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Industrial policy and the creation of new industries: evidence from Brazil's bioethanol industry

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Industrial policy programs are frequently used by governments to stimulate economic activity in particular sectors of the economy. This study explores how an industrial policy program can affect the creation and evolution of an industry and, ultimately, the long-term performance of firms. We examine the history of the Brazilian bioethanol industry, focusing on the industrial policy program implemented by the Brazilian government in the 1970s to develop the industry. We put together a novel data set containing detailed information about the history of bioethanol producers. Our findings show that plants founded during the industrial policy program tend to be, in the long run, more productive than those founded before the program was in place. Based on additional analyses and complementary fieldwork, we infer that the wave of acquisitions that occurred after the end of the industrial policy program had an important effect on the performance of the plants founded when the program was in place. Industrial policy, especially in conjunction with a competitive post-industrial policy business landscape, can succeed in nurturing competitive firms.

JEL classification: L25, L52, O25, Q16.

1. Introduction

Governments play a major role in fostering industrial activity and can generate significant changes in the structure of an industry (Malerba and Orsenigo, 1996; Porter *et al.*, 2000; Ring *et al.*, 2005; Athreye *et al.*, 2009). State intervention in specific industries—commonly called *industrial policy*—can stimulate growth and

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create new jobs (Johnson, 1984; Griffiths and Zammuto, 2005; Spencer *et al.*, 2005). More specifically, an *industrial policy period* is a distinct period during which the government makes or fosters large investments and uses multiple tools to develop a particular industry—for example, subsidies, incentives, tax reductions, new regulations, institutional reforms, and investments in infrastructure. As Pack and Saggi (2006: 267) put it, "Industrial policy is a type of selective government intervention or policy that attempts to alter the structure of production in favor of sectors that are expected to offer better prospects for economic growth in a way that would not occur in the absence of such intervention in the market equilibrium." The idea of using industrial policy programs to push the development of an industry is attractive. Many governments in both developed and less developed countries have used and are using industrial policy programs with the hope of increasing the level of economic activity and technological development in their nations (Rosenstein-Rodan, 1943; Amsden, 1989, 2001; Murphy *et al.*, 1989; Stiglitz, 1996; Kim, 1998; Hausmann and Rodrik, 2003; Mahmood and Rufin, 2005; Lerner, 2009; Chu, 2011).

In this article, we explore how an industrial policy program can affect the creation and evolution of an industry and, ultimately, the long-term performance of firms. Despite the importance of industrial policy as a development tool, its effects on firm strategy and profitability have not received significant attention in the literature (for some exceptions, see Branstetter and Sakakibara, 1998; Porter *et al.*, 2000). A particular limitation of the existing literature is its focus on industry aggregates rather than leveraging and studying firm-level responses to industrial policy programs (Aw *et al.*, 2001; Barua *et al.*, 2012; Kolesnikova, 2010).

We aim to improve our understanding of how governments affect both the development of new industries and the strategic choices made by new and existing entrepreneurs (Johnson, 1984; Griffiths and Zammuto, 2005; Athreye *et al.*, 2009; Pearce *et al.*, 2009). Firm profitability depends on many different factors, including aspects related to the industry, firm, and business (McGahan and Porter, 1997, 2002; Adner and Helfat, 2003). In addition to these factors, we emphasize the importance of government-level issues that affect profitability. An industrial policy period is an important and eventful stage in the life of an industry—substantial changes occur in the environment surrounding new and existing firms (Thomas, 1994). Thus, industrial policy offers a unique setting that can provide multiple lessons to scholars studying the impact of the environment on organizations, entrepreneurship, and business performance (Child, 1972; Aldrich, 1979; Gartner, 1985; Donaldson, 2001).

The empirical analysis focuses on the history of the Brazilian bioethanol industry and the industrial policy program implemented in the 1970s to develop the industry. This program led to the creation of one of the largest alternative fuel industries in the world (Hausmann and Wagner, 2009). The bioethanol program in Brazil is an interesting setting because the onset and end of *Pro-alcohol* (this is the name given to the subsidy period) were due mainly to exogenous shocks—high and low oil prices, respectively. Our historical analysis of the bioethanol industry in Brazil and its industrial policy program is based on a novel data set containing detailed information about the history of bioethanol producers coupled with fieldwork.

2. Literature review and theoretical framework

Government policies can play a major role in the creation and development of an industry (Malerba and Orsenigo, 1996; Dosi *et al.*, 1997). More specifically, industrial policy programs can provide a way of generating the *big push* needed to expand markets and get out of no-industrialization traps (Rosenstein-Rodan, 1943; Murphy *et al.*, 1989). These traps exist for different reasons. For example, the presence of a small domestic market combined with costly foreign trade can explain why new technologies are not adopted (Murphy *et al.*, 1989). Theoretically, implementing an industrial policy program would be beneficial when, despite the nation's potential comparative advantage in an industry, some form of failure is preventing investors from investing in the industry at a socially optimal level (Brahm, 1995).

Inadequate infrastructure—for example, "hard" infrastructure such as roads or "soft" infrastructure such as education—can be the result of a coordination failure: the industry is not developing because good infrastructure does not exist, whereas the required infrastructure is not being developed because the industry does not exist. In other words, whereas the rate of return to coordinated investments is high, the rate of return to individual investments remains low. Under these circumstances, governments can induce the coordination of different agents by directly investing in infrastructure. This intervention can be very important to get out of a "bad equilibrium" (Rodrik, 1995, 1996). For example, it is difficult to imagine the development of world-class electronic industries in some East Asian countries if government policies designed to improve the educational infrastructure in math, science, and engineering were not previously established (Stiglitz, 1996).

Coordination failure can also prevent the emergence of crucial intermediaries that facilitate different types of market transactions (Khanna and Palepu, 2000, 2010). Intermediaries usually wait until a critical threshold of activity is surpassed before entering a market or industry. For example, financial analyst firms will not focus on an industry that is below a certain size. The shortage of information about the industry will discourage investors from investing in this market. Thus, the size of the industry will probably stay low and financial analysts' lack of interest in the market will continue. Other types of crucial intermediaries are venture capital firms, market research and advertising firms, insurance companies, and technical educational institutions. Naturally, the absence of intermediaries will further increase the hurdles that an industry must overcome to get out of a low-equilibrium trap. In this case, the government can also step in to support the development—and sometimes take the role—of these important agents. Getting out of these low-equilibrium traps is considered critical to the achievement of higher levels of economic development. The argument is that after an economy gets out of the trap, a momentum builds between growth and productivity that drives industrialization and technological development forward (Amsden, 1989; Mahmood and Rufin, 2005). Industrial policy might be arbitrary in its support of specific industries, but the bright side of "promiscuity" can be the activation of a broad-based growth momentum. In part, this explains the popularity and support that many politicians and business leaders give to industrial policy programs (Amsden, 2001).

A complementary perspective is proposed by Hausmann and Rodrik (2003). They argue that, in less developed countries, entrepreneurs are more reluctant to learn "what a country is good at producing." This phenomenon occurs because the first entrepreneur who makes the "discovery" can appropriate only a small part of the social value that is generated, especially in emerging markets where there is a lack of property rights and weak institutions are ubiquitous. If this is the case, Hausmann and Rodrik recommend governments to use industrial policy to stimulate the discovery process.

Industrial policy also has critics. Easterly (2006) states that less developed countries have "bad governments," inadequate institutions, and a lack of ability to generate good policies. According to him, governments in less developed countries will have a lot of difficulties implementing industrial policies successfully, no matter how appealing these might be. Hayek (1945) argues that governments lack the information needed to coordinate a large industrialization program. According to Krueger (1974), widespread government intervention amplifies returns to political rent seeking, intensifying poverty traps.

Industrial policy programs elicit strong reactions from academics, economists, and policy makers (Rodrik, 2004; Pack and Saggi, 2006). Those who believe in the efficiency of markets see industrial policy as an invitation to rent seeking behavior. Those who believe that the presence of market failures is pervasive argue that industrial policy is a necessary tool to develop new industries and increase the level of economic development.

2.1 Theoretical framework

Industrial policy programs can have a significant impact on the number of newly created firms and their characteristics (Sine *et al.*, 2005). During an industrial policy period, many new entrepreneurs enter the industry. Naturally, the ability of these entrepreneurs plays a crucial role in the foundation and early development of their ventures (Baron *et al.*, 1999; Shane and Venkataraman, 2000; Santarelli and Vivarelly, 2007). Additionally, the organizational environment at the time of founding can also have an important impact on the behavior of these new entrepreneurs and the success of their companies. Naturally, all these changes that occur during the industrial policy period can have long-lasting effects on the future performance of firms. To understand how industrial policy programs can affect the creation and subsequent evolution of an industry, we divide the theoretical discussion in two parts. First we focus on the industrial policy period and then on the post-industrial policy period.

2.1.1 Period of industrial policies

When studying industrial policy programs, it is important to consider the effects of entrepreneurial ability. The ability of an entrepreneur can have a significant impact on the performance of his or her firm (Gimeno *et al.*, 1997; Shane, 2000). We argue that subsidies and incentives associated with industrial policy programs facilitate the entrance of a high number of entrepreneurs with differing ability levels (Santarelli and Vivarelli, 2002). We use the term *industrial policy entrepreneur* to denote those entrepreneurs that enter the industry during the industrial policy period. In this study, our focus is on the ability to manage companies successfully in different types of business settings. For example, industrial policy entrepreneurs with a high ability would be able to adapt to their surroundings and make their businesses succeed.

