Cleansing Under the Quota:

The Defense and Survival of Sugar Mills in 1930s Cuba

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This paper examines the effects of the shock of the Great Depression, and the compositional effects of heterogeneous plant survival, on the industrial structure in the Cuban sugar industry. Testing for the "cleansing effect" of the Depression on technical vintages, we observe less plant closure than warranted by the demand reduction. The reason: Cuban authorities adopted a sugar quota system in 1931 that served to protect inefficient mills. The paper uses discrete survival analysis of mill-level data to test predictions of the patterns of mill closures and analyzes their implications for the compositional change often associated with recession, Schumpeter's "creative destruction." Our findings support the general literature on firm survival but provides new insights into the role of institutions in the cleansing process. It also gives new insights into issues of Cuban political economy during the Revolution of 1933 and afterward.

When Joseph Schumpeter developed his argument for "creative destruction," it was motivated, in part, as a warning against some of the policies implemented in the New Deal. Such remedies, he thought, suppressed a painful but necessary function of economic crises to force liquidation of bad investments and enterprises. He insisted that preventing their liquidation would make matters worse. In his words, it would "add to an undigested remnant of maladjustment new maladjustment of its own which has to be liquidated in turn, thus threatening business with another crisis ahead" (1934, p. 20).

Schumpeter thought the measures being adopted to obstruct the cleansing process would adversely affect the recovery and undermine the processes of innovation and long-run growth. He was greatly concerned about the political and institutional dimensions. "What we face," he complained about the remedies of the early New Deal, "is not merely the working of capitalism, but of a capitalism which *nations are determined not to allow to function*" [italics his] (1934, p. 16).

Some recent studies have rekindled interest in the "cleansing effect" of recessions that Schumpeter considered so important to the dynamics of the capitalist system (Davis and Haltiwanger 1992, Caballero and Hammour 1994; De Long 1990). Bresnahan and Raff (1991) and Bertin, Bresnahan and Raff (1996), which show how cleansing worked during the Great Depression by producing compositional changes favoring the survival of more efficient plants in the motor vehicles and blast furnace industries. Now a growing body of empirical work uses census-based and industry-specific longitudinal data to study appearances and disappearances in firm and establishment-level data.[1] This work highlights the existence of "churning" (high levels of simultaneous entry and exit), which indicates how the cleansing process may take place continuously and at two margins, rather than strictly during recessions. But in the flurry of interest, little has yet been done to illuminate what happens when political demands press to prevent the cleansing mechanism from functioning.

This paper sheds light on this question by looking at the adoption of sugar controls in Cuba during the Great Depression. A striking observation motivates our

[1] Notable contributions include: Audretsch 1991, 1995, Audretsch and Mahmood 1995, Chen 2002, Deily 1991, Dunne and Hughes 1994, Krannenberg, Palm and Pfann 2002, Mata and Portugal 1994, Salvanes and Tveteras 2004, and Thompson 2005.

interest is this question. As the demand shock from the Great Depression began to be felt in the sugar industry, the demand for Cuban sugar exports collapsed. By the end of the decade of the thirties, demand for Cuban sugar had recovered to only half what it had been in the middle and late 1920s. One would expect the severity of the crisis to have produced a major shakeout of firms or production units (sugar mills) in Cuba. Data presented in this paper on the number of mill closures, compiled by the authors, shows the opposite pattern. Many more exits occurred before the crisis than after. From 1919 to 1929, 55 mills exited the industry, out of 198 active mills in 1919. Yet from 1930 to 1939, only 10 mills exited, and all of them took place between 1930 and 1933. No mills exited after 1933 even though Cuban sugar exports hit their low point in 1933. What explains this unexpected pattern of closures? And what were its consequences?

As an explanation, the obvious candidate is an institutional one. The sugar crop restrictions, export quotas, and marketing controls that the Cuban government implemented in 1931, and the additional control measures enacted from 1934 to 1937, were adopted to prevent the shakeout. As the possibility of a shakeout was foreseen, political pressure from multiple interest groups, including both sugar mill owners and labor, mobilized to demand measures that would prevent the pain of shakeout.

The analysis here focuses on the consequences of the political intervention that prevented the shakeout of firms and sugar mills in the face of the crisis in Cuba. Did it "make matters worse" and heap maladjustment upon maladjustment, as Schumpeter warned? Did it have the desired political consequences? Or did it "threaten" the sugar industry "with another crisis ahead"? (Schumpeter 1934, p. 20) The paper analyzes of the decision-making margins of firms to generate predictions about the survival and closure of mills (establishments), with and without the imposition of production controls. The empirical strategy involves a baseline observation of mill closure behavior during a previous period, when no production controls were imposed, which is compared with mill closure patterns after the controls were imposed. Discrete survival analysis, using a logit model, is the statistical procedure employ to estimate decision-making behavior under market conditions and controls. Interpretation of the estimates and subsequent discussion show that the controls caused crippled the competitiveness of the Cuban sugar industry by preserving and even increasing the average inefficiency of mills.

Why were such levels of inefficiency tolerated? An analysis of the explosive political situation in Cuba will have to await further research. One central issue, on which this paper touches, is the question of imperialism and the role of foreign-owned sugar companies in Cuba. A prominent view in the historical literature maintains that North American companies exercised monopoly power that gave them survival advantages over Cuban mills. Contemporaries feared that a shakeout would be born exclusively by Cuban-owned companies. Our analysis accounts for ownership characteristics, including nationality, the large multiple-mill organizations (affiliated often with North American corporations), and vertical integration. We find that, after controlling for mill characteristics, North American firms did not survive more frequently. However, consistent with contemporary expectations, most of the shakeout would have been born by Cuban-owned companies. A counterfactual estimate suggests that the share of North American ownership of milling capacity in Cuba would have gone from 70 percent in 1929 to over 85 percent in 1939, if controls of some kind had not been imposed.

Background

The onset of the Great Depression in the United States has been characterized as "a defining moment" in the development of American economy – a watershed for popular perceptions and ideological constructs about the role of government in the economic affairs of nations (Bordo, et al. 1998). As with many countries, it was a defining moment also for Cuba. The initial production restrictions adopted in 1931 were sponsored and governed primarily by sugar mill owners, both foreign and national, as price stabilization. The measures included restriction of the aggregate sugar crop, a repartition of rights to produce in the form of quotas at two levels – sugar production quotas to mills and sugarcane production quotas to cane growers, and the distribution of certificates authorizing the export of sugar, distinguishing between the United States and other destinations, in proportion to the sugar production quotas allotted.[2]

[2] Our primary source of information on the operation of production restrictions is from the records of the principal regulatory agency after 1936, Cuban Sugar Stablization Institute (*Instituto Cubano de Estabilización del Azúcar*), Cuban National Archives, Havana, Fondo ICEA. Other sources include the

The shock to the sugar industry in Cuba was monumental. Earnings from sugar exports fell by more the 70 percent.[3] The overall effect on the Cuban economy was massive. Already plagued the major problems of seasonal unemployment, the crisis threw masses of people into unemployment for most of the year. Even in the peak sugar grinding season, unemployment probably exceeded 30 percent (Foreign Policy Association 1935). The impact was so great because economic activity in Cuba was so heavily concentrated in sugar production. A small open economy that imported much of its food from the United States, it obtained more than 75 percent of its export earnings from sugar exports. The heavy specialization in sugar for export was consistent with Cuba's outstanding comparative advantage in sugar production. A survey of the U.S. Tariff Commission shows that in 1929 Cuban unit costs were __ percent below those in the U.S. beet sugar industry and __ percent those in the Louisiana cane sugar industry (U.S. Tariff Commission 1934). But the limited diversification of the economy increased the exposure of the national economy to the fluctuations in the demand for its principal export product. In addition, heavy reliance on exports of sugar to the United States, which had to do with the structure of trade protection for sugar globally, increased Cuba's exposure to both the greater severity of the depression and the increased protection extended to the domestic sugar industry in the United States in 1930 and 1934.[4]

The shock had serious consequences for the political stability of the country, too. The crisis wreaked havoc upon the lives of sugar workers and the communities that lived on sugar-industry income.[5] At critical moments, idleness, frustration, and sheer hunger

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Cuban Economic Research Project (1963), and the records from the Braga Brothers Collection, University of Florida at Gainesville.

[3] Taken from Dye (2005), which estimates the effects of the depression in sugar exports on the Cuban economy.

[4] The effect of protectionism had serious consequences for Cuba, adding to the shock of the Depression significantly. Work in progress by Dye (2005) decomposes the income-induced and tariff-induced components of the demand shock and finds that the latter accounts for at least one-third of the overall demand shock on sugar imports from Cuba. For work on the effect of protectionism in the United States on Cuban sugar, see Dye and Sicotte (2004, 2005, 2006) and Dye (2005a).

[5] Pérez (1999) gives a penetrating image and analysis of the pervasiveness with which sugar mills dominated communities and the lives of the people who lived in them in the communities outside the major cities. Meanwhile, sugar financing and commerce dominated the economic activities being conducted in the major cities, it was commonly said that *sin azúcar, no hay país* ("without sugar, there would be no country").

motivated widespread rural violence, insurgency, and seizure of sugar mills (Carr 1996). The dictatorial government of Gerardo Machado was too weakened by the crisis to respond effectively, and it was overthrown in 1933.

At the onset of the crisis, in 1929, 70 percent of the grinding capacity in Cuba was owned by North American companies. Table 1 shows the distribution. Anti-imperialist political opposition had been brewing against the penetration of North American capital since the mid-1920s, but the severity of the crisis ignited a bitter populist reaction against the power mill owners. The revolutionary government that emerged in 1933 conceded to the demands of mobilized nationalist interest groups, notably small mill owners, sugarcane growers and sugar workers. Fulgencio Batista emerged as Commander-in-Chief of the Cuban army and *de facto* head of the Cuban government, in part, by pursuing a populist agenda of nationalist reforms that especially targeted a reform of the sugar-control regulations to provide additional protections to smaller sugar mills, independent sugarcane growers, and labor (Gellman 1973; Whitney 2000; Zanetti 1996, 2004).[6]

Patterns of Exit

The approach taken in this paper follows the work by Bresnahan and Raff (1991) and Bertin, Bresnahan and Raff (1996) on the U.S. motor vehicles industry also during the Great Depression. They find that the efficiency gains in manufacturing establishments observed as the industry adjusted to the shock were caused by a compositional effect that came about in a shakeout that led to the closure of inefficient plants and the "survival of the fittest" technology and organizational forms. We ask: How did the Cuban sugar industry compare? Our hypothesis is that Cuba would have experienced a similar composition change, except that controls prohibited it.

A number of similarities between the two cases indicate the appropriateness of the sugar industry for the study. The existence of cost heterogeneity is, obviously, central to the proposition of the compositional effect. The U.S. Tariff Commission conducted a

[6] Measures introduced to protect other stakeholders included preferential quotas for small sugar mill owners; concessions in cane quota regulations, rights of permanency, and minimum shares for independent cane growers; and wage controls and various restrictions on the number of hours worked for workers in the cane fields and sugar mills (Zanetti 2004, pp. 147-90)

survey of 77 Cuban sugar mills in 1931 and 1932, which estimates average costs per lb. at, respectively, 1.62 cents and 1.31 cents per lb., with a standard deviation of 0.3 each year.[7] Cost heterogeneity is sometimes associated with imperfect competition. The raw sugar industry, however, more closely approximated competitive conditions, with a homogeneous product and thousands of active suppliers in the global export market.[8] (The sugar refining industry was known to be imperfect, but refiners were buyers of raw sugar.[9]) We show below that mills with heterogeneous costs coexisted under competition conditions because capital-embodiment of technology created vintage effects. This is consistent with the theory of cleansing effects; for example, Caballero and Hammour (1994) assume vintage capital to drive their model. They find that increasing adjustment costs were necessary to associate cleansing with recessions. Increasing adjustment costs have been shown to be an influential factor in investment in new mills in Cuba (Dye 1998).

Turning now to the event of the crisis, Cuban sugar exports fell by 1933 to a low of 46 percent of the 1929 level, measured in tons, and it recovered only to 54 percent by 1939. Since most of the sugar crop was exported (only 5-6 percent was consumed domestically), production and exports are almost identical. The magnitudes can be observed in Figure 1. The shock to the demand for exports of Cuban sugar called for an equally permanent adjustment in long-run production in Cuba of, say, 40 to 50 percent.

How was the long-run downward adjustment in production levels accomplished? An initial glimpse is offered in Table 2, which shows the patterns of entry and exit of sugar mills from 1919 to 1939. Two observations stand out. First, the numbers of both entries and exits of mills is higher before the crisis than after. The number of entries tapers to zero by 1926, when the price of sugar began to fall steadily, except for one entry in 1927. Similarly, the number of exits also fell to zero by 1934, and after that no mills exit the industry. The decline in the number of entries is as one might expect, but the decline in the number of exits in the depth of the crisis seems counterintuitive. It is not

[7] Author's elaboration of the individual data of the U.S. Tariff Commission, collected from the U.S. National Archives, Records of the United States Tariff Commission, R.G. 81, A1/Entry 54 Box 240.
[8] Cuba exported only ½ to 2/3 of its exports of sugar to the United States.
[9] On imperfect competition in the U.S. refining industry, see Eichner (1969), and Genesove and Mullin (2001) Refiners owned a few raw sugar operations in Cuba, but they were not as dominant as many believe. See Table 1.

explained by a rapid reduction in production capacity sufficient to offset the reduction in demand. Export demand fell by 54 percent from 1929 to 1933, whereas rated milling capacity fell only by 17 percent.[10]

Second, there was a large number of transitory closures whereby mills were closed but maintained and reopened at a later date. In the table, we define "exits" and temporary "closures" as separate categories. "Exits" counts the number of "permanent" mill closures each year, counting only the first year it closed (See notes in Table 2 for definitions). "Temporary closures" counts the number of mills that closed in each year that reopened by 1946.[11] "Entries" counts the number of new mills that appeared in each year, and "reopenings" counts the number of existing, but temporarily closed, mills that reopened each year. Bresnahan and Raff (1991) report a similar pattern of transitory closure in the motor vehicles industry, which they refer to as "mothballing." They were unsure of whether their observation of "mothballing" was real or an artifact of their data. We know from independent evidence that the practice of transitory closure of Cuban sugar mills was common and not an artifact of the data.[12] In fact, temporary closure was one among several important margins of adjustment that mill managers could consider when deciding how to respond to the crisis in the sugar market. The number of temporary closures increased after the crisis hit, even as the number of exits declined.

