

FACTOR ENDOWMENTS AND CONTRACT CHOICE WHY WERE SUGAR CANE SUPPLY CONTRACTS DIFFERENT IN CUBA AND HAWAII, 1900–1929?

Alan Dye

Until the late nineteenth century the story of cane sugar was the story of plantations. In the latter half of the nineteenth century, and especially after 1880, outside contracting for cane emerged as a viable practice, and in some important pockets of the global cane sugar industry, the dominance of the plantation as the mode of organization of the sugar enterprise was displaced. Although the displacement was not universal, neither was it insignificant. Between 1880 and 1925 market or institutional developments that provided for outside supplies of cane to sugar mills were known to be important in Australia, Cuba, Fiji, Guadeloupe, Martinique, Mauritius, the Philippines, Puerto Rico, St. Lucia, and Trinidad (see Graves 1993, chap. 2; Haraksingh 1988; Johnson 1972;

Advances in Agricultural Economic History, Volume 1, pages 127-176.
Copyright © 2000 by JAI Press Inc.
All rights of reproduction in any form reserved.
ISBN: 0-7623-0612-2

Moynagh 1981; Nagano 1988; North-Coombes 1988; Ramos Mattei 1984; Shlomowitz 1979a; on vertically integrated areas, see Albert and Graves 1988, 1987; Boomgard 1988; Deerr 1950–1951; Mollett 1961). The share of cane sugar on the world market supplied by this set of countries ranged between 45 and 55 percent during those years. That is, the displacement was of global proportions.

Despite its widespread adoption, in the economic historical literature, the outside growing and contracting of sugar cane has been perceived as an anomaly. The principal analysis is provided by Shlomowitz (1984), who demonstrates that, in contrast with cotton, sugar production was subject to transaction costs that favored integrated organization of cultivation and milling. Therefore, after the abolition of slavery, when share tenancy was adopted throughout the cotton South, the “sugar South” preserved the centrally organized plantation, and worked former slaves as wage-earning gang laborers.

But if the transaction costs of producing sugar favored integration, why then was the transition to contracting out experienced in so many parts of the world? The high transaction costs of contracting out for cane could have been offset either by other transaction costs or by lower transformation costs. For instance, smaller units of production might have reduced costs of labor supervision (a transaction cost). Otherwise, the parcelization and allocation of land to smaller operators may have entailed lower pecuniary costs to the mill if the offer of land was seen, by the operator, as part of the workers’ compensation package.¹ Shlomowitz’s findings regarding the Queensland sugar industry place greater weight on the second proposition (1979a, pp. 114–15; 1982, p. 341). He concludes that “in order to induce white labor to enter the sugar cane industry, the plantations were subdivided into parcels of land to be sold or let to smallholders” (1984, p. 15). Subdivision of plantations, he points out, was done in order to attract white settlers who were unwilling to perform gang labor. Comments to that effect were common by contemporaries not only in Australia, but also in Cuba, Fiji, and Trinidad, when outside cane growing was adopted.

Although the “White Australia Policy” was extremely significant to the specific institutional changes in Australia’s sugar industry, it has two major weaknesses when presented as an explanation for why the vertically integrated structure of the sugar plantation dissolved. First, subdivision did not solve the labor-shortage problem. Even after subdivision, efficient harvesting of sugar cane was still done in gangs, and so,

whether employed by plantation managers or farm operators, laborers willing to work in gangs were needed.² As noted, smallholders may have had an advantage in supervision costs; yet other than offering the suggestion, Shlomowitz's findings offered no direct evidence of differential supervision costs. Second, if one seeks a general explanation of the emergence of cane farming, the "White Australia Policy," which represented a major regulatory shock to the labor market, such as does not have a counterpart in many of the countries where outside cane growing emerged. Indeed the environment surrounding the emergence of cane contracting (or the retention of internal cane production by mills), from country to country, is very great. It remains difficult to generalize about its causes because geographical and institutional circumstances differed widely. Other than Shlomowitz, scholars who have written about various national cane-growing systems have not framed their studies in a manner that permits comparative institutional analysis.

In the interest of extending the scope of comparative analysis, this paper focuses on a comparison of the incentive structures behind the choice of organizational modes in the sugar industries of Cuba and Hawaii. As students of organization would expect, both organizational modes were present in both countries. Nevertheless, preponderance of one or the other mode clearly distinguishes the two countries. Hawaii was a case where the former pattern of the vertically integrated structure was largely retained, whereas Cuba was a case where vertical ownership and internal cultivation of sugar cane was widely abandoned in favor of contracting with outside growers. In Hawaii from 1913–1914 only 11 percent of cane was supplied by outside growers, the rest was internally produced. By contrast, in 1913, 87 percent of cane was supplied by outside growers (U.S. Department of Commerce 1917, p. 47; Dye 1998, p. 189). Indeed, in Cuba, the emergence of outside cane growing was seen to be nothing less than a revolution in the way sugar production was organized. New sugar production techniques developed in Hawaii were also seen as revolutionary, but these innovations were organized and implemented within the structure of the vertically integrated mill-plantation complexes, and their trade association, the Hawaiian Sugar Planters' Association.³

The analysis presented below reaffirms, but also completes, Shlomowitz's argument that the tendency toward vertical integration was caused by transaction costs that favored internalization and central organization of cane growing and milling. Although, as Shlomowitz

argues, in the case of sugar, a decentralized, market transaction of cane supplies can result in high transaction costs, it is also true that doing away with the discipline of the market can result in high costs of transacting. The act of internalization (or externalization) of a transaction involves a tradeoff between different sets of transaction costs, or transaction-related problems. I demonstrate that the divergence in organizational practice in Cuba and Hawaii is explained by offsetting transaction costs that, in Cuba's case, favored contracting out for cane supplies, but in Hawaii favored internalization. The differences in transaction costs between Hawaii and Cuba arose out of different factor endowments and technical choices available to the two regions. More specifically, in Cuba high agency costs of internal governance tipped the balance in favor of outside contracting to take advantage of market discipline. In Hawaii greater scope for coordination failure and greater contractual complexity, if outside contracts had been used, led producers to prefer internalization of the cane transaction. The tradeoff in the choice of technique and organizational structure was driven largely by differing land availabilities and capital intensities of cane cultivation.

Regarding the relevance of the places chosen for comparison, Cuba is notable as the country where most sugar made from outside cane was produced. In 1913 Cuba produced about 35 percent of all cane sugar produced in the world, by far the largest contributor of cane sugar on the world market; 87 percent of Cuba's cane crop was produced by outside cane growers under contract. A rough estimate suggests that more than half of the cane sugar produced globally from cane grown by outsiders came from Cuba. Outside cane growing first arose in Cuba in the 1870s and 1880s as the gradual transition away from slave-based production proceeded (Scott 1984, 1985; Bergad 1990; Venegas Delgado 1987; Guerra y Sánchez 1944; Eltis 1987). By the 1890s the share of cane supplies coming from outside growers had risen to about 30 percent; by 1905 it had risen to 70 percent; and by World War I it was above 80 percent (Dye 1998). The transition appears to have happened in Cuba at about the same time it did in Australia. In other places it often happened later, as scholars have noted for Trinidad and Fiji (Shlomowitz 1982; Moynagh 1981; Johnson, 1972; Beachey 1957). But in comparison with Australia, whose industry was protected and produced sugar primarily destined for domestic consumption, almost all of Cuba's sugar was exported, and indeed, it had to overcome tariff barriers. Most was sold in the United States at a 20 percent discount from the

official full sugar duty. However, after 1909 Cuba was the only duty-paying country that exported sugar to the United States. One of its chief competitors in the U.S. market was Hawaii.

By the end of the nineteenth century a large number of new suppliers of cane sugar entered as competitors in the world market which did not have a history of slavery. Many of these had vertically integrated firm structures. Notable for their technological successes were Hawaii and Java. However, we also find emergent suppliers, without a history of slavery, that depended primarily on outside cane growing. Notable were Australia, Fiji, and the Philippines. In Cuba, because of its history of slavery, which ended at about the same time as the outside cane growing institution there was adopted, it has been argued that its rise was because of the ending of slavery. As we will note in the last section, there are strong reasons to believe that the influence of slavery was secondary to other important influences, in particular technology. It was the emergence of new technology which gave rise to "central milling" that caused the transition to occur in Cuba and Australia at roughly the same time.

The paper is organized in the following way. The first section discusses the incentives for vertical integration of cane growing and milling. The second section discusses the reasons for the differences in the choice of cane cultivation techniques in Hawaii and Cuba. The next few sections focus on a comparative analysis of particular problems of cane field management in Cuba and Hawaii. The conclusion summarizes and attempts some generalization by comparing the findings here to the observations about the Australian, Louisiana, and other sugar industries.

VERTICAL INTEGRATION

A central question in the economic literature on contracting has been: what causes a firm to integrate backward by internalizing the production of an intermediate product that could be purchased on the market? One of the most frequently advanced reasons is the presence of specific assets in one or both stages of production. When this concept was first introduced and developed by Klein, Crawford, and Alchian (1978) and Oliver Williamson (1983, 1985), its proponents argued that the stability of contractual agreements broke down in the presence of specific assets and led to vertical integration despite the problems of internal governance it created. Empirical work that has followed has identified many

instances in which the prediction is consistent with the evidence, but it has also identified important cases in which long-term contracting is used as a substitute for integration to mitigate the problems in buyer-supplier relationships caused by specific assets (Monteverde and Teece 1982; Masten 1984; Joskow 1988; Stuckey 1983). These studies suggested that the original claims made by the proponents of the theory related to specific assets were too strong. The presence of specific assets did not always break down the ability of a buyer to contract with a supplier, yet sometimes it appears to lead to vertical integration.

Exactly what determines the choice between internal organization and the contractual alternative has not been transparent. Subsequent empirical work has suggested that the choice between long-term contracting and internalization of the supplier stage depends on relative, or offsetting, transaction costs. For example, Joskow finds for coal-burning utilities, where strong site specificity is prominent, that location of the utility next to the coal mine that supplies it intensified the degree of site specificity and most often results in integration of the two activities. Similarly, Scott Masten finds that greater complexity of the processes associated with the production of aeronautical components more likely leads to vertical integration of buyer and supplier, whereas a lesser degree of complexity often permits successful long-term buyer-supplier agreements. Presumably, in the latter case, the relative costs of negotiation make the difference; and in the former, the large gap between the current supplier and the next-best alternative precludes any credible threat of withdrawing from the relationship. Typically, the discipline of the market does not work if one or both parties perceive no reasonable alternatives. The obverse, however, is also true. To the extent that the parties do perceive alternatives, the more internalization may be resisted—to preserve the disciplinary advantages of the market. Therefore, internalization of a supplier relationship might happen because of the presence of a specific asset, but the firm will weigh the expected gains from internalization against the expected costs (inefficiencies) of internal governance. In short, internalization may result in reduced transaction costs associated with a specific asset, but it may also create higher transaction costs in other spheres of activity within the firm.

The modern sugar industry provides an intriguing case study of this organizational decision. By the beginning of the twentieth century both internal and market organization for arranging cane supplies at sugar mills were used worldwide. A substantial investment in specific assets

was required to complete the transaction of cane between the grower and the mill. As will be explained below, this made the mill vulnerable to holdup and provoked the need either for a contractual arrangement or for internalization to resolve the transaction costs associated with the threat of holdup (Dye 1998, 1994a). Similar milling technology used in Cuba, in Hawaii, indeed, throughout the world, produced similar transaction costs associated with strong asset specificity, which created an incentive for integration. Therefore, variation in contractual practices must have been caused by other influences. An obvious candidate is offsetting transaction costs. First, I discuss the particular circumstances creating specific assets in the sugar industry, then, I address the question of offsetting transaction costs.

Technology, Fixed Costs, and Coordination

Technical features associated with the process of cane sugar manufacture provide the incentive basis for internalization of the cane transaction; therefore, some background in cane sugar manufacturing technology will be useful. The process of cane sugar manufacture is essentially the extraction of sucrose from cane. At the mill, sugar cane is ground, and the resulting cane juice is purified, evaporated, and crystallized. In the final stage of processing the crystallized sugar and its byproduct, molasses, are separated. In 1860 the grinding process was mechanized, but the subsequent processes relied on a basic technology that had existed for a century or more. By the end of the nineteenth century application of sophisticated equipment and the concept of continuous processing had fundamentally transformed the sugar mill. As a consequence, the capital intensity of sugar milling increased considerably. And similar to the experience of other industries that adopted continuous-process technology during that period, the scale of production increased enormously. The average capacity of sugar mills rose roughly by a factor of 100 between 1860 and 1929 (Dye 1998). By the beginning of the twentieth century cane sugar manufacture had become a highly sophisticated industrial process. Fixed capital costs were a large component of the total costs of production. Efficient use of the capital equipment required a continuous flow of materials through the factory. Interruptions or shortfalls in the supplies of cane to the mills raised unit fixed costs and could have a substantial impact on the profitability of the sugar enterprise.

The tendency of sugar mills to remain vertically integrated is explained primarily by the interaction of a biological characteristic of cane as a raw material and sugar manufacturing technology. The quality of cane is highly sensitive to the timing of the harvest and grinding. Once cane is cut the sucrose content and the water content of the cane declines rather quickly. Since the process of sugar production is essentially the extraction of sucrose, these losses represent a rapid deterioration in quality once it is cut; therefore, it must be shipped almost immediately to be processed. A rule of thumb often cited is that cane should be ground within 24 hours after cutting. To accomplish this, the harvesting and grinding of cane had to be synchronized and closely coordinated (Shlomowitz 1984, Moreno Fraginals 1983, 1986).