Certainly, government subsidies and incentives attract a group of high-quality entrepreneurs that in the past have been reluctant to enter the industry. However, industrial policy programs also attract low-ability entrepreneurs who would not enter the industry under normal circumstances (Evans and Jovanovic, 1989). For example, empirical studies have shown that the introduction of public policies that ease the cost of external finance attracts individuals with a wide range of entrepreneurial ability, including less gifted entrepreneurs (Nanda, 2011). Naturally, the long-term effects that low-ability entrepreneurs have on the industry depend on the capacity of the industry to select them out at a later stage—for example, after the possible winding-down of the industrial policy program.

In addition to the attraction of a significant number of entrepreneurs with different levels of innate ability, an industrial policy period generates a protective environment in the industry that can also have long-term implications for the firms created during this time. Environmental conditions at founding can determine the future success or failure of an organization (Stinchcombe, 1965; Boeker, 1989; Carroll and Hannan, 1989; Marquis, 2003; Johnson, 2007; Geroski *et al.*, 2010). Based on their empirical analysis of 100 high-technology firms, Hannan *et al.* (1996) infer that initial conditions at founding have strong effects in shaping the evolution of firms. Zaring and Eriksson (2009)'s empirical study of Sweden's information technology industry reports that conditions at the time of founding imprint organizations with persistent characteristics that can affect their future probability of closure.

More formally, according to the "organizational imprinting hypothesis," organizations are imprinted for life by the technological, economic, political, and cultural context at the time of founding (Stinchcombe, 1965; Marquis and Tilcsik, 2013). The founder usually plays a crucial role during the imprinting process because he or she is the most important link between the environment and the young organization. The concept of organizational imprinting involves two processes: (i) the process through which the founding context shapes the organization during its foundation; and (ii) the reproduction process of the characteristics acquired at founding, or in other words, the persistence of these characteristics during the life of an organization (Johnson, 2007). Environmental conditions at founding can have an important effect on organizational growth and survival (Romanelli, 1989; Eisenhardt and Schoonhoven, 1990; Tucker *et al.*, 1990; Swaminathan, 1996; Dobrev and Gotsopoulos, 2010). As Kimberly (1979: 438) puts it, "just as for a child, the conditions under which an organization is born and the course of its development in infancy have important consequences for its later life."

The set of public policies implemented during an industrial policy program is an important part of the institutional and business ecosystem faced by firms in the target industry (Guillen, 1994, 2001; Haveman *et al.*, 2001; Russo, 2001). Thus, the environmental context associated with industrial policy can *imprint* the cohort of firms—and their entrepreneurs—created during the policy period (Boeker, 1988; Swaminathan, 1996). In other words, industrial policy can affect the future prospects of an industry through its imprinting effect. For example, lobbying and influencing the public sector decision-making process can be crucial in an environment where discretionary government decisions play a significant role in the allocation of large subsidies and incentives (Mahmood and Rufin, 2005; Holburn and Zelner, 2010). A firm founded in an environment like this one can become imprinted with a preference and ability to generate rents through political means (Henisz, 2000; Delios and Henisz, 2003; Garcia-Canal and Guillen, 2008). In short, firms founded during a period of industrial policies develop abilities, routines, and organizational structures that, after becoming imprinted, can have important implications for the future survival and success of the firm.

2.1.2 The aftermath of industrial policy

After an industrial policy program is terminated, a period of changes and restructuring occurs. The end of the program can lead to a significant shakeout in the industry (Klepper and Graddy, 1990; Mitchell and Mulherin, 1996; Klepper, 1997). During the post-industrial policy period, firms experience a large number of changes in strategy, ownership, and governance (Kim and Prescott, 2005). Many firms owned by low-ability entrepreneurs will not be achieving their true potential because they are poorly managed. In other words, these firms would be more valuable if owned by other entrepreneurs. Naturally, high-ability entrepreneurs are in a better position to provide good management and take advantage of synergies and economies of scale. Acquisitions can be an important mechanism of adjustment during the turbulent post-industrial policy period (Mitchell and Mulherin, 1996). We argue that, during the post-industrial policy period, high-ability entrepreneurs will acquire mismanaged firms that are in financial trouble, thereby selecting out some of the low-ability entrepreneurs.

Summarizing, we propose three main mechanisms:

(i) First, during the industrial policy period a high number of entrepreneurs of varying abilities are attracted into the industry.
(ii) Second, a protective environment imprints companies founded during the industrial policy period. This imprinting process can affect the future capability of these firms to compete.
(iii) Finally, the end of the industrial policy program leads to significant changes in the industry. For instance, we can observe a high number of acquisitions where the most successful entrepreneurs grow by acquiring troubled firms.

In the next sections, we empirically analyze the validity of our theoretical arguments using the case of the Brazilian bioethanol industry.

3. The Brazilian bioethanol industry and its industrial policy program

The Brazilian economy grew quickly during the late 1960s and early 1970s. The "Brazilian miracle" was fueled by investments in infrastructure, cheap oil prices, and foreign direct investment (Gordinho, 2010). This period of growth ended abruptly with the onset of the 1973 oil shock, which tripled the cost of oil imports. During that time, oil imports constituted about 80% of domestic oil consumption. In 1975, Brazil's military dictatorship—under the presidency of Ernesto Geisel—initiated an industrial policy program called *Pro-alcohol* in response to the oil crisis (Mathews, 2006; Gordinho, 2010). The objective of the program was to create an industry capable of supplying significant amounts of sugarcane-based ethanol to be used as transportation fuel,[1] with the final goal of making the country less susceptible to the economic downturns associated with international oil crises. Some sources also mention the creation of an additional market for Brazilian sugar producers as a secondary objective of the program (Walter and Cortez, 1999).

The role played by the government in the emergence of the Brazilian bioethanol industry was crucial (Moraes, 2000; Mathews, 2006). Many experts agree that this industry would not have been able to take off without the public policies implemented by the government from 1975 to 1985. What happened in other countries at that time shows how critical this program was. Nations like India and Thailand also have favorable geographical and natural conditions for sugarcane growth. As in

[1] In Brazil, bioethanol is produced using sugarcane. Other feedstocks can also be used to produce bioethanol. For example, in the United States corn is the main input used to manufacture this fuel. Currently, the cheapest way to produce bioethanol is using sugarcane.

Brazil, their sugar industries were quite developed and their economies were highly dependent on foreign oil in 1973. However, the governments of India and Thailand never implemented industrial policies to develop the industry. Intriguingly, bioethanol industries did not emerge in these countries.

Coordination failure is the most probable reason that explains why the Brazilian government had to intervene in order to induce the development of the bioethanol industry. Everything else seemed to be in place for the emergence of the industry: (i) Brazil has always been among the best places in the world for the cultivation of sugarcane because of its climatic and geographical conditions; (ii) the Brazilian sugar industry is among the most competitive in the world, and this was also the case at the time the government started the ethanol fuel program. Therefore, these plants could easily start producing bioethanol if the business prospects looked promising; and (iii) the automobile industry in Brazil has played a very important role in the economy for more than 40 years (Shapiro, 1994). The auto industry has enjoyed a level of development and sophistication that is rarely seen in less developed countries. Thus, a domestic auto industry that could potentially supply ethanol-compatible vehicles was in place before the start of Pro-alcohol.

Despite these ideal conditions, government intervention was needed to offset coordination failures. Potential bioethanol producers were not going to invest in ethanol production if vehicles capable of running on ethanol were not produced, automobile producers were not going to manufacture these vehicles if the fuel was not widely available at gas stations, and consumers were not going to buy ethanol vehicles if a reliable distribution network for this fuel was nonexistent. The development of a distribution network for ethanol required the coordination of multiple actors.[2]

The bioethanol program involved a mix of government policies. The program initiated mandatory blending of ethanol in gasoline, extensive ethanol distribution at service stations, and the introduction of vehicles running on pure ethanol (Gordinho, 2010). Also, the state offered low-interest loans and credit guarantees for the construction of distilleries and the development of new sugarcane plantations. These attractive loans persuaded incumbents—who were already in the sugarcane business before the start of Pro-alcohol—and new entrepreneurs to invest in industrial units to produce bioethanol. For example, Pro-alcohol attracted landowners and farmers without any experience in sugarcane planting (Gordinho, 2010). As a result, the construction of bioethanol facilities and new sugarcane plantations flourished. Some of the industrial facilities were attached to existing sugar factories; other units produced only bioethanol.[3]

The government signed agreements with the major automobile companies in the country to produce vehicles that could run on 100% ethanol—a fundamental

[2] A similar situation is currently taking place in the electric vehicle industry.

[3] Facilities that produce only bioethanol are typically called "autonomous distilleries."

partnership was forged with the automotive industry. There was a reduction in the Tax on Industrialized Products (IPI[4]) for ethanol cars. In 1978, the industry started doing research to develop ethanol cars. The lower tax made it possible to sell an ethanol vehicle for the same price as a gasoline-powered model. Additionally, the government established tax incentives for the purchase of cars fueled by ethanol, such as a lower rate of the Road Tax (TRU[5]). It also manipulated and subsidized bioethanol prices, making it cheaper than gasoline even after accounting for ethanol's lower energy content—on average, ethanol fuel has 30% less energy content than traditional gasoline. The price of ethanol was controlled through the creation of the "Alcohol Account," which operated as a compensation tax. Through this mechanism, the government guaranteed bioethanol producers a price that provided a reasonable profit. At the same time, ethanol was sold to final consumers at a more competitive price than that of gasoline. According to an executive of the Brazilian Sugarcane Industry Association (UNICA[6]):

> At the beginning of the program the government set the price (of ethanol) above production costs so that it was highly profitable, and also made the pump price highly competitive. So, the first decision of the government was that ethanol should cost approximately 50% of the price of gasoline. The government created all these conditions for the market to exist. They gave the producer a good price; they gave the consumer a very attractive price; and they gave the distributor a tax advantage. The government created this whole favorable environment and the program really took off. (Gordinho, 2010: 79)

The government also funded R&D programs to improve agricultural and industrial techniques used to produce sugarcane and ethanol. In addition, the government mandated that Petrobras—at that time Brazil's state-owned oil monopoly—distribute the alternative fuel. Finally, the government required gas stations in every town of at least 1500 habitants to install ethanol pumps. Interestingly, ethanol could be sold every day, whereas gasoline pumps were closed (by government order) on weekends.