Margins of Adjustment

Different margins were available to producers for adjusting output in response to the crisis. Alchian's (1959) cost framework offers simple framework for distinguishing the available margins. It identifies between three dimensions over which adjustments to output could be made: the "volume" of output (say, annual), "rate" (or speed) of production (say, output per day or per hour), and the "duration" or length of time devoted

[10] Export data are from Cuba Económica y Financiera, *Anuario azucarero*, 1940; and mill capacity data are compiled from annual issues of Cuba, Secretaría de Agricultura, Comercio y Trabajo, *Memoria de la zafra*, 1919-1929, continued by *Memoria azucarera*, 1930-1939.
[11] All but three reopened by 1939.
[12] Evidence is in reports in the trade press, including *The Louisiana Planter and Sugar Manufacturer*, *Facts About Sugar*, and in the archives of the Cuban Sugar Stabilization Institute, Cuban National Archives, Havana, Fondo ICEA.

to production. Only two of the three can be decided independently because the annual production is the product of the average rate of processing and the duration. That is, $y = r \cdot z$, where y is the annual volume produced, r is the average rate of processing, and z is the length of the production period.

In the usual application of this model, for example, in manufacturing differentiated products, z is associated with the production "run" or "batch," and the cost associated costs are setup costs.[13] In the case of cane sugar processing, z is the length of the grinding season. In cane sugar production, the amount of sucrose in cane standing in the fields is seasonal and dependent on weather conditions. To maximize how much sucrose is recovered during processing, sugar manufacturers time their harvest and grinding to coincide with the dry season—the period of maximum sucrose content. In Cuba, that period (if unbarred by production restrictions) typically lasted about six months, from December to June.

Milling operations in cane sugar production in Cuba were fairly capital-intensive. The technological revolution, known as the second industrial revolution, that swept processing industries in the latter half of the nineteenth century had led to the almost complete abandonment of traditional plantation technologies for continuous-processing technologies, as in many other food processing, distilling and refining industries of the day. The technological revolution was still underway in the 1920s. Modern sugar-processing technologies had diffused in some form prior to World War I. However, continual improvements meant a steady introduction of new, more efficient equipment available for purchase and installment. The records of the Cuban Secretary of Agriculture, Commerce and Labor show a conventional pattern of diffusion of best-practice technology throughout the beginning of the twentieth century into 1920s. The cost surveys of the U.S. Tariff Commission show a consistent and predictable pattern of cost heterogeneity among mills. Besides capital-intensive milling equipment, for reasons that are clarified below, mills also built internal railroads and incurred other significant fixed investments in the cane fields, fire lanes, bridges and other infrastructure to haul cane to the mills (Dye 1998).

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[13] See Bertin, Bresnahan and Raff (1996).

Available cost data does not strictly identify the fixed costs, but estimates using cost surveys from the U.S. Tariff Commission, and other sources, place the unit fixed costs for the average sugar mill at no less than 40 percent of unit costs of production.[14] The share of fixed costs in best-practice mills would have been considerably higher, probably at least 50 percent.

Variable costs, for sugarcane, labor and fuel, created incentives to maximize the rate of production, given the technical constraints on the grinding equipment and other fixed facilities. Cane was produced internally, using field labor, or contracted out on a share basis.[15] As for labor, field workers were paid piece rates, but mill workers were paid a daily wage. Two-thirds or more of the employees at the mill were seasonally employed, so that a large share of the wage bill for the season was proportional to the number days grinding. As for fuel expenses, there were startup costs to firing up boilers and running the steam engines that powered the continuous-processing machinery, with no significant advantages to slowing the rate of production to save fuel. Mills were run 24 hours per day during the grinding season (with weekly shutdowns for cleaning and occasional unplanned interruptions), and optimal processing rates were determined primarily by technical considerations.

These cost conditions are reasonably approximated by a production model with constant average variable costs per day with respect to varying the rate of production, r, such that marginal costs are constant; significant fixed costs in the short run; and a fixed limit to the daily rate of production, determined by daily grinding capacity, k.

Costs of production per day, denoted by $C(r, z)$, as long as $r \leq k$, are depicted with reasonable accuracy as: $C(r,z) = vr + F/z$, where v, the average variable cost per day, does not vary with the rate of production, r, or the length of the grinding season, z, as long as $r \leq k$ (but if $r > k$, $v \to \infty$). F reflects the annual fixed cost of financing and maintaining the mill's fixed plant and equipment; and F/z is the imputed user cost per day of operating the mill's fixed plant and equipment.

Costs per unit of output are (see also Figure 2):

[14] U.S. Tariff Commission (1926).
[15] Independent growers contracted for a share of the sugar produced from the cane supplied.

$$c(r,z) = \frac{C(r)}{r} = v + \frac{F}{rz} \qquad (1)$$

With these costs, mill managers minimize costs by spreading the fixed costs over more units of production. Under competitive conditions with price-taking, managers would set the rate of production, r, at its maximum, k , and maximize the length of the grinding season, z , subject to constraints.

In the pre-controls period of the 1920s, two constraints were of significance. First, as noted, seasonal effects on sucrose content in the cane acted as a constraint because they made optimal rates of sucrose extraction possible for only about six months of the year. Second, the amount of cane available to the mill at times could be a binding constraint. Weather conditions, fire hazards, and other contingencies made the size of the crop unpredictable. Mills typically contracted for the cane that they expected to grind, plus a margin to buffer against contingencies, but shortfalls sometimes did occur.

After controls were imposed, the authorities distributed production quotas limiting the annual production at each mill. The institutions of enforcement of these quotas were effective, so, during the control period, production quotas were binding constraints on z.[16]

A key insight for interpreting Table 2 comes from asking how the crisis might have affected the choices of individual mill managers. The optimal rate of production and length of grinding season for the individual mill were independent of the number of mills the market could support. The demand shock should not have altered the choices of r and z for mills that survived. The model predicts that production adjustments in response to the crisis would have occurred through mill closures, not through internal adjustments of r or z.[17]

But that is not what happened. Table 2 shows that mill closures fell or became temporary as the crisis deepened and adjustments were made almost exclusively by shortening the length of the grinding season.[18] In 1933, the worst year of the crisis, only one mill exited; and none exited in the following years. Fifty mills closed temporarily

[16] The evidence of effective enforcement is contained in work in progress by the authors, which is outside the scope of this paper.
[17] This is consistent with Bresnahan and Raff (1991).
[18] The "internal" adjustments were, of course, externally decided and enforced by the authorities.

after 1929, but 54 reopened between 1929 and 1939, not inclusive. Figure 1 gives the remaining production capacity against production and exports. It shows that the notably weak downward adjustment in aggregate milling capacity in the early 1930s was offset by the steady reentry of mills from 1930 to 1935.

Table 3 shows average daily rates of production, r , and average duration, z , per active mill. Two measures of duration are given, shown in the first and second columns of Table 3. The first is the number of days from the start to the finish of each mill's grinding season. (Commencement and termination dates are reported in the official records for all years in our study). Second, from 1930, mills reported their effective hours of grinding, accounting for interruptions. Hours are converted to days in Table 3 assuming a 24-hour day. Observing either measure, after 1931, when controls were put into place in 1931-1939, the length of the grinding season was 40-45 percent shorter than the average for the uncontrolled years, 1919-1925 and 1929-1930.[19] Figure 4 shows how days grinding were correlated with fluctuations and, after 1931, constrained by sugar production.

Daily rates of production, r, per official day and per effective day are shown in the fourth and fifth columns. Average production per official day grew steadily during the 1920s. This was caused by steady adoption of new technology in the 1920s (explained further in the next section). At the onset of the crisis, investment in equipment virtually ceased with the crisis, yet the daily rate of production, r , did not fall. It remained steady throughout the period. The third column gives the ratio of effective to official days of grinding. Its steadiness gives further evidence that standard practices affecting rates of production were not altered.[20]

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[19] Controls were also imposed in 1926, 1927 and 1928. The legislation for it was passed in May of 1926, after most of the mills had completed their 1926 grinding campaigns, so for practical purposes, we do not consider 1926 to have been an effective control year. Controls were more significant in 1927 and 1928, but less stringent than in the post-Depression years. Also, mill owners considered them as a temporary stopgap measure for dealing with the immediate accumulation of physical stocks, such as those highlighted in Kindleberger (1973). For the purposes of the paper, we do not treat these two years as part of the "control period," but we also do not include them when making comparative inferences about the uncontrolled years.

[20] The difference between the effective and official days of grinding are explained primarily by weekly shutdowns, delays in expected deliveries of cane, and occasional cane fires. See Dye (1998a,b) for analyses of the delays and their consequences.

The number of days of grinding is level during the 1920s, consistent with the model's prediction that the duration of the grinding season was typically determined by seasonal conditions.[21] The average grinding season in the uncontrolled years, 1920-1926, ranged between 112 and 145 days. Average duration in 1929 and 1930 almost reaches the 1920-1926 range. The reason is probably explained by cane shortages in some mills caused by disease and reduced cane acreage following the crop restrictions of 1927 and 1928.[22]

The Pre-Controls Decision to Exit

What determined the decision to close the mill either temporarily or retire it for good? Dye (1998a, pp. 121-42) shows that the patterns of investment in new milling capacity were consistent with Salter's (1966) model of vintage capital. Salter's model offers a prediction for how mill closure decisions were determined. If technology was embedded in the fixed capital equipment, each piece of equipment could be identified by its "vintage," which reflects the state of the art at the time the equipment was built. Mills with heterogeneous technologies and costs operate contemporaneously sunk costs on fixed equipment drove a wedge between the opportunity costs of operating existing equipment compared with investing in new equipment (for more complete explanation, see footnote 23). Therefore, the fixed costs of investing in capital-embodied technology, which enter in the decision to invest in new equipment, do not enter in the decision to continue using existing equipment. The decision to continue to using an existing vintage is determined, instead, by the condition: $v_{t-k} \geq p$, where v_{t-k} is the per unit variable cost in year t for a mill with equipment of age k, and p is the price of sugar.[23]

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[21] A crop reduction of 10 percent was imposed in 1927, and another 10 percent was imposed in 1928, but the first phase of crop restriction was abandoned for the 1929 and 1930 crops. Tighter crop restrictions were imposed beginning in 1931. Cuban Economic Research Project (1963).

[22] A disease known as mosaic was ravaging the varieties of cane commonly grown in Cuba at that time. Some mills were importing mosaic-resistant varieties from Java, but the commodity crisis in the sugar industry, fully under way by that time, slowed the rate of investment in importing and renovating the cane stock. Braga Brothers Collection, Series 10c. Some mills apparently faced shortages of cane. In any case, in 1927, 1928 and from 1931 to 1939, we distinctly observe the effect of government-controlled crop restrictions on the number of days grinding.

[23] In any year, t, the vintages in use will display a range of per unit variable costs of production, v_{t-i} ; and the costs advantages they give are sorted by their vintages, such that $v_t < v_{t-1} < \ldots < v_{t-k}$, where t

If the price should fall, this margin contracts. The sugar price fell decisively over the span of the 1920s. As Figure 3 shows, it saw wide fluctuations in the early 1920s and then fell fairly steadily from 1925 to 1933 and began to reach historically minimal levels by 1930. As the price fell, the model predicts that older vintages, v_{t-k}, would close before newer ones, v_{t-j} ($j<k$). Using similar reasoning, the model also accounts for temporary closures when prices were expected to fluctuate, as they did in the early 1920s. As prices dipped, mills with older, or possibly intermediate vintages, just inside the closure margin, might close temporarily and await an improvement in prices. The expected future price, therefore, affected whether the decision to close was permanent or temporary.

Our empirical strategy involves comparing observed behavior of closures in the uncontrolled 1920s with the period of controls from 1931 to 1939. The vintage-capital model helps us understand the patterns of investment in new mills and the "churning" (simultaneous entry and exit) in the 1920s—without the interference of controls. We know there was active development of new technology in sugar manufacturing in the 1920s, and the leading producers in Cuba were among the most aggressive in the world at adopting these new technologies (Maxwell 1927; Prinsen Geerligs, et al., 1929; Deerr 1955; Dye 1998).[24] Evidence shows that new technology was associated with larger scales of production. As mills were built or remodeled, they almost invariably adopted larger scales of the steadily increasing optimal grinding capacities of best-practice milling technology. Dye (1998, pp. 129-37) shows that grinding capacities and rates of mill expansion correlated with performance measures in the mills, such as the extraction rates of cane juice and yields (sugar to cane) ratios. Cost data are not as abundant, but surveys of the U.S. Tariff Commission of the Cuban sugar industry in 1922 and 1933 show considerable cost heterogeneity in Cuba (U.S. Tariff Commission 1926, 1934). The survey data reported by the Tariff Commission do not include mill capacity and

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identifies the latest vintage, and *t-k* identifies a vintage that is *k* years old. If costs of fixed equipment are sunk in the short run, a range of technical vintages may be in use at the same time (Salter 1966). A more complete explanation of its application to the Cuban sugar industry is in Dye (1998, pp. 121-42).

[24] A report from the renowned sugar technician, Noël Deerr, was commissed by the Cuban Government, which also outlines the natural and technical advantages of the Cuban sugar industry, relative to the rest of the world. A copy of the report that resulted: "Memorandum: Conditions of the Sugar Industry in Cuba," Havana, 1915. A copy of the memorandum is in U.S. National Archives, R,G. 81, Records of the U.S. Tariff Commission, A1/Entry58 – Correspondence, Reports, and Other Records Relating to Investigations and General Operations – 5.0 Sugar Production, 1940-1941 to 5.0, A-B, 1931-1946, Box 204.

performance data, so we matched their survey with the data on mill characteristics and production records that mill managers reported annually to Cuban authorities. When controlling for other factors, this data shows a strong inverse relationship between grinding capacities and sugar manufacturing costs per unit.

Under these conditions of steady improvement of best-practice technology and its correlation with grinding capacities, the Salter model predicts the churning we observe in Table 2 as a gradual upward shift in the equilibrium size distribution of the grinding capacities of mills, as new mills entered with larger grinding capacities and the older, smaller mills exited (Salter 1966). Figure 5 shows this pattern. It displays the distribution of four size classes grinding capacities from 1919 to 1939. The figure shows a steady decline in mills that had rated milling capacities of less than 140,000 bags (of 325 lbs.) per year, and an increase in the number of mills that had grinding capacities of 140,000 bags or more. The figure also shows distinctly how the pattern was altered after production controls were adopted. Smaller mills, reflecting older vintages, not only continued to survive; many reopened. After 1935, there was a significant reentry of the smallest, technically marginal mills (those having capacities less than 70,000 bags).

The shifting distribution of scales explains the pattern we observed in Table 3—of a steadily increasing average daily production per mill in the 1920s, which levels off in the 1930s. The pattern is consistent with our prediction that individual managers chose to maximize the rate of production, r , independent of market conditions or changes in the number of mills the market could support.