Reliability of cane deliveries was a great concern to mill managers. Permitting cane to accumulate at the mill increased production costs because of the rapid deterioration in quality of the raw material. Delays in delivery were also costly because the time lost resulted in a considerable increase in unit costs (because unit fixed costs were a large component) and fuel costs increased as boiler pressure was lost and extra fuel had to be spent to rebuild it. The standard practice in Cuba during grinding seasons was to run the mills 24 hours a day, with scheduled stops only for cleaning. Consequently, coordination of the harvest and milling activities was one of the principal problems to be addressed in a successful sugar enterprise. Minimizing the delays at the mill was key to a successful enterprise. Dye (1998) shows that in Cuba delays in cane deliveries were by far the most frequent cause of unintentional stoppages of mills. Resolving the bottlenecks was one of the principal problems that managers faced on a day-to-day basis.

According to Shlomowitz (1984, p. 9), it was the strict coordination requirements and the high fixed costs in sugar milling that caused the transaction costs of using outside suppliers to be prohibitively high. His argument can be understood by considering the following model of cane acquisition. Mill owners had the option of obtaining their cane supplies from one of two possible contractual arrangements. They could either contract with outside suppliers or they could organize cultivation internally.

1. Spot transactions were not possible because of the speed of delivery and coordination required and the increase in unit fixed costs the mill would suffer in the event of a shortfall or

- interruption in cane deliveries. Because of the sensitivity of the mill's costs to shortfalls in deliveries, the mill could not transfer the risks or agency costs of growing the cane entirely to an outside supplier.
2. Contracting with outside suppliers entailed high transaction costs because it required negotiating an agreement that would assure adequate supplies of cane and prevent coordination failures at delivery. The agreement would also have to be monitored and enforced.
 3. As an alternative to contracting out, internalization of the cane transaction offered advantages. Internal governance of the cane transaction placed the control of planting and harvest decisions in the hands of the central organization.

Internalization also entailed an offsetting set of monitoring and enforcement costs to ensure satisfactory managerial performance within the organization. With an outside supplier, these costs were reduced by built-in market incentives, but with internalization, the costs of monitoring and enforcing the agreement with the internally employed cane field manager rose because the self-motivating discipline of the market was replaced by less effective internal mechanisms for discipline (for example, see Williamson's [1985] discussion of selective intervention).

Asset Specificity and Holdup at the Sugar Mill

To explain the tendency to retain the vertically integrated structure in sugar mills, Shlomowitz suggests that the transaction costs of negotiating, monitoring, and enforcing contracts with the outside supplier exceeded the transaction costs associated with internal governance. As evidence, he cites contemporary reports from Queensland and Louisiana that assert the riskiness of shortfalls when relying on contractual arrangements for cane. The difficult task of measuring the direct impact of the proposed transaction costs was not accomplished in this study. However, in other empirical work it has been shown that contractual complexity, such as these coordination requirements introduced, does lead more frequently to internalization of the transaction (Joskow 1993, pp. 128, 131–32; Masten 1984).

Analysis of specific assets in the cane transaction both reinforces Shlomowitz's coordination-based argument and focuses on one type of transaction costs that is more easily operationalized. The story of the rise of holdup problems in the Cuban sugar industry is the following. The deterioration of cane after cutting and the necessity of strict coordination of the harvest and grinding activities required that cane be hauled quickly to the mill. In the days of slave-based plantations, hauling was done using oxen or mules. As the cane requirements per mill increased under the new technology in the late nineteenth century, draft animals were found too slow or unreliable to cover the greater average hauling distance. Innovations in cane transport were used everywhere to increase the speed and reliability of delivery to the mills. For most sugar-producing countries the railroad became an essential feature of the modern sugar mill to ensure quick delivery of the massive quantities of cane needed by the new continuous process mills (Dye 1998; Moreno Fraginals 1983, 1986; Guerra y Sánchez 1944).

Because of the use of the railroad, whenever a producer contracted for cane with a new outside supplier, investment in a rail line to connect the supplier's cane fields with the mill was required to complete the transaction. The rail line, fixed once it was laid down, was a site-specific asset, tied to the site of the outside supplier's cane fields.⁴ The party which invested in the specific asset, usually the mill, is subject to potential opportunistic behavior (Williamson 1985; Klein, Crawford and Alchian 1978). Even though the two parties may have agreed *ex ante* on a mutually beneficial price and other stipulations in the contract, once the railroad was built, the second party—the outside supplier—could appropriate a greater portion of the quasi-rents from the investment by threatening to hold up the transaction. Because the railroad expenditure was now sunk, the outside supplier could force the mill to renegotiate terms up to the point where the losses to the mill were equal to the salvage value of the railroad (which was considerably less than its use value). Evidence of these problems is readily found in the statements of mill managers and in the relative costs of cane between mills (see Shlomowitz 1984; Dye 1994a). Econometric evidence that holdup problems had an effect on investment decisions is found in Dye (1994b). The potential holdup costs associated with investment in cane railroads gave strong incentives for the internalization of cane cultivation by the mill to reduce these costs.

The literature on the economics of organization has shown that specific assets introduce problems in formulating stable and enforceable contracts that satisfy the expectations of both parties in the contract. As noted, empirical studies of specific assets have shown that internalization of the transaction is sometimes undertaken by firms, yet in other cases, long-term contracts are devised that substitute for internalization as a means to mitigate the costs of holdup. In the next sections I argue that, for the choice of organization in sugar, the incentives created by site-specific assets were universal. Or at least, they were common between Cuba and Hawaii, because similar industrial technologies were used to process the cane. What differed significantly between the two places was the techniques used to cultivate cane and deliver it in a timely fashion to the mills. Those differences resulted in different preferences for the cane transaction.

In the early formulations of the theory, Williamson (1985, pp. 95–96) argued that some forms of asset specificity were stronger in degree; he suggests that site specificity is possibly the strongest.⁵ Furthermore, Joskow (1985) gives evidence that the site-specific assets that are located together (such as mine-mouth utilities, or in case of cane supplies, fields adjacent to sugar mills) increases the probability that vertical integration will be used instead of long-term contracting as a provision to guard against potential opportunism (see also Joskow 1993, p. 126).⁶

Although the singling out of site specificity as a category, rather than as a magnitude to be measured, is too simplified, the distinction might lead one to expect the long-term contracting solution to be less probable in the case of arranging for cane supplies than in other industries, where the specific capital is less fixed. If so, the emergence of outside cane supplying arrangements appears as the choice in greater need of explanation.

Regardless, Cuban producers clearly showed a preference for contracting arrangements. The share of cane coming from outside growers, referred to in Cuba as *colonos*, rose from 70 to 82 percent between 1905 and 1927. This trend suggests that there was something inherently attractive to the mills about the outside supplier arrangements as they were set up in Cuba. Other evidence supports this notion. Correspondence between mill managers indicates that problems of coordination during harvest attributed to the *colonos* persisted, yet suggestions that the cane fields be internalized were not frequently raised, and when

they were, more experienced managers dismissed them saying that the *colonos* were essential to the efficient operation of the mill.⁷ Furthermore, a survey of sugar industry conditions in Cuba by the U.S. Department of Commerce (1917, p. 375) determined that *colono* cane was produced at lower unit costs than internally produced cane. Unit cane costs were estimated at \$2.64 per 100 arrobas for internal cane and at \$2.04 for *colono* cane (1 arroba = 25 lbs.) The evidence suggests that there were cost advantages in contracting with outside suppliers in Cuba that offset the coordination and holdup problems that otherwise plagued the nonvertically integrated sugar enterprise. If so, what were they? The techniques used for sugar manufacture were similar in Cuba and Hawaii, but the techniques used in cane cultivation differed. The answer may lie in the differences in the choice of techniques used for cane cultivation.

THE CHOICE OF CULTIVATION TECHNIQUES

Differences in factor endowments resulted in different choices of cultivation techniques between the two countries. In determining these choices, the most important was the relative availability of land suited to cane cultivation. Cuba was known to have an almost ideal climate and perhaps the best soil conditions in the world for sugar cane. Not only this, the favorable soils were in great abundance and stretched continuously across the plains of the central and eastern parts of the island. This continuity prevented geographical barriers from acting as constraints on the area that new large-scale mills serviced, and the flatness of the terrain permitted relatively low-cost construction of railroads connecting fields and mills.

Hawaiian sugar producers did not enjoy the abundance of fertile, easily accessible land that Cuba's vast fertile plains offered. Hawaiian soils suited to cane were scarce, usually located along the coastal areas and limited in area. Mills were usually built along the shore and the cane fields on the slopes nearby. Given the mountainous topography of the islands, the good cane lands were often separated or interrupted by steep gradients. This both prevented the easy consolidation of good cane lands and made the cost of railroad construction relatively high. In fact, in Hawaii alternative means were often used to transport cane from the fields to the mills on the shore below. One of the more interesting alternative forms was the portable flume, which had the advantage of

being less costly than a railroad on steep slopes but the disadvantage of operating only in one direction (Mollett 1961, p. 24; Maxwell 1927; U.S. Department of Commerce 1917; Vandercook 1939).

The implication for the economies of scale in milling is obvious. At Hawaiian mills, expansion of the cane zone to service a mill was often quite limited so that much more attention was put into raising the yields per acre in Hawaiian cane cultivation as a means of reaping economies of scale in milling. Meanwhile, the Cuban strategy for reaping economies of scale at the mill was to extend the boundaries of the mill's cane zone and rely on lower-cost railroads to bring in cane from greater distances. Output per mill in Cuba averaged 26,300 tons compared with 17,600 tons in Hawaii (Maxwell 1927, chap. 8). Accordingly, the yield of cane per acre in cane in Hawaii was about twice that in Cuba (U.S. Department of Commerce 1917, p. 374; HSPA 1921, p. 12). This figure belies an even greater difference in intensity of use of each acre since Hawaii's cooler climate also requires an 18-24 month growing season to reach maturity in comparison with a 12-15 month growing season in Cuba, which meant that only half of the Hawaiian acreage was harvested each grinding season (Maxwell 1927, p. 21).

The higher yields per acre in Hawaii were accomplished through the greater application of complementary inputs. In particular, cultivation of cane in Hawaii was known to be the most capital-intensive in the world. Mechanization in the fields had advanced more than in other places, but more important was the extensive use of irrigation and new agricultural technology to increase yields. By contrast, the capital intensity of cane field work in Cuba was on average quite low. In the more virgin lands, cane was said to grow "like a weed." Land that had been in use longer required more attention, but the qualitative differences with Hawaiian fields were still great (Maxwell 1927, pp. 13-14).

Besides less favorable soil and temperature conditions, Hawaiian producers also faced unfavorable natural rainfall patterns. Rainfall was abundant on the windward side of the islands, but the best soils were situated mostly on the leeward side (Maxwell 1927, pp. 10-12). Because of the lack of coincidence of water and good cane land, massive irrigation systems were absolutely necessary to carry the abundant rainfall to the cane fields. Huge investments by the mills in reservoirs and other irrigation infrastructure were made to solve this problem. By contrast, in Cuba irrigation was rare. Their natural rainfall patterns suited cane, except that droughts devastated crops in some years. Table 1 gives the

Table 1. Use of Intensive Cane Cultivation
Methods in Hawaii and Cuba, 1913–1914

	Cane obtained ^a	
	(millions metric tons)	(percent)
Hawaii, 1914		
irrigated	3.1	82
fertilized	3.9	100
total	3.9	100
Cuba, 1913		
irrigated	2.1	9
fertilized ^b	8.2	36
total	22.7	100

Notes: ^a The figures for Cuba overstate the amount of cane obtained from irrigated or fertilized fields. Mills in the Cuban data reported irrigating and fertilizing categorically (binary response) even though in all cases only a fraction of their canefields were irrigated or fertilized. The data for Hawaii indicate on the other hand that a large number of mills were wholly irrigated and/or fertilized. Therefore the figures in the table are biased toward making Cuba and Hawaii look more alike than they actually were.

^b "Fertilized" means use of commercial fertilizers. Traditionally throughout Cuba, the leaves of the cane were left on the fields as natural fertilizer.

Sources: Cuba, Secretaría de Agricultura, Comercio y Trabajo (1914); U.S. Department of Commerce (1917).

percentages of mills using irrigation for 1913–1914. The table shows that in Hawaii 82 percent of the cane was produced using irrigation, and in Cuba 9 percent of the cane mills were only partially irrigated. These data actually understate the true differences in the amount of irrigation used. The Hawaiian figures for irrigated cane were aggregated at the mill level; 60 percent were categorized as wholly irrigated while 22 percent were declared partially irrigated. In Cuba the data express the amount of cane ground by a mill that can claim *some* use of irrigation. No distinction similar to the one in the Hawaiian data was made because all mills were only partially irrigated. Typically, those mills in Cuba that used irrigation only irrigated a select few fields which were directly managed by the mill.

Complementary to irrigation was the application of commercial fertilizers. The use of nitrates was highly effective if they could be applied with ample amounts of water in a controlled environment—implying the complementarity of irrigation. In Cuba the use of commercial fertilizers was more frequent than irrigation but not extensive, and Cubans typically saw their results as marginal. Table 1 gives some idea of the

Table 2. Unit Costs of Production, Cuba and Hawaii
(cents/lb.)