These measures and incentives generated a lot of changes in the Brazilian sugarcane industry. Many established entrepreneurs in the traditional sugar industry invested in the construction of annexed distilleries and started selling bioethanol. Drastic changes in organizational structure and business strategy were implemented. The equipment, supporting systems, and procedures in these new "integrated plants"[7] had to satisfy the demands of customers coming from two different markets:

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[4] Imposto sobre Produtos Industrializados.

[5] Taxa Rodoviária Única

[6] UNICA is the largest organization in Brazil representing sugarcane producers.

[7] The term *integrated plant* is commonly used to refer to plants that have the infrastructure to produce both sugar and bioethanol. These plants have a sugar factory and an annexed distillery for the production of alcohol.

food and fuel. On the other hand, new entrepreneurs entered the emerging industry mainly through the construction of autonomous distilleries that were initially focused only on the production of bioethanol—some of these distilleries were transformed into integrated plants later on.

In 1986, the price of oil plummeted. This price reduction—in addition to a shortage of ethanol fuel—brought into question the use of ethanol as a substitute for gasoline and led the Brazilian government to start terminating the Pro-alcohol program. The industrial policy program was coming to an end. During the period following the end of Pro-alcohol, the government stopped offering soft loans for the construction of new bioethanol plants and support for the bioethanol program from state trading companies was eliminated (Weidenmier *et al.*, 2008). During the early 1990s, the *Instituto do Açúcar e do Álcool* —the main government agency in charge of regulating the sugarcane sector—was dismantled. The sugarcane sector underwent a period of significant restructuring.

During the 1990s, there was an active period of acquisitions in the industry (Mingo, 2013b). The sugarcane company Cosan[8] exemplifies what was occurring in the Brazilian sugarcane sector after Pro-alcohol ended. The company, with a sugarcane tradition dating back to the 1930s, started an aggressive acquisition program in 1986—until that year the company owned only one plant. Taking advantage of a fragmented and troubled industry, Cosan acquired six new plants during the period 1986–2000. The growth and success of the company has allowed it to become a global giant in ethanol and sugar production. During the aftermath of Pro-alcohol, the business environment in Brazil facilitated the occurrence of acquisitions in many sectors of the economy (KPMG, 2001). This "acquisition boom" was a consequence of the opening and liberalization of the Brazilian economy in the early 1990s. Figure 1 provides a timeline of the evolution of the Pro-alcohol program in Brazil.

Even though our focus is on Pro-alcohol and the creation of the bioethanol industry in Brazil, it is important to note that different forms of government intervention have continued to exist.[9] For instance, according to federal law, gasoline sold at the pump must be blended with anhydrous ethanol. During the past 10 years, the percentage of ethanol content in a liter of gasoline has fluctuated between 20% and 25%. The government adjusts this percentage depending on fuel prices and the supply of ethanol available in the market. Additionally, the government has incentivized the adoption of flex-fuel technology in motor vehicles since its introduction in

[8] The sugar and ethanol business of Cosan is now part of Raízen, a separate company that was created in 2010. Raízen—the most important ethanol producer in Brazil—is a joint venture between Shell and Cosan that focuses on ethanol and sugar production, cogeneration of electricity, and fuel distribution.

[9] We want to thank two anonymous reviewers for suggesting the discussion of Post-alcohol government intervention.

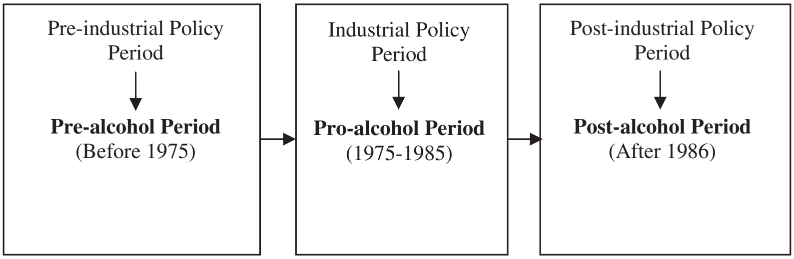

Figure 1 The Pro-alcohol program in Brazil. The stages of Pro-alcohol are based on historical accounts written by Brazilian scholars that are experts in the industry (Shikida and Bacha, 1999; Walter and Cortez, 1999; Moraes, 2000; Mathews, 2006).

2003—flex-fuel technology allows vehicles to run on any mixture of gasoline and ethanol. Taxes on flex-fuel vehicles are lower than taxes on gasoline-powered vehicles, especially the Tax on Industrialized Products. Some tax incentives for ethanol fuel use have also continued to exist in the industry. For example, ethanol was exempted from the CIDE[10] *Combustíveis* tax from May 2004 to June 2012.

4. Data and methods

To explore our theoretical arguments empirically, we put together a novel data set using a sample of bioethanol and sugar plants in the Brazilian Center-South Zone[11] (Figure 2). First, we collected information about the yearly production and operational performance of these plants during the period 1999–2005. Therefore, our operational performance data covers a period that occurred approximately 15 years after the end of Pro-alcohol. We define three different subgroups: plants founded before the Pro-alcohol period; plants founded during the Pro-alcohol period; and plants founded after the Pro-alcohol period. We define the Pro-alcohol period as the period between the years 1975 and 1985, which is when the major government policies and incentives intended to *create* and develop the bioethanol industry were in place (Shikida and Bacha, 1999; Walter and Cortez, 1999; Moraes, 2000; Mathews, 2006). All the data used to estimate the operational performance of the plants come from UNICA.

Second, we collected detailed historical information about the plants and the entrepreneurs that owned them. Our focus was on getting data about the origins and ownership history of each plant, including the current owners. In this case, by

[10] Contribuição de Intervenção do Domínio Econômico.

[11] More than 85% of the sugarcane produced in Brazil comes from the Center-South Zone. The states in the Center-South Zone are: Espírito Santo (ES), Goiás (GO), Minas Gerais (MG), Mato Grosso (MT), Mato Grosso do Sul (MS), Paraná (PR), Rio de Janeiro (RJ), Rio Grande do Sul (RS), Santa Catarina (SC), and São Paulo (SP).

Figure 2 Map of Brazil's Center-South Zone.

current owners we mean owners during the period 1999–2005—approximately 15 years after the end of Pro-alcohol. We identified the year when every plant founder entered the industry and whether the owner of a plant is an independent entrepreneur, family-owned business, or another type of organization—for example, a co-operative. Several sources were used to reconstruct the ownership history of these plants: industry associations, data coming directly from the firms, master and doctoral dissertations published in Brazil, historical accounts of the towns where some of the plants were located, and local and international news databases. As an example, Appendix A shows the case of Generalco, a plant founded during Pro-alcohol.

The data gathering process allowed us to build a sample of 193 plants. These plants represent more than 80% of all the plants located in the Center-South Zone at the end of 2006.[12] Last but not least, we complement these data through fieldwork that included interviews with experts in the history of the sugarcane industry and

[12] During the 2005–2006 harvest season, the total number of plants in the Brazilian Center-South Zone was approximately 240.

Pro-alcohol, and executives of some of the most important sugar–ethanol companies in Brazil.

4.1 Dependent variable

The main dependent variable (*Operational performance*) is the average of the yearly operational performance of a plant for the period 1999–2005. The specific measure we use as a proxy for plant performance is the total amount of kilograms of sucrose produced divided by the total number of tons of sugarcane crushed during a harvest season. The dependent variable behaves reasonably well, with a histogram that is close to a normal distribution. Figure 3 shows a simplified diagram of the production process in an integrated sugar–ethanol plant—note that each "plant" is comprised of the plantation and the processing facility. A higher capability to produce sucrose per ton of sugarcane is not only the result of a more efficient transformation of sugarcane into final products, but also the result of a higher level of sucrose content in the sugarcane farmed. Small variations in operational performance can have a considerable impact on the quantity of product that can be produced from a ton of sugarcane. Since the production of bioethanol and sugar is a low-margin commodity business, even small changes in operational performance can have a significant impact on the income statement of these companies.

4.2 Independent variables

The first independent variable (*Industrial policy plant)* is a dummy that is equal to one if the plant was founded during the industrial policy period and zero otherwise. The second independent variable (*Industrial policy entrepreneur*) is a dummy variable that is equal to one if a plant is currently owned by an entrepreneur who entered the industry during the Pro-alcohol period. As previously mentioned, we call these entrepreneurs industrial policy entrepreneurs. To define current ownership we consider the period after 1999. Note that plants currently owned by industrial policy entrepreneurs are not necessarily industrial policy plants—some of these entrepreneurs have acquired plants founded in other periods. Also, there are many industrial policy plants managed by entrepreneurs that did not enter the industry during the policy period (Table 1). Another independent variable (*Acquired plant*) is a dummy indicating if the plant was acquired at some point after the end of Pro-alcohol, that is, after 1985.