The Decision to Exit Under Controls

The rules that governed the Cuban crop restriction were designed to reduce aggregate sugar production levels and, yet, to prevent the exit of sugar mills. The laws that created the crop restriction authorized the President to decree the aggregate size of the sugar crop each year and determined the date that grinding would begin each year. The restricted crop was, then, apportioned between mills, and the assignment of production quotas was determined by the executive according to rules established in the legislation, administered by a corporate agency, made up of representatives of the sugar

industry and endowed with official capacity from the state. From 1931 to 1935, this agency was CENDA (the Corporación Exportadora Nacional de Azúcar), or the National Sugar Export Corporation.[25] Any contingencies not provided for in the legislation were addressed in more detailed rules and guidelines established by this agency.[26]

Mills' quota assignments were determined pro rata (with some exceptions) based on two factors—their existing grinding capacity and their available standing cane, including both internal and contracted cane, with restrictions on how much internally grown cane could be used.[27] The main exception was a preferential minimum quota that favored the smallest mills (those that produced 60,000 bags or less annually). The reason, on the surface, was to protect national mills. Most of the mills that were at risk of having to close down permanently in a shakeout were owned by Cuban or Spanish nationals. Fewer foreign-owned mills were at risk. The politics, which will be discussed further below, was actually more complex. The Cuban government had reasons to discourage the closure of both national and foreign mills.

Other critical institutional features involved how it was decided who, or what mills, had the right to be assigned a quota, and under what conditions quotas were transferable. Under CENDA rules, mills that had ground in the previous two crops would be assigned a quota. A mill that had not ground in the last two crops could receive a quota by showing that its mill was operable and that it had sufficient cane available, either internal or contracted, to meet its quota. Both assessments were formally at the

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[25] CENDA was founded originally in 1929 as a "single seller" or central marketing organization through which all sugar producers had to sell their sugar. After 1935, CENDA was abolished, and its responsibilities were transferred to the Cuban Sugar Stabilization Institute, known as ICEA (the Instituto Cubano de Estabilización del Azúcar). The agency reform resulted in a transfer of authority from an organization, CENDA, that was made up of representatives of the North American banking and foreign-owned sugar companies as well as Cuban or Spanish sugar interests, but most of whom might be considered "transnationals" in a dependency framework, to an organization, ICEA, that was made up of representatives of interest groups recognized as strictly national – Cuban mill owners and colonos. Zanetti (2004).

[26] These more detailed regulations were updated occasionally, when new contingencies or controversies emerged, and were published regularly as "Reglas de la Corporación Exportadora Nacional del Azúcar sobre entrega de cuotas de aportación a la misma y producción y exportación de azúcar." Copies are found in the paper of Manuel Rionda, Braga Brothers Collection, University of Florida—Gainesville, Series 10C, Box 108, f. "CENDA"; and Box 109 "curtailment sugar laws".

[27] Cane growers initially were "attached" to the mills with which they had contracted historically. Later, regulations were relaxed that allowed them to renegotiate contracts with other mills, always subject, of course, to the natural restriction that cane could not be effectively shipped long distances.

discretion of CENDA's agents and officers, but decisions could be, and sometimes were, overridden by "higher ups" in the government. CENDA rules in 1931 established that quotas were transferable, but only on the condition that the transferee must fulfill the contractual obligations of the transferor toward the growers. Quota transfers, however, met political opposition for several reasons, and the conditions in which grinding quota transfers were permitted became more restricted in subsequent years. Clearly, there were some uncertainties over how rules or their enforcement might change. There was also uncertainty and politically induced changes in what it took to maintain the right to be assigned a quota (to be discussed below).

If rights to receive a quota had been more clearly defined and transfers of grinding quotas between mills had been liberally permitted, cost heterogeneities and potential economies of scale would have given efficient mills the incentive to acquire quota rights from less efficient mills; and the shakeout would have occurred despite controls, although with some compensation to the owners or creditors of exiting mills.

But institutional features had the effect, instead, of blocking closures of mills that would otherwise have taken place. As Table 2 shows, of the 65 mills that closed permanently between 1919 and 1939, only nine closed after 1931, when controls were implemented, and none closed from 1934 on, after the revolutionary government of 1933 and its successors came into power. Forty-four mills closed temporarily during the 1930s period of controls, but most had reopened by 1938.

The Empirical Model

To gain a better understanding of the observed closure patterns, we develop an econometric model to identify the factors that affected decisions to close permanently or temporarily in a multivariate framework. *A priori* we expect mill closures in the 1920s, before the crisis, to be determined by market conditions and the effects of vintage capital and continuous technical change on the distribution of technology, reflected also in grinding capacities. The imposition of controls, particularly after 1930, when they were not seen as temporary stopgap measures seems, from casual observations, to have interfered with the vintage-driven "churning" of entries and exits that we observe in the

1920s. To compare the two policy regimes, we first estimate a baseline model that tests only for the factors predicted by the vintage-capital market on mill closures using only observations from pre-controls period, 1919 to 1929. Then, we expand the data to include the post-crisis period through 1939, and incorporate variables that test for the institutional interferences on mill closure patterns.

The data were compiled by the authors and are presented for the first time in this paper. They include the population of active mills, collected from the annual *Memorias* of the Cuban Secretaría de Agricultura, Comercio y Trabajo.[28] They consist of over 5000 observations, forming a panel of 239 mills, consisting of all mills that were active in any year between 1919 and 1939.[29]

The empirical model is a random-effects logit model estimated for three different dependent variables. *All closures* assigns a "1" to the first year a mill was inactive (in a period of inactivity); "0" otherwise, it combines, and does not distinguish between, temporary and permanent closures. *Permanent closures* similarly identifies the first year of inactivity of a permanently closed mill, where "permanent" is operationalized as any mill that did not reopen by 1946.[30] In both variables, observations beyond the year of a *permanent closure* are treated as missing values. A third dependent variable, *temporarily inactive*, is an indicator variable that includes only the set of all "continuing" mills (active plus temporarily inactive) and assigns a "1" to each year that a mill was temporarily inactive; "0" otherwise.

This treatment of dependent variables in a limited-dependent variable model follows a conventional discrete-time method of survival analysis (Box-Steffensmeier and Jones 2004; Yamaguchi 1991). An alternative approach would be to use continuous-time survival analysis, as in the familiar Cox hazard model (Cox and Oakes 1984, Van den Berg 2001). The method presented is preferred because it is more suited to handling time-varying explanatory variables, it offers greater flexibility in the definition of dependent

[28] Cuba, Secretaría de Agricultura, Comercio y Trabajo, *Memoria de la zafra* (1919-1929), continued by *Memoria azucarera* (1930-1939).
[29] Supplemental data on sugar prices come from Willett and Gray, *Weekly Statistical Sugar Trade Journal*. Data on ownership are from the authors' extensive investigations to identify majority ownership and transfers of ownership. See Table 1 for sources.
[30] As in Table 1, "permanent" is defined as not reopening by 1946, pending further data collection.

variables, and it corresponds more naturally with our conceptual model of the mill closure decision. In preliminary work, not reported here, we estimated a comparable model of *exits* using the Cox model, with similar results; but the assumptions of the Cox model are not well-suited to handle temporary exits or inactivity.

Following the empirical literature on firm and establishment survival, we consider the influence of four broad classes of explanatory variables – mill-specific variables, firm-specific variables, industry or market-level variables, and geographical differences.[31]

As for mill-specific variable, we incorporate two variables to capture the effects of technical vintage, which one of the factors in which we are most interested. The first one, *age*, is the number of years since the founding date of the mill to year *t* for mills founded after 1902. For mills founded before 1902, to avoid construction of meaningless outliers, ages are calculated as if the founding date was 1902.[32] Many mills were founded in the middle and late nineteenth century; a few surviving mills were even founded in the eighteenth century. Mills with those origins were inevitably completely remodeled as modern technologies were developed. The dates of remodeling are difficult to identify, except that most of the milling capacity on the island was damaged during the devastating war for independence from Spain (1895-98). Infusions of capital to rebuild and renovate older mills accelerated after the institution of the Platt Amendment in 1902 signaled investors of the United States' intention to intervene, if needed, to preserve the peace and defend property rights.[33] The explanatory power of the variable is weak, however, since only 75 mills were built after 1902.

The second technical variable is *expansion history*. This variable captures mill owners' access to resources needed to modernize, including credit and specialized knowledge. Some mill owners, and especially large corporate owners, had advantages in obtaining credit and human capital from international financial and labor markets. Others,

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[31] See note 1.

[32] Data for *age* are compiled from Santamaría (2001); Farr & Co., *A Manual of Sugar Companies* (1919-1939, especially 1936); Jiménez (2000).

[33] The main institutional innovation was the Platt Amendment of 1902 (a treaty between the United States and Cuba, and an amendment to the Cuban constitution), which established the United States as a overseer of Cuban democracy and gave it the right to intervene militarily to protect individual property and the fiscal responsibility of the government. See Buell, Jenks, Márquez Sterling, Pérez.

because of differential managerial ability or inability to signal, had limited access. These differences were revealed in the history of investment of the mills and, because of the correlation between vintage and grinding capacity, the history of mill expansion (Dye 1998, McAvoy 2003; Speck 2006). To capture the mill's propensity to maintain up-to-date technology, e*xpansion history* gives the ratio of the maximum to the minimum capacity achieved by mills between 1919 and 1929.

Capacity gives the rated daily grinding capacity of mills. This variable is not production but an engineering variable stating the capacity of the milling equipment.[34] This variable captures economies of scale, but since new vintages were built on larger scales, vintages are inseparable from milling capacities and so that this variable may also reflect the effects of technology or vintage. *Local cane market* and *internal transfers* are other mill-specific variables. Explanation of these is deferred until the next section.

The second class of explanatory variables is firm characteristics. We test for three ownership characteristics that are given a prominent role in the historical literature on the Cuban sugar industry. The imperialist argument that foreign firms had monopoly power is one of the most prominent (Ayala 1999, Guerra y Sánchez 1944, Ibarra 1998, Pino-Santos 1973). To test for it, we include *North American*, which assigns a "1" to all mills owned by persons or companies from the United States or Canada, including (consistent with the historical literature) firms that were owned by families that might be considered of "transnational," combined North American and Cuban or Spanish heritage.[35] Most of the mills assigned zeroes in *North American* were Cuban or Spanish-owned. A handful of mills whose families originated in France or the Netherlands, but these families were long-time residents, who were unquestionably non-transient immigrants. If the imperialist

[34] Daily grinding capacities were reported annually to the Cuban Sec. de Agricultura, Comercio y Trabajo and published in the annual sugar industry *Memoria*.

[35] "Transnationals" include such persons as the Bostonian, Edwin Atkins, married and maintained his family in Cuba, while he directed a Boston sugar refinery and managed sugar mills in Cuba. There were English-Canadian investors who lived permanently in Cuba, but maintained close connections in North America. They also include the Rionda family, which was one of the most important "sugar baron" families in Cuba, owning multiple sugar mills as well as the prominent New York sugar brokerage, the Czarnikow-Rionda Co. Two of three brothers of this family migrated from Spain to Cuba and invested in sugar mills. The third, who migrated to New York, became the President of the New York branch of Czarnikow-McDougall, which later split off and became Czarnikow-Rionda. He became the patriarch of all the family's properties who worked with his New York-born nephews to run the brokerage and set up his Cuban-born nephews to manage the family's sugar mills in Cuba, under his direction (McAvoy 2003).

argument is valid, one would expect the North American companies to survive more frequently.

It should be noted that, contrary to a common misperception, not all technically superior mills were foreign-owned. Most advanced mills were owned by North American corporations, but many were owned by Cuban, or Spanish or French-born residents who had good access to foreign credit and maintained best-practice mills. One contemporary opinion was that the best Cuban-owned companies were managed better than the American-owned companies because the Cuban owners had, on average, a better understanding of the sugar business, better knowledge of local institutions and labor markets, and a better social network from which to recruit local talent.[36] Long-term resident foreigners has similar advantages over recent acquisitions by foreign companies, such as the 20 mills acquired and operated by North American banks in the 1920s.

The other two ownership characteristics test for effects from two forms of vertical integrations that were well-represented in the Cuban sugar industry. (Vertical integration or subsidiary status is a common variable found in the survival literature [e.g. Harhoff 1998].) The first is *bank ownership*, which assigns a "1" if a mill was owned by a bank. North American banks acquired 20 mills in the 1920s (Dye and Sicotte 2006). A few Cuban or Spanish banks also owned mills, but most were owned by U.S. or Canadian banks.

The second form of vertical integration was subsidiary ownership of mills by a large North American refinery. *Refiner ownership* identifies when a mill was part of the upstream subsidiary operations of a large North American refinery. The historical literature suggests that mills that were vertically integrated into refinery operations in the United States had privileged positions as part of an internal "captured" market (Ayala 1999). The main two refiners involved were the sugar trust refiners, the American Sugar Refining Co., and the National Sugar Refining Co., which were the largest two refining operations, and were known, at least at times, to have colluded over prices. The theory of the firm suggests, however, given the competitiveness of the raw sugar market, that it

[36] This was probably true particular when compared with the large number bankrupt mills acquired and operated by New York banks in the early and mid-1920s. See Braga Brothers, Series 10c; Smith (1960); Dye and Sicotte (2006), and McAvoy (2003).

would not have been in the parent firm's interest to relieve the subsidiary of market discipline (by buying their raw sugar at higher rates) if it could purchase raw sugar at a lower price from independent suppliers. Both of these large industrial enterprises refined significantly more raw sugar than they procured from their own raw sugar operations. If vertical integration offered any advantages, it should have affected the likelihood of survival in a positive way. However, one cannot rule out strategic decisions of the refiners to sell raw sugar operations, which alters their ownership status in our data.

We control for three market factors. The main one is the *price* of sugar, which is the net of duty price received by Cuban sellers in the New York market.[37] Other variables used to capture market conditions in the firm survival literature include entry or exit rates. We include *lagged entries* and *lagged closures*, which are the number of mills that entered or closed, lagged one year. Audretsch, et al, (2000) hypothesize that lagged entries may have a negative sign, if higher entry rates increase the failure risk of existing firms. Conversely, the sign could be positive reflecting the influence of improved market conditions. In either case, the inverse effect may also be expected of the exit rate.

Descriptive statistics for the variables are given in Table 4. The model assumes that all the non-indicator variables enter in log-linear form, so their descriptive statistics are of the logs of the variables described. The regressions also include controls for provinces and individual-mill random effects.

The results for the baseline regression are given in the first two columns of Table 5. The overall results confirm the validity of the baseline model, recalling that it is estimated on a subset of the data that excludes the control years 1931-1939. Consider, first, the baseline results for the dependent variable, *permanent closures*, in the first column. The two proxies for technical vintage perform as expected. *Age* has the expected sign, but it is statistically insignificant, consistent with our misgivings about how well this measure could capture the effective vintages of the equipment in the mills. *Expansion history* serves as a successful alternative proxy, and of course, *capacity*, serves two purposes, capturing effects of both economies of scale and technical vintage. Both are significant and have expected inverse relationship with the probability to exit. The

[37] Taken from Willett and Gray, *Weekly Statistical Sugar Trade Journal*.

evidence does not reject the significance of factors that validate the vintage-model prediction of mill closures during the 1920s. Almost identical results for *all closures* (permanent and temporary combined), in the second column, show similarities between permanent and temporary closure decisions.

