Managing Quantity, Quality, and Timing in Indian Cane Sugar Production: Ex Post Marketing Permits or Ex Ante Production Contracts?

*Sandhyarani Patlolla, Rachael E. Goodhue, and Richard J. Sexton**

Private sugar processors in Andhra Pradesh, India use an unusual form of vertical coordination. They issue 'permits' to selected cane growers a few weeks before harvest. These permits specify the amount of cane to be delivered during a narrow time period. This article investigates why processors create uncertainty among farmers using ex post permits instead of ex ante production contracts. The theoretical model predicts that ex post permits are more profitable than ex ante contracts or the spot market under existing government regulations in the sugar sector, which include a binding price floor for cane and the designation of a reserve area for each processor wherein it has a legal monopsony for cane. The use of ex post permits creates competition among farmers to increase cane quality, which increases processor profits and farmer costs. Empirical analysis supports the hypothesis that farmers operating in private factory areas have higher unit production costs than do their counterparts who patronize cooperatives. JEL codes: L14, L22, L66

India is the second-largest producer of sugarcane in the world (following Brazil) and accounted for approximately 19 percent of the world cane production in 2012 (FAOSTAT 2014). The sugar industry is crucial to the Indian agro economy. It serves approximately 7.5 percent of the rural population through the production, transportation and processing of sweeteners. It involves approximately 45 million cane farmers and employs a larger number of agricultural laborers (Government of India 2014). Sugar manufacturing is the second-largest

* Sandhyarani Patlolla is a lecturer at San Francisco State University; her email address is sandhya@sfsu.edu. Rachael Goodhue (corresponding author) and Richard Sexton are professors at the University of California Davis; their email addresses, respectively, are goodhue@primal.ucdavis.edu and rich@primal.ucdavis.edu. Goodhue and Sexton are members of the Giannini Foundation of Agricultural Economics. The authors thank Travis Lybbert for his advice regarding the survey design, James Chalfant for his advice regarding the empirical analysis, the regulators and processors in the Indian sugar industry who provided valuable institutional information, Acharya N.G. Ranga Agricultural University for providing assistance with survey data collection, and the survey respondents for sharing their time and knowledge. Elisabeth Sadoulet and three anonymous referees provided useful comments. No external funding supported this research.

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agro-processing industry in India, accounting for nearly three percent of the total value of industrial production in India (FAO 2014).

The Indian government has instituted a variety of pricing, marketing, and distribution policies for sugarcane, sugar, and allied products. The primary objectives of government intervention have been to provide a support price for cane farmers, to ensure the availability of cane to sugar factories at that support price, to promote the production of sugar, and to ensure the availability of sugar to consumers at a reasonable price. The complex structure of the policies, however, raises important questions about how these regulations interact to impact the welfare of participants in the cane and sugar marketing chain. This article explores a unique cane procurement mechanism adopted by processors in one of India's major producing states. The article shows that this mechanism has emerged as a direct consequence of these government policies and functions as a device to transfer rents from cane farmers to processors.

In India's tropical state of Andhra Pradesh (AP), private sugar processors issue 'permits' to selected cane growers a few weeks before harvest. These permits allow growers to deliver a specified amount of cane during a specified period of time. Why do sugar processors in AP create uncertainty among farmers by using ex post permits instead of offering ex ante production contracts? The theoretical model demonstrates that ex post permits are more profitable than either ex ante contracts or spot-market purchases under the government regulations and market conditions facing processors in AP. Specifically, the model shows that the system enables the transfer of rents from sugarcane farmers to privately held sugar processors by inducing farmers to compete for permits by increasing the quality of their cane, a benefit for which they are not compensated under India's sugar cane price floor policy.

The model's predictions are tested using data from a fall 2008 household survey. The results provide strong support for the prediction that a factory's choice of ex post permits is more profitable than the available alternative procurement options due to the transfer of rents from farmers to privately held processors. The results also suggest that a permit policy reduces efficiency in the sense that farmers' incremental costs to raise quality exceed the value of the higher-quality cane to processors.

Despite its importance to the Indian economy, there have been relatively few economic analyses of the sugar sector in India or of India's complex sugar and cane policies. Studies to date have addressed Maharashtran sugar cooperatives (Banerjee et al. 2001; Lalvani 2008) and compared the technical efficiency of sugar processors across organizational forms, including private factories, cooperatives, and public (state-owned) factories (Ferrantino and Ferrier 1995; Ferrantino, Ferrier, and Linvill 1995; Patlolla, Goodhue, and Sexton 2012). To the authors' knowledge, no studies have considered the specific cane procurement methods used by private sugar processors in India or investigated the links to product quality and government policy.