Additionally, to take a more detailed look at the Pro-alcohol period and take into account the fact that Pro-alcohol might have ended more gradually, we break the industrial policy period into different subperiods. Since the Pro-alcohol period lasted about a decade, it is important to analyze more closely the behavior of the models by using subperiods. These additional analyses try to isolate even more the effects of Pro-alcohol. In one of the estimations, we divide Pro-alcohol into two subperiods—we use the dummy variables *Industrial policy plant founded in 1975–1979* and

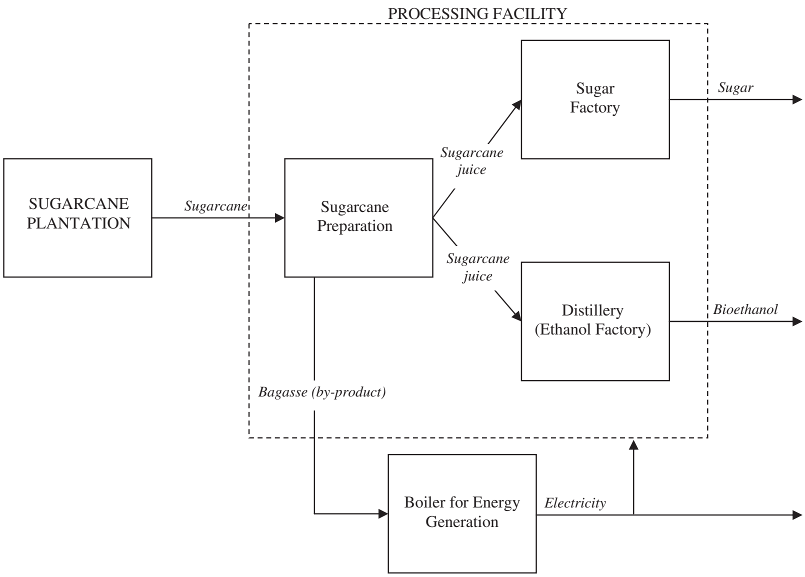

Figure 3 Production of sugar and bioethanol in an integrated plant. Both the plantation and the processing facility are considered part of what we call a plant.

Table 1 Number of plants per type of plant and entrepreneur[a]

	Industrial policy plant	Other plants
Industrial policy entrepreneur	34	6
Other entrepreneurs	51	102

[a]The total number of plants is 193.

Industrial policy plant founded in 1980–1985. In another case, we use three subperiods: 1975–1977, 1978–1981, and 1982–1985. Models with more than three subperiods did not yield stable results because there is not enough statistical power to run these analyses.

Every model also includes two interaction terms that are designed to explore how post-industrial policy acquisitions affect the performance of firms depending on their date of founding and the origins of the owner of the company. The first one is the interaction between the variables *Industrial policy plant* and *Acquired plant*. The second one is the interaction between the variables *Industrial policy entrepreneur* and *Acquired plant*—this last interaction term was included to tease out the impact of industrial policy entrepreneurs that made acquisitions during the aftermath of Pro-alcohol. Finally, we also include the indicator *Post-industrial policy* *plant*. This dummy variable is equal to one if a plant was founded after the industrial policy period.

4.3 Control variables

We control for different factors that could be leading to omitted variable bias or other spurious results. An important control is the average amount of sugarcane crushed (*Sugarcane processed*). Naturally, the amount of sugarcane that a plant processes is highly correlated with its production capacity and plantation size. We also include the quadratic term of this control variable to account for scale economies in the production process.

The average proportion of sugarcane used to produce sugar is another important determinant of the operational performance of a plant.[13] We control for this by including the variables *Proportion of sugar production* and its quadratic term *(Proportion of sugar production)*^{2}.

We also use a set of ownership indicators. The type of ownership of a plant can have an impact on the organizational structure and the quality of management, affecting operational performance. We include four ownership indicators: (i) *Founded and owned by a multi-plant company* indicator; (ii) *Family-owned* indicator; (iii) *Owned by a cooperative* (of farmers) indicator; and (iv) *Owned by foreign capital* indicator. It is important to note that only (ii), (iii), and (iv) are mutually exclusive.

Finally, state indicators—to control for geography—are also included. State indicators are important because operational performance is highly dependent on geographic location. Some states, such as São Paulo, are known for their excellent conditions to grow sugarcane.

To analyze our cross-section of 193 plants, we use ordinary least squares regressions with heteroskedasticity-robust standard errors. Problems of multicollinearity were not observed. Descriptive statistics are reported in Table 2.

5. Results and discussion

We start with a simple analysis of how the performance of a plant depends on the period when it was founded. The 193 plants in the sample were classified according to their year of founding: 85 plants were founded before the Pro-alcohol period (*Pre-alcohol* plants); 85 plants were founded during the Pro-alcohol period (*Pro-alcohol* plants); and 23 plants were founded after the Pro-alcohol period (*Post-alcohol* plants). Table 3 shows the average operational performance for each of these three categories. According to the *t*-tests for equality of means, the mean performance of

[13] Note that sugarcane can be transformed either into bioethanol or sugar. Therefore, if the proportion of sugarcane dedicated to sugar production is r, then the proportion of sugarcane dedicated to bioethanol production is $(1 - r)$.

Table 2 Descriptive statistics[a]

Variable	Mean	Standard deviation	Minimum	Maximum
Operational performance (kg of sucrose/ton of sugarcane)	142.86	12.66	91.59	174.34
Plant Foundation Year	1965.04	27.31	1877	2005
Pre-industrial policy plant	0.44	0.50	0	1
Industrial policy plant	0.44	0.50	0	1
Post-industrial policy plant	0.12	0.32	0	1
Acquired plant	0.23	0.42	0	1
Industrial policy entrepreneur	0.21	0.41	0	1
Ownership indicators:				
(i) Founded and owned by a multi-plant company	0.47	0.50	0	1
(ii) Family owned	0.85	0.35	0	1
(iii) Owned by a cooperative	0.08	0.27	0	1
(iv) Owned by foreign capital	0.02	0.12	0	1
(v) Owned by an independent entrepreneur	0.05	0.22	0	1
Sugarcane processed (10^4 ton)	141.22	114.04	4.21	666.77
Proportion of sugar production	0.42	0.28	0	1

[a]$n = 193$.

Table 3 Average performance by date of founding

Date of founding	*Operational performance*
Plant founded before Pro-alcohol (*Pre-alcohol* plants)	141.24
Plant founded during Pro-alcohol (*Pro-alcohol* plants)	144.01
Plant founded after Pro-alcohol (*Post-alcohol* plants)	144.60

Pro-alcohol plants is significantly higher than that of *Pre-alcohol* plants ($P < 0.10$). The difference between the mean performance of *Pro-alcohol* plants and *Post-alcohol* plants is not significantly different from zero ($P = 0.415$).

The correlation coefficients are reported in Table 4. There is a weakly positive correlation between *Operational performance* and *Industrial policy plant* (0.081; $P = 0.266$). Also, there is a weakly negative correlation between *Operational performance* and *Pre-industrial policy plant* (−0.114; $P = 0.116$). The correlation between

Table 4 Correlations[a]

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Operational performance	1.000												
2. Pre-industrial policy plant	−0.114	1.000											
	(0.116)												
3. Industrial policy plant	0.081	−0.787**	1.000										
	(0.266)	(0.000)											
4. Post-industrial policy plant	0.051	−0.326**	−0.326**	1.000									
	(0.484)	(0.000)	(0.000)										
5. Acquired plant	−0.059	−0.119†	0.153*	−0.052	1.000								
	(0.419)	(0.100)	(0.034)	(0.477)									
6. Industrial policy entrepreneur	−0.043	−0.402**	0.422**	−0.030	−0.070	1.000							
	(0.553)	(0.000)	(0.000)	(0.676)	(0.331)								
7. Founded and owned by a multi-plant company	0.216**	0.238**	−0.327**	0.137†	−0.515**	−0.299**	1.000						
	(0.003)	(0.001)	(0.000)	(0.057)	(0.000)	(0.000)							
8. Family owned	0.043	0.277**	−0.346**	0.106	0.123†	−0.552**	0.385**	1.000					
	(0.549)	(0.000)	(0.000)	(0.142)	(0.089)	(0.000)	(0.000)						
9. Owned by a cooperative	−0.145*	−0.219**	0.249**	−0.047	−0.160*	0.234**	−0.271**	−0.705**	1.000				
	(0.044)	(0.002)	(0.001)	(0.516)	(0.026)	(0.001)	(0.000)	(0.000)					
10. Owned by foreign capital	0.111	0.057	−0.027	−0.046	0.228**	0.246**	−0.118	−0.305**	−0.037	1.000			
	(0.124)	(0.429)	(0.708)	(0.523)	(0.001)	(0.001)	(0.104)	(0.000)	(0.615)				
11. Owned by an independent entrepreneur	0.045	−0.207**	0.264**	−0.086	−0.129†	0.457**	−0.219**	−0.568**	−0.068	−0.029	1.000		
	(0.538)	(0.004)	(0.000)	(0.235)	(0.074)	(0.000)	(0.002)	(0.000)	(0.348)	(0.685)			
12. Sugarcane processed	0.314**	0.261**	−0.155*	−0.162*	−0.189**	−0.072	0.412**	0.174*	−0.160*	0.004	−0.084	1.000	
	(0.000)	(0.000)	(0.031)	(0.025)	(0.008)	(0.318)	(0.000)	(0.016)	(0.026)	(0.955)	(0.245)		
13. Proportion of sugar production	−0.206**	0.379**	−0.288**	−0.140†	−0.006	−0.138†	0.194**	0.238**	−0.248**	0.069	−0.117	0.282**	1.000
	(0.004)	(0.000)	(0.000)	(0.053)	(0.931)	(0.056)	(0.007)	(0.001)	(0.001)	(0.343)	(0.106)	(0.000)	

[a] Significance levels in parentheses. †$P<0.10$; *$P<0.05$; **$P<0.01$.