As for other proposed effects, *North American ownership* is significant but with the opposite sign from that proposed in the imperialist literature. When controlling for other factors (an analytical condition that is not entertained in the imperialist literature), we find that mills owned by North Americans were more likely to exit. The two classes of vertical integration, *bank ownership* and *refiner ownership*, are insignificant. The market controls, *price* and *lagged exits* are significant and lend support to the price effect on decisions to close or exit in the vintage model.

The baseline results show the validity of market determination, consistent with the vintage-capital model, of "churning," or concurrent entry and exit of mills, in the 1920s. Now we turn to incorporate the imposition of production controls in the 1930s. We capture their effects in two ways. First, we define an indicator variable, *control period*, which is assigned a "1" from 1931 to 1939. This variable does not assign "1" to the previous control years, 1927 and 1928 for two reasons. These were pre-depression years, when the impact of the controls was much lower; and most mill owners saw these as temporary measures that were intended to correct an overhang of excess accumulation of unsold physical stocks of sugar from the bumper crop of 1925. By contrast, the control measures adopted in 1931 were perceived as the inauguration of possibly permanent state intervention in the sugar industry. *Control period* is also interacted with *age*, *expansion history*, and *capacity*. In additional unreported results, we included interactions with *North American*, *bank*, and *refiners*; these were all statistically insignificant, and we chose to suppress them. *Transfer*, which requires some institutional background to understand, will be deferred until the next section.

The estimated regressions for *permanent closures* and *all closures* are given in the third and fourth columns of Table 5. Notice, the results in the baseline model are robust to extending the data to include the years in which production controls were implemented and adding the new variables that capture the effects of the production restrictions.

However, the interactions of the period of *controls* with the vintage-related variables, *age* and *expansion history*, are consistently significant and show that the coefficients were altered after the controls went into effect. In the case of *expansion history*, in the pre-control baseline marginal effect on *permanent closures* is -1,70, but the post-control marginal effect is -1.70 + 2.56 = 0.86. This shows that the usual correlation between investment in best-practice technology and survival was offset by a post-controls adverse effect on the survival of technically superior mills. A similar result is obtained for *all closures*. Accounting for other factors, technically backward mills became more likely to survive under controls than those using more up-to-date technology. The results on *age* echo those on *expansion history*. Although insignificant in the pre-control baseline, *age* in the control period becomes significant and negative, showing that older, less efficient mills were more likely to survive. The regulations were, in effect, intended to protect those who owned older mills. These results show that they were effective at doing it. Over all, the results support the expected effects of the nationalist and populist measures that were built into the control regulations that supported smaller mills with older technologies.

Cane Transactions and Quota Rights

Two variables are included in the regressions to capture how the controls affected the efficiency of procuring the raw material, sugar cane. The first variable is the *local cane market*. Capacity utilization of sugar mills depended on the supplies of cane. The ripening and yields of cane fields varied with local temperatures, sunshine and rainfall patterns. Measures that mill managers took to smooth the effects of weather-related fluctuations on mill capacity utilization have been discussed elsewhere (Dye 1998, 2000). One such measure involved cane transactions between mills. Because of varying local conditions, neighboring mills could reap gains from trading cane.

The possibilities for trading cane, however, were limited to local transactions because of the perishability of sugarcane. When it was cut, to avoid losses of water and sucrose content, mills routinely tried to grind cane within 24 hours of cutting it. Even for their internal operations, mills built private railroads or used existing public service

railroads to haul cane from the perimeters of their contracted cane zones to the mills. In most cases, the perimeters of their internal and contracted cane zones accessed by railroad might extend 10-20 km from the mill site. In the case of non-routine exchanges between mills to cover seasonal deficits, exchanges might have crossed longer distances, but freshness requirements made still such gains from trade feasible only between neighboring mills with railroad connections.[38] Feasibility of cane transactions between mills also varied because some mills were more isolated geographically than others.

To capture the extent of possible local cane transactions between neighboring mills, we constructed a variable to measure the size of the potential the *local cane market* of mill *i*. It is calculated for mill *i* and year *t* as the log ratio of the sum of the maximum milling capacities achieved between 1919 and year *t* by all mills within a 30 km radius of mill *i* (not including mill *i*) over the maximum capacity achieved by mill *i* up to year *t*. Mill capacities are used instead of reported cane ground because they more accurately capture planned acreage,[39] and historical maxima are used instead of annual records because they account better for the dynamics of cane field development (see note for further explanation).[40] One would expect higher local cane availability to increase the

[38] In the days before railroads, ox-carts were used to haul cane, then, later, portable light rail systems. Oxen continued in use for short hauls, and were relied upon significantly in some of the older, technically deficient mills operating in the 1920s. The great mills built during World War I and afterward, however, could not have functioned without rails for hauling cane. Zanetti and García (1998).

[39] Data for actual cane ground is also available, but large annual variations make it difficult to distinguish between the timing of new cane field development and weather fluctuations. Relative milling capacity is a better proxy for relative intended cane availability. There was no effective spot market for cane, except marginally for filling deficits, as discussed. Therefore, mills would not invest in new milling capacity without planning for cane procurements to supply it. In fact, reports of new mill construction projects typically mention that options on land and contingent contracts were arranged with local cane growers were typically secured prior to, and probable as a condition to, the decision to invest in the new mill. Reports of new mill construction projects and expansions were often described in the trade press during World War I and in the 1920s, especially, *The Louisiana Planter*, *Facts About Sugar*, *Cuba Review* and *Mundo Azucarero.*

[40] The ratio is constructed of historical maxima, instead of yearly observations, to account for two features of local cane markets during the period. First, the expansion of milling capacity in the 1920s was accompanied by extensive clearing and development of virgin lands into cane fields. Second, this development of arable land was partially irreversible. When mills were closed, the cane fields were often maintained and the cane they produced was available to be ground at other nearby mills. Even when cane fields were not maintained after a mill was abandoned, the costs of restoring them were smaller than *de novo* developments, where the land had to be cleared and roads and loading stations built to handle the shipment of cane from field to mill. The annual amount of cane ground is reported, but it is so influenced by weather and other variable factors that mill capacities are a better indicator of cane capacity, under the assumption that mills planned ahead to have cane sufficient to keep mills operating as close to optimal capacity as possible.

survivability of a mill. This effect is consistently supported in all the regressions reported in Table 5.

When production quota controls were introduced, limits were placed on the rights of mills to transfer quotas. Implicitly, production quota rights were assigned at two levels. First, grinding quotas were assigned to sugar mills. But then, grinding quotas conveyed rights for cane growers attached to the mills to have their cane ground according to rules written into the legislation.[41] As noted, according to the CENDA rules established in 1931, mills could transfer cane as long as transferee fulfilled the contractual obligations with growers for grinding their cane. This restriction is more binding than it may at first appear. Because of the perishability of cane, compliance with the restriction effectively limited all quota tranfers to local transactions between neighboring mills. For reasons explained below, CENDA rules became stricter after the first two years. Initially, transfers of quotas that would grind internal cane, instead of contracted cane, were not restricted. After 1932, all quota transferees were legally required to grind the cane attached to the original quota, whether contracted or internal.[42]

Compliance, however, was not perfect. The main challenge was that companies that owned two or more neighboring mills tried to assert the right to operate as a single operating entity and to choose where to grind their cane among multiple facilities—without explicit authorization from the authorities. It was claimed that the horizontal integration of grinding facilities was standard operating procedure before the controls, and for efficiency reasons the government should not interfere with internal operations. Obviously, the incentives for combining operations were even greater under crop restriction than they were in the pre-control period because reassigning the quota could rationalize production. Operating one mill, instead of two, would increase the efficiency of grinding because all cane could be ground at the superior mill and it would reap economies of scale. Evidently, from the record, one infers that the authorities did not, or

[41] Since the amount of cane depended on sucrose-to-cane yields, these quotas were effectively rights to supply a fixed share of the mill's cane requirements.

[42] CENDA rules were published annually in as *Reglas de la Corporación Exportadora Nacional de Azúcar sobre entrega de cuotas de aportación a la misma y producción y exportación de azúcar.* Copies are found in the Braga Brothers Collection, University Archives, University of Florida—Gainesville, R.G. 4, Series 10C, Box 108, f. "CENDA", and Box 109, f. "curtailment sugar laws".

could not, fully enforce restrictions on transfers between adjacent mills owned by a single company.

If the right for the transferor mill to continue to receive future quota assignments could be secured independently, then the lower transaction costs of transferring quotas between neighboring, jointly owned mills might result in a higher rate of closure of such mills, since companies that owned pairs of adjacent mills had an incentive to grind both mills' quotas at the more efficient of the two and cease operating the other. To test for this effect, we construct the variable, *internal transfers*. It is defined as the log of the sum of the milling capacities of mills were (i) within 30 km of mill *i*, (ii) owned by the same company and mill *i*, and (iii) received a quota in the year in question. The variable is assigned a "0" for mills that had no neighboring mill that satisfied all three criteria. From the discussion, one would expect this variable to have a positive effect on closures. (All mills receive zeroes in years when quotas were not assigned.)

In Table 5, the results for *internal transfers* differ when regressed on *permanent closures* and *all closures*. On *permanent closures*, the effect of *internal transfers* is significant and has the expected sign. Standing alone, the result supports the expected higher rate of closure for jointly owned, neighboring mills. The same does not hold for *all closures.* If one accepts the validity of the effect on *permanent closures*, the correlation between the *internal transfers* variable and temporary inactivity must reflect a different relationship. The last column in Table 5 shows the results. Regressed on *temporarily inactive* mills (which is "1" for each year a continuing mill is inactive; 0 if it is active) *internal transfers* is significant but negative.

Why the opposite effects? First, consider the vintage model's prediction for temporary closures. Further thoughts on local cane markets can shed some light. Temporary closures were likely to involve mills that were at, or close to, the exit margin. A lower sugar price could cause marginal mills to shut down temporarily awaiting improved conditions. The local market for cane could also affect this decision. The manager of an inferior mill could decide each year between operating the mill or selling its cane to a neighboring mill. Potential buyers of cane typically contracted for their cane using long-term contracts; but weather, fire hazards, and other uncertainties sometimes

produced shortfalls in raw material; so even when ex ante supplies were fully contracted, there was a local market for cane. Cost heterogeneities created the possibilities for gains from trade. Comprehensive data of such transfers have not survived, but the archival record suggests that it was fairly common. Candidates for these decisions were by and large in single-mill companies, all assigned zeroes in the construction of the *internal transfers* variable.

Now let's look more closely at the 10 mills that closed permanently after 1931 (see Table 2). Nine of the 10 were mills were assigned a "1" in the *internal transfers* variable—owned by a company that had another neighboring mill. But no such mills exited after 1933—not in any year between 1934 and Cuban Revolution of 1959. Two things seem to be key to understanding this pattern—the original ambiguity in the law over how the forward right to a quota was maintained in subsequent years, and the political revolution at the end of 1933. The proposed reason that these mills closed down was that the horizontally integrated companies that owned them had an incentive to reassign their cane internally to another mill it owned located nearby – thus having a single mill grind its own quota plus the retired mill's quota. In the long run, the company could benefit from this permanent internal reassignment of quotas only if it maintained the right to receive quota allocations for the retired the mill after it was retired. In fact, all 10 retired mills were assigned quotas every year at least into World War II, when quotas were suspended, even though they never reopened. (After the war, we do not have data on the ex ante quota assignments, so the assignment of quotas may have continued.)

After 1933 something in the incentives changed—because permanent closures ceased altogether after 1933. The controls were implemented initially, in 1926 and again in 1931, under President Machado, who was friendly with the sugar interests and American banks with investments in Cuba. CENDA rules provided that mills that had ground in one of the two previous crops would receive a quota, but any mills that had not ground had to demonstrate operability and cane availability. When quotas were assigned, CENDA sent its recommendations to the President, who typically made some alterations before decreeing each year's quotas. These 10 mills evidently obtained concessions to have their internal reassignments of quotas permitted without penalty in future quota assignments, under Machado. The concessionaires were mills owned by the most

powerful North American Corporations with interests in sugar on the island—the National City Bank; the Royal Bank of Canada; Cuban Cane Products Corporation, which was being reorganized at the time into the Cuban Atlantic Sugar Co.; and Cuban Dominican Sugar Co., which was being reorganized into the West Indies Sugar Finance Corporation. At least some of the mills receiving these concessions did not meet CENDA's requirement of operability. Two of them were destroyed in a hurricane in 1931 and were dismantled (Farr 1959).

Exceptions to the pattern prove their privileged nature. Another concession went to George Fowler, an English-Cuban mill owner, whose family had been resident in Cuba since the mid-nineteenth century obtained a similar concession, after which he sold the mill to a prominent Cuban hacendado of Spanish birth, Nicolás Castaño. Another went to a mill owned by the Rionda family, which owned one of the most prominent sugar dynasties in Cuba. These were all persons or companies with privileged access to the Machado government.

But why were the concessions maintained after 1933, when no comparable concessions were made after 1933? President Machado, who by 1929 had violated his constitutional powers to remain in office, was forced out of office in August 1933; the interim president, handpicked by the U.S. State Department, was overthrown in September in a military coup. The government that took control in September 1933 was a revolutionary junta with a populist and anti-imperialist agenda (Aguilar 1972, Gellman 1973). It is said that the agencies administering the sugar controls were the only branches of the bureaucracy that continued to function through most of this period. Widespread labor unrest resulted in the seizure of some of the mills and disrupted the sugar crop for part of the 1934 grinding season (Carr 1996). The revolutionary government, hostile to the privileges of the powerful foreign companies and Cuban *hacendados* (the term used for non-foreign sugar mill owners), implemented reforms to the sugar control regulations aimed at removing their privileges, conceding more rights and protections to cane growers and sugar workers. Besides tightening restrictions on cane transfers, they established minimum payments to growers and minimum wages for sugar workers, an eight-hour day, nationality requirements on employment at all skill levels. In the sugar industry, additional protections were given to smaller, nationally-owned sugar mills; cane

growers were absolved of certain contractual obligations to mills and given permanency rights if they were tenants. If the revolutionary government was willing to seize and reassign these property rights from the privileged mill owners and cede them to growers and labor, why didn't they also cancel the production quotas of these ten inactive mills?

By the end of the year, Fulgencio Batista had asserted his power as Commander-in-Chief and government strongman. The United States had identified Batista as the man in Cuba most likely to restore the peace and prevent a renewed collapse into the political disorder of 1933-1934. At home, however, his political support depended significantly on his retention of the populist agenda of his revolutionary predecessors. An indispensable constituency became burgeoning and highly mobilized organized labor. But the political situation regarding labor was explosive. At the depth of the crisis, daily wages had fallen to less than half what they had been during the late 1920s. Plus, as we see in Table 3, the grinding season was severely curtailed, seasonal work was almost cut in half. Average annual earnings of sugar workers fell to something between 1/3 and ¼ of pre-crisis levels (Foreign Policy Association 1935, Dye 2005). The labor situation in Cuba was fragile. Batista probably could not have held onto power in those years if he had attempted to disregard these kinds of demands of labor (Whitney 2000).