	1913-1914		1917-1918		1921-1922	
	Cuba	Hawaii	Cuba	Hawaii	Cuba	Hawaii
Cane costs	1.03	1.92	2.20	3.53	1.16	2.64
Manufacture and Transportation	0.43	0.33	1.07	0.44	0.28	0.35
Repairs, maintenance & fixed charges	0.39	0.82	0.89	1.38	0.71	1.02
Total unit costs	1.84	3.07	4.16	5.34	2.15	4.01
U.S. duties paid	1.35		1.00		1.76	
Unit costs + duties paid	3.20	3.07	5.17	5.34	3.91	4.01

Sources: Prinsen Geerligs et al. (1929, p. 9); U.S. Tariff Commission (1919, pp. 14-15); Czarnikow-Rionda (1930).

differences in use. All mills in Hawaii were fertilized, but only 36 percent of mills in Cuba used some amount of commercial fertilizers. Again the figures understate the differences because the amount of fertilizer used per mill, the number of fields actually fertilized, and the effectiveness (expected benefit) of fertilizing were all much lower in Cuba.

To develop varieties of cane that would do well in the Hawaiian climate and epidemiological environment also required breeding of new strains, and mills generally went to considerable cost and effort to attract experienced technicians from the mainland. Therefore, the human capital component of cane cultivation was high in Hawaii (Mollett 1961, p. 39). Furthermore, the soils were worked more, which required more capital either in machinery—steam plows were in common use—or in draft animals. In Cuba fields were plowed less frequently, sometimes not at all. At times fields were not cleared of stumps and stones, as is typical of more extensive agricultural methods. And until 1927 when mosaic disease hit Cuban fields, the naturally occurring cane variety, *cristalina*, was preferred almost everywhere in Cuba with results that were the envy of the rest of the world (Maxwell 1927; Cuba, Secretaría de Agricultura, Comercio y Trabajo 1914; Ayala 1995).

In summary, Hawaiian mills were capital-intensive, and Cuban mills were land-intensive. Because of relatively limited suitable lands and less naturally favorable rainfall patterns, Hawaiian sugar producers concentrated on developing and applying intensive agricultural methods to increase cane yields per acre (Mollett 1961, p. 24). In Cuba land abundance and natural conditions were so favorable that capital-inten-

sive cultivation was unadvised. Cuban producers, by contrast, continued to rely on natural rainfall, and they found land-intensive methods to be the most economical (Deerr's report in U.S. Department of Commerce 1917, p. 375).

The differences in technique, of course, had cost implications. Unit cane costs were relatively high for Hawaiian mills. Table 2 shows that they were 75 percent higher in Hawaii than in Cuba in 1913–1914 and more than twice as high in 1921–1922. The differences in cane costs translated into higher overall unit costs in Hawaii, but these were offset by the duties Cuban producers had to pay to have access to the U.S. market. Hawaiian sugar was domestic and paid no duties.

CANE FIELD MANAGEMENT

The coordination problems and the presence of site-specific assets present at all modern mills arguably biased the organizational choice in favor of integration. Why, then, did Cuba, as well as a number of other sugar-producing countries, develop the practice of contracting out for cane? The next few sections focus on Cuba and argue that offsetting monitoring and enforcement costs of internalization discouraged internalization of the cane transaction in Cuba. It will be seen, however, that choice of the contracting option also depended on a contractual arrangement that gave the mill considerable rights of control to coordinate both the size of the growers crop and the timing of deliveries of cane to the mill so that they were adaptable to unexpected changes in the mill's needs. Subsequent sections discuss how priorities, from the mill's standpoint, as to how cane cultivation and deliveries were organized were not the same in Hawaii.

We might begin with a contemporary explanation of contracting out in Cuba. The U.S. Department of Commerce conducted a detailed survey, published in 1917, of sugar production costs and practices in Hawaii, Louisiana, Cuba, and Puerto Rico. The part on Cuba was conducted by a team of scientists headed by Professor Earle, who directed the Experiment Station at Santiago de las Vegas and studied the methods and practices of cane cultivation employable in Cuba. Part of their study focused particularly on the cane farming institution, or "*colono* system," which was considered "peculiar" in light of the practices found among U.S. domestic producers. They concluded that there were

two principal reasons that the *colono* system offered special advantages in Cuba:

It is the practice on many estates to divide the cane fields among a large number of colonos an important advantage being the *better protection against fire*. The small cane farmers will watch their cane areas more closely than is possible through supervision of the large estate. The large labor force used in growing cane, especially in the harvesting, is difficult to obtain by one employer for a large area, and it is found that the *colono* can *more readily secure the help he requires*, and, having a direct pecuniary interest, will be apt to exercise more efficient supervision (U.S. Dept. of Commerce 1917, pp. 364–65, emphasis added).

Their conclusions point to the argument that *colonos* in Cuba were more effective managers in the fields for preventing fires and maintaining labor supplies. Transaction-cost considerations support the argument. As a residual claimant in the sugar enterprise, the *colono* would naturally have had a greater income incentive than a salaried manager to halt any threats to the resources of the enterprise such as a shortage of cane or labor. For example, if fire threatened, the *colono*'s income was highly sensitive to a shortfall of cane. However, one would think that similar advantages to such built-in income incentives would have accrued to Hawaiian producers as well.

A model to set out explicitly the organizational choice on which we focus will be useful. The mill's profits are given in equations (1) and (2).

$$\pi^M = (ps - v)Q^H - G(Q^e, k) - M \quad (1)$$

$$Q^H = Q(Q^e, \theta, e) \quad (2)$$

where π^M is the mill's profits of one grinding season, p is the price of sugar, s is the ratio of sugar to cane ground, Q^H is the cane harvested. Q^H is dependent on Q^e , the ex ante expected volume of cane formed at the point of planting; θ , which represents uncertain factors that can affect the volume of cane harvested at the end of the season; and e , which represents managerial effort. Three types of costs are singled out. The variable, M , represents all costs at the mill and is assumed to be predetermined, largely dependent on mill capacity. The function, G , represents the field costs of planting, soil and crop maintenance, dependent on the area planted and capital embodied in physical equipment, the technical staff and infrastructural capacity in the fields, captured by

Q^e and the capital-intensity of field work, represented by k . The costs of the harvest, dominated by labor costs, are represented by v . Actual practices were consistent with this specification—field labor was usually paid piece rates, or, to be precise, by the weight of cane handled.

Equation (2) focuses on the principal organizational question, which regarded the conversion of cane plantings into harvested cane. The issue was who would be responsible for carrying out the process represented in equation (2), or who would incur the costs of an unexpected shortfall in Q^H/Q^e . To clarify what this stage of production consisted of, in both Cuba and Hawaii the mill organization handled the transportation of cane from the fields to the mills through a separate internal department, but the field gangs were responsible for placing the cut cane in the hands of the cane transportation department. In Cuba this most commonly meant delivery of the cut cane by ox-cart to a designated railroad loading station. In Hawaii cut cane was sometimes delivered to a loading station, but more often portable railroads or flumes were placed at intervals in the fields. In short, equation (2) represents the process of planting the crop, bringing it to maturity, harvest, and delivery into the hands of the transportation department, and the principal difference between Cuban and Hawaiian organizations was whether this set of responsibilities was internalized or not.⁸

As regards the question of who was responsible for equation (2), we might characterize the choice as being one of two possibilities. The mill might have placed the supervision of the fields in the hands of a salaried manager or it might have placed it in the hands of an outside supplier. If the latter was chosen, arrangements had to be made as to who would provide the land and capital needed for the field work. These arrangements varied in Cuba. *Colonos* were sometimes landowners and sometimes tenants of the mill. A *caveat* should also be noted. They were not counterparts to sharecroppers or share tenants in the southern United States. Many were small-holders, but many others were large landholders, sometimes of the aristocratic or merchant classes in Cuba.⁹ *Colonos* spoke of themselves as businessmen and managers. Outwardly, their principal tasks were the hiring and managing of the labor-intensive tasks of cane field work—the planting and the harvest. These tasks were typically performed employing labor gangs seasonally (Dye, forthcoming; Guerra y Sánchez 1944; Martínez-Alier 1974; Scott 1985).

The use of a fixed-salaried field manager meant that the responsibility for the cane field work was in the hands of the mill because the costs of

poor managerial performance would be incurred directly by the mill. Salaries to field managers in Hawaii were not strictly fixed. Bonuses were also used to encourage satisfactory performance, but the size of bonuses was internally determined by the mill central management, and one can infer that they were a blunt rather than a sharp instrument for transferring responsibilities to the field managers (Maxwell 1927). An alternative was to contract out for cane supplies similar to what was done in Cuba. In Cuba payment to the *colono* was determined in the contract as a fixed payment in sugar per 100 pounds of cane delivered. The income received by *colono* i is characterized by:

$$\pi_i^C = p(\lambda_i - w_i)q_i^H - g_i(q_i^e, k_i) \quad (3)$$

where π_i^C is the residual claim of *colono* i , λ_i is the rate of payment, which ranged roughly between five and seven pounds of sugar per 100 pounds of cane in the period we are looking at, or around half the sugar output for a given amount of cane, although the exact proportions in terms of sugar output depended on mill performance. Regarding the costs, w_i is the unit labor and material costs, and $g(q_i^e, k_i)$ is the capital, planting, and maintenance costs. The *colono*'s cane production function is $q_i^H = q(q_i^e, \theta_i, e_i)$. What is distinctive in the payment scheme represented in equation (3) is that the *colono*'s income was sensitive to shortfalls in cane regardless of their cause. It was also sensitive to risks due to the prices of sugar and field labor (Stiglitz 1974). It is argued below that this kind of payment scheme was particularly useful because of the nature of the contingencies that could affect q_i^H in Cuba, which are captured in θ_i , and the incentives for a more effective managerial response to those contingencies, reflected in e_i .¹⁰

The fact that the Department of Commerce report gave equal, or perhaps greater, weight to cane fire prevention among its two principal reasons may, to the reader, seem misplaced. Management of labor gangs during the harvest was one of the principal tasks to be performed in the cane field. One would think that cane fires would have been a secondary consideration whose risks could have been reduced by insurance. I argue that the two reasons given in the report are more similar than they appear at first glance. The underlying advantage of the *colono* system in Cuba was that it was more effective in responding to contingencies that might be classified as crisis situations in which brief negligence or slowness of response would threaten a substantial shortfall of cane.

Recalling equation (2), the advantage of the *colono* system was the vigilance and responsiveness it evoked in managerial effort, Δe_i , to an unexpected threat, $\Delta \delta_i$, to q_i^H/q_i^e .¹¹ Regarding the task of fire prevention, the argument is: Using a salaried manager, mill management would have found it prohibitively costly to monitor effectively the qualities of effort—vigilance and immediate responsiveness—required for effective fire prevention (Barzel 1982). Therefore, *colonos* were employed instead of salaried managers in Cuba. For such an argument to hold, it must be that the threat of fire damage in Cuba was an ever-present menace and that conditions in Hawaii were much different. This indeed was the case, as we shall see.

As regards labor management, the advantage of the *colono* system to the mill was not in the direct supervision of labor tasks. In the literature, to explain the pervasiveness of share contracts in agriculture, it is sometimes argued that monitoring costs are higher in agriculture because the work is often performed in the absence of the landowner. Consequently, it is difficult to distinguish between the effects of stochastic influences and shirking in field labor. This argument, which applies specifically to the laborer, does not apply directly to the choice of the share arrangement in *colono* contracts because the share is going to the *colono*, who manages the field workers, but performs little, if any, of the labor himself. *Colonos* offered income incentives to laborers in other ways. Both piece rates and the employment of subcontractors for specific tasks or services were common. Besides, labor tasks in cane cultivation were naturally performed in gangs. For the work of cutting and hauling, workers' individual outputs were measurable, so monitoring costs remained relatively low. Rather than the quality of labor, it was often the quantity of laborers that threatened the efficiency of mills. Unexpected fluctuations in the local demands or supplies of field labor had to be resolved quickly in order not to disrupt the coordination of field labor with the objective of continuous grinding at the mill. Just as in the case of fires, the advantage of the *colono* seems to have been his degree of responsiveness to an unmet need, which of course was motivated by the income losses he would incur. I argue below that, as in the case of cane fires, fluctuations both in local labor demands and labor supplies were greater in Cuba than in Hawaii.

A second feature in the central mill management's cane management policy was important for the assignment of income losses from fire damage. Equation (1) suggests that the profits of the mill also were

quite sensitive to the performance of the *colono*—whether there were shortfalls of cane. However, contractual stipulations determined that losses due to shortfalls of cane (caused by fire or other causes) were often only incurred by the *colono*. It was the policy of central mills to arrange to plant more cane than they expected to grind in order to have surpluses to serve as buffer supplies. Then, if losses of standing cane were moderate, the mill suffered no reduction in the amount of cane delivered, Q^H , even though total available cane was reduced, Q^e less any losses due to fire or other contingencies. By contrast, the same absolute losses of cane would have represented relatively more of the total income base of *colonos*. *Colonos* who suffered fire damages were much more likely to incur substantial losses. Obversely, buffer cane left unharvested one year could be harvested the following year with little or no loss of cane quality.¹² Therefore, arranging for more cane than could be ground in a season acted as an insurance policy for the central mill against shortfalls of cane due to fire or other contingencies. Minor fires might also not have had any effect on the *colonos*' expected income, but fires tended to spread quickly so that buffer stocks were not effective insurance for the *colono*, unless the *colono* took preventive action quickly.