Operational performance and *Acquired plant*, and *Operational performance* and *Industrial policy entrepreneur,* are not significantly different from zero. The correlation between *Industrial policy plant* and *Acquired plant* is positive and significant (0.153; $P = 0.034$), indicating that plants founded during the industrial policy period tend to be acquired at a higher rate than those that were not built during the policy program. As it would be expected, there is also a positive correlation between *Industrial policy plant* and *Industrial policy entrepreneur* (0.422; $P < 0.01$), indicating that existing entrepreneurs that entered the industry during Pro-alcohol tend to manage plants founded during that period.

Regarding ownership indicators, the dummy variable *Founded and owned by a multi-plant company* is positively correlated with performance (0.216; $P < 0.01$). On the other hand, the variable *Owned by a cooperative* is negatively correlated with performance (−0.145; $P = 0.044$). Also, as expected, we observe a positive correlation between *Operational performance* and the amount of sugarcane processed (0.314; $P < 0.01$). Therefore, we can infer that the operational performance of a plant is positively correlated with its size. This is consistent with the presence of scale economies. The correlation between *Operational performance* and the proportion of sugarcane used to produce sugar is significant and negative (−0.206; $P < 0.01$), finding that is also consistent with our previous discussion.

The results for the regressions analyzing the impact of industrial policy on operational performance are reported in Tables 5, 6, and 7. In Table 5, Model (1), the coefficient on *Industrial policy plant* is positive and significant, that is, the current performance of plants founded during Pro-alcohol is higher than the performance of those built before Pro-alcohol. On the other hand, the performance of plants founded *after* Pro-alcohol is not significantly higher than the performance of Pre-alcohol plants. Based on our fieldwork, a possible explanation for this result is that, in the long run, the industry ended up retaining the most promising plants and entrepreneurs from the Pro-alcohol period. Pro-alcohol probably generated a large pool to select from. Regarding the size of the impact, the prediction is that a Pro-alcohol plant produces 3.62 kg of sucrose per ton of sugarcane more than in the case of Pre-alcohol plants. This is roughly equivalent to a 4% increase in operational efficiency. In the Brazilian sugarcane sector, changes of this magnitude can have a significant impact on profits, especially during tight economic cycles characterized by low sugar and energy prices. As in many commodity businesses, operational efficiency is crucial.

Similar results are observed if we break up Pro-alcohol into subperiods (see Models (5) and (9) in Tables 6 and 7, respectively). Industrial policy plants founded during the periods 1975–1979 and 1980–1985 have an operational performance that is significantly higher than the performance of Pre-alcohol plants. Again, we find that Post-alcohol plants do not have a significantly higher performance than Pre-alcohol plants (Table 6). When we divide the industrial policy period into three subperiods (Table 7), we observe that the coefficients for each of the three subperiods are also

Table 5 Impact of industrial policy on performance

Model: Dependent variable	(1) *Operational performance*	(2) *Operational performance*	(3) *Operational performance*	(4) *Operational performance*
Regressors[a]				
Industrial policy plant	3.620*	4.739**	4.788**	0.430
	(1.500)	(1.540)	(1.617)	(1.664)
Post-industrial policy plant	2.202	3.114	3.413	2.281
	(2.945)	(3.047)	(2.927)	(2.661)
Industrial policy entrepreneur		−4.345*	−5.431*	
		(2.178)	(2.428)	
Acquired plant			0.436	−3.859
			(2.884)	(3.922)
(Industrial policy entrepreneur) (Acquired plant)*			6.673	
			(4.315)	
(Industrial policy plant) (Acquired plant)*				11.407**
				(4.102)
Founded and owned by a multi-plant company	2.735	2.442	2.781	3.581
	(1.735)	(1.723)	(2.205)	(2.196)
Family owned	1.109	−2.165	−3.627	−2.281
	(3.158)	(3.558)	(3.969)	(3.729)
Owned by a cooperative	0.726	−1.486	−1.779	−0.09
	(3.264)	(3.372)	(3.377)	(3.269)
Owned by foreign capital	11.635	12.317	5.043	9.571
	(8.588)	(8.295)	(9.272)	(7.148)
Sugarcane processed	0.082**	0.082**	0.082**	0.081**
	(0.022)	(0.021)	(0.022)	(0.022)
(Sugarcane processed)^2	−0.000**	−0.000**	−0.000**	−0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Proportion of sugar production	0.527	1.346	2.501	0.05
	(9.750)	(9.599)	(9.556)	(9.978)
(Proportion of sugar production)^2	−20.228	−20.595	−21.411†	−18.797
	(12.766)	(12.579)	(12.526)	(13.486)
Constant	118.443**	122.070**	123.219**	122.824**
	(5.065)	(5.770)	(5.937)	(4.796)
State indicators (geographical)?	Yes	Yes	Yes	Yes
R^2	0.51	0.52	0.53	0.55
Number of observations	193	193	193	193

[a]Below the value of each coefficient are the heteroskedasticity-robust standard errors, shown in parentheses. $^\dagger P<0.10$; $^*P<0.05$; $^{**}P<0.01$.

Table 6 Impact of industrial policy on performance

Model: Dependent variable	(5) *Operational performance*	(6) *Operational performance*	(7) *Operational performance*	(8) *Operational performance*
Regressors[a]				
Industrial policy plant founded in 1975–1979	3.958†	5.588*	6.264**	0.717
	(2.093)	(2.216)	(2.332)	(2.133)
Industrial policy plant founded in 1980–1985	3.452*	4.381**	4.208*	0.29
	(1.660)	(1.635)	(1.690)	(1.835)
Post-industrial policy plant	2.173	3.08	3.424	2.253
	(2.958)	(3.058)	(2.932)	(2.670)
Industrial policy entrepreneur		−4.509*	−5.918*	
		(2.247)	(2.538)	
Acquired plant			0.370	−3.820
			(2.883)	(3.937)
(Industrial policy entrepreneur) (Acquired plant)*			7.771†	
			(4.615)	
(Industrial policy plant) (Acquired plant)*				11.387**
				(4.108)
Founded and owned by a multi-plant company	2.758	2.487	2.835	3.617
	(1.744)	(1.724)	(2.186)	(2.205)
Family owned	1.008	−2.53	−4.427	−2.38
	(3.156)	(3.608)	(4.026)	(3.735)
Owned by a cooperative	0.67	−1.704	−2.222	−0.134
	(3.258)	(3.380)	(3.393)	(3.273)
Owned by foreign capital	11.417	11.821	3.154	9.355
	(8.454)	(8.023)	(8.995)	(7.117)
Sugarcane processed	0.082**	0.081**	0.082**	0.081**
	(0.022)	(0.022)	(0.022)	(0.022)
(Sugarcane processed)^2	−0.000**	−0.000**	−0.000**	−0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Proportion of sugar production	0.517	1.355	2.682	0.05
	(9.796)	(9.682)	(9.687)	(10.025)
(Proportion of sugar production)^2	−20.185	−20.506	−21.367†	−18.769
	(12.815)	(12.658)	(12.642)	(13.539)
Constant	118.472**	122.275**	123.738**	122.850**
	(5.015)	(5.636)	(5.698)	(4.763)
State indicators (geographical)?	Yes	Yes	Yes	Yes
R^2	0.51	0.53	0.53	0.55
Number of observations	193	193	193	193

[a]Below the value of each coefficient are the heteroskedasticity-robust standard errors, shown in parentheses. †$P<0.10$; *$P<0.05$; **$P<0.01$.

Table 7 Impact of industrial policy on performance

Model: Dependent variable	(9) *Operational performance*	(10) *Operational performance*	(11) *Operational performance*	(12) *Operational performance*
Regressors[a]				
Industrial policy plant founded in 1975–1977	4.440	5.960	6.656	0.289
	(4.459)	(4.518)	(4.606)	(4.668)
Industrial policy plant founded in 1978–1981	3.412*	4.661**	4.792**	0.556
	(1.585)	(1.638)	(1.703)	(1.696)
Industrial policy plant founded in 1982–1985	3.785†	4.486*	4.152*	0.101
	(2.035)	(2.021)	(2.036)	(2.183)
Post-industrial policy plant	2.173	3.090	3.410	2.284
	(2.962)	(3.060)	(2.934)	(2.670)
Industrial policy entrepreneur		−4.419*	−5.677*	
		(2.231)	(2.518)	
Acquired plant			0.479	−3.855
			(2.886)	(3.945)
(Industrial policy entrepreneur) (Acquired plant)*			7.245†	
			(4.365)	
(Industrial policy plant) (Acquired plant)*				11.470**
				(4.158)
Founded and owned by a multi-plant company	2.784	2.529	2.954	3.603
	(1.763)	(1.747)	(2.207)	(2.202)
Family owned	0.967	−2.374	−4.076	−2.263
	(3.184)	(3.607)	(4.052)	(3.737)
Owned by a cooperative	0.624	−1.617	−1.994	−0.046
	(3.337)	(3.422)	(3.446)	(3.325)
Owned by foreign capital	11.230	11.800	3.677	9.632
	(8.237)	(7.890)	(8.788)	(7.223)
Sugarcane processed	0.082**	0.082**	0.082**	0.081**
	(0.022)	(0.022)	(0.022)	(0.022)
(Sugarcane processed)^2	−0.000**	−0.000**	−0.000**	−0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Proportion of sugar production	0.547	1.293	2.479	−0.003
	(9.871)	(9.747)	(9.732)	(10.111)
(Proportion of sugar production)^2	−20.290	−20.470	−21.190†	−18.670
	(12.960)	(12.820)	(12.800)	(13.730)
Constant	118.200**	121.900**	123.200**	123.000**
	(5.275)	(5.841)	(5.906)	(5.014)
State indicators (geographical)?	Yes	Yes	Yes	Yes
R^2	0.52	0.53	0.53	0.55
Number of observations	193	193	193	193

[a]Below the value of each coefficient are the heteroskedasticity-robust standard errors, shown in parentheses. †$P<0.10$; *$P<0.05$; **$P<0.01$.

positive, though the coefficient for 1975–1977 is not significant. It is interesting to note that, despite its lack of significance, the coefficient for the subperiod 1975–1977 is larger than the coefficients for the other two industrial policy subperiods. Finally, the coefficient on *Post-industrial policy plant* continues to be not significant, that is, the performance of Post-alcohol plants is not significantly better than the performance of Pre-alcohol plants (Table 7).