Anti-imperialist interests in government might have demanded the removal of the quota concessions for the retired foreign mills. The U.S. State Department was in no position at that time, and was not disposed, under Roosevelt's Good Neighbor policy, to demand discrimination in favor of the American sugar companies (Gellman 1973). However, removal of the concessions for the retired mills would have stirred labor opposition in the communities where quotas would have been lost. The concessions had been granted with the provision that the cane on those sites would still be ground in neighboring mills. The record is transparent in the case of two mills that were destroyed by hurricane. As the quotas for 1932 crop were being considered, these mills clearly would not be operable by the time the grinding season started. Cane growers and local sugar workers' organizations petitioned government and initiated a public campaign not only to retain their quotas but to demand additional quotas of the state to help the community rebuild after a devastating hurricane (*Diario de la Marina*, Sept-Nov. 1932). At the time, then, the concessions to the American companies were also concessions to

their laborers, cane growers, and their communities. Removing these concessions after 1934 would have stirred potentially violent opposition, given the revolutionary agitation and labor mobilization of the time.

Nine years later, in 1943, a similar event occurred. The Central Tinguaro, a mill of a large American-owned company, was burned to the ground. The company decided it was not profitable to rebuild it, but the state intervened threatening to seize the property and rebuild the mill itself, unless the owner rebuilt it. After an intense legal battle, the owner conceded and rebuilt the mill. The main reason for the government's insistence was that local labor demand would otherwise be disrupted, and the populist government did not wish to accept the political damage that would cause.[43]

The labor unrest during the revolution and the mobilization of organized labor that followed it were at least as important as the mill owners in shaping of the post-revolutionary institutions that governed the quota assignments. When quotas were initially set up, large, multiple-mill companies, key constituents of the Machado government, pressed for the right to transfer quotas between mills (without attaching the cane). The Machado government refused it on the grounds that it would be too disruptive to the communities where mills were closed. Transfers of grinding quotas initially were not disallowed in cases where the cane growers' contracts were not violated, but labor opposed any transfer that resulted in the geographical redistribution of the demand for field and mill labor. Most sugar mills were so large that they completely dominated the employment opportunities of the communities where they were located. Many were company towns; others had come to surround preexisting municipalities. In either case, the closure of a mill, if its cane was not ground at a neighboring mill, could mean the impoverishment, even the disappearance, of a community.

The retired mill owned by the Rionda family was mentioned in the customary introductory clauses of a bill submitted to the Cuban House of Representatives in 1937 proposing to prohibit all quota transfers. It read:

> "Considering that these transfers of quotas have come to harm municipal revenues … such that municipalities such as Guáimaro in the province of

[43] Records of the U.S. State Department, R.G. 59, U.S. National Archives.

> Camagüey is expected to disappear if the Central Elia continues practicing the policy of transferring its quota every year [to the neighboring Central Francisco, both mills owned by the Francisco Sugar Co.]."

The following introductory clause declares:

> "Considering that in epochs of economic crisis and unemployment, like the current one, it is wise and necessary to adopt any measure that tends to keep in activity as many sugar mills as possible, to procure an increase in labor and a better distribution of the benefits of the sugar crop."

The bill goes on to propose prohibiting all transfers of quotas between mills whether they are owned by different companies or not.

Mill owners fought against the bill and prevented it from passing the Senate. Manuel Rionda, principal owner of the Francisco Sugar Co., commented on the bill while it was being considered in the House that "this effort to impose grinding in two mills what can be ground in one for only half the grinding season is absurd. If they want, we could pay the municipality of Guáimaro what it would receive if the Elia did grind. That's not as bad as having to grind at both mills."[44]

The restriction on quota transfers was intended to prevent a geographical redistribution of the rights assigned to growers to grow cane. Without the restriction—the attachment of obligation to grind site-specific cane to the transaction, a nationwide market for sugar grinding quotas would have permitted a redistribution of the rights to produce sugar to the most efficient mills. That redistribution could have rationalized the use of existing capacity by facilitating the transfer of rights to grind to the mills that could have accomplished it at the lowest cost. It would further have allowed the most efficient mills to operate at capacity and achieve greater scale economies than what was permitted under the quota regime. Naturally, that would also have led to a widespread abandonment of inefficient grinding capacity and a shakeout of mills. Prevention of such transfers obviously had negative consequences on the efficiency at which mills were allowed to operate under controls.

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[44] Letter of September 27, 1937, from M. Rionda to Aurelio Portuondo, of the Rionda's import-export company, the Cuban Trading Co., and officer in ICEA, found in the Braga Brothers Collection, R.G. 4, Series 10C, Box 85, f. "quotas 1936, 1937."

Compositional Effects

One of the negative consequences was its disruption of the compositional effect of the cleansing process. Data limitations prohibit direct observation of the changes in costs or efficiency measures, but grinding capacity, which evidence shows to be closely correlated with newer technical vintages, show that the shakeout was effectively prevented.

Table 6 gives evidence for this observation. The first column shows the average daily grinding capacity per mill for each year. The remaining columns break out average daily grinding capacities for entering, exiting, active and temporarily inactive mill, after correcting for a dynamic feature of milling capacities, which is necessary in order not to distort the pattern. Dye (1998) shows that entering mills invariably entered and operated for the first few years at suboptimal scales of production. High adjustment costs of building a new mill and developing the cane fields made it preferable to "ramp up" production over time, causing mills to achieve their intended optimal scales of production after the initial three to five years. The vintage of new mills corresponds with their optimal scales, not their startup scales. To identify optimal scales of operation, for each year, t , we take the maximum capacity that each mill reached in 1919-1929 and average it across all active mills that year. That is, $\overline{c}_t = \frac{1}{n} \cdot \sum_{i}^{n} \max(c_{it}, c_{is}, ...)$; where c_{it} is the capacity of mill i at year t , alternately of active mills, entries, exits, and inactive mills; and the max is determined for each mill i across all years from 1919 to 1929 (s and t index all relevant years). No mills were built or expanded significantly after 1929; therefore, this correction captures the optimal scales of mills reasonably well. The primary effect of the correction is to alter the values for the early to mid-1920s for entries and active mills, which can be seen by comparing the average capacity of active mills, in the first column, with the average maximum capacity of active mills, in the second column.

The patterns in the 1920s are consistent with predictions of the vintage-capital model. The "optimal" average capacity of new, entering mills is, in most years, above the

average active maximum capacity, which is what we expect of mills entering in at the best-practice margin. (There were some exceptions after 1921. A postwar financial crisis in 1921 and updating of forecasts about future sugar market growth – initially too optimistic – caused some entering mills never to achieve the intended scale.) Exits reflect small, suboptimal scales. The scale of temporarily inactive mills reflects their inframarginality, having grinding capacities that were smaller-than-average, but larger than exiting mills. The comparison between temporarily inactive and active mills continues under controls, but the mills that exit, especially after 1931, no longer reflect the suboptimal scales that earlier exiting mills had. We observed from Table 2 (reflected also in Table 6) that the defensive quotas in the 1930s stopped mills from exiting at all after 1933. We observe here, that the disciplinary mechanism that selected inefficient mills for exit in the 1920s was also obstructed, for the last several mills that exited, if capacity is accepted as an indicator of efficiency.

How did the obstruction of exit affect the costs of production? The main issue was that forcing mills with substantial fixed costs to operate well below capacity raised the unit fixed costs of production. The U.S. Tariff Commission, in a survey of Cuban sugar production costs, mentioned above, captured costs that were affected by operating below capacity. Using the cost assumptions established in the model represented in equation (1), we produce a rough estimate of the percent increase in unit costs caused by producing below capacity.

We determined above that costs could be represented by a model in which average variable costs did not vary with respect to output. It can be shown that the unit cost of production for operating at any level of capacity in the short run relative to the unit costs at maximum capacity is:

$$\frac{c}{c_o} = 1 + \gamma_o \left(\frac{y_o}{y} - 1 \right) \qquad (2)$$

Where c is the per unit cost of production at any below-capacity level, c_o is the per unit cost of producing at capacity, the unconstrained optimum, and γ_o is the share of fixed costs. (This relationship is derived in an appendix.)

An estimate of the efficiency loss from operating below capacity can therefore be estimated with only two bits of information – the share of fixed costs and the reduction in output of the mill relative to capacity. For the former, a plausible (probably understated) estimate of the share of fixed costs is 0.43. It is inferred from the cost estimates from U.S. Tariff Commission cost survey results for Cuba from 1913 to 1923.[45] These were years for which mills operated without the imposition of external production constraints.

Maintaining the assumption that the fixed cost share was 0.43, we use aggregate production data, assuming a pro rata quota allocation to all active mills, to calculate the average $\frac{y_o}{y}$ each year. Table 7 gives two series of estimates of average relative per unit costs, due to the crop restriction each year. The two sets of estimates are based on different approximations of y_o. Column (a) assumes $y_o = y_o(t)$ is equal to the maximum attained level of production to date (between 1917 and year t). This estimate of y_o may overstate expected unconstrained production, since mills often did not usually operate exactly at capacity even when unconstrained. As an alternative, column (b) gives an estimate assuming y_o is equal to the average production from 1925 to 1929. This should be a downwardly biased estimate of expected unconstrained production, since 1926-1928 were years in which crop restrictions were implemented. Therefore, column (a) may overstate the average efficiency loss, and column (b) understates it.

The table shows that, at the depth of the crisis, estimated relative costs were between 65 and 97 percent higher than if mills had produced at capacity, and even as late as 1939, they were still 23 to 44 percent higher, on average. It should also be observed that these estimates are based on an average estimate for the fixed share of costs. For more advanced mills, the fixed share of costs was higher, and therefore the efficiency losses would have been even greater.

One of the principal concerns, which motivated political demands for them, was the expectation that most of the at-risk mills were owned by nationals and most of the North American mills would survive. What can we discern about the effect a shakeout might have had on the foreign-versus-national ownership composition? If only the

[45] U.S. Tariff Commission (1926).

milling capacity could be supported by long-run demand survived, and the most efficient mills were the survivors, would the change in the nationality composition of surviving firms have confirmed the fears many Cuban mill owners had? A simple counterfactual approximation can be obtained by assuming the shakeout would have sorted out according to vintage, or our best measure of it, daily grinding capacity.

Table 8 gives an estimate of the nationality composition of mills under the assumption for 1939 under for this counterfactual. The procedure used is simple and transparent. Instead of the approximately pro rata allocation of production, as occurred under the quota system, assume that by 1939 all capacity beyond that which could be supported by the market had closed down, and the order in which mills were selected for survival was in descending order of their daily grinding capacities. It would be excessive to assume that the surviving mills operated at either a historical maximum or at rated capacity. During the unrestricted period from 1919 to 1925, mills operated on average at about 80 percent of their historical maximum level of production. Correspondingly, we assume that the surviving mills would operate on average at 80 percent of their historical maximum production level, or equivalently that the market would carry milling capacity in the long run that was 20 percent in excess of actual production.

The counterfactual estimates confirm the view that Cuban and Spanish-owned (or precisely non-North American-owned mills) would have born the greater part of the shakeout. Of the surviving mills, 39, or 81 percent, would have been North American, and only 9 mills would have been Cuban. Since the surviving North American mills were on average larger, they would represent 86 percent of the total surviving grinding capacity. The burden can also be viewed from the standpoint of the failing mills. Here the stereotypical view that only Cuban mills would have failed does not hold up, but nonetheless, the burden still does fall significantly more on the Cuban mills. The estimates predict that 81 Cuban mills, representing 70 percent of the closed capacity, and 28 North American mills, 30 percent of the closed capacity, would have failed.

This counterfactual is not strictly plausible because it does not account for transfers of ownership. Ownership transfers were constrained by the restrictions that forced mills to operate at highly suboptimal levels. On top of that, the government had

imposed a moratorium on sugar mill debt that interfered further with possibilities of financing a rationalization of the industry's milling capacity (Wallich 1960). But permitting a compositional cleansing would have created opportunities for reorganization. One historically tested possibility was the oligopolistic consolidation, as occurred years earlier in petroleum, chemicals, sugar refining, and other industries in the United States. In fact, the Cuban Cane Products Co., formerly Cuba Cane Sugar Corporation, was sugar baron, Manuel Rionda's, attempt at such a consolidation. But this company went bankrupt in 1930, was reorganized and failed again in 1931, then as with other large companies in the 1930s, it was so encumbered by the nature of the controls that, in the second reorganization, proceedings dragged on until 1937 (Farr 1938).

By 1939, the European war disrupted the former equilibrium in the sugar market and created a boom for Cuban sugar. The nationalistic concern that the entire sugar industry could be taken over by Americans was real; but in fact the American banks with holdings in sugar would have been happy to unload at an attractive price. The Cuban government could have adopted alternative measures that encouraged, or even forced, equity transfers to Cubans without taking the draconian measures that resulted in the destruction of Cuban sugar industry competitiveness. Indeed, it seems quite plausible that American and Cuban sugar industry representatives could have negotiated a superior settlement, except that it could not easily have solved the labor problem. Labor-oriented populism only became stronger and more deeply embedded in the Cuban politics of the late 1930s and 1940s.

The actual outcomes were quite the opposite. The composition of sugar mills in Cuba, in numbers and aggregate milling capacity, remained largely as it had been in 1934 until the triumph of Castro's July 26th Movement in 1959. The grinding capacities of the mills were maintained fairly close to what they were in order for mills to maintain their rights to quota allocations. There was, however, almost no new investment in milling equipment; so the distribution of equipment vintages was left to age.[46] By the 1940s, critics of the crop restrictions lamented Cuba's former, almost unchallenged competitiveness and warned that Cuba's former cost advantages in sugar production,

[46] One of the authors observed that mills that had best-practice equipment in the 1920s were still using some of the same equipment at the end of the century.

formidable and undeniable in the 1920s, had been undermined by the restrictions to the point that Cuban producers were no longer competitive outside of the protected U.S. market.[47]

Concluding Remarks and Discussion

Did the adoption of the system of defensive production quotas obstruct the cleansing process and create an enduring maladjustment, as Schumpeter warned? The policy of maintaining the pre-1930 production capacity intact, requiring all mills to bear the demand shock by lowering production levels pro rata at all mills, had two major detrimental effects on the efficiency of the Cuban sugar industry. First, it prevented the compositional cleansing of inefficient production units, as it halted the closure of older, inefficient mills. Second, requiring mills to operate at suboptimal capacities increased the costs of all mills, efficient and inefficient. Our estimate of the efficiency loss says that the average costs were at least 20 percent higher in the long run than if mills had operated at full capacity. For larger mills it was probably higher.