This study contributes to understanding the economic impacts of India's sugar and sugar cane policies and contributes more generally to a growing body of literature on the impacts of alternative procurement mechanisms in developing countries' agriculture (e.g., Fafchamps, Hill, and Minten 2008; Reardon and Minton 2011; Barrett et al. 2012). Most of these studies on India have addressed the use of agricultural contracts; none has examined the permit system, which is the focus here. Early studies compared the economic aspects of a contracted crop with the same crop not grown under contract (Haque 1999; Dileep and Grover 2000; Dileep, Grover, and Rai 2002; Dev and Rao 2004) or with a competing traditional crop (Bhalla and Singh 1996; Chidambaram 1997; Rangi and Siddhu 2000). Most of these studies found that growers' net returns under contract farming are higher. More recently, however, Narayanan (2012) demonstrated that welfare outcomes under contracting have been mixed for Indian farmers and that not all have benefitted from contracting. Agricultural-product procurement practices and the movement toward greater vertical coordination in India continue to be hotly debated topics (Singh 2002; Singh 2003; Chakraborthy 2009).

Government Policy, Ex Post Permits, and Cane Farming in AP

Processors' profit-maximizing procurement method is influenced by the policy framework, the structure of the farm sector, and the physical requirements of cane production. Most of the cane production in India is used to manufacture three sweetening agents: plantation white sugar (hereafter 'sugar') and two traditional Indian sweetening agents, gur and khandsari. The Indian government's regulations regarding sugarcane sales vary across buyers. The government implements a floor price that sugar processors must pay for cane that meets a specified base quality.[1] However, gur and khandsari producers are exempt from these price regulations.[2] Thus, the effect of a sugar processor's choice of procurement method on the incentives for farmers will depend on the expected cane price in the competing unregulated market.

Depending on their locations, another regulation that may affect farmers' incentives is the geographic 'reserve area' that the government defines for each factory based on its crushing capacity.[3] Reserve areas are set so that factories do not need to compete with each other for sugarcane produced nearby. A sugar

1. Quality is defined as the sugar recovery rate (units of sugar produced per unit cane). In most years, the government announced a baseline floor price for an 8.5 percent sugar recovery rate and then set a (slightly) higher factory-specific floor price that depended on the factory's characteristics, including its sugar recovery rate in the previous season, processing costs, and returns from sugar and its byproducts.

2. Relatively little cane is utilized for khandsari production in AP. For brevity, this article uses gur to refer to both products.

3. The incentives facing factories lead to a difference between the annual crushing capacity defined by the government and the effective annual crushing capacity. Crushing capacity is defined as the amount of cane crushed per day, and government computations for a factory's reserve area assume 130 days per season. The owners of a factory, however, have an incentive to extend the number of operating days to the maximum extent possible to increase the utilization of fixed assets.

processor has the right of first refusal on all sugarcane produced in its reserve area. If a factory is willing to buy cane in its reserve area at the effective minimum price or higher, farmers may not use it for other purposes or sell it to other buyers, except for seed. The processor may, however, extend its cane-collection area outside its reserve area even if it does not purchase all of the cane produced in its reserve area. Although the factory's cane collection area is not limited by regulation, it is, as a practical matter, limited geographically because sugarcane degrades quickly after harvest, limiting the distance it can be transported.

In a normal year, the cane production in a factory's cane collection area in AP is greater than the factory's effective capacity, which means that not all cane producers can obtain permits for all of their production. In AP, the marginal revenue product of cane in gur production is below the floor price paid by sugar factories, so farmers compete for a permit to obtain a better price. Each year, an estimated 20–25 percent of cane produced in AP is sold in the gur market. Of 158 farmers interviewed in private factory areas, 68 reported experiencing at least one denial of a permit during their years cultivating cane.

Processors implement the permit system through fieldmen, who inspect cane fields in their assigned area, measure the average brix of the cane, and determine to whom to award permits.[4] A higher brix represents greater cane quality and a higher yield of sugar. Each permit specifies the cane delivery date to the factory, the transportation method, and the price. A farmer who does not obtain a permit must sell cane in the unregulated market. At the time of planting, a farmer has no guarantee of obtaining a permit, so he must make decisions about acreage allocation and the application of most inputs without knowing his cane market outlet or price.