The Incidence of Cane Fires

Did the threat of fire in Cuba weigh as heavily as the Department of Commerce report suggested? Could the threat of fires truly have been a deciding factor in contract choice? An affirmative answer would depend largely on frequency and the potential or expected damage that fires could do.¹³

Quantitative evidence of the 1920s indicates that the incidence of cane fires each year was remarkably high, sometimes surprising. Tables 3 and 4 give data regarding the percentage of the cane crop that was burned each year (ratio of cane burned to cane ground). Table 3 gives aggregate figures for the island. It indicates that between 1917 and 1929 on average 11 to 14 percent of the cane crop in Cuba was burned. Fluctuations were considerable, and in some years the percentage burned surpassed 20 percent. Table 4 gives summary statistics of unweighted annual figures for individual mills, which reflect the severity of the impact of burnt cane relative to each mill's capacity. The maximum (column 5) indicates that amount of cane burnt each year was unevenly

Table 3. Aggregate Cuban Cane Crop Burned, 1917–1929

Year	Percent of cane crop burned		Cane ground by mills reporting burnt cane	Cane ground by all mills	No. mills reporting burnt cane	No. mills grinding
	Upper estimate	Lower estimate	Millions of metric tons	Millions of metric tons		
1917	16	9	15.1	28.1	88	199
1918	8	4	14.3	30.8	77	198
1919	10	5	18.7	36.0	93	198
1920	13	9	23.4	33.7	114	193
1921	8	4	18.9	36.0	93	198
1922	23	16	24.7	34.1	127	188
1923	17	12	21.8	30.9	102	182
1924	7	5	24.5	35.0	110	180
1925	9	8	39.1	45.6	146	183
1926	16	15	40.0	42.7	155	176
1927	19	18	36.4	39.6	153	177
1928	22	21	32.0	34.3	145	172
1929	18	17	37.9	41.8	140	163
mean	14	11	26.7	36.1	118.7	185.2

Notes: In the reports, zeroes are not recorded so that one cannot distinguish between a zero entry and a failure to report. The upper estimate is calculated treating mills that do not report burnt cane as missing observations, thus treating only mills that reported burnt cane as part of the sample. The lower estimate assumes that any mill not reporting burnt cane had zero burnt cane. The lower estimate is clearly downward biased because some mills obviously did not report, especially in the earlier years of the sample. The upper estimate is likely upward biased since some of the mills that failed to report probably did so because burnt cane was negligible.

Sources: Cuba, Secretaría de Agricultura, Comercio y Trabajo, (1916/1917–1929); and Sec. de Hacienda (1916/1917–1929).

distributed—at some mills it was extremely high. In more troubled years, some mills lost considerably more cane to fire than they ground.

Despite the magnitude of fire damage, at times these fires were not the catastrophes they might seem to someone unfamiliar with the cane sugar industry. Burnt cane, in principal, could be ground, and if a fire were small it is possible that much of the damage could be salvaged. However, the daily capacities of the mills strictly limited how much burnt cane could be salvaged. The reason is that whatever was burnt had to be ground immediately or it spoiled. The trick to keeping green cane fresh until the mill was prepared to grind it was to leave it standing and growing in the fields. But burnt cane would not remain fresh even uncut. Evaporation and the loss of sucrose set in immediately. If a fire was reasonably large, the losses in cane would be substantial regardless

Table 4. Summary Statistics of Annual Reports of Cane
Burned at Reporting Central Factories, 1917–1929
(percent of cane ground at each mill)

Year	Mean	Standard deviation	Mean plus 2 std. deviations	Maximum	No. mills reporting
1917	20	40	100	256	88
1918	9	9	27	60	77
1919	9	9	26	58	93
1920	13	13	39	59	114
1921	8	9	26	50	93
1922	25	51	126	512	127
1923	14	12	38	69	102
1924	7	8	23	49	110
1925	9	10	28	73	146
1926	16	16	48	109	155
1927	21	60	142	740	153
1928	18	16	50	78	145
1929	14	14	41	68	140
average	14	21	55	168	119

Source: See Table 3.

because it would be infeasible to grind it all. Furthermore, if it should rain, burnt cane was completely ruined. Some cane could be salvaged but usually only a portion of that damaged by a fire.

Central mill management retained discretion over whether to grind burnt cane. Supposing the mill should decide to grind it, abnormal costs were involved. First, costs of coordination increased. Grinding burnt cane disrupted the more routine coordination of field activities because harvest operations in all other fields had to be suspended to give the burnt cane immediate attention. Under the normal routine, all *colonos* had daily quotas they were expected to fulfill. But if burnt cane was to be ground, the quotas of other *colonos* were typically suspended temporarily.¹⁴ Second, when grinding burnt cane, manufacturing yields (sugar/cane ratios) declined somewhat. Third, the average daily amount of cane ground declined because the charred cane caused the machinery to gum up so that grinding had to be interrupted more frequently for cleaning.¹⁵

Examination of the standard contract is instructive for understanding the relationship between the mill and *colono* regarding this contingency. It is relevant that the liabilities with regard to other “acts of nature” were usually not explicitly stipulated in the contracts, but cane

Table 5. Contrato de Colonia, Washington Sugar Company, ca. 1917

		Article
General	1	Determination of the plot of land to which the contract applies.
	23	Taxes on the colonia are the responsibility of the colono.
	24	Prohibits the colono from mortgaging or ceding the cane to a third party without the consent of the Company.
Planting and cultivation	2	Specifies the location and area to be planted in cane.
	3	Timing of planting determined.
	5	The colono is obligated to maintain the canefields, <i>guardarrayas</i> , drainage ditches, etc. according to "good custom". No other crop can be planted among the cane.
		If the obligation is not fulfilled, the Company has the right to take charge at the colono's expense. Lack of attention to the canefields gives the Company the right to cancel the contract.
Credit	6	Establishes a maximum amount of credit per caballería of cane planted.
	9	Specifies the amount of advances per cab. to be made to the colono for planting.
	10	Specifies an amount (1 peso oro español) to be advanced per 100@ delivered the year before for cleaning the ratoons.
	11	Specifies the advance of 1.60 pesos oro español for each 100@ to be delivered.
	19	Payments for purchases of cane to be made to the colono are first applied toward liquidation of the debt of the colono with the Company.
Supervision and reporting obligations	4	Establishes the Company's right to inspect the planting.
	7	Gives the Company the right to inspect all operations on the colonia.
	8	Requires of the colono an account of all expenses for each operation during the season.
Cane fires	15	In the case of an accidental cane fire, cane will be received for grinding without discount only if it is neither dry nor charred. It must be delivered within (typically 3) days after the fire, and it must not have rained. If these conditions are not fulfilled, the Company has the option both to accept or reject the cane and to fix the price.
	21	Cane burned intentionally is not admitted for grinding. The Company has the right to halt delivery from other colonias whenever a fire has occurred in one of the colonias in order to give preference to the burnt cane.

(continued)

Table 5. (Continued)

		Article
Grinding	13	The Company has the sole right to grind the cane, or decide where to grind the cane.
	14	Cane must be delivered free of straw, roots, in proper maturity and condition. The Company can refuse to accept or require a discount of cane that does not meet these conditions.
	20	The Company will specify the date at which grinding begins and the quota to be delivered to the loading stations daily.
	22	Any interruptions in grinding due to the fault of the Company will be resolved in a manner "mutually beneficial" to both parties of the contract.
Sale of cane to the Company	17	Payment is established in the contract as arrobas sugar (of standard polarization) per 100 arrobas of cane delivered.
		Who paid for the sugar bags is established in the contract. It varied with negotiations from year to year.
	18	Payment is to be made in money on the date of each month. The sugar was valued according to official monthly sugar price averages published by the Colegio de Corredores de La Habana. (If the Company was obtaining better prices than the quotations, they gave the colono the option of accepting the Company's average monthly price.)
Expiration of contract	25	At the termination of the contract, if the colono desires to sell or rent the land, the Company has preference over any other buyer or renter.
	26	Specifies the date of termination.
Disagreements	27	To be settled by arbitration.

Source: Braga Brothers Collection, Record Group II, series 10a-7-32.

fire clauses were very detailed. The agreements were designed to encourage fire prevention on the part of the *colono*. Cane fire clauses, as well as most other sections of the contracts, were quite standardized by the 1920s (Dye, forthcoming). Table 5 presents a representative example of the standard *colono* contract, of the Central Washington, in the province of Santa Clara.¹⁶ The only "act of nature" explicitly mentioned was fire. The cane fire clause stipulated that cane from fires set intentionally would not be accepted. Otherwise, if the fire had been set accidentally, the contract stipulated that the burnt cane would be admitted for grinding (1) only if it had not dried out, (2) only if had not been charred too badly, (3) only if it was delivered within three¹⁷ days after

the fire had occurred, and (4) only if it had not rained since the fire had occurred. Furthermore, the payment to the *colono* for burnt cane was discounted. As mentioned above, the central mill had the right to interrupt the cane quotas of the other *colonias* until all the admitted burnt cane had been ground, but in some contracts this action was taken only at the mill management's discretion.¹⁸ Cane fire policies expressed in the contracts of other central mills were virtually the same. Under these policies, the *colono*'s expected income from a burnt cane field was much lower than an unburnt cane field. First, it was not improbable that the mill would refuse to grind. Second, the mill sometimes penalized the *colono* by requiring a discounted payment for the burnt cane. Third, given the practice of lengthy ratoons in Cuba (i.e., harvesting repeated crops from the same planting), fires could damage the root systems and shorten the life and capital value of the plantings.¹⁹

The Causes of Cane Fires

The high incidence of cane fires in Cuba depended both on natural and human factors. Annual rainfall in Cuba is high (a necessity in cane sugar production), but the amount of rainfall fluctuates considerably from month to month and year to year. Droughts and dry spells are frequent.²⁰ The harvest coincided with a distinct dry season in Cuba, during which much of the field labor activity was carried out. Given the dry foliage and the abundance of tobacco in Cuba, careless field workers during harvest were likely a great danger. Another factor, the vast cane plantings stretched across the Cuban plains and cover many thousands of acres contiguously. A cane fire, once started, could spread suddenly and consume a considerable area of cane fields before it could be stopped. Negligence on the part of the *colono* could contribute significantly to potential damages. The responsibilities of the *colono* included maintenance of fire breaks and railroad fire lanes (*guardarrayas*) to protect against flying sparks of locomotives. Sometimes fire resistant plants could be planted strategically. The design of the field layout with cognizance of the prevailing winds was also important. In his manual for the *colono*, written in the 1890s, Juan Bautista Jiménez discusses the prevailing winds, the proper layout, the care of fields, and other strategies for effective fire control.²¹

The influence of the human factor was more complicated, however, because many fires were intentionally set. Mill managers suspected

Table 6. Cane Burnt, Central Francisco, 1917/1918–1919/1920
(000 arrobas)

Year	1917/1918	1918/1919	1919/1920
Cane cut	30850.5	34260.1	49349.2
Cane burnt	346.5	3685.8	562.8
declared intentional	233.0	1015.0	39.3
declared accidental	0.5	320.1	7.5
declared locomotive	2.0	159.2	34.2
Percent of cane burned	1.1	10.8	1.1
Percent of Burnt Cane			
declared intentional	67.3	27.5	7.0
declared accidental	0.1	8.7	1.3
declared locomotive	0.6	4.3	6.1
declared unknown or undeclared	32.0	59.5	85.6
Percent of Burnt Cane for Which a Cause was Declared			
declared intentional	99.0	67.9	48.5
declared accidental	0.2	21.4	9.2
declared locomotive	0.8	10.7	42.2

Source: Braga Brothers Collection, series 96.

many fires to be intentional and often caused by cane cutters. As an example, Table 6 shows percentages of burnt cane at the Central Francisco, Camagüey, for which the cause was declared to be “intentional” or otherwise by the mill management over three years’ time. Of course, it was likely very difficult to determine the cause with accuracy, but in certain cases it could be inferred reasonably well.²² Considering only the fires for which the mill management declared or assigned a cause, the amount of burnt cane declared “intentional” ranged between 49 and 99 percent over these three years. One manager commented that “It is evident that, when cane cutting is paid well, there are few fires, which gives proof against the workers.”²³ Dissatisfaction with the wage among cane cutters might explain the high percentages of cane burned in 1922 and 1923 since cane cutters’ wages fell from an average of about 1.20 pesos per 100 arrobas in the previous years to about 0.80 pesos beginning in 1922.²⁴

For cane cutters, setting fires offered a means of increasing the hourly wage rate. Cutters’ wages were in terms of a fixed amount per 100 arrobas (1 arroba = 25 lbs.) of cane cut and delivered. Payment was

made on the basis of weight of the stalks net of leaves. Burnt cane was easier and faster to cut because the leaves were out of the way of the cutter and did not have to be removed. Furthermore, setting the fire did not reduce the total amount of cane (stalks) to be cut. Regardless of whether the burnt cane was to be ground, it still had to be cut because the field had to be cleared. If it wasn't, leaving the burnt stalks standing created problems for the next crop and could damage subsequent ratoon crops (Agete y Piñero 1946, pp. 332–334; *Bohemia* 1973). Therefore, cane cutters did have incentives to set fire to the fields, even when there was a chance that the burnt cane would not be ground.²⁵

Other intentional fires were caused by “enemies” or “blackmailers.” Sometimes the threats were politically motivated, but according to one suspicious manager, the cause was sometimes arson set by a neighbor or a competitor. Another manager, remarked of an incident of extortion in which “blackmailers” were demanding payment threatening to set fire to the cane fields otherwise.²⁶ One politically motivated incident was during the crop of 1916/1917. During the height of the harvest, the February Revolution of 1917 broke out. Insurgents were ordered to plunder and set fire to cane fields. At one central mill, more than a tenth of the year's cane crop was lost in three days. According to the claims filed by one central mill, the Central Francisco, on average *colonos*' burnt cane reached almost 48 percent of their standing cane, and only about 9 percent of the burnt cane was ground. Six out of 36 *colonos* lost over 75 percent of their cane.²⁷ What is more remarkable is that the overall magnitude of total crop losses of the 1917 crop were not unusual. This is evident in Table 3. In other years, not affected by political insurgency, other sources of discontent affected the threat of fire in the cane fields. For instance, the high cane losses in 1922 and 1923 may have been caused by recently fallen real wages (see Dye 1998, p. 161). Then, 1927 and 1928 were the years of the Verdeja Act, when the Cuban government legislated an across-the-board crop reduction of 10 percent for each mill. Under the restriction, if mills adopted the likely policy of not grinding burnt cane, cane field workers could increase the overall demand for cutting by setting fields afire. Burnt fields would have to be cut even if they were not ground.