How certain are we that the shakeout would have taken place, absent the defensive measures that blocked it? After all, previous studies show that shakeout did not necessarily occur even when left unobstructed. In the automobile industry, Bresnahan and Raff (1991) find an efficiency-enhancing compositional effect caused by the closure of inefficient plants; but their subsequent (1996) study, with Bertin, on the blast furnaces industry, they find a much weaker compositional change and considerably more internal adjustment. Comparing the two, they conclude that the main difference was the degree of competition. Automobile plants were disciplined by competition of national scope, but blast-furnace establishments faced fewer direct competitors, because high transportation costs insulated them from distant producers and reduced the scope of competition. On this score, the raw sugar industry was more competitive and of greater scope. Compared with U.S. automobile assemblers, Cuban producers produced an undifferentiated product

[47] Such remarks are found in the trade press. For example, Cuba Económica y Financiera, *Anuario azucarero*; Willett & Gray, *Weekly Statistical Sugar Trade Journal*; and Luis Mendoza & Co.'s sugar trade newsletter.

and competed in a global market with competitive suppliers numbering at least in the thousands.[48]

The "churning" observed in the 1920s reveals an active and fairly continuous cleansing process, even before the crisis, being carried out simultaneously with new entries and diffusion of new technology. Our regressions show that the closure patterns in the 1920s were consistent with the vintage-capital model of technical adoption and retirement. But under controls, the estimated coefficients changed significantly, as defensive measures blocked the market-driven cleansing effects of the 1920s. What if that obstruction had not occurred? Even if exit had continued at the same rate as in the 1920s, the process of cleansing would slowly have brought about efficiency-enhancing compositional change. But imagining a constant rate of cleansing is too conservative. In other studies where churning is found, closures tend to be more concentrated during recessions (Davis and Haltiwanger 1992). The evidence suggests that the compositional change in Cuban sugar would have been at least as corrective as what Bresnahan and Raff find in the U.S. motor vehicles industry.

One of the most debilitating aspects of the sugar controls was the prohibition of transfers of quotas between mills (independent of cane quotas). If transfers of quotas had been allowed, a nationwide market for quotas could have generated a reallocation of quotas to the most efficient mills – a compositional change comparable to that expected of the market process. Mill owners and the authorities (most of the officials who administered the program were mill owners) understood the significance of this quite well. Corporate owners, who may have favored restrictions initially for other reasons, argued that the right of transfer should at least be given to mills in the same company. This naturally would have given them the advantage of being able to rationalize capacity internally, even if other mills could not. The historical record suggests that managers of corporations, when the regulations were first implemented, were surprised that it was

[48] The markets in which Cuba was active were in the United States and the world "residual" market, where Cuba and other producers that were not fully protected by domestic or colonial preferential treatment competed. The principal importing countries in the "residual" market included the UK, the Netherlands, and several countries in Asia, which small amounts purchased by many lower-income countries throughout the world. Other than the UK, European countries maintained prohibitive tariffs or quotas. On the structure of the global sugar industry of this time, see Dye and Sicotte (2005). In subsequent decades, the structure has remained in similar form. See Pérez-López (1991) and Álvarez and Peña Castellanos (2001).

disallowed, and in the initial years they violated regulations and wrote repeatedly trying to obtain "clarifications" and variances on the policy[49].

The reason, despite the large cost to the nation's principal industry's competitiveness, was to address demands for labor at a moment in history when failure to do so could be explosive. Whether we are looking at the pre-1933 pro-sugar Machado dictatorship, the short-lived revolutionary government, or the post-revolutionary populist Batista regime, the need to distribute the burden on labor as evenly as possible and avoid the local backlashes that closures of sugar mills incited predominated other factors, when deciding how to frame the rules of quota assignments. Even the President of the revolutionary government, Ramón Grau San Martín, who was politically aligned with the populists, admitted that he might have done things differently, but lacked the political strength to resist the concessions that workers' were demanding (Zanetti, p. 145).

"What we face," Schumpeter warned, "is not merely the working of capitalism, but of a capitalism which *nations are determined not to allow to function*" [italics his] (1934, p. 16). The Cuban revolutionaries would have agreed with this statement, but unlike Schumpeter, they were convinced that stopping the effect of the shakeout on the national industry and on labor was better than allowing it to happen. It remains to be shown how the institutions that were put into place contributed to the march toward the next revolution in 1959. We can be certain that they were not insignificant.

[49] Braga Brothers Collection, series 10c.

Appendix. Estimate of the Average Efficiency Loss of Operating Mills Below Capacity

Our rough estimate of short-run efficiency loss caused by low capacity utilization is derived as follows. Assume average or per unit costs, *c*, are:

$$c = v + F / y$$

Where *v* represents average variable costs, assumed constant, *F* is the annual imputed fixed cost, and *y* is annual quantity produced. Let y_o represent output when operating at capacity, and known value. The share of fixed costs is known to be γ_o , so that

$$g = \gamma_o c_o y_o$$

where $c_o = c(y_o)$; and

$$v = (1 - \gamma_o) c_o$$

From this, we know a lot about how costs are altered by production curtailment. With regard to fixed costs, we know that the per unit fixed costs at any *y* are equal to

$$\frac{g}{y} = \frac{g}{y_o} \cdot \frac{y_o}{y}$$

and

$$c = (1 - \gamma_o) c_o + \gamma_o c_o \frac{y_o}{y}$$

or

$$c = c_o \left[1 + \gamma_o \left(\frac{y_o}{y} - 1 \right) \right]$$

That is, relative to costs at y_o , costs at the curtailed production level, $y < y_o$, are a function of the inverse of the relative curtailment and the share of fixed costs.

$$\frac{c}{c_o} = 1 + \gamma_o \left(\frac{y_o}{y} - 1 \right)$$

An estimate of the share of fixed costs using cost estimates from U.S. Tariff Commission cost survey results for Cuba from 1913 to 1923 is 0.43. If the curtailment level is half the capacity level of production, then,

$$\frac{c}{c_o} = 1 + 0.45\left(\frac{2y_o}{y_o} - 1\right) = 1.45$$

Costs per unit increase by 45 percent, holding all cost parameters constant but requiring that fixed costs be covered by fewer units of production.

References

Agarwal, Rajshree and David Audretsch. "The Evolution of Markets and Entry, Exit and Survival of Firms. *Review of Economics and Statistics* 78.3 (2001): 21-43.

Agarwal, Rajshree and Michael Gort. "Firm and Product Life Cycles and Firm Survival." American Economic Review. 92:2 (2002), 184-190.

Aguilar, Luis E. *Cuba 1933: Prologue to Revolution*. Ithaca: Cornell University Press, 1972.

Alchian, Armen. "Costs and Outputs," in Moses Abramovitz, et al., *The Allocation of Economic Resources: Essays in Honor of Bernard Francis Haley*. Stanford University Press, 1959.

Álvarez, José, and Lázaro Peña Castellanos. *Cuba's Sugar Industry*. University of Florida Press, 2001.

Audretsch, David, and Talat Mahmood. "New Firm Survival: New Results Using a Hazard Function." *Journal of Industrial Economics* 77.1 (1995): 97-103.

Audretsch, David. "New-firm Survival and the Technological Regime." *Review of Economics and Statistics* 73.3 (1991): 441-50.

Audretsch, David. *Innovation and Industry Evolution*. Cambridge, MA: MIT Press, 1995.

Ayala, César. *American Sugar Kingdom: The Plantation Economy of the Spanish Caribbean, 1898-1934*. Chapel Hill, NC: University of North Carolina Press, 1999

Ballinger, Roy A. *A History of Sugar Marketing*. U.S. Dept. of Agriculture, Economic Research Service, Agricultural Economic Report no. 197, Feb. 1971.

Bertin, Amy L., Timothy F. Bresnahan, and Daniel M. G. Raff. "Localized Competition and the Aggregation of Plant-Level Increasing Returns: Blast Furnaces, 1929-1935." *Journal of Political Economy,* 1996.

Bordo, Michael D., Claudia Goldin, and Eugene N. White, eds. *The Defining Moment: The Great Depression and the American Economy in the Twentieth Century*. University of Chicago Press, 1998.

Box-Steffensmeier, J.M., and Bradford Jones. *Event History Analysis: A Guide for Social Scientists*. Cambridge University Press, 2004.

Bresnahan, Timothy F., and Daniel M.G. Raff. "Intra-Industry Heterogeneity and the Great Depression: The American Motor Vehicles Industry, 1929-1935." *Journal of Economic History*, 1991.

Caballero, Ricardo, and Mohamad L. Hammour. "The Cleansing Effect of Recessions." *American Economic Review* 84.5 (1994): 1350-68.

Carr, Barry. "Mill Occupations and Soviets: The Mobilization of Sugar Workers in Cuba 1917-1933," *Journal of Latin American Studies* 28.1 (1996): 129-58.

Chen, Min-Yang. "Survival Duration of Plants: Evidence from the U.S. Petroleum Refining Industry. *International Journal of Industrial Organization* 20 (2002): 517-55.

Cox, D.R., and D. Oakes. *Analysis of Survival Data*. London, 1984.

Cuba, República de, Secretaría de Agricultura, Comercio y Trabajo, *Memoria de la zafra*, 1919-1929. Havana: Imprenta y Papelería de Rambla, Bouza y Cía. Continued by: *Memoria azucarera*, 1930-1939.

Cuban Economic Research Project, J. Álvarez Díaz, ed. *Un estudio sobre Cuba*. Miami Beach: University of Miami Press, 1963.

Dalton, John. Sugar: A Case of Government Control. New York: Macmillan, 1937.

Davis, Steven J., and John Haltiwanger. "Gross Job Creation, Gross Job Destruction, and Employment Reallocation." *Quarterly Journal of Economics* 107.3 (1992): 819-63.

De Long, J. Bradford. "'Liquidation' Cycles: Old-Fashioned Real Business Cycle Theory and the Great Depression." NBER Working Paper, No. 3546, December 1990.

Deerr, Noël. *The History of Sugar*. 2 vols. London: Chapman and Hall, 1949-1955.

Deily, Mary. "Exit Strategies and Plant-Closing Decisions: The Case of Steel." *RAND Journal of Economics*. 22:2 (1991), 250-263.

Dunne, Paul, and Alan Hughes. "Age, Size, Growth and Survival: UK Companies in the 1980s. *Journal of Industrial Economics* 42.2 (1994): 115-40.

Dye, Alan, and Richard Sicotte. "How Brinkmanship Saved Chadbourne: Credibility and the International Sugar Agreement of 1931." *Explorations in Economic History* 43.2 (2005): 223-56.

Dye, Alan, and Richard Sicotte. "The Interwar Turning Point in U.S.-Cuban Trade Relations: A View Through Sugar-Company Stock Prices," working paper, 2006.

Dye, Alan, and Richard Sicotte. "The U.S. Sugar Program and the Cuban Revolution,"64.3 (2004): 673-704.

Dye, Alan. *Cuban Sugar in the Age of Mass Production*. Stanford: Stanford University Press (1998).

Dye, Alan. "Cuba and the Origins of the U.S. Sugar Quota." *Revista de Indias* 65.233 (2005): 193-218.

Dye, Alan. "The Smoot-Hawley Tariff and Crisis in Cuba," working paper, 2005.

Dye, Alan. "Why Did Cuban Cane Growers Lose Autonomy?" In John Coatsworth and Alan Taylor, eds., *Latin America in the World Economy*. : David Rockefeller Center for Latin American Studies, Harvard University Press, 1998

Eichner, Alfred S. *The Emergence of Oligopoly: Sugar Refining as a Case Study*. Baltimore, MD: Johns Hopkins Press, 1969.

Farr & Co. *A Manual of Sugar Companies*. Annual series.

Foreign Policy Association, Commission on Cuban Affairs. *Problems of the New Cuba*. New York: J.J. Little and Ives, 1935.

Gellman, Irwin F. *Roosevelt and Batista: Good Neighbor Diplomacy in Cuba, 1933-1945.* Albuquerque, NM: University of New Mexico Press, 1973.

Genosove, David and Wallace Mullin. "Rules, Communication and Collusion: Narrative Evidence from the Sugar Institute Case." *American Economic Review* 91.3 (2001): 379-98.

Ghemawat, Pankaj, and Barry Nalebuff. "The Devolution of Declining Industries." Applied Industrial Economics (1998): 81-97.

Guerra y Sánchez, Ramiro. *Azúcar y población en las Antillas*. Havana: Cultural, 1944.

Guerra y Sánchez, Ramiro. *La Industria Azucarera de Cuba*. Havana: La Cultural, 1946.

Harhoff, et al., "Legal Form, Growth and Exit of West German Firms—Empirical Results for Manufacturing, Construction, Trade and Service Industries." *Journal of Industrial Economics* 46.4 (1998): 453-88.

Ibarra, Jorge. *Prologue to revolution : Cuba, 1898-1958*. Boulder, CO: Lynne Reinner, 1998.

Jiménez, Guillermo. *Enciclopedia económica de Cuba republicana. Vol. I: Las empresas de Cuba 1958*. Miami, FL: Editoriales Universal, 2000.

Kindleberger, Charles, *The World in Depression, 1929-1939*. Berkeley: University of California Press, 1973.

Kranenburg, H.L.V., F.C. Palm, and G.A. Pfann. "Exit and Survival in a Concentrating Industry: The Case of Daily Newspapers in the Netherlands." *Review of Industrial Organization* 21 (2002): 283-303.

Libecap, Gary D. "The Great Depression and the Regulating State: Federal Government Regulation of Agriculture, 1884-1970." Pp. 181-226. In Michael D. Bordo, Claudia Goldin, and Eugene N. White, eds. *The Defining Moment: The Great Depression and the American Economy in the Twentieth Century*. University of Chicago Press, 1998

Mata, José, and Pedro Portugal. "Life Duration of New Firms." *Journal of Industrial Economics* 42.3(1994): 227-45.

Maxwell, Francis. *Economics Aspects of Cane Sugar Production*. London: Norman Rodger, 1927.

McAvoy, Muriel. *Sugar Baron: Manuel Rionda and the Fortunes of Pre-Castro Cuba*. Gainesville, FL: University Press of Florida, 2003.

Mitchener, Kris and Marc Weidenmier. "Empire, Public Goods and the Roosevelt Corollary." *Journal of Economic History* v65, n3 (Sept. 2005): 658-92.

Pérez, Louis A. *On Becoming Cuban: Identity, Nationality and Culture*. New York: Ecco Press, Harper Collins, 1999.

Pérez-López, Jorge. *The Economics of Cuban Sugar*. University of Pittsburgh Press, 1991.

Pino-Santos, Oscar. *El asalto a Cuba por la oligarquía financiera yanqui*. Havana: Casa de las Américas, 1973.