This analysis begins by developing a theoretical model that generates the hypothesis that a processor chooses to create this uncertainty because ex post permits enable the processor to effectively circumvent the floor price. Farmers know that fieldmen issue permits depending on the cane quality and distance to the mill. The theoretical model generates the testable hypothesis that the nature of the system incentivizes farmers to produce higher quality cane to increase their chances of getting a permit. In other words, the ex post permit system creates quality-based competition among farmers to obtain a permit to receive the mandated floor price.

Offering price premia for higher quality is the obvious alternative incentive instrument. Factories are required to test the quality of delivered cane on a daily basis and report it to the government. The results are one of the factors that regulators consider when setting the factory-specific cane floor prices the next year.[5]

4. This on-site inspection represents the means by which processors determine that a farmer's cane meets the minimum quality level required to earn the floor price.

5. Factories measure the sucrose content of cane using a polarimeter. The reading is called pol% and is used as a measure of raw cane quality.

In addition to the floor prices, the government announces a premium schedule for higher qualities of cane supplied by the farmers. However, sugar processors do not implement the premium schedule. They argue that the transaction costs of measuring and recording the sucrose content of each load of cane is too costly due to the large number of farmers who each supply a small amount of cane. Individual deliveries average 1.5 metric tons for bullock-drawn carts and 6 metric tons for tractor-drawn carts. In comparison, the daily processing capacity of sugar processing factories in AP ranges from 1,000-8,000 metric tons/day. On average, an Indian sugar processing factory deals with 25,000 farmers (Rajendran 2012).

If a processor can procure higher quality cane using an incentive instrument other than a premium, he may gain a profit from the higher sugar recovery rate, depending on the cost of providing the incentive. The permit system reduces testing costs and avoids the payment of any premiums for quality. Issuing a permit to a farmer based on a one-time field inspection is less costly than testing individual deliveries at the factory gate. To provide perspective, the average AP cane field is 1.76 acres and produces 35-40 metric tons per acre, so the number of tests required by a delivery-based system is an order of magnitude or more larger than the number required under the permit system. Furthermore, post-harvest testing at the factory gate could delay processing and reduce quality.

The opportunity to receive the floor price may motivate farmers to improve cane quality depending on the marginal expected return relative to the increased effort required. Cane requires continuous management to increase yield and quality. Along with the timely usage of non-labor inputs, cane quality is mostly a function of labor-intensive production practices that prevent lodging and manage pests and diseases. Nonetheless, as the next section demonstrates, cane farmers in AP may rationally invest in these production practices to improve cane quality and increase their probability of obtaining a permit and a higher price.

Theoretical Model

This section develops a model to study farmers' optimal choices of cane quality under either the ex post permit system or ex ante contracts. It then evaluates a processor's choice between ex post permits and ex ante production contracts given farmers' behavior.

The marginal processing cost of sugar from cane (c) is assumed to be constant, and the processor is a perfect competitor in the sugar market, taking the price of sugar (SP) as given. $SP - c$ denotes the unit sugar price less the unit processing cost. Set $SP - c = 1$, and normalize the other monetary variables accordingly.

Let p_f denote the exogenous floor price for cane set by the government for a representative processor. Farmers must supply at least the base level of quality to receive the floor price. Define θ as the measure of quality. Set the government-specified base level of quality as the lower bound for θ, and normalize it to zero.

The processor recovers $1+\theta$ units of sugar per unit cane of quality θ. Its return over variable costs from the purchase of a unit of cane is $1+\theta-p_f$.

Let there be n farmers in the factory's cane-collection area. Farmers are heterogeneous in the amount of land, L, they own. The quality of cane produced by a farmer i, θ_i, and the amount of land that he owns affect his production cost per unit of cane according to the function

$$C_i = C_i(\theta_i; L_i) \quad i = 1, \ldots, n.$$

Assume that C_i is an increasing function of quality: $\frac{\partial C_i}{\partial_\theta} > 0$. The cost to produce a unit of cane of the base quality is assumed to be constant per unit land owned.[6] The amount of land owned by a farmer is expected to influence his cane production cost because small farmers generally have access to more family labor per unit of land than do large farmers. Family members are less subject to moral hazard than hired labor, so their effective productivity is greater (Mangala and Chengappa 2008), implying the hypothesis $\frac{\partial C_i}{\partial L_i} \geq 0$.