In Models (2), (6), and (10), we include the variable *Industrial policy entrepreneur,* which indicates if the current owner of a plant is an entrepreneur who entered the industry for the first time during the period of policies. The coefficient on *Industrial policy entrepreneur* is always negative and significant. Plants managed by industrial policy entrepreneurs are, on average, less efficient than those plants that are managed by other types of entrepreneurs. Note that industrial units currently managed by industrial policy entrepreneurs are not necessarily Pro-alcohol plants—some industrial policy entrepreneurs have acquired and founded *non*-Pro-alcohol plants. Existing industrial policy entrepreneurs seem to be, on average, of a lower ability than other types of entrepreneurs. Interestingly, in Model (2), the variable *Industrial policy plant* is still significant but with higher coefficients than in the case of Model (1). Thus, the coefficient on *Industrial policy plant* in Model (1) appears to be picking up the negative effect of the variable *Industrial policy entrepreneur*. A similar result is observed in Models (6) and (10).

As already discussed, several new ethanol and sugar companies were created during Pro-alcohol. According to our records, a total of approximately 100 plants were built during this period, almost doubling the total number of units. This led to a substantial increase in the level of fragmentation in the industry. Local farmers and business owners residing in small towns established many of the Pro-alcohol units—the government encouraged the creation of the plants in some of these localities. Interestingly, and despite the wave of acquisitions and consolidation after the end of the program, the high level of fragmentation remained. Several underperforming local ethanol producers became entrenched in the industry given their importance in the economy of some of these small towns. For instance, during 2005—the last year in our data set—the four largest players in the sugarcane sector processed slightly more than 15% of the total sugarcane harvested during the year. Based on the statistical results in Model (2), and the nature of this persistent fragmentation, we conjecture that a considerable amount of low-ability industrial policy entrepreneurs were still part of the industry even after two decades since the end of the program.

In Models (3), (7), and (11), we include the variables *Acquired plant* and the interaction *(Industrial policy entrepreneur)*(Acquired plant)*. In these three regressions, the coefficients on *(Industrial policy entrepreneur)*(Acquired plant)* are greater than zero with values ranging from 6.7 to 7.8. In the case of Models (7) and (11), the coefficients are significantly greater than zero with $P < 0.10$. Plants that were acquired by industrial policy entrepreneurs after the end of the program tend to have a higher performance than those plants owned by this type of entrepreneur but that have never been acquired. Additionally, the coefficient on *Acquired plant* is not significantly different from zero and the coefficient on *Industrial policy entrepreneur* is still negative and significant. It is also interesting to note that in Model (11) the difference between the coefficient for 1975–1977 and the other two industrial policy subperiods gets even larger than in Models (9) and (10).

There are several interesting cases of successful sugar and ethanol producers that entered the industry during Pro-alcohol and later grew their companies through acquisitions. For example, Unialco was founded in 1980 with the support of Pro-alcohol in Guararapes, São Paulo. During the aftermath of Pro-alcohol, Unialco acquired Alcoolvale, an industrial policy plant located in the state of Mato Grosso do Sul. Another example is Sabarálcool. This company—also created with Pro-alcohol support—acquired Cooperbal in the early 1990s. Cooperbal was originally established in the 1980s by a cooperative of farmers in the municipality of Perobal, Paraná. Based on our fieldwork and statistical results, we conjecture that (i) existing industrial policy entrepreneurs are, on average, of a lower ability than entrepreneurs that did not enter during the period of policies, and (ii) within the group of existing industrial policy entrepreneurs there is a subgroup of a higher ability level that were the ones making acquisitions after the end of the policy program.

In Models (4), (8), and (12), we include the variable *Acquired plant* and the interaction *(Industrial policy plant)**(*Acquired plant*). In Model (4), the coefficients on *Industrial policy plant* and *Acquired plant* are not significantly different from zero. However, the coefficient on the interaction between both variables is positive and significant with a value of 11.41. Similar results are obtained for the models that use subperiod dummies for Pro-alcohol (Tables 6 and 7). Plants founded during the Pro-alcohol period that were acquired during the aftermath of industrial policy have a higher level of operational performance than Pro-alcohol plants that were never acquired. Many of the biggest sugar and ethanol producers operating in 2005 participated actively during the post-industrial policy acquisition wave. Typically, these were family businesses that started professionalizing their companies during the aftermath of Pro-alcohol. Some of these companies, such as Cosan, followed the strategy of growing through acquisitions instead of greenfield investments because they saw a greater opportunity to create value by buying undermanaged assets. Generally, these acquisitions were quite effective in terms of improving operational performance. Agricultural best practices were transferred to the new acquired unit relatively quickly, such as more effective use of fertilizers, improved monitoring of the crops, more efficient harvesting methods, and use of new sugarcane varieties and agricultural equipment. Based on these insights learned through fieldwork and Models (4), (8), and (12), we conjecture that successful entrepreneurs acquired Pro-alcohol plants that were owned by less skilled entrepreneurs. Through this process, a fair number of low-ability entrepreneurs should have been selected out. It is important to highlight that the coefficients on *Industrial policy plant* in Model (4) and the industrial policy subperiods in Models (8) and (12) get close to zero. This would be consistent with our argument that post-industrial policy acquisitions are a mechanism that could explain the superiority of industrial policy plants.

Certainly, other mechanisms might explain our results. For example, the long-term effects of industrial policy might be confounded with the imprinting effects of the technologies available at the time of founding of industrial policy plants. In other words, newer plants could be imprinted with better technologies. Even though we cannot completely rule out the possibility of a "positive" technological imprinting, it is reassuring that the operational performance of *Post-alcohol* plants in all of our regressions is not significantly higher than in the case of *Pro-alcohol* plants (Tables 5, 6, and 7). According to this result and those presented in Table 3, newness does not necessarily translate into better performance.

During our fieldwork, we also discussed directly with managers how technology at the time of founding could affect the future performance of plants. The main conclusion that emerged during these conversations was that investments in agricultural equipment and technologies do not have a significant imprinting or long-term effect on the overall operational performance of sugarcane units.[14] Two arguments stood out. First, operational performance is mostly affected by agricultural practices and technologies that determine the quality of the sugarcane grown and subsequently harvested—the impact of the industrial phase of production is not as crucial (Martines-Filho *et al.*, 2006). The fact that the agricultural phase represents 75–80% of the costs of production of ethanol shows the importance of this stage compared to the industrial phase. Sugarcane companies focus most of their R&D investments on agricultural improvements, such as the development or purchase of new sugarcane varieties.[15] Second, the development of new agricultural equipment and technologies in this industry are frequent, incremental, and dynamic. For example, companies and government agencies are frequently developing improved sugarcane varieties using biotechnology and genetic research (Mingo, 2013a). Also, companies regularly invest to upgrade their agricultural machinery, make land improvements, and install more technologically advanced harvesting systems.

As we discussed previously, government intervention has continued to be present in the industry. Even though current government intervention is of a different nature to that of the Pro-alcohol industrial policy program, this is another issue that could affect the interpretation of our results. Certainly, continued government intervention

[14] It is important to remember that, although the Pro-alcohol period goes from 1975 until 1985, we measure operational performance between 1999 and 2005. Therefore, the newest plant founded inside the Pro-alcohol period would be approximately 15 years old in 1999.

[15] The sustained capacity to improve sugarcane productivity is one of the most important factors underlying the success and growth of Brazil's sugar/ethanol industry. Sugarcane productivity has risen steadily at a 2.3% growth rate between 1975 and 2004. This growth rate is the result of new variety development, biological pest control, improved agricultural management, and greater soil selectively (Martines-Filho *et al.*, 2006).

has had an effect on the performance of surviving bioethanol producers. However, we have no reason to believe that Pro-alcohol plants have benefited more than other types of plants from this continued government intervention.

As a robustness check, instead of averaging the yearly operational performance of a plant over the period covered by the data (1999–2005) to perform our analyses, we used each yearly observation separately and add year dummies as control variables—the number of observations increases to 810. In all these additional analyses, results are very similar to the ones discussed above and the interpretation is the same. It is interesting to note that the year dummies are controlling for anything affecting all the plants in a similar way during a specific year. Therefore, these dummies help to control for the impact of continued government intervention that has had a similar effect on all units during a specific year.