Prinsen Geerligs, H.C., F.O. Licht, and Gustav Mikusch. *Sugar: Memoranda Prepared for the Economic Committee*. Geneva: Series of League of Nations Publications, No. C.148.M.57; Economic and Financial, 1929.II.20 (1929).

Salter, W.E.G. *Productivity and Technical Change.* Cambridge, Engl.: Cambridge University Press, 1966.

Salvanes, Kjell and Ragnar Tveteras. "Plant Exit, Vintage Capital and the Business Cycle." *Journal of Industrial Economics*, 52:2 (2004), 255-276.

Santamaría García, Antonio. *Sin Azúcar, No Hay País: La Industria Azucarera y la Economía Cubana, 1919-1939*. Seville, Spain: Universidad de Sevilla, 2001.

Schary, Martha. "The Probability of Exit." *RAND Journal of Economics*. 22:3 (1991), 339-353.

Schumpeter, Joseph A. "Depressions," in Douglass V. Brown, et al., *The Economics of the Recovery Program*. New York: Whittlesey House, McGraw-Hill, 1934. Pp. 3-21.

Smith, Robert F. *The United States and Cuba: Business and Diplomacy, 1917-1960*. New York: Bookman Associates, 1960.

Speck, Mary. "Prosperty, Progress and Wealth: Cuban Enterprise during the Early Republic, 1902-1927." *Cuban Studies* 36 (2006): 50-86.

Swerling, Boris. *The International Control of Sugar, 1918-41*. Commodity Policy Studies, No. 7. Stanford University, Food Research Institute. Stanford University Press, 1949.

Thompson, Peter. "Selection and Firm Survival: Evidence from the Shipbuilding Industry, 1825-1914." *Review of Economics and Statistics* 87.1 (2005): 26-36.

Timoshenko, Vladimir, and Boris Swerling. *The World's Sugar: Progress and Policy*. Stanford University Press, 1957.

U.S. Tariff Commission. Sugar. *Report of the United States Tariff commission to the President of the United States. Differences in costs of production of sugar in the United States and Cuba*. Washington, D.C.: GPO, 1926.

U.S. Tariff Commission. Sugar. *Report to the President of the United States. Differences in costs of production of sugar in the United States and in the chief competing country*. Washingon, D.C.: GPO, 1934.

Van de Berg, G.J. "Duration Models: Specification, Identification and Multiple Durations," *Journal of Econometrics* 5 (2001).

Whitney, Robert. "The Architect of the Cuban State: Fulgencio Batista and Populism in Cuba, 1937-1940," *Journal of Latin American Studies* 32 (2000): 435-59.

Yamaguchi, K. *Event History Analysis*. Newbury, Sage Publications, 1991.

Zanetti Lecuona, Oscar. *Dinámica del estancamiento: El cambio tecnológico en la industria azucarera cubana entre 1926 y 1958*. Havana: Instituto de Historia de Cuba, 1996.

Zanetti Lecuona, Oscar. "The Workers" Movement and Labor Legislation in the Cuban Sugar Industry, 1996," *Cuban Studies* 25 (1996): 183-205.

Zanetti Lecuona, Oscar. *Las manos en el dulce.* Havana: Editorial de Ciencias Sociales, 2004.

Table 1. Nationality of Ownership and Industrial Concentration in the Cuban Sugar Industry
(percent)

	Owned by North Americans [a]	Owned by North-American Banks [b]	Owned by North American Refiners [c]
1909	--	--	--
1914	38.3	0.0	0.0
1919	49.8	0.5	0.5
1924	64.5	6.8	5.2
1929	66.9	11.6	5.0
1934	68.4	12.1	5.4
1939	62.2	10.2	6.4

Sources: To determine the ownership and nationality of sugar mills from Cuban official sources is less than straightforward. The lists usually used are incomplete and contain many discrepancies. The authors have compiled information to determine ownership from a wide array of sources including: Cuba, Secretaría de Hacienda, *La industria azucarera y sus derivados* (1910, 1914); Pino-Santos (1973), pp. 45-47; Cuba, Secretaría de Agricultura, *Memoria de la zafra* (1916-1929), *Memoria azucarera* (1930-1939), Farr & Co. (1922-1942), Santamaria (2001), McDowall (1993), Jiménez (2000), García Álvarez (1990), McAvoy (2003), USNA Record Group 59 Serial no. 837.61351/924 1/18/1935, and *the Louisiana Planter and Sugar Manufacturer* passim.

[a] North American ownership includes millls owned by citizens of or companies based in the United States or Canada. It also includes mills owned by companies that are "transnational," that is, the owners are members of a family that have roots in both the United States or Cuba. It is the convention in the literature to include them as "American" mills.

[b] Bank-owned mills include all sugar properties owned by General Sugars Corporation, which was the operating subsidiary, wholly owned by National City Bank; the Sugar Plantations Operating Co., which was the operating subsidiary of the Royal Bank of Canada; The First National Bank of Boston; and Chase National Bank.

[c] Refiner-owned mills include only mills owned as subsidiaries whose core business was sugar refining. These include: the American Sugar Refining Co., the National Sugar Refining Co., and Warner Refining Co. The following are not included in the refiner-owned percent given here: the Cuban-American Sugar Co. owned a small refinery in Louisiana; the Rionda family acquired the McCahan refinery; but their chief business was raw sugar production. In both cases, the refining capacity they owned was small relative to their raw sugar producing capacity. Also, the Hershey Corporation owned a refinery, located in Cuba, also is not included in the refiner-owned figures in the table. For alternative views on the refiner and bank-owned properties, see Rowe (1930), Pino-Santos (1973), and Ayala (1999).

Table 2. Entry and Exit of Sugar Mills
No. of mills that entered, exited, closed temporarily and reopened in each year, and the number of mills that were active and temporarily inactive.

year	Entries	Exits	Temporary closure	Reopening	Active	Temporarily inactive
	i	ii	iii	iv	v	vi
1919	7	-9	-1	0	198	34
1920	1	-5	-1	0	193	29
1921	5	-1	0	1	198	20
1922	7	-11	-6	0	188	20
1923	1	-8	-3	4	182	14
1924	1	-2	-4	3	180	13
1925	3	-2	-3	5	183	11
1926	0	-4	-4	1	176	11
1927	1	-3	-1	4	177	6
1928	0	-7	0	2	172	9
1929	0	-3	-7	1	163	5
1930	0	-1	-6	0	156	3
1931	0	-6	-13	3	140	9
1932	0	-2	-8	3	133	15
1933	0	-1	-13	6	125	25
1934	0	0	-4	14	135	30
1935	0	0	-5	3	133	37
1936	0	0	0	13	146	27
1937	0	0	0	11	157	29
1938	0	0	0	1	158	16
1939	0	0	-1	0	157	5
total	26	-65	-80	75	--	--

Sources: Data compiled by the authors from annual issues of Cuba, Secretaría de Agricultura, Comercio y Trabajo, *Memoria de la zafra*, 1919-1929, continuing as, *Memoria azucarera*, 1930-1939.

"Exits" count the first year a mill closed "permanently," where permanently to date is observed through to 1946 (further data collection will check for reentry through 1959. Casual inspection shows that only a few mills that had not reentered by 1946 reentered at all.

"Temporary closure" counts mills that closed permanently by

Table 3. Estimates of the Duration of the Grinding Season and Average Daily Production Rates

year	No. Days of Grinding Season	Effective Days of Grinding Season	Effective Days / Days of Grinding Season	Average tons of raw sugar per mill per day	Average tons of raw sugar per mill per effective day
	i	ii	iii	iv	v
1919	157	-	-	125	-
1920	143	-	-	132	-
1921	135	-	-	144	-
1922	121	-	-	174	-
1923	112	-	-	168	-
1924	127	-	-	174	-
1925	145	-	-	191	-
1926	134	-	-	206	-
1927	101	-	-	255	-
1928	86	-	-	260	-
1929	109	-	-	280	-
1930	107	90	84	271	323
1931	76	64	86	304	354
1932	79	65	85	268	312
1933	67	56	86	249	292
1934	77	56	73	205	280
1935	72	61	86	273	316
1936	75	62	84	249	289
1937	78	64	84	257	298
1938	71	61	88	278	314
1939	68	61	91	269	292

Sources: See Table 1.

Table 4. Summary Statistics of the Regression Variables

	N	Mean	St. dev.	Min	Max	Sum
Dependent variables						
permanent closures (exits)	3745	0.02	0.13	0	1	67
all closures (permanent and temporary)	3745	0.04	0.20	0	2	147
temporarily inactive mills	3678	0.06	0.24	0	1	228
Explanatory variables						
age	4427	3.03	0.59	0	3.64	-
expansion history	4893	0.59	0.50	0	2.66	-
capacity	4824	6.93	1.22	0.57	10.08	-
local cane market	4744	2.22	1.07	-1.29	7.24	-
North American ownership	5012	0.41	0.49	0	1	2073
bank ownership	5019	0.08	0.28	0	1	426
refinery ownership	5019	0.03	0.16	0	1	135
sugar price	5019	4.72	2.24	1.83	11.79	-
lagged exits	5019	3.57	3.19	0	11	-
lagged entries	5019	1.86	2.83	0	10	-

Sources: See text.

Table 5. Random-Effects Logit Regression on Permanent and Temporary Closures and Temporarily Inactive Mills

	Baseline regressions		Regressions incorporating control period		
	permanent closures	all closures	permanent closures	all closures	temporarily inactive
age	0.36	0.18	0.68	0.15	0.86 **
	(0.91)	(0.66)	(1.49)	(0.64)	(2.30)
age x controls			-3.03 ***	-1.65 ***	-1.28 *
			(-3.15)	(-3.74)	(-1.86)
expansion history	-1.55 ***	-1.36 ***	-1.70 ***	-1.35 ***	-5.47 ***
	(-3.03)	(-3.54)	(-3.08)	(-3.71)	(-6.42)
expansion history x controls			2.56 ***	1.72 ***	5.53 ***
			(3.08)	(3.67)	(7.20)
capacity	-2.43 ***	-2.10 ***	-2.86 ***	-1.96 ***	-6.27 ***
	(-5.18)	(-6.38)	(-5.44)	(-7.06)	(-9.16)
capacity x controls			0.61	0.76 ***	-0.01
			(1.01)	(2.61)	(-0.02)
local cane market	-0.77 ***	-0.44 *	-0.76 **	-0.22	-0.74 ***
	(-2.57)	(-1.92)	(-2.52)	(-1.25)	(-2.57)
internal transfers			0.19 ***	0.03	-0.20 **
			(2.72)	(0.78)	(-2.49)
North American ownership	0.81 **	0.71 **	1.18 ***	0.53 **	1.82 ***
	(2.00)	(2.22)	(2.73)	(2.07)	(4.28)
bank ownership	0.73	0.33	0.92	0.37	1.07
	(1.12)	(0.64)	(1.62)	(1.09)	(1.54)
refinery ownership	-37.39	-0.48	-33.96	-0.42	-0.53
	(0.00)	(-0.44)	(0.00)	(-0.54)	(-0.38)
prov1	-2.07 **	-1.42 *	-1.56	-1.23 *	-4.06 **
	(-2.07)	(-1.80)	(-1.58)	(-1.87)	(-2.52)
prov3	-0.14	0.04	0.04	0.33	0.31
	(-0.25)	(0.08)	(0.06)	(0.78)	(0.35)
prov4	-0.54	-0.14	-0.37	0.21	1.06
	(-0.96)	(-0.29)	(-0.59)	(0.52)	(1.38)
prov5	-1.42	-1.71	-0.18	-0.27	2.93 **
	(-1.17)	(-1.48)	(-0.22)	(-0.50)	(2.56)
prov6	-1.82 ***	-0.79	-1.78 **	-0.60	0.82
	(-2.65)	(-1.53)	(-2.44)	(-1.40)	(1.14)
price	-0.38 ***	-0.43 ***	-0.46 ***	-0.50 ***	-0.70 ***
	(-3.26)	(-4.80)	(-3.82)	(-6.45)	(-7.47)
lagged exits	0.08	0.12 **	0.11 *	0.12 ***	0.20 ***
	(1.19)	(2.46)	(1.77)	(3.53)	(4.63)
lagged entries	0.08	0.01	0.08	0.03	-0.21 ***
	(1.14)	(0.22)	(1.17)	(0.60)	(-2.96)
controls = 1 from 1931-1939			2.25	-1.17	3.22
			(0.40)	(-0.45)	(0.77)
constant	16.12	14.19	17.82 ***	12.73 ***	41.27 ***
	(4.25)	(5.10)	(4.36)	(5.50)	(7.88)

T-statistics in parentheses.
*** indicates significance at 0.01, ** at 0.05, and * at 0.1.

Table 6. Average maximum mill capacities of mill in each category (metric tons per day)

year	Average grinding capacity for all active mills	Average maximum grinding capacity for all active mills				Ratio of each to the active maximum grinding capacity of active mills		
		active mills	entries	exits	temporarily inactive	entries	exits	temporarily inactive
1919	212	333	462	87	396	1.39	0.26	1.19
1920	223	342	737	78	371	2.16	0.23	1.09
1921	222	339	217	142	442	0.64	0.42	1.30
1922	243	367	581	117	234	1.58	0.32	0.64
1923	250	372	265	203	235	0.71	0.55	0.63
1924	262	373	-	147	263	-	0.40	0.71
1925	274	373	367	139	245	0.98	0.37	0.66
1926	316	383	-	174	184	-	0.45	0.48
1927	321	381	442	220	202	1.16	0.58	0.53
1928	350	389	-	136	190	-	0.35	0.49
1929	358	400	-	187	186	-	0.47	0.47
1930	362	403	-	260	249	-	0.65	0.62
1931	381	423	-	322	216	-	0.76	0.51
1932	383	422	-	472	253	-	1.12	0.60
1933	383	424	-	368	279	-	0.87	0.66
1934	372	421	-	-	241	-	-	0.57
1935	382	426	-	-	228	-	-	0.54
1936	366	404	-	-	277	-	-	0.69
1937	357	394	-	-	295	-	-	0.75
1938	357	393	-	-	368	-	-	0.94
1939	358	394	-	-	334	-	-	0.85

Source: Cuba, Secretaría de Agricultura, Comercio y Trabajo, *Memoria de la zafra* (1919-1929), and *Memoria azucarera* (1930-1939).

[cleansing margins.xls]

Table 7. Estimates of Short-run Cost Increases Caused by Operating Below Capacity

Year	c/c_o (a)	c/c_o (b)
1931	1.36	1.18
1932	1.65	1.44
1933	1.77	1.50
1934	1.97	1.65
1935	1.57	1.34
1936	1.48	1.27
1937	1.38	1.19
1938	1.38	1.19
1939	1.44	1.23

Source: calculations by the authors, using data from U.S. Tariff Commission (1926), and Moreno Fraginals (1978).