As discussed above, the cane losses due to fire could be attenuated because it is technically feasible to grind burnt cane. Therefore, the losses to the *colono* might not have been as great as inferred in the previous paragraph(s). However, to reiterate, there were both technical and

contractual limitations. Time limitations in grinding burnt cane, imposed both by spoilage and by the contractual limitations (see Table 5 and the text above), dictated that losses were more likely if the fire was allowed to spread uncontrolled. As described above, contractual rules regarding grinding were established, but guidelines were not clearly drawn, and central mill management maintained much discretion over whether to grind burnt cane or not. Contracts usually stipulated that cane burned intentionally would not be ground. How it was determined whether a fire was intentional was not typically specified in the contract, but the judgment was most likely made by the mill's inspectors. Furthermore, even if the cane was accepted to be ground, some mills maintained discretion over whether to require other *colonos* to stop their quotas while the burnt cane was ground. This means that the mills could determine the rate at which the burnt cane was ground over the following three permissible days. Consequently, the payment scheme combined with the policy of arranging for buffer stocks and mills' control over grinding burnt cane caused the risk of fire or other shortfalls in cane to be born primarily by the *colono*.

No comparable figures or anecdotes are available for fires on Hawaiian plantations. Perhaps the reason is that Hawaiian producers utilized cane fires as a technique of production. Whereas in Cuba a premium was placed on fire prevention, in Hawaii the mill management organized planned burning of the cane fields in order to reduce field labor costs. Labor costs in cutting were reduced because the leaves did not have to be removed by hand, and the visibility of the cutter was increased, which improved both the speed and quality of the cut. Needless to say, this practice reduced the economic incentives of field workers in Hawaii to set fire to the cane themselves. As a result, fires were controlled and fire prevention management, which proved so difficult to monitor in Cuba, was less relevant in Hawaii.

This method of harvesting cane, commonly practiced in Hawaii, that involves deliberate, planned burning of the cane field is commonly known today and has even been practiced to a limited extent in Cuba since the 1970s. (In Cuba it was adopted only after the revolutionary government imported some mechanical cane harvesters from Australia that could only harvest stripped or burnt cane [Centro de Investigaciones de la Caña 1973; Pollitt 1982].) But, historically, in Cuba specialists perceived the technique of deliberate burning as involving a tradeoff—it reduced labor costs of cane cutting, but it increased other

costs of cane field maintenance. The negative effect of the burning on the sucrose content of the cane was small, but the rate of deterioration of burnt cane was greater than for green cane. Burnt cane had to be delivered and ground more quickly with fewer interruptions; therefore, greater requirements were placed on the organization of the harvest and its coordination with the grinding. Cuban sugar producers both ground more cane per day per mill and carried that cane over much longer distances. Although they were informed of the success of the practice in Hawaii, they expressly did not find the tradeoff advantageous in their own factor-cost environment.²⁸

Lower relative labor costs do not seem to have been the reason. Wages for field labor were slightly lower in Cuba than in Hawaii, but both Hawaii and Cuba were high-wage areas according to international sugar-industry standards. Wages paid to unskilled workers per day around 1924 in U.S. dollars were \$1.25 in Cuba and \$1.55 in Hawaii. Wages for cane field and sugar mill work in other countries, Australia excepted, were considerably lower (Maxwell 1927, pp. 88–90).

The disposition in Cuba against the method of deliberate burning continued in later decades. One of the leading mid-century Cuban authorities on the subject, Fernando Agete y Piñero, advised strongly against deliberate cane burning. He wrote in his manual for cane cultivation in 1946 that “fires, whether accidental or intentionally made to facilitate the cutting of the standing cane, are always harmful to the *cepa* [root systems] of the cane, causing more harm the greater the amount of *paja* [leaves] and the slower the fire...” (Agete y Piñero 1946, pp. 332–334). He notes further that the damage done to the *cepa* could be contained by immediate cultivation, but that increased the amount of labor needed in Cuba’s labor-extensive fields. He also commented that there was some evidence that the degree of damage varied with different varieties of cane (p. 334).

In synthesis, two factors seem to explain the higher costs of cane fires in the Cuban factor environment: (1) the greater damages to the cane field, and (2) the higher costs of controlling the fire, relative to Hawaii. First, because ratooning was practiced extensively in Cuba, cane burning raised the frequency, therefore, the costs of planting. Burnt fields would have to be replanted because the root systems were sometimes damaged. Root system damage from fires at harvest were not important to the decision of Hawaiian producers because they typically replanted after every cutting anyway (Maxwell 1927). However, in Cuba ratooning was prac-

ticed with a goal of obtaining six to 10 crops from a single planting.²⁹ In effect, the relative expense in planting explains why Cuban producers did not favor the method of deliberate burning as Hawaiian producers did. In Cuba ratooning reduced the frequency of planting to keeping labor costs low. The planting season coincided with the peak labor demands. Reducing the effectiveness of ratooning would have raised peak-time labor demands. Meanwhile, in Hawaii land-restricted high yields per acre were key, there was no attempt to economize on the number of plantings to keep labor costs down, and the practice of ratooning was very limited. Also, as noted, the human control over the length of the grinding season in Hawaii effectively reduced peak-load problems of labor demand. Given these practices, the costs of adopting the method of deliberate burning were low in Hawaii, but high in Cuba.

Second, the costs of managed control of a cane fire was higher in Cuba. First, managed control of a fire was more complicated in Cuban cane fields. The fields covered greater areas. Given the relative yields per acre, the area to be burned in Cuba was three or four time greater than in Hawaii for a given quantity of cane (Maxwell 1927). Burning took place on unprotected windy plains rather than on protected mountain slopes, and fires could more easily be carried from intended to unintended areas. If more than a day's cutting were burned by accident, losses could be substantial. Furthermore, in Hawaii fire control could be managed at relatively low marginal cost using the existing hydraulic infrastructure, noted above. In Cuba no such infrastructure existed; fire control equipment would have required greater capital costs. The result was that the risks of fire getting out of hand, or the costs of keeping it within bounds, were greater.³⁰

The conclusion we must draw is that the factor endowments in suitable lands and their relative quality led producers in Cuba and Hawaii to face different transaction costs, governed by or complemented by their choice of technique in cultivation. As the foregoing sections show, in Cuba the agency problems of cane field management weighed more heavily in the organizational choice than in Hawaii. The next section argues that, in Hawaii, an alternative set of problems associated with coordination threats, more readily solved by internalization, weighed more heavily.

CAPITAL INTENSITY AND INTERNALIZATION

The capital-intensity of Hawaiian cultivation itself may have pointed to higher transaction costs of outside contracting relative to internal gov-

ernance. First, given that the mill incurred the capital costs of the cane field infrastructure, placing those assets in the hands of an outside supplier might have resulted in asset dissipation since the outside supplier did not incur the cost of replacing them. Conditions could be established in the contract to ensure proper use, but monitoring costs would have to be incurred to enforce them. Capital intensification in the fields per se was not the principal obstacle since the mill could have provided the mechanized services to the growers.³¹ Overall, maintenance of the capital values of cane field assets was not likely the principal issue.

Proper use of those assets was a different story, especially as regarded irrigation. The irrigation infrastructure was operated as a system to coordinate the transfer, storage, and utilization of water, and there were advantages to its internal management. The application of water affected the sucrose levels in the cane during the growing cycle; therefore, the timing of water application was integral to the coordination of the harvest and grinding at Hawaiian mills. The substitution of irrigation for natural rainfall gave Hawaiian producers greater human control over the length of the grinding season. Under the influence of natural rainfall, the cycle of tropical wet and dry seasons dictates sucrose levels. The wet season is the time when most of the growth in cane volume occurs, but the sucrose content remains proportionately low until the dry season. The paucity of direct rainfall in Hawaiian plantations permitted producers to configure plantings and water application of different fields in a staggered fashion so as to stretch the length of the grinding season to 10-11 months of the year. In Cuba the grinding season, determined by seasonal rainfall patterns, was of only five to six months duration each year. Controlling the volume and timing of water application increased the rate of utilization of fixed mill capital in Hawaii relative to Cuba.

Consequently, proper use both of volume and timing of water usage was critical for the overall efficiency of the mill. High fixed costs meant that poor use of the irrigation infrastructure would raise unit costs substantially. As in the harvest of cane, there were strong incentives for the mill to maintain control over how much and when water was applied, except in this case coordination was required throughout the growing season, not only during planting and harvest as was the case in Cuba and most other sugar-producing countries. On the one hand, surrendering the control and use of these assets to outside growers increased the contracting costs of coordinating water usage. Furthermore, the con-

tract would imperfectly coordinate and enforce proper water usage because of commons problems as multiple growers used a centrally constructed water source.³² On the other hand, complete retention of control of the irrigation system by the mill would have been unpalatable to outside growers because the cost of poor performance by the mill in water application would have been incurred by the growers. Conditions might have been written in the contracts to correct some of these problems, but the degree of complexity in writing such contracts, therefore their costs, would have been high.³³

As noted, only 11 percent of Hawaiian cane came from outside growers. These often were tenants on company land. Tenancy lands tended to be small plots that either unimproved, difficult to access—"not usually suitable to put under direct management of a plantation" (Mollett 1961, p. 19; La Croix and Fishback, this volume). They were most often not irrigated, not subject to other major capital improvements, and without access to the services of the HSPA, its experiment stations and technicians. Although the Department of Commerce reported a rising trend in small independent landowning cane growers, that growth was limited because the lands they occupied were marginal and the cane they produced was both more costly to produce and of lower quality (1917, pp. 151–153) (see also La Croix and Rose 1999).

Additional economies of scope in cane field supervision might have swung the balance even further in the favor of internalization of cane fields. It is often argued that the introduction of supervisory staff to monitor capital usage in agriculture reduces the unit costs of monitoring labor. Empirical support for the existence of such a relationship can be found in Alston and Higgs (1982), and Alston, Datta, and Nugent (1984).

LOCAL LABOR SUPPLY INSTABILITY

The Commerce Department report cited both cane fire prevention and labor procurement as the most important functions of the *colono* system in Cuba. More work needs to be done to understand the differences in labor hiring and management in Cuba and Hawaii, but a few remarks are useful to show the similarity between the activities of fire prevention and field labor procurement in Cuba. I suggest that the transaction costs associated with ensuring sufficient supplies of

labor paralleled those for fire prevention. Comparing the differences between labor management practices in the two countries entails one principal issue—field labor demands in Cuba were seasonal, but in Hawaii they were year-round.

As noted, in Cuba the harvest period lasted five to six months. Sugar industry employment during the dead season fell by one-third to one-half of the grinding season average (Commission on Cuban Affairs 1935). The amplitude of peak demands during the harvest period was even exacerbated by the fact that the growing season in Cuba was 12 to 15 months, which meant that much of the planting had to be done during the harvest. Planting and harvest were the two principal labor-intensive field activities. In the dead season the majority of field laborers were dismissed until the next season. A large portion of the field labor force, which migrated either regionally or internationally, returned to their homes, and they had to be sought out again when the next harvest was due.³⁴

These labor market conditions made local labor supplies unstable, and instability could be very costly. When the harvest began it proceeded at a rapid pace—a race to grind as much cane as possible before it was halted by the beginning of the rainy season in May or June. Volume was important to keep down unit fixed costs. Interruptions in grinding due to lack of labor or any other reason raised unit fixed costs. Sometimes there were difficulties obtaining labor supplies at the precise time they were needed. However, expenditures on fixed capital and on the crop were made on the assumption that enough field workers would be on hand when the time came. If they were missing, lost time was costly; so strong incentives were given to *colonos* to prevent or solve the problems of temporary shortages quickly. The agency problem here resembles the one evoked by the problem of cane fires. What was needed of the field manager or *colono* was a quick response to prevent labor shortages or to resolve them quickly should they arise. Whether he was doing his job was difficult to monitor because it was difficult to measure the quickness of the field managers' response when a shortage arose, or whether it could have been prevented before it started. Obviously, there were economies of scope in using the *colonos* to solve problems both in temporary local labor demands and in fire prevention. Therefore, the choice to use *colonos* in Cuba was reinforced by unstable local labor demand and supply conditions and the comple-

mentarity of the use of the residual claim to perform both the fire prevention and labor search functions.

Contrary to the practice in Cuba and most other sugar-producing countries, field labor demands in Hawaii were not seasonal. The geographical factors that encouraged the use of capital-intensive agricultural methods in Hawaii also changed the character of field labor demands. Control over water application permitted grinding over most of the year. This had two important effects. Plant and equipment could be used the entire year so that sugar producers did not consider lost time to be quite so critical; they had the luxury to run their machinery the most of the year to cover fixed costs (Mollett 1961). More important, it allowed Hawaiian sugar producers the advantage of offering year-round employment to field laborers. The Hawaiian Sugar Planters' Association (HSPA), as it sought to recruit labor from overseas, emphasized this advantage—that the Hawaiian sugar industry offered the worker more stable work than other sugar-producing countries. Peak-time labor demands for the harvest, one of the major problems that the Cuban *colono* was expected to solve, hence was not a problem in Hawaii.

