry away from state subsidies rather than abruptly destroying the market.⁴⁵ All the while, producers successfully remarketed the industry as part of a rising environmentalist movement to diminish carbon emissions, garnering public and state support anew (Brilhante 1997, 435–449; Hochstetler and Keck 2007, 207).

Private producers continued to expand ethanol production with state support until 1999, when the government finally removed all sugar and ethanol subsidies (Dias de Moraes and Zilberman 2014, 2). Despite Proálcool's formal end, the industry thrived in the 2000s. In 2003, Volkswagen launched the flex-fuel engine, which gave consumers the choice of filling their tanks with any mixture of alcohol and gasoline. This revolutionized the car market anew. Producers were positioned to capitalize again, as they had so many times before, as ethanol became a national energy solution during a new oil crisis in the 2000s.

Conclusion

Ethanol has been an important part of Brazil's energy identity since the early twentieth century and more broadly, sugar, since the sixteenth century. Ethanol's development relied heavily on government as well as private actors over the course of the century. Sugar producers countrywide were quick to look to the government for increased support when profits dropped first in the 1930s and then after sugar prices collapsed in 1974. Yet, private actors, from sugar producers to government funded scientists, also shaped the government's response in 1975. Proálcool became the government's unique agroindustrial "response to the energy crisis."⁴⁶ The government's large-scale divergent energy approach transformed ethanol and the ethanol-fueled car into a particularly Brazilian experiment.

Today, Brazil is one of the world's largest ethanol producers, but multinationals have infiltrated the once exclusively Brazilian-owned industry. Foreign producers lead the automobile market with flex-fuel cars. However, the country's large-scale use of ethanol remains uniquely Brazilian. The industry remains an important part of the country's energy model as it represents more than 15 percent of the country's annual energy production. The realities of climate change have driven other countries to seek to emulate the large-scale alternative energy integration into their markets as Brazil did under Proálcool. However, its history shows that this industry was a critical part of Brazilian energy identity long before the 1970s oil crisis. Indeed, Brazilian ethanol existed long before many of its nationalist industries, including Petrobras. Here, the nationalist importance of energy independence encouraged the state to continually support private producers in the industry even when it contravened popular opinion and simple economic analysis, not unlike the American corn-based ethanol industry today. Tracing the unique history of public and private investment in the sugar-based ethanol industry suggests that the assertion made by *Revista Globo Rural* may have been a more precise account than other national histories would suggest. Ethanol may be just as Brazilian as cachaça.

Acknowledgements

I would like to thank Peter Beattie, Anne Hanley, Gail Triner, Marshall Eakin, Tom Rogers, Nick Breyfogle, Bart Elmore, Casey Lurtz, the anonymous reviewers, and editor Aníbal Pérez-Liñán for their insightful feedback and critiques on earlier drafts. I also thank the Ohio State Mershon Center for financial support for related research.

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⁴⁴ For example, "Um sonho corroído," *Veja*, May 24, 1989; Uziel Nogueira, "Proálcool: a solução é a de mercado," *ESP*, April 13, 1990, 22.

⁴⁵ President Fernando Collor in "Desenvolvimento é o objetivo," *ESP*, August 30, 1990, 74.

⁴⁶ President Figueiredo to Paulo Sotero in "Figueiredo e o desafio dos anos 80," *Veja*, June 13, 1979, 93.

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How to cite this article: Eaglin, Jennifer. 2019. "More Brazilian Than Cachaça": Brazilian Sugar-Based Ethanol Development in the Twentieth Century. *Latin American Research Review* 54(4), pp. 927–943. DOI: <https://doi.org/10.25222/larr.28>

Submitted: 13 March 2017

Accepted: 18 August 2018

Published: 11 December 2019

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