Farmer i's unit profit is the difference between the cane price he obtains and his production cost per unit cane. He maximizes expected profit (π_i) per unit cane by choosing θ_i. Next, the processor's profits from using the ex post permit system and ex ante production contracts are compared using this framework.

Ex Post Permits

Farmer i's expected cane price depends on his probability, δ_i, of obtaining a permit. We assume that the quantity of cane produced in a factory's cane collection area is greater than its processing capacity, so $\delta_i < 1$. The farmer's expected net price of cane is then

$$P_i = \delta_i p_f + (1-\delta_i) p_g,$$

where p_g is the exogenous net price received from selling sugarcane in the unregulated gur market and is assumed to be strictly lower than p_f. Farmer i's expected profit from one unit of cane production under ex post permits is

$$\pi_i = [\delta_i p_f + (1-\delta_i) p_g] - C_i(\theta_i; L_i) \quad i = 1, \ldots, n.$$

The farmer's probability of obtaining a permit is a function of θ_i and the quality of the cane produced by all other farmers in the region (θ_k for all $k \neq i$). Farmer

6. In practice, farmers allocate acreage across cane and other crops. Acreage allocation decisions will not reverse this assumption regarding the cost of quality production provided there are non-increasing returns to scale in quality production.

i's chance of receiving a permit is increasing in θ_i, $\dfrac{\partial \delta_i(\theta_1, \ldots, \theta_n)}{\partial \theta_i} > 0$, and decreasing in θ_k: $\dfrac{\partial \delta_i(\theta_1, \ldots, \theta_n)}{\partial \theta_i} < 0$, $k \neq i$. A risk-neutral farmer faces the following expected profit-maximization problem under an ex post permit system:

$$\underset{\theta_i \geq 0}{Max}\ \pi_i = [\delta_i(\theta_1, \ldots, \theta_n)p_f + (1 - \delta_i(\theta_1, \ldots, \theta_n))p_g] - C_i(\theta_i; L_i) \quad i = 1, \ldots, n.$$

The associated Kuhn-Tucker conditions are

$$\left.\begin{array}{c} (p_f - p_g)\dfrac{\partial \delta_i(\theta_1, \ldots, \theta_n)}{\partial \theta_i} - \dfrac{\partial C_i(\theta_i; L_i)}{\partial \theta_i} \leq 0, \\ \theta_i \geq 0, \\ \theta_i\left((p_f - p_g)\dfrac{\partial \delta_i(\theta_1, \ldots, \theta_n)}{\partial \theta_i} - \dfrac{\partial C_i(\theta_i; L_i)}{\partial \theta_i}\right) = 0 \end{array}\right\} \quad i = 1, \ldots, n.$$

Solving the n farmers' maximization problems simultaneously obtains θ_i^*, the cane quality produced by i as a function of the difference between the floor price and the expected gur price, and the amount of land owned by each farmer:

$$\theta_i^* = \theta_i^*(p_f - p_g, L_1, \ldots, L_n) \quad i = 1, \ldots, n.$$

The marginal revenue, $MR\ (\theta_i)$, from increasing quality does not vary across farmers because the probability of obtaining a permit given a specified quality of cane produced and the cane prices in the two markets is independent of farm size. All else equal, $MR\ (\theta_i)$ is strictly positive when evaluated at $\theta_i = 0$: $MR(\theta_i) = (p_f - p_g)\dfrac{\partial \delta_i(\theta_1, \ldots, \theta_n)}{\partial \theta_i}\bigg|_{\theta_i = 0} > 0.$

In contrast, the marginal cost of increasing quality may vary across farmers. Let $b_i(L_i) = \dfrac{\partial c_i(\theta_i, L_i)}{\partial \theta_i} > 0$ represent i's marginal cost of increasing quality evaluated at $\theta_i = 0$, where b_i is dependent on i's farm size L_i. Given that $b_i \in (0, \infty)$ and $p_f - p_g > 0$, assume that $b_i < (p_f - p_g)\dfrac{\partial \delta_i(\theta_1, \ldots, \theta_n)}{\partial \theta_i}\bigg|_{\theta_i = 0}$ for some of the $i = 1, \ldots, n$ farmers, in which case their profit maximizing choice of θ is strictly positive: $\theta_i^* > 0$.

Farmer i's expected profit-maximizing quality increases in the difference between the floor price and the price in the unregulated market: $\dfrac{\partial \theta_i^*}{\partial (p_f - p_g)} > 0$. As the expected price difference increases, the farmer has a greater incentive to undertake costly, quality-enhancing production practices.