The greater stability in labor demands facilitated the kinds of solutions to labor shortage problems that were implemented in Hawaii. Local labor recruitment was circumvented by industry-wide organization and solved through collective recruiting efforts abroad managed by the HSPA. First, substantial up-front financial commitments were made to conduct a highly organized overseas labor recruitment. In 1905, in response the Hawaiian territorial government set up a Board of Immigration charged with recruiting labor in 1905, which continually sought new sources of stable plantation labor. Since the late nineteenth century plantation laborers were recruited from Japan and southern Europe; after 1900 immigration from Puerto Rico, Russia, Korea, and the Philippines supplemented the earlier streams (La Croix and Fishback, this volume).

Second, efforts were made by planters to reduce the movement of plantations workers between plantations. High wages were paid and other pecuniary incentives were given to encourage recruits to settle on plantations, such as bonuses for experience or for low absenteeism. Beechert argues that a collusive agreement of mill owners was established under the auspices of the HSPA to restrict wage increases and to prevent workers to move from one plantation to the next in search of a

higher wage (Beechert 1985, pp. 134–139, 183–188; Maxwell 1927, pp. 76–90). Collusion was relatively easy to enforce because of a single point of entry for all immigrant workers and a high degree of concentration of ownership in the Hawaiian sugar industry. The “Big Five” sugar companies in Hawaii produced 90 percent of Hawaii’s sugar. Presumably, the Big Five exerted considerable control over the Board of Immigration, the HSPA, and the allocation of migrant laborers, which was organized centrally by the HSPA. The powerful sugar producers also worked closely with officials in the territorial government. Labor contracts, which provided for return passage for the migrant worker, required workers to remain at the same plantation for a specified duration in order to claim the return passage. Competition between plantations for laborers was not completely inexistent, but it was considered improper behavior within the HSPA. The HSPA established a schedule of uniform plantation wages to be applied throughout the islands. When plantations claimed to have been “raided” by labor recruiters other plantations (typically trying to entice workers with claims of better housing or other non-pecuniary benefits) sought indemnification through the HSPA (Beechert 1985, pp. 136, 184).

Beechert suggests that the HSPA was unable to enforce its restrictions perfectly. This, of course, does not mean its policies were ineffective. One would never expect perfect compliance. Furthermore, in an industry characterized by five dominant firms and a fringe, one would expect restrictions on acts by the large firms against the smaller ones to be unenforceable. However, restrictions between the five dominant firms, which provided 90 percent of the industry’s output, would have been enforceable by mutual agreement and expectation of long-term cooperation. Evidence suggests that restrictions were effective in limiting competition for labor. La Croix and Fishback (this volume) provide evidence of low mobility of migrant labor, showing that plantations were able to maintain differential mean wages and to act as monopsonists in hiring laborers to work the fields.

What is most important for the argument is simply that these restrictions contributed greater local stability to Hawaiian labor markets relative to Cuban regional labor markets. The fact that “raids” were a matter to be addressed by the HSPA suggested lower mobility. By contrast, first, Cuban mill owners had not organized to collude in labor markets. Labor “raids” were not discussed as such because inter-plantation recruitment of field workers and wage competition was the norm. For

example, the Central Manati regularly distributed posters advertising that it would match any wage offer (Braga Brothers Collection, Record Group II, series 10c). What was expected of the Cuban *colono* in labor procurement was conditioned by this highly competitive environment. The instability of local markets for field labor, which the *colono* faced, was much greater—driven by the seasonality of labor demands, the habit of laborers to migrate in and out of the sugar regions seasonally, and the competition between different mills and *colonos* as they bid for the services of these laborers.

CONCLUSION

In summary, the managerial effort toward vigilance and responsiveness was a requirement of cane field management in Cuba that was not shared in Hawaii. Acute problems in measuring that kind of effort might have induced Hawaiian sugar producers to contract for more of its cane, but the techniques employed in cane cultivation had largely eliminated those managerial responsibilities. Meanwhile, in Hawaii greater emphasis had to be placed in managing and monitoring the use of capital inputs in the fields. The harvesting method and social conditions made the threat of damaging cane fires greater in Cuba, but under normal circumstances, the outside grower could be made to bear most of those losses. The apparent greater local instability during the harvesting season of labor supplies in Cuba relative to Hawaii, would have had a similar effect on organizational choice. These two features of cane cultivation in Cuba favored the incentive structure that contracting out created because it assigned the losses to the party in the best position to minimize them. By contrast, aside from losses from fire and labor shortages, the costs from failure to coordinate skillfully the day-to-day tasks of cultivation, including the application of water, were much greater in Hawaii. Contracts for apportioning water usage would be complicated and possibly difficult to enforce. Meanwhile, the costs to the mill, if the outside grower turned out to be a bad manager, were much greater, since the required cane productivity per acre to meet the mill's capacity needs depended on greater managerial skills in Hawaii. In Cuba even neglected fields did relatively well, but not in Hawaii.

High coordination costs and asset specificity in sugar production favored unified control of the decisions of cane suppliers and users and, therefore, supported vertical integration of factory and field. The

advantages that internal governance of the cane transaction offered were present at all modern sugar mills. However, it appears that in some environments they were offset by opposing costs of internal governance. In Cuba the instability of local labor supplies and the incidence of cane fires resulted in agency problems that were more easily resolved using a contractual arrangement in which payment was based on the measurable output of cane, with incentives built into the payment scheme, rather than managing the fields with salaried personnel. In Hawaii the costs of contracting and the risks of managerial failure were great enough to tip the balance in favor of internalized cane cultivation.

As Shlomowitz has noted, progress toward understanding the forces behind the organizational transformation in the cane sugar industry over the last century or so has considerable significance. One remarkable feature of the global sugar industry of this century is the great variation both within and among cane sugar-producing countries in the organizational choice. The preservation of the (vertically integrated) plantation system has been quite distinctive in some countries, whereas in others, it met its demise just before or after the turn of the century, replaced with outside cane-growing institutions with variant features. On one extreme, we find places such as Hawaii, Java, and Guyana that have internally grown about 90 percent of their cane. On the other, we find places such as Australia, Cuba, and Fiji that have produced 85 percent or more through outside contracting. Then there are intermediate cases, such as Louisiana, Barbados, Jamaica, Trinidad, and Mauritius (Shlomowitz 1982, pp. 329–336).

To what extent the above findings, based on a comparison of Cuba and Hawaii, explain this variation is unclear. Few cane sugar-producing countries have been studied with adequate attention given to the costs of transacting cane, so it is difficult to make generalizations. In his comparative study of cane sugar organization in Australia and Louisiana, Shlomowitz (1979a, 1982) comes to different conclusions about the root cause of the Australian cane farming system. He concludes that policy decisions mattered. In the Queensland industry, outside contracting arose and became the dominant organizational form in response to the “White Australia Policy,” by which immigration of Pacific Islanders and Asians, who had been the previous sources of labor in the Queensland sugar industry, was first restricted and then prohibited. To replace them, plantation land was gradually subdivided and apportioned to white settlers, who occupied the land either as

owner-operators or as fixed-rent tenants and signed long-term contracts for supplying cane. He argues that mills had to offer the non-pecuniary incentives associated with possessing land in order to attract white labor to replace restricted immigration labor. He also notes, however, that in its initial years (from the 1870s), the whites who took up cane farming in Queensland were managers who then hired remaining Pacific Islander and Asian laborers to do the harvesting. It was not until 1913 that immigrant labor was completely excluded from the industry. By that time the white laborers attracted to do the harvesting were not being offered land in compensation. White settlers did planting, cultivating, and off-season labor themselves so that, at the margin, white settlers even before 1913 added to the supply of labor in the cane fields. The non-pecuniary incentive of land-holding provoked the settlers to work harder and for longer hours than wage laborers would have done for the same pay. Contemporaries in turn-of-the-century Trinidad made similar remarks about the advantages of non-pecuniary incentives of land-holding for Indian and black cane farmers there (Shlomowitz 1982, pp. 328–333). Nevertheless, although the non-pecuniary incentives seem to have been present, they do not explain the global variation in organizational choice. Shlomowitz's argument that the "White Australia Policy" mattered for Queensland's adoption of its cane farming institution is an explanation specific to Australia, where wages for cane field work were more than two and one-half times higher than in any other part of the globe (Maxwell 1927, p. 88). Of the two places with the next highest wages, Hawaii was mostly vertically integrated, and Cuba mostly contracted out.

As regards the supply of labor for field work in Cuba, the explanation offered for Australia by Shlomowitz does not fit because no comparable legislation blocked the entrance of a sizable wage labor force. In fact, the seasonal migration of Spaniards and West Indians provided a substantial and relatively elastic source of labor (Pérez de la Riva 1979; Maluquer de Motes 1992). More similar to Australia, in Hawaii prohibition of contract labor in 1900 also led to labor shortages on sugar estates. Acknowledging Australia's successes with cane farming, a homestead law was passed in 1905 that provided for federal land grants to settle cane growers and laborers on the perimeters of estates. Despite the legislative efforts, few of these grants were actually awarded. Estate owners showed a clear preference for retaining the integrated structure.

Even the management of cane operations on homesteads was soon absorbed by the local mills (La Croix and Rose 1999; U.S. Department of Commerce 1917; Beechert 1985, p. 127).

Shlomowitz's finding that political institutions mattered does not contradict the finding here that factor endowments mattered. Indeed, other remarks by contemporaries in various places are consistent with the view that contracting out served to reduce some, but not all, transaction costs. In Trinidad officials remarked that contracting out reduced the need for monitoring. Even in Hawaii, in the limited extent to which contracting out for cane was practiced, it was noted that the costs of that cane were cheaper—because the independent contractors worked harder and for longer hours (Shlomowitz 1982, p. 332). Similarly, Moynagh (1981, pp. 41–43), in a study of the Fiji industry acknowledges that outside growers were “better able to control labour costs.” These observations are consistent with both the non-pecuniary incentive argument and the monitoring-cost argument. Yet the monitoring-cost argument seems the more fruitful one for explaining the global variation in organizational choice—in light of the comments made in the foregoing two paragraphs.

In principle, the findings of this paper might be generalizable at two possible levels. On the one hand, the incidence or intentional use of cane fires, local labor instability, and the use of irrigation (or perhaps drainage) may be important factors in the “grow-or-buy” decision of mills in other countries. On the other hand, even if the specific sources of agency costs in Cuba were not present in other countries where cane farming was important, an explanation based on offsetting transaction costs may still be the key to understanding the choices of different countries. Even though it may be difficult to identify or measure the alternative transaction costs of market-based contractual exchanges versus internal governance, their influence is compelling.

Alternative explanations that do not necessarily compete with this one also need to be addressed. Particularly relevant is the question whether path-dependent processes, through political or institutional developments, may have had an influence on the preferences for one type of arrangement over the other. Although identifying such influences is intuitively satisfying, establishing refutable tests or direct empirical support is difficult. It is clear from the work of Shlomowitz and others that the influence that chronic labor shortages may have had on the institutionalization of cane farming as a means of procuring more

reliable labor must be given weight in a generalized answer. Although this does not appear to have been the defining characteristic of the Cuban *colono* system, it does seem to have been more important to Australia. In this light, endogenous institutions not addressed above may have been important in the evolution of the organizational forms found in Cuba and Hawaii, but if they were, their influence on organizational choice was shared with the offsetting transaction costs. It seems quite probable that the influence of offsetting transaction costs of internal governance and agency was a universal factor—although not the only factor—that explains the global variation in the use of the plantation or contracting out in the twentieth-century cane sugar industry.

ACKNOWLEDGMENTS

I wish to thank Lee Alston, Tim Guinnane, Sumner La Croix, Margaret Levenstein, Scott Masten, Larry Neal, Leandro Prados, Richard Sicotte, James Simpson, members of the economic history workshops at the Universidad Carlos III de Madrid, University of Illinois, University of Michigan, and Yale University, and an anonymous referee.

NOTES

1. North's distinction between transformation and transaction costs as the two components of production costs is useful here. The supervisory costs are a transaction cost and the offer of land as part of the compensation package represents an addition to the transformation costs of acquiring the necessary resources.

2. Shlomowitz also emphasizes the importance of the emergence of "butty gangs," which were democratically organized, worker peer groups which contracted out as teams to conduct the cane harvest (see Shlomowitz 1979b). The relative autonomy of butty gangs provided the additional non-pecuniary incentives needed to attract white workers to do the gang work required of cane cultivation. Shlomowitz links the butty gang development and the subdivision of plots into small-holds. Certainly the two institutional developments were historically linked in Australia, but in principle there is no reason why vertically integrated plantation-mill complexes could not also have adopted innovative practices for contracting out with laborers to provide additional incentives. Indeed, the Hawaiian sugar industry is a case in point, where large vertically integrated production units were experimented with numerous kinds of incentive contracts to encourage greater labor effort and reduce turnover of the labor force (see La Croix and Fishback, this volume; Department of Commerce 1917, pp. 106-110; Maxwell 1927, pp. 83-84).