[MA est efficiency loss.xls]

Table 8. The Nationality Composition of the Counterfactual Shakeout

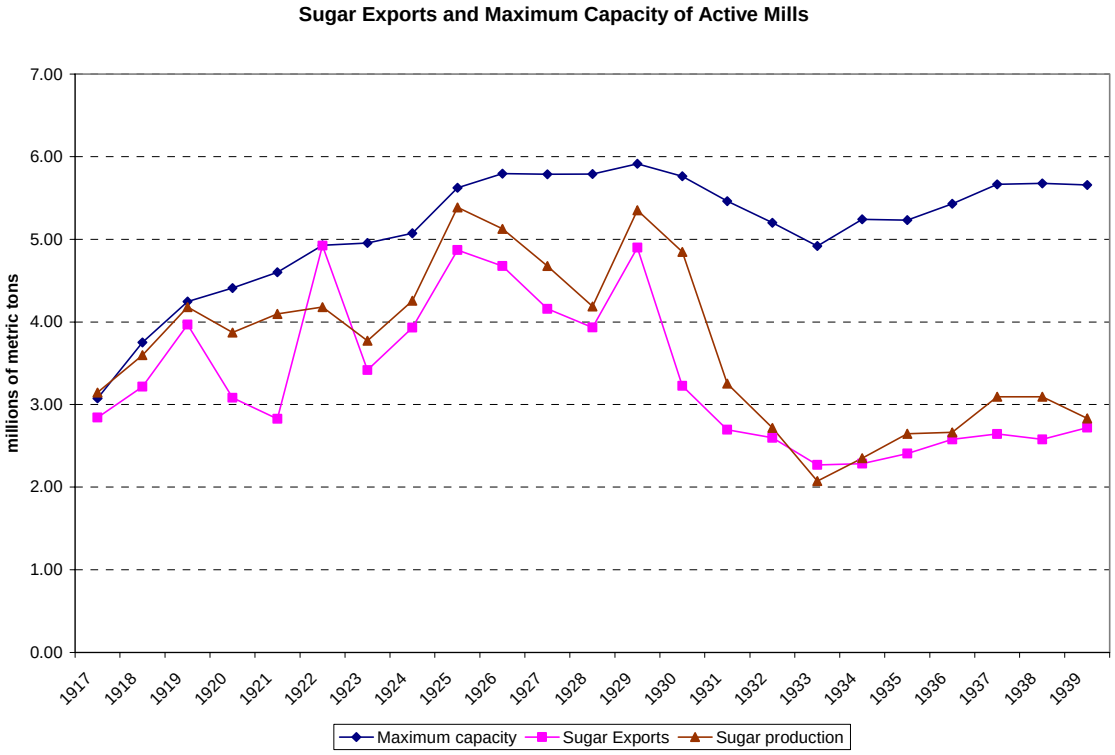
Ownership		Surviving mills	Failing mills
North American	no. mills	39	28
	% of no. mills	81.3	25.7
	% of capacity	85.9	29.8
non-North American	no. mills	9	81
	% of no. mills	18.8	74.3
	% of capacity	14.1	70.2
	Total mills	48	109

Source: Author's elaboration. See text.

Note: the counterfactual is based on the assumptions that (i) by 1939, milling capacity not exceeding the size of the market plus 20 percent excess capacity would have survived, (ii) surviving mills were selected by descending order of daily grinding capacity. Assumption (i) is based on observed excess capacity in the pre-controls period.

[cleansing effect on nationality.xls]

Figure 1. Sugar Production, Exports and Maximum Capacity of Active Mills



Sources: production figures are from Moreno Fraginals (1978), vol. 3; exports are from Cuba Económica y Financiera, *Anuario azucarero* (1959); mill capacities are authors' elaboration using data from the Sec. de Agricultura, Comercio y Trabajo, *Memoria de la zafra* (1919-1929); continued by *Memoria azucarera* (1930-1939).

Figure 2. Raw Sugar Manufacturing Costs per Unit

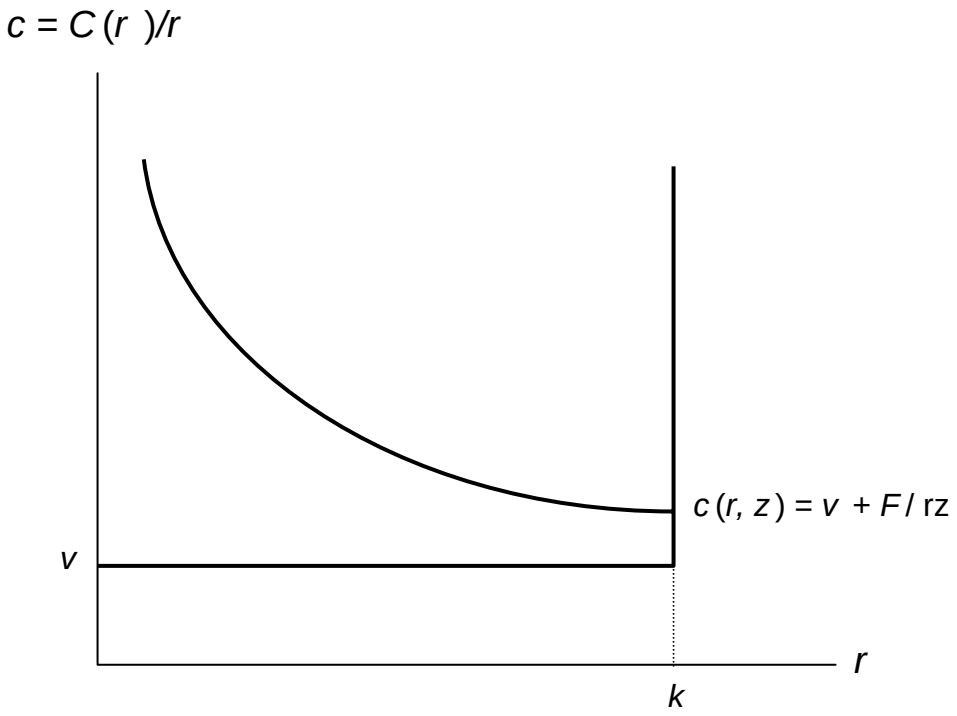


Figure 3. The Price of Sugar in New York and London, New York
(Includes net-of-duty price on Cuban sugar in New York.)

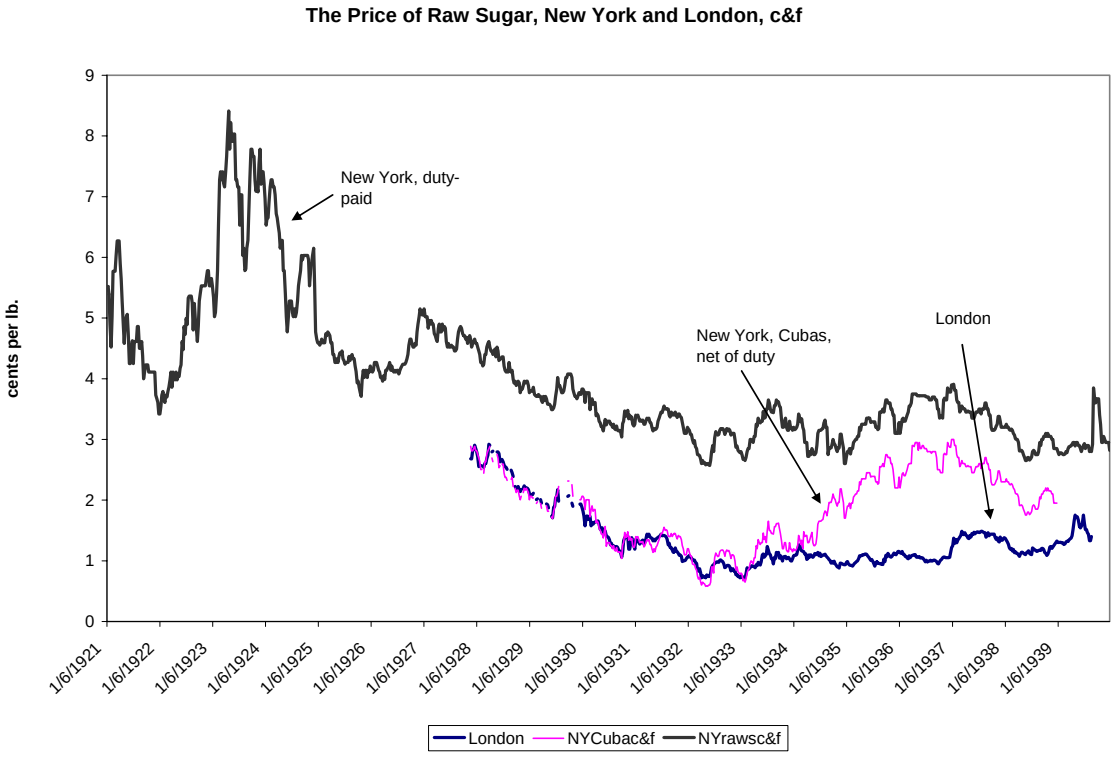


Figure 4. Average Length of the Grinding Season Compared With Production

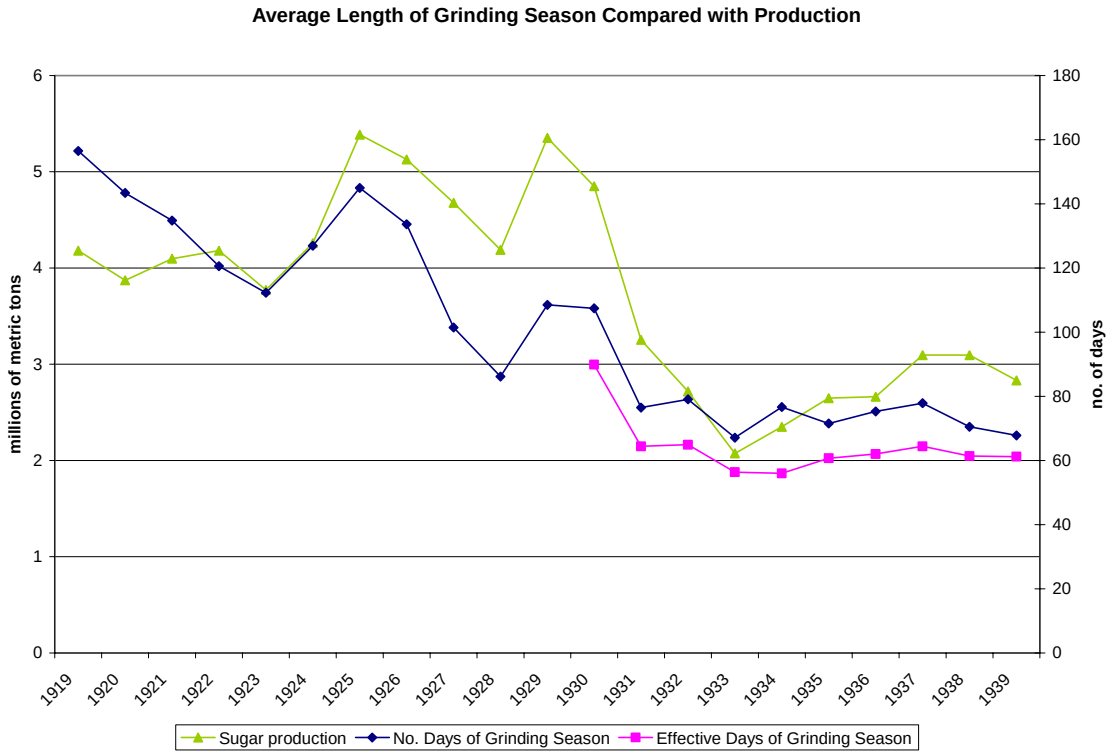
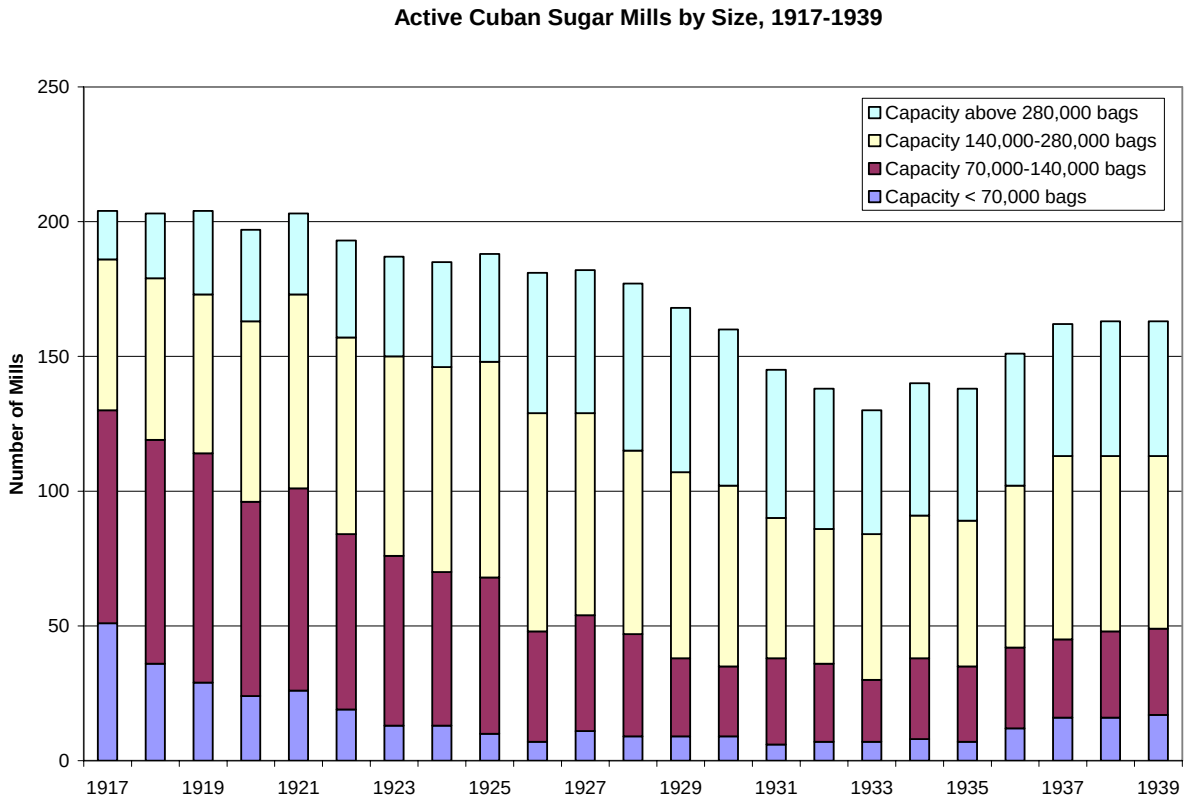


Figure 5. Active Sugar Mills by Daily Grinding Capacities



Source: Cuba. Secretary of Agriculture. *Memoria Azucarera*. Mills' capacities are evaluated at their 1926 levels. Bags are 325 pounds each.