6. Conclusion

Industrial policy programs are frequently used by governments to stimulate economic activity in particular sectors of the economy. This study focuses on how these policy programs affect the creation and evolution of an industry and the long-term performance of firms. Based on an historical analysis of the Brazilian bioethanol industry and a data set with detailed information about the history of bioethanol producers, we show that there are systematic differences in operational performance depending on the origins and ownership history of the sugar–ethanol units. The statistical analyses are complemented with fieldwork performed by the authors. The results show that industrial policy units that survived the aftermath of Pro-alcohol ended up being more productive than pre-industrial policy survivors.

This work represents a contribution to research on the interactions between management and public policy (Mahoney *et al.*, 2009). Our study analyzes two important aspects related to public policy—entrepreneurial ability and organizational imprinting—separately. Environments at the time of founding not only can affect a company directly, but also indirectly by attracting entrepreneurs of different characteristics and abilities. As far as we know, this is the first study that theoretically distinguishes between these two effects in an industrial policy setting. More specifically, the study highlights the importance of industrial policy entrepreneurs. This cohort of entrepreneurs, by creating multiple companies during a relatively short period of time, can introduce long-lasting changes to the structure of an industry and the characteristics of its companies. In other words, these entrepreneurs can have significant implications for the future evolution of the industry. Lastly, we contribute to the literature on acquisitions by discussing an atypical context—industrial policy—where they can play a crucial role in the evolution of an industry.

Many implications for both businessmen and policy makers emerge from this study. Managers and entrepreneurs should not underestimate the effects associated with industrial policy programs. Implementing the right strategy can allow their companies to take advantage of the opportunities generated by industrial policy programs and deal with the threats associated with them. For example, successful entrepreneurs should be aware that numerous opportunities to grow through acquisitions could be available during the post-industrial policy period. On the other hand, less successful entrepreneurs that entered during the period of subsidies should keep in mind that their companies could have trouble later on, thus a well thought-out exit strategy is crucial.

This work improves our understanding of how government policies can affect the development and evolution of industries and their firms. However, this study has several limitations that need to be addressed in future research. The external validity of our analyses is one concern. Although we are aware that our results might not be generalizable to all industries and countries, the bioethanol program in Brazil still offers a nice opportunity to assess the effect of these programs on firm performance. Also, by focusing on only one industrial policy program, we were able to go deeper in terms of describing and understanding the phenomena. Future studies should focus on other industries and country settings. One of the most important limitations of this work is our inability to test directly the mechanisms that are part of our theoretical arguments. We try to address this limitation by providing insights from our fieldwork and knowledge about the history of the industry and the Pro-alcohol program in particular. Finally, we acknowledge that, even though Pro-alcohol ended more than two decades ago, some forms of government intervention that have continued to exist in the industry could be affecting the accuracy of some of our analyses. Our results should be interpreted with caution.

This study has improved our understanding of how industrial policy programs can (i) ignite the development of new industries that can have significant economic and social impact, and (ii) affect the long-term performance of firms founded during the period of policies. Future research should explore how industrial policy programs can affect the long-term competitiveness of the industry as a whole.

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References

Adner, R. and C. E. Helfat (2003), 'Corporate effects and dynamic managerial capabilities,' *Strategic Management Journal*, **24**, 1011–1025.

Aldrich, H. E. (1979), *Organizations and Environments*. Prentice-Hall: Englewood Cliffs, NJ.

Amsden, A. H. (1989), *Asia's Next Giant: South Korea and Late Industrialization*. Oxford University Press: New York.

Amsden, A. H. (2001), *The Rise of "The Rest": Challenges to the West from Late-Industrializing Economies*. Oxford University Press: New York.

Athreye, S., D. Kale and S. V. Ramani (2009), 'Experimentation with strategy and the evolution of dynamic capability in the Indian pharmaceutical sector,' *Industrial and Corporate Change*, **18**(4), 729–759.

Aw, B. Y., X. Chen and M. J. Roberts (2001), 'Firm-level evidence on productivity differentials and turnover in Taiwanese manufacturing,' *Journal of Development Economics*, **66**, 51–86.

Baron, J. N., M. T. Hannan and M. D. Burton (1999), 'Building the iron cage: determinants of managerial intensity in the early years of organizations,' *American Sociological Review*, **64**, 527–547.

Barua, A., D. Chakraborty and C. G. Hariprasad (2012), 'Entry, competitiveness and exports: evidence from the Indian firm data,' *Journal of Industry, Competition and Trade*, **12**(3), 325–347.

Brahm, R. (1995), 'National targeting policies, high-technology industries, and excessive competition,' *Strategic Management Journal*, **16**, 71–91.

Branstetter, L. and M. Sakakibara (1998), 'Japanese research consortia: a microeconometric analysis of industrial policy,' *Journal of Industrial Economics*, **46**(2), 207–233.

Boeker, W. (1988), 'Entrepreneurial and environmental imprinting at time of founding,' in G. R. Carroll (ed.), *Ecological Models of Organizations*. Ballinger: Cambridge, MA, pp. 33–51.

Boeker, W. (1989), 'Strategic change: the effects of founding and history,' *Academy of Management Journal*, **32**, 489–515.

Carroll, G. R. and M. T. Hannan (1989), 'Density delay in the evolution of organizational populations: a model and five empirical tests,' *Administrative Science Quarterly*, **34**, 411–430.

Child, J. (1972), 'Organizational structure, environment and performance: the role of strategic choice,' *Sociology*, **6**(1), 1–22.

Chu, W.-W. (2011), 'How the Chinese government promoted a global automobile industry,' *Industrial and Corporate Change*, **20**(5), 1235–1276.

Delios, A. and W. J. Henisz (2003), 'Policy uncertainty and the sequence of entry by Japanese firms, 1980-1998,' *Journal of International Business Studies*, **34**, 227–241.

Dobrev, S. D. and A. Gotsopoulos (2010), 'Legitimacy vacuum, structural imprinting, and the first mover disadvantage,' *Academy of Management Journal*, **53**, 1153–1174.

Donaldson, L. (2001), *The Contingency Theory of Organizations*. Sage Publications: Thousand Oaks, CA.

Dosi, G., F. Malerba, O. Marsili and L. Orsenigo (1997), 'Industrial structures and dynamics: evidence, interpretations and puzzles,' *Industrial and Corporate Change*, **6**(1), 3–24.

Easterly, W. (2006), 'The big push déjà vu: a review of Jeffrey Sachs's *The End of Poverty: Economic Possibilities for Our Time*,' *Journal of Economic Literature*, **44**(1), 96–105.

Eisenhardt, K. M. and C. B. Schoonhoven (1990), 'Organizational growth: linking founding team, strategy, environment, and growth among U.S, semiconductor ventures, 1978-1988,' *Administrative Science Quarterly*, **35**, 504–529.

Evans, D. S. and B. Jovanovic (1989), 'An estimated model of entrepreneurial choice under liquidity constraints,' *Journal of Political Economy*, **97**, 808–827.

Garcia-Canal, E. and M. F. Guillen (2008), 'Risk and the strategy of foreign location choice in regulated industries,' *Strategic Management Journal*, **29**, 1097–1115.

Gartner, W. B. (1985), 'A conceptual framework for describing the phenomenon of new venture creation,' *Academy of Management Review*, **10**, 696–706.

Geroski, P. A., J. Mata and P. Portugal (2010), 'Founding conditions and the survival of new firms,' *Strategic Management Journal*, **31**, 510–529.

Gimeno, J., T. B. Folta, A. C. Cooper and C. Y. Woo (1997), 'Survival of the fittest? Entrepreneurial human capital and the persistence of underperforming firms,' *Administrative Science Quarterly*, **42**, 750–783.

Gordinho, M. C. (2010), *From Alcohol to Ethanol: A Winning Trajectory*. União da Indústria de Cana-de-Açúcar (UNICA): São Paulo.

Griffiths, A. and R. F. Sammuto (2005), 'Institutional governance systems and variation in national competitive advantage: an integrative framework,' *Academy of Management Review*, **30**, 823–842.

Guillen, M. F. (1994), *Models of Management: Work, Authority, and Organization in a Comparative Perspective*. University of Chicago Press: Chicago.

Guillen, M. F. (2001), *The Limits of Convergence: Globalization and Organizational Change in Argentina, South Korea, and Spain*. Princeton University Press: Princeton.

Hannan, M. T., M. D. Burton and J. N. Baron (1996), 'Inertia and change in the early years: employment relations in young, high technology firms,' *Industrial and Corporate Change*, **5**(2), 503–536.

Hayek, F. A. (1945), 'The use of knowledge in society,' *American Economic Review*, **35**, 519–530.

Hausmann, R. and D. Rodrik (2003), 'Economic development as self-discovery,' *Journal of Development Economics*, **72**, 603–633.

Hausmann, R. and R. Wagner (2009), 'Certification strategies, industrial development and a global market for biofuels,' *Belfer Center Discussion Paper 2009-15*. Cambridge, MA.

Haveman, H. A., M. V. Russo and A. D. Meyer (2001), 'Organizational environments in flux: the impact of regulatory punctuations on organizational domains, CEO succession, and performance,' *Organization Science*, **12**, 253–273.

Henisz, W. J. (2000), 'The institutional environment for economic growth,' *Economics and Politics*, **12**(1), 1–31.

Holburn, G. L. F. and B. A. Zelner (2010), 'Political capabilities, policy risk, and international investment strategy: evidence from the Global Electric Power Generation Industry,' *Strategic Management Journal*, **31**, 1290–1315.

Johnson, C. (1984), 'The industrial policy debate re-examined,' *California Management Review*, **27**(1), 71–89.

Johnson, V. (2007), 'What is organizational imprinting? Cultural entrepreneurship in the founding of the Paris opera,' *American Journal of Sociology*, **113**, 97–127.