3. There was also regional variation in the frequency of contracting out, both in Cuba and Hawaii. The sharp contrast between the two countries is, nonetheless,

great enough to warrant ignoring the intra-regional differences in the current paper in order to highlight the differences between the two countries. For an analysis of the intra-regional differences in Cuba, see Dye (1998, 1994a). Mention of regional differences in Hawaiian are made by Maxwell (1927, p. 64) and U. S. Department of Commerce (1917, pp. 47, 149-151).

4. It was customary in the sugar industry in various parts of the world to use narrow gauge, portable rails for delivery of cane. Because of the greater distances covered, the ruggedness of the terrain, and size of the load, on Cuban plantations portable railroads were quickly replaced by permanent, broader gauge rail networks for carrying cane from the cane fields to the mill (Cok Márquez 1981). Portable railroads were sometimes used to carry cane from the fields to their local rail loading stations, but in Cuba ox-carts were typically the preferred mode for this link in the cane transport network.

5. Williamson (1985) suggests four distinct types of asset specificity—site specificity, physical asset specificity, human asset specificity, and dedicated assets (see pp. 95-96).

6. Four distinct types of relationships due to specific assets are usually made—site-specificity, physical asset specificity, human asset specificity, and dedicated assets (see Williamson 1985, pp. 95-96).

7. Braga Brothers Collection, University Archives, University of Florida at Gainesville (henceforth Braga Brothers Collection), Record Group II, series 10c.

8. As a parenthesis, the activity of coordination of the harvest and grinding, which is emphasized above, is not made explicit in equations (1) and (2). It is suppressed not because it was unimportant but rather to focus on the organizational outcome of cane field management itself. As regards the organization, the mills tended to orchestrate the coordination of cutting and grinding in both Hawaii and Cuba.

9. They were also not counterparts to the laborers who worked on “contract” in the Hawaiian sugar industry. In the Hawaiian industry groups of laborers were sometimes contracted to care for fields. However, mills retained ownership of the standing cane, conducted the planting and watering, and provided all materials (Department of Commerce 1917, pp. 106-110; La Croix and Fishback, this volume, Table 3).

10. Could the Hawaiian mill management not have devised a scheme to make the salaried manager’s income linear in cane harvested, similar to the *colono* payment? If they had, it might be argued that the organizational structure was not qualitatively different. Hawaiian mills did subcontract out some field tasks. In particular, some cane cutters and loaders were permitted to choose between subcontracting their tasks, or receiving piece-rate or daily wages (Maxwell 1927; Beechert 1985). But these subcontracting arrangements were for specific field tasks that needed to be performed, not responsibility for the entire crop from planting to delivery. The completion of the entire set of field work tasks was supervised by salaried managers with income incentives that were more blunt—less sensitive to shortfalls of cane quality or quantity.

11. As regards the responsiveness of the *colono*, it can be argued that the marginal rate of substitution between degrees of effort expended by the *colono*, or cane field manager, at different subintervals of time within the growing and harvest seasons will be greater under the *colono* payment scheme than under a fixed salary plus a bonus or

penalty determined by monitoring of effort levels. The reason is that monitoring is likely to invoke a relatively constant stream of effort from the cane field manager whereas the *colono's* effort levels are governed by the probability of shortfalls. The income derived from the cane is received at the end of the year, but it may be threatened at any subinterval during the year. Therefore, as long as the threats are detectable, clustering of effort to avert threats should be preferred to constant effort levels.

12. U.S. Dept. of Commerce (1917, p. 367). Companies surveyed in this report commented that uncut cane would not suffer deterioration by being held over to the next season. Typically, in the *colono* contract, the mill assumed no obligations for loss of cane or failure to grind it due to termination of the grinding season. Braga Brothers Collection, Record Group II, series 10c.

13. In the late nineteenth-century discussions of the emerging *colono* system, cane fires certainly occupied a prominent place. José de la O. García, a lawyer who published a series of articles about the legal problems of *colono* contracts, wrote in one of these articles about the problem of cane fires.

14. Sometimes other *colonos* were required by contract or implicit agreement to lend laborers and other services to the *colono* who had suffered the fire.

15. Braga Brothers Collection, Record Group II, series 1, boxes 9, 20, 22; series 2, box 25; series 10c, box 67, f. 18.

16. In its experimental phase in the 1880s and 1890s, there were many discussions about how a well-functioning and just *colono* contract should be written, the question of liability in case of fire was frequently raised. *Revista de Agricultura* 8.19 (June 10, 1888); 10.18 (May 4, 1890). By the 1920s *colono* contracts had become relatively standardized, and most clauses, including the stipulations regarding cane fires, were very similar from one mill to another. Contracts with outside growers in the British West Indies also included cane fire clauses that established similar stipulations (Maxwell 1927).

17. The printed form of the contract of the Central Washington leaves the number of days blank, to be filled in; however, the three-day policy was the convention, established in the 1890s and fixed in many *centrales'* contracts. Braga Brothers Collection, Record Group II, series 10c; *Revista de Agricultura* 10.20 (May 18 1890).

18. Contracts of other central factories included similar cane clauses. Contractual stipulations regarding cane fires seem to have been relatively uniform. Braga Brothers Collection, series 10a, box 7, f. 32; series 10c, box 17, f. 9. Example contracts are also found in Guerra y Sánchez (1944, App. 4); and U.S. Department of Commerce (1917, pp. 362-364).

19. Pérez-López (1991, p. 67); *Bohemia*, "Una familia de 5 (Quema y cultivo)," *Bohemia* vol. 65, no. 45, 9 Nov. 1973). A fourth loss was the cane trash (leaves). The cane trash was left lying on the ground after the cane was cut as fertilizer. Thus it was scattered forming a layer of trash over the soil that served additionally to prevent evaporation of the soil, which was important in Cuba due to the frequency of long periods of drought. In a fire the trash was consumed and no longer available for this function (see the report by Deerr in U.S. Department of Commerce 1917, p. 376).

20. The sugar technician, Francis Maxwell (1927, p. 20) remarked that Cuba had the second best climate in the world for cane production (second to Java) except that "there has never been one year over a period of 49 without a three month drought."

21. Jiménez' book, *La Colonia*, was published initially chapter by chapter in the 1890 issues of the *Revista de Agricultura*. The chapter regarding fire management was published in vol. 10, no. 24 (June 22, 1890).

22. Braga Brothers Collection, Record Group IV, Series 96. Explanations for the declarations were not generally made, but in one case a fire was declared intentional because on inspection after the fire they found a stub of a candle in the burnt field.

23. Braga Brothers Collection, Record Group II, Series 10c, Box, 67, f. 18. This is found in a letter written on Sept 14, 1922 by Jose (Pepe) Alonso (colono Caja de Agua, Central Tuinucu, Santa Clara) to the owner of the colonia land, his aunt Ramona Rionda (Noreña, España).

24. Wages are obtained from Braga Brothers Collection, Record Group II, Series 10a, Box 7, f. 9; Series 10c, Box 27, ff. 27, 38; and Series 96.

25. To understand this incentive better, consider the nature of the cane cutter's job. Cane cutting is known to be one of the most strenuous of agricultural tasks (Engerman 1983). The cutter, working with a machete, had to cut the cane stalk as close to the ground as possible. Then he stripped the stalk of its leaves before leaving it on the ground to be loaded into an ox-cart. Removal of the leaves by burning made this strenuous work easier and it quickened the pace for a number of reasons. First, it relieved the cutter of one of his tasks—stripping the stalk—without decreasing the wage per stalk. Second, the leaves were an obstruction that decreased visibility and increased the difficulty of cutting. The sharp leaves had to be treated with care to avoid damage to the eye or skin. Third, the fire cleared out rats and other animals that might have been dangerous (Centro de Investigaciones de la Caña 1972).

26. Braga Brothers Collection, Record Group II, Series 1, Box 9, John Durham, manager of the Central Francisco, to Manuel Rionda (12-18-1906); Series 10c, Box 67, f. 18 Jose Alonso (colono Caja de Agua, Tuinucu), to Ramona Rionda (Noreña, España, 9-14-1922). Moreno Friginals (1978, vol. 1, p. 182) also comments that during the time of slavery in Cuba fires were set by the slaves as a means of rebellion.

27. Braga Brothers Collection, Record Group II, Series 10c, Box 26, f. 21. During the height of the harvest, the "February Revolution of 1917" arose because of an alleged fraudulent presidential election. Insurgent forces took control of the provinces of Camagüey, Oriente, and parts of Santa Clara and were given orders to steal horses and arms, threaten field workers, and set fire to cane fields, bridges, and other structures of some of the *centrales*. On February 24 insurgent forces set fire to the cane fields of the Francisco. The general manager immediately obtained the aid of U.S. marines from a U.S. battleship docked nearby (see also Pérez 1986, pp. 161, 167-170). The year of insurgency represents an abnormal situation; however, interestingly, the amounts of cane burnt in more peaceful years were not that much smaller. Even though in 1917 the insurgent generals had ordered the cane fields to be burned, the outcome in burnt cane was only double that of more moderate years (See Tables 3 and 4). Therefore, the potential losses to the *colono* even in peaceful years were high. Furthermore, from the point of view of the *colono*, the distribution of fires was highly unequal, as one might expect, so that the losses suffered by any one *colono* could be considerable even when the overall losses for the *central* were small. For example, according to Table 4, the incidence of fires on the Central Francisco was less than half the national average during the three crops after 1916/1917; however, nine out of 45 *colonos* lost 10 percent or more of one of these three crops,

and two lost more than 45 percent. These magnitudes, it should be understood, represent damages to *colonos* at a *central* with a relatively good record in years that were relatively mild. In years of trouble, such as the insurgency of 1917 or the labor discontentment of 1922, damages were much higher.

28. Without careful organization, sucrose and water loss would have been extreme. A letter (January 1910) from George F. Renton, Chairman of the Committee on Cultivation, Fertilization, and Irrigation, of the Hawaiian Sugar Planters' Association, to Manuel Rionda, one of the more prominent sugar producers in Cuba, commented about the sucrose loss and rate of deterioration, as well as reports of the experiments that had been performed at some of the Hawaiian estates on cane water-weight loss and reductions in the cane juice purity of burnt cane. Braga Brothers Collection, Record Group II, series 2, box 25. Experiments in Cuba in the 1970s have confirmed the reports of Renton and have added that the cane juices from burnt cane are more impure and difficult to process (Centro de Investigaciones de la Caña 1972, pp. 93-118; Pérez-López 1991, p. 67). Regarding the greater organizational requirements imposed on the harvest, Alberto Pozos commented, "Most important, it has not escaped us that the question [of cane burning] is not 'to set the fire' but to have this activity submitted to the most diligent methods" (1970, pp. 28-34).

29. Hawaiian soils were not as fertile as Cuban soils. Ratoons there yielded a lower volume of cane per acre so that ratooning implied an inefficient use of scarce cane land. This, of course, implied greater labor requirements in Hawaii for planting since the fields was replanted for each crop (Maxwell 1927).

30. Limited cane burning in Cuba, which began in 1971 has continued through 1986 because of the stock of Australian Massey-Ferguson cane harvesters, which can only be used effectively on burnt cane because they do not remove the leaves. But it has diminished considerably because it was found to be damaging to the cane yields, and fires were more costly and more risky when irrigation was absent or relatively costly (Pollitt 1982, p. 15; *Bohemia* vol. 78, no. 39 1986). On purchases of mechanical cane harvesters in Cuba, see Pérez-López (1991, pp. 63-67) and Mesa-Lago (1978, p. 51).

31. In fact, in the marginal cases where Hawaiian mills did purchase cane from outside suppliers, the contracts stipulated that the mill would provide the plowing at market rates upon the request of the grower (Maxwell, 1927, p. 177).

32. This is not to say that institutional arrangements could not have evolved to mitigate the coordination problems effectively. It is sufficient that the problem existed to a different degree in Hawaii relative to Cuba and that a rational response to the implied different in transaction costs was internalization of irrigation control and cane cultivation along with it.

33. Evidence that technical complexity increases the likelihood of internalization is found in Masten (1984).

34. The labor force consisted of Cubans from other parts of the island, and migrant workers from Jamaica, Haiti, and Spain (many from the Canary Islands). Haitians and Jamaicans by law could not stay on the island during the dead season. Some were deported, some wandered, but they could not settle (Moreno Fragonals 1983; Pérez de la Riva 1975).

REFERENCES

- Agete y Piñero, Fernando (1946). *La caña de azúcar en Cuba. (Sugar Cane in Cuba)* Vol. 1. Havana: Ministerio de Agricultura, Dirección de Estaciones Experimentales, Estación Experimental de la Caña de Azúcar.
- Albert, Bill, and Graves, Adrian, eds. (1988). *The World Sugar Industry in War and Depression: 1914-40*. London: Routledge.
- Alston, Lee, and Higgs, Robert (1982). "Contractual Mix in Southern Agriculture since the Civil War: Facts, Hypotheses, and Tests." *Journal of Economic History* **42**, 237-353.
- Alston, Lee, Datta, Samar K., and Nugent, Jeffrey (1984). "Tenancy Choice in a Competitive Framework with Transaction Costs." *Journal of Political Economy* **92**, 1121-33.
- Ayala, César (1995). "Social and Economic Aspects of Sugar Production in Cuba, 1880-1930." *Latin American Research Review* **30**: 95-124.
- Ballinger, Roy (1971). *A History of Sugar Marketing*. U.S. Dept. of Agriculture, Economic Research Service, Agricultural Economic Report no. 197, Feb.
- Barzel, Yoram (1982). "The Costs of Measurement." *Journal of Law and Economics* **25** (April), 27-48.
- Beachey, R.W. (1957). *The British West Indies Sugar Industry in the Late 19th Century*. Westport, CT: Greenwood Press.
- Beechert, Edward D. (1985). *Working in Hawaii: A Labor History*. Honolulu: University of Hawaii Press.
- Bergad, Laird (1990). *Cuban Rural Society in the Nineteenth Century: the Social and Economic History of Monoculture in Matanzas*. Princeton: NJ: Princeton University Press.
- Boomgard, Peter (1988). "Treacherous Cane: the Javanese Sugar Industry between 1914 and 1940." In Bill Albert and Adrian Graves (Eds.) *The World Sugar Industry in War and Depression: 1914-40*. London: Routledge.
- CERP (Cuban Economic Research Project) (1965). *A Study on Cuba: The Colonial and Republican Periods, The Socialist Experience*. Coral Gables, FL: University of Miami Press.
- Centro de Investigaciones de la Caña (1972). "Efectos de la quema de los campos en la producción de azúcar" (Effects of Field Burning in Sugar Production). *Economía y Desarrollo* **10**, 93-118.
- Centro de Investigaciones de la Caña (1973). "Introducción en Cuba del sistema australiano de corte" (Introduction into Cuba of the Australian Cutting System). *Economía y Desarrollo* **15**, 49-71.
- Cok Márquez, Patria (1981). "La introducción de los ferrocarriles portátiles en la industria azucarera, 1870-1880" (The Introduction of Portable Railroads in the Sugar Industry, 1870, 1880). *Santiago* **41**, 137-47.
- Commission on Cuban Affairs (1935). *Problems of the New Cuba*. New York: Foreign Policy Association.
- Cuba, República de, Secretaría de Agricultura, Comercio, y Trabajo (1914). *Portfolio Azucarero, Industria Azucarera de Cuba, 1912-14 (The Sugar Portfolio, Sugar Industry of Cuba, 1912-14)*. Habana: Lib. e Imprenta "La Poesía Moderna."

- Cuba, República de, Secretaría de Agricultura, Comercio, y Trabajo (1903, 1915/16-1930a). *Industria Azucarera, Memoria de la Zafra (The Sugar Industry, Harvest Memorandum)*. Annual series. Habana: Imprenta y Papelería de Rambla, Bouza y Ca.
- Cuba, República de, Secretaría de Hacienda (1903/1904-1929a). *Industria azucarera y sus derivados (The Sugar Industry and its By-Products)*. Annual series. Habana: Imprenta Mercantil; P. Fernandez y Ca.; Imp. y Lit. "Habanera;" Imprenta y Papelería "La Propagandista;" Montalvo y Cárdenas; Imp. Carasa y Ca.; Fernandez Solana y Cia.; Tipos Molina y Cia.
- Czarnikow-Rionda (1930). *Czarnikow-Rionda Annual Sugar Review*.
- Deerr, Noel (1950). *The History of Sugar*. 2 vols. London: Chapman and Hall, Ltd.
- Dye, Alan (1994a). "Avoiding Holdup: Asset Specificity and Technical Change in the Cuban Sugar Industry, 1899-1929." *Journal of Economic History* (Sept), 628-53.
- Dye, Alan (1994b). "Cane Contracting and Renegotiation: A Fixed Effects Analysis of the Adoption of New Technologies in the Cuban Sugar Industry, 1899-1929." *Explorations in Economic History* 31, 141-75.
- Dye, Alan (1998). *Cuban Sugar in the Age of Mass Production: Technology and the Economics of the Sugar Central, 1899-1929*. Stanford, CA: Stanford University Press.
- Dye, Alan (forthcoming). "Privately and Publicly Induced Institutional Change: Observations from Cuban Cane Contracting, 1880-1936." In Stephen Haber (Ed.) A monograph to be published. Stanford, CA: The Hoover Foundation.
- Eltis, David (1987). *Economic Growth and the Ending of the Transatlantic Slave Trade*. New York: Oxford University Press.
- Engerman, Stanley (1983). "Contract Labor, Sugar, and Technology in the Nineteenth Century." *Journal of Economic History* 43: 635-60.
- Graves, Adrian (1993). *Cane and Labour: The Political Economy of the Queensland Sugar Industry*. Edinburgh: Edinburgh University Press.
- Guerra y Sánchez, Ramiro. (1944). *Azúcar y población en las Antillas*, 3d ed. Habana: Cultural. Also appears in translation as: *Sugar and Society in the Caribbean*. New York: Yale University Press, 1964.
- HSPA (Hawaiian Sugar Planters' Association) (1921). *The Sugar Industry of Hawaii and the Labor Shortage*. Honolulu: Hawaiian Sugar Planters' Association.
- Haraksingh, Kusha (1988). "The Uneasy Relationship: Peasants, Plantocrats and the Trinidad Sugar Industry, 1919-1938." In Bill Albert and Adrian Graves (Eds.) *The World Sugar Economy in War and Depression*. London: Routledge.
- Johnson, Howard (1972). "The Origins and Early Development of Cane Farming in Trinidad, 1882-1906." *Journal of Caribbean History* 5, 46-74.
- Joskow, Paul L. (1985). "Vertical Integration and Long-term Contracts: The Case of Coal-burning Electric Generating Plants." *Journal of Law, Economics and Organization* 1.1 (Fall), 33-80.
- Joskow, Paul L. (1988). "Asset Specificity and the Structure of Vertical Relationship: Empirical Evidence." *Journal of Law, Economics, and Organization* 4.1 (Sept), 95-117.
- Joskow, Paul L. (1993). "Asset Specificity and the Structure of Vertical Relationships: Empirical Evidence." In Oliver Williamson and Sidney Winter (Eds.) *The Nature of the Firm*. New York: Oxford University Press.

- Klein, Benjamin, Crawford, Robert G., and Alchian, Armen A. (1978). "Vertical Integration, Appropriable Rents, and the Competitive Contracting Process." *Journal of Law and Economics* 21: 297-326.
- La Croix, Sumner J., and Rose, Louis A. (1999). "The Political Economy of the Hawaiian Home Lands Program." In Linda Barrington (Ed.) *The Other Side of the Frontier: Economic Explorations into Native American History*. Boulder, CO: Westview Press. Pp. 259-85.
- La Croix, Sumner J., and Roumasset, J. (1990). "The Evolution of Private Property in Nineteenth-Century Hawaii." *Journal of Economic History* 39, 129-142.
- Maluquer de Motes Bernet, Jordi (1992). *Nación e inmigración: los españoles en Cuba (ss. XIX y XX)* (*Nation and Immigration: The Spanish in Cuba, 19th and 20th Centuries*). Barcelona: Editorial Ariel.
- Martinez-Alier, J. (1974). "The Cuban Sugar Cane Planters, 1934-1960." *Oxford Agrarian Studies* 2 (1).
- Masten, Scott (1984). "The Organization of Production: Evidence from the Aerospace Industry." *Journal of Law, Economics and Organization* 27.
- Maxwell, Francis (1927). *Economic Aspects of Cane Cultivation*. London: Norman Rodger.
- Mesa-Lago, Carmelo (1978). *Cuba in the 1970s: Pragmatism and Institutionalization*. Albuquerque: University of New Mexico Press.
- Mollett, J.A. (1961). *Capital in Hawaiian Sugar: Its Formation and Relation to Labor and Output, 1870-1957*. Hawaii Agricultural Experiment Station, Agricultural Economics Bulletin, no. 21.
- Monteverde, Kirk, and Teece, David (1982). "Supplier Switching Costs and Vertical Integration in the Automobile Industry." *Bell Journal of Economics* 13.
- Moreno Fraginals, Manuel (1978). *El ingenio: El complejo económico social cubano del azúcar*. 3 vols. Havana: Editorial de Ciencias Sociales. Volume 1 appears as: *The Sugamill: the Socioeconomic Complex of Sugar in Cuba*. Trans. Cedric Bel-frage. New York: Monthly Review Press, 1976.
- Moreno Fraginals, Manuel (1983). "Plantaciones en el Caribe: el caso de Cuba - Puerto Rico - Santo Domingo (1860-1940)" (Plantations in the Caribbean: The Case of Cuba, Puerto Rico, and Santo Domingo (1840-1940)). In Moreno Fraginals (Ed.) *La historia como arma: y otros estudios sobre esclavos, ingenios y plantaciones* (*History as an Arm: And Other Studies about Slavery, Sugar Mills and Plantations*). Editorial Crítica, Grupo Editorial Grijalbo.
- Moreno Fraginals, Manuel (1986). "Plantation Economies and Societies in the Spanish Caribbean, 1860-1930." In Leslie Bethell (Ed.) *The Cambridge Economic History of Latin America*, Vol. 4. Cambridge: Cambridge University Press.
- Moynagh, Michael (1981). *Brown or White? A History of the Fiji Sugar Industry, 1873-1973*. Canberra: Australian National University.
- Nagano, Yoshiko (1988). "The Oligopolistic Structure of the Philippine Sugar Industry during the Great Depression." In Bill Albert and Adrian Graves (Eds.) *The World Sugar Economy in War and Depression*. London: Routledge.
- North-Coombes, M.D. (1988). "Struggles in the Canefields: Small Growers in Mauritius, 1921-1937." In Bill Albert and Adrian Graves (Eds.) *The World Sugar Economy in War and Depression*. London: Routledge.

- Pérez, Louis A., Jr. (1986). *Cuba Under the Platt Amendment, 1902-1934*. Pittsburgh, PA: University of Pittsburgh.
- Pérez de la Riva, Juan (1975). "Los recursos humanos de Cuba al comenzar el siglo: inmigración, economía y nacionalidad (1899-1906)" (The Human Resources of Cuba at the Turn of the Century: Immigration, Economy, and Nationality). *Anuario de estudios urbanos*, vol. 1 Havana: Editorial de Ciencias Sociales. Pp. 11-44.
- Pérez de la Riva, Juan (1979). "La migración antillana, 1900-1931" (Migration from the Antilles, 1900-31). *Anuario de estudios cubanos*. Havana: Editorial de Ciencias Sociales.
- Pérez-López, Jorge (1991). *The Economics of Cuban Sugar*. Pittsburgh, PA: University of Pittsburgh Press.
- Pollitt, Brian (1982). "Transformación en la agricultura cañera de Cuba: 1959-1980" ("Transformation in Cuban Cane Agriculture: 1959-1980"). *Areíto* 8 (30), 13-17.
- Pozos, Alberto (1970). "Por qué la quema de cañas?" (Why Burn Cane?) *Bohemia* 62 (50), 28-34.
- Prinsen Geerligs, H. C., Licht, F. O., and Mikusch, Gustav (1929). *Sugar: Memoranda Prepared for the Economic Committee*. Geneva: Series of League of Nations Publications, No. C.148.M.57; Economic and Financial II.20.
- Ramos Mattei, Andrés A. (1984). "The Growth of the Puerto Rican Sugar Industry Under North American Domination, 1899-1910." In Bill Albert and Adrian Graves (Eds.) *Crisis and Change in the International Sugar Economy, 1860-1910*. Norwich, CT: ISC Press. Pp. 121-32.
- Scott, Rebecca (1984). "The Transformation of Sugar Production in Cuba After Emancipation," In Bill Albert and Adrian Graves (Eds.) *Crisis and Change in the International Sugar Economy 1860-1914*. Norwich, CT: ISC Press.
- Scott, Rebecca (1985). *Slave Emancipation in Cuba*. Princeton, NJ: Princeton University Press.
- Shlomowitz, Ralph (1979a). "The Search for Institutional Equilibrium in Queensland's Sugar Industry, 1884-1913." *Australian Economic History Review* 19, 91-122.
- Shlomowitz, Ralph (1979b). "Team Work and Incentives: The Origins and Development of the Butty Gang System in Queensland's Sugar Industry, 1891-1913." *Journal of Comparative Economics* 3, 41-55.
- Shlomowitz, Ralph (1982). "Melanesian Labor and the Development of the Queensland Sugar Industry, 1863-1906." In Paul Uselding (Ed.) *Research in Economic History*. Greenwich, CT: JAI Press.
- Shlomowitz, Ralph (1984). "Plantations and Smallholdings: Comparative Perspectives from the World Cotton and Sugar Cane Economies, 1865-1939." *Agricultural History* 58, 1-16.
- Stiglitz, J.E. (1974). "Incentives in Risk-sharing in Sharecropping." *Review of Economic Studies* 41, 219-55.
- Stuckey, John A. (1983). *Vertical Integration and Joint Ventures in the Aluminum Industry*. Cambridge, MA.
- U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce (1917). *The Cane Sugar Industry: Agricultural, Manufacturing, and Marketing Costs in Hawaii, Porto Rico, and Louisiana, and Cuba*. Washington, DC: GPO.

- U.S. Tariff Commission (1919). *Costs of Production in the Sugar Industry*. Tariff Information Series, no. 9. Washington, DC: GPO.
- Vandercook, John (1939). *King Cane: the Story of Sugar in Hawaii*. New York: Harper & Brothers.
- Venegas Delgado, Hernán (1987). "Acerca del proceso de concentración y centralización de la industria azucarera en la región remediana a fines del siglo XIX" (On the Process of Concentration and Centralization of the Sugar Industry in the Region of Remedios at the End of the 19th Century). *Islas* 86 (Jan.-Apr.), 102-38.
- Williamson, O.E. (1983). "Credible Commitments: Using Hostages to Support Exchange." *American Economic Review* 73, 519-40.
- Williamson, O.E. (1985). *The Economic Institutions of Capitalism*. New York: Free Press, Macmillan.
- Williamson, O.E. (1996). *The Mechanisms of Governance*. Oxford University Press.