Khanna, T. and K. Palepu (2000), 'The future of business groups in emerging markets: long-run evidence from Chile,' *Academy of Management Journal*, **43**, 268–285.

Khanna, T. and K. G. Palepu (2010), *Winning in Emerging Markets: A Roadmap for Strategy and Execution*. Harvard Business Press: Boston.

Kim, B. and J. E. Prescott (2005), 'Deregulatory forms, variations in the speed of governance adaptation, and firm performance,' *Academy of Management Review*, **30**, 414–425.

Kim, S. R. (1998), 'The Korean system of innovation and the semiconductor industry: a governance perspective,' *Industrial and Corporate Change*, **7**(2), 275–309.

Kimberly, J. (1979), 'Issues in the creation of organizations: initiation, innovation and institutionalization,' *Academy of Management Journal*, **22**, 437–457.

Klepper, S. (1997), 'Industry life cycles,' *Industrial and Corporate Change*, **6**(1), 145–182.

Klepper, S. and E. Graddy (1990), 'The evolution of new industries and the determinants of market structure,' *RAND Journal of Economics*, **21**(1), 27–44.

Kolesnikova, I. (2010), 'State aid for industrial enterprises in Belarus: remedy or poison?' *Munich Personal RePEc Archive (MPRA)*. Paper No. 22403.

KPMG (2001), *Mergers & Acquisitions in Brazil: An Analysis of the 90's*. KPMG Corporate Finance: São Paulo.

Krueger, A. O. (1974), 'The political economy of the rent-seeking society,' *American Economic Review*, **64**(3), 291–303.

Lerner, J. (2009), *Boulevard of Broken Dreams: Why Public Efforts to Boost Entrepreneurship and Venture Capital Have Failed—and What to Do about It*. Princeton University Press: Princeton.

Mahmood, I. P. and C. Rufin (2005), 'Government's dilemma: the role of government in imitation and innovation,' *Academy of Management Review*, **30**, 338–360.

Mahoney, J. T., A. M. McGahan and C. N. Pitelis (2009), 'The interdependence of private and public interests,' *Organization Science*, **20**, 1034–1052.

Malerba, F. and L. Orsenigo (1996), 'The dynamics and evolution of industries,' *Industrial and Corporate Change*, **5**(1), 51–87.

Marquis, C. (2003), 'The pressure of the past: network imprinting in intercorporate communities,' *Administrative Science Quarterly*, **48**, 655–689.

Marquis, C. and A. Tilcsik (2013), 'Imprinting: toward a multilevel theory,' *Academy of Management Annals*, **7**, 193–243.

Martines-Filho, J., H. L. Burnquist and C. E. F. Vian (2006), 'Bioenergy and the rise of sugarcane-based ethanol in Brazil,' *Choices*, **21**(2), 91–96.

Mathews, J. (2006), *A Biofuels Manifesto: Why Biofuels Industry Creation should be 'Priority Number One' for the World Bank and for Developing Countries*. Unpublished manuscript, Macquarie Graduate School of Management, Sydney.

McGahan, A. M. and M. E. Porter (1997), 'How much does industry matter, really?' *Strategic Management Journal*, **18**, 15–30.

McGahan, A. M. and M. E. Porter (2002), 'What do we know about variance in accounting profitability?' *Management Science*, **48**, 834–851.

Mingo, S. (2013a), 'Entrepreneurial ventures, institutional voids, and business group affiliation: the case of two Brazilian start-ups, 2002–2009,' *Academia Revista Latinoamericana de Administración*, **26**(1), 61–76.

Mingo, S. (2013b), 'The impact of acquisitions on the performance of existing organizational units in the acquiring firm: the case of an agribusiness company,' *Management Science*, DOI: 10.1287/mnsc.2013.1727.

Mitchell, M. L. and J. H. Mulherin (1996), 'The impact of industry shocks on takeover and restructuring activity,' *Journal of Financial Economics*, **41**, 193–229.

Moraes, M. A. F. D. (2000), *A Desregulamentação do Setor Sucroalcooleiro do Brasil*. Caminho Editorial: Americana, Brazil.

Murphy, K. M., A. Shleifer and R. W. Vishny (1989), 'Industrialization and the big push,' *Journal of Political Economy*, **97**, 1003–1026.

Nanda, R. (2011), 'Entrepreneurship and the discipline of external finance,' *Working Paper no. 11-098*. Harvard Business School: Boston.

Pack, H. and K. Saggi (2006), 'Is there a case for industrial policy? A critical survey,' *World Bank Research Observer*, **21**(2), 267–297.

Pearce, J. L., R. Dibble and K. Klein (2009), 'The effects of governments on management and organization,' *Academy of Management Annals*, **3**, 503–541.

Porter, M. E., H. Takeuchi and M. Sakakibara (2000), *Can Japan Compete?* Basic Books: Cambridge, MA.

Ring, P. S., G. A. Bigley, T. D'Aunno and T. Khanna (2005), 'Introduction to special topic forum: perspectives on *how* governments matter,' *Academy of Management Review*, **30**, 308–320.

Rodrik, D. (1995), 'Getting interventions right: How South Korea and Taiwan grew rich,' *Economic Policy*, **10**(20), 53–107.

Rodrik, D. (1996), 'Coordination failures and government policy: a model with applications to East Asia and Eastern Europe,' *Journal of International Economics*, **40**, 1–22.

Rodrik, D. (2004), 'Industrial policy for the twenty-first century,' *Paper prepared for the United Nations Industrial Development Organization (UNIDO).*

Romanelli, E. (1989), 'Environments and strategies of organization start-up: effects on early survival,' *Administrative Science Quarterly*, **34**, 369–387.

Rosenstein-Rodan, P. N. (1943), 'Problems of industrialization of Eastern and South-Eastern Europe,' *Economic Journal*, **53**(210/211), 202–211.

Russo, M. V. (2001), 'Institutions, exchange relations, and the emergence of new fields: regulatory policies and independent power production in America, 1978-1992,' *Administrative Science Quarterly*, **46**, 57–86.

Santarelli, E. and M. Vivarelli (2002), 'Is subsidizing entry an optimal policy?' *Industrial and Corporate Change*, **11**(1), 39–52.

Santarelli, E. and M. Vivarelli (2007), 'Entrepreneurship and the process of firms' entry, survival and growth,' *Industrial and Corporate Change*, **16**, 455–488.

Shane, S. (2000), 'Prior knowledge and the discovery of entrepreneurial opportunities,' *Organization Science*, **11**, 448–469.

Shane, S. and S. Venkataraman (2000), 'The promise of entrepreneurship as a field of research,' *Academy of Management Review*, **25**, 217–226.

Shapiro, H. (1994), *Engines of Growth: The State and Transnational Auto Companies in Brazil*. Cambridge University Press: New York.

Shikida, P. F. A. and C. J. C. Bacha (1999), 'Evolução da Agroindústria Canavieira Brasileira de 1975 a 1995,' *Revista Brasileira de Economia*, **53**(1), 69–89.

Sine, W. D., H. A. Haveman and P. S. Tolbert (2005), 'Risky business? Entrepreneurship in the new independent-power sector,' *Administrative Science Quarterly*, **50**, 200–232.

Spencer, J. W., T. P. Murtha and S. A. Lenway (2005), 'How governments matter to new industry creation,' *Academy of Management Review*, **30**, 321–337.

Stiglitz, J. E. (1996), 'Some lessons from the East Asian miracle,' *World Bank Research Observer*, **11**(2), 151–177.

Stinchcombe, A. (1965), 'Social structure and organizations,' in J. G. March (ed.), *Handbook of Organizations*. Rand McNally: Chicago, pp. 142–193.

Swaminathan, A. (1996), 'Environmental conditions at founding and organizational mortality: a trial-by-fire model,' *Academy of Management Journal*, **39**, 1350–1377.

Thomas, L. G. (1994), 'Implicit industrial policy: the triumph of Britain and the failure of France in Global Pharmaceuticals,' *Industrial and Corporate Change*, **3**(2), 451–489.

Tucker, D. J., J. V. Singh and A. G. Meinhard (1990), 'Founding characteristics, imprinting and organizational change,' in J. V. Singh (ed.), *Organizational Evolution: New Directions*. Sage: Newbury Park, CA, pp. 182–200.

Walter, A. and L. Cortez (1999), 'An historical overview of the Brazilian bioethanol program,' *Renewable Energy for Development*, **11**(1), 2–4.

Weidenmier, M. D., J. H. Davis and R. Aliaga-Diaz (2008), 'Is sugar sweeter at the pump? The macroeconomic impact of Brazil's alternative energy program,' *Working Paper*, *National Bureau of Economic Research*, Cambridge, MA.

Zaring, O. and C. M. Eriksson (2009), 'The dynamics of rapid industrial growth: evidence from Sweden's information technology industry, 1990–2004,' *Industrial and Corporate Change*, **18**(3), 507–528.

Appendix A

Example of information collected for each of the plants: the case of *Generalco* [information until 2006]

Year of founding

1980 (Pro-alcohol plant)

Location

General Salgado, São Paulo

Ownership history

Local farmers and entrepreneurs founded the unit in 1980. Grupo Aralco acquired the plant in 1999. The plant had financial problems at the time of the acquisition. Grupo Aralco, founded in 1978, was a pioneer in the production of ethanol fuel in the northeastern part of the state of São Paulo. In 2006, Aralco also controlled the following plants: Aralco and Alcoazul.

Facilities

The distillery was built during the Pro-alcohol period to produce ethanol. Sugar production started around 2005. The plant experienced significant organizational changes after its acquisition in 1999. In 2006, the plant was also involved in electricity cogeneration.