Ex Ante Contracts

Suppose that a contract requires farmers to supply at least the base quality to receive the floor price. Then, farmer *i*'s profit-maximization problem for each unit of cane production is

$$\underset{\theta_i \geq 0}{Max}\ \pi_i = p_f - C_i(\theta_i; L_i).$$

The profit-maximizing choice of θ_i is zero because price is independent of quality and the per-unit cost of production increases with quality. In contrast to the case with ex post permits, *i*'s profit-maximizing choice of θ_i is independent of the price of gur. Thus, the processor's profit from purchasing a unit of cane from *i* using ex ante contracts is $1 - p_f$. This outcome is a classic case of moral hazard; once the farmer has a contract, he has no incentive to improve quality.

Conversely, the processor's return from purchasing each unit of cane from farmer *i* using ex post permits equals $1 + \theta_i^* - p_f$. Thus, the processor's profit under ex post permits from *i*'s production is greater than or equal to its profit from using ex ante contracts, assuming fixed costs are unaffected and total cane use is determined by the factory's capacity. Because, by assumption, $\theta_i^* > 0$ for some $i \in [1, n]$, the ex post permits system yields strictly greater profits for the processor.[7] Because cane production cost is an increasing function of cane quality, farmers' cultivation costs under ex post permits are greater than or equal to their costs under ex ante contracts and are strictly greater for those farmers for whom $\theta_i^* > 0$. In other words, the increase in the processor's profit under ex post permits is associated with an increased cost and reduced profit for farmers.

Alternative Contractual Strategies

In theory, processors could procure cane using a variety of ex ante contracts that could attenuate the moral hazard problem present in the basic contract. However, each of these possibilities is problematic in this setting. If a processor specifies a higher quality than the government's minimum requirement, it could be obligated by the government to pay the base price plus the associated quality price premium, unlike under the ex post permit system.[8] Furthermore, the quality premium schedule is specified by the government and cannot be selected by the processor to maximize profits. A payment incentive schedule for higher

7. Strictly speaking, for the ex post permit system to be more profitable, its transaction costs cannot be larger than the transaction costs of the ex ante contract system by more than the increment in profits, given θ_i^*. This condition is met provided that the use of ex ante contracts requires at least one on-farm visit, as the permit system does.

8. An Assistant Cane Commissioner in the AP State Cane Commission indicated in an interview with one of the authors that none of the factories in India specifies higher cane quality precisely because of this possibility.

quality levels faces the same issues, and farmers may believe that the processor is offering multiple incentives to manipulate the price.[9] As discussed above, another factor is that processors consider the transaction costs incurred by post-harvest testing of the quality of every delivery to be prohibitive.

A second possibility is that a processor could design a contract that requires farmers to undertake specific production practices. Farmers' moral hazard is the main reason for the non-utilization of such contracts. Repeated monitoring could address this moral hazard problem, but the cost would be prohibitive because a processor deals with thousands of farmers. In contrast, with ex post permits, a processor can limit individual farm inspections to a single visit when a permit is either issued or not. This inspection evaluates the net outcome of the entire set of production practices chosen by the farmer and is much less costly than monitoring compliance with mandated production practices.

A third alternative is to forego vertical coordination entirely and purchase all delivered cane at the floor price. Under this option, it is difficult, if not impossible, to manage the timing of cane deliveries. The inability to do so would increase the time gap between harvesting and processing, cause cane quality to deteriorate, and increase the likelihood that the plant's capacity will not be utilized efficiently.[10]

Empirical Analysis

The theoretical model predicts that a processor's per unit profit from cane purchased and farmers' unit production costs are higher under ex post permits than they are under ex ante contracts. This section tests the latter hypothesis. There are no private factories that use ex ante contracts in AP, so farmer members of sugar cooperatives represent farmers with ex ante contracts in the empirical analysis. Although the members of the cooperative receive a proportional profit share, each farmer's supply is a very small fraction of the total cane purchased by the cooperative, making his contribution to the profit negligible. This situation creates incentives to free ride and a moral hazard problem (Holmstrom 1982). Cooperative members have no incentive to improve their cane quality above the minimum specified level, as is the case for farmers with ex ante contracts in the

9. District Agriculture Advisory and Transfer of Technology Center officials in Medak stated in an interview with one of the authors that farmers do not like differential payments across farmers and deliveries from the same buyer. Because the processor depends on farmers for its raw material, gaining their trust is very important for long-term success.

10. A referee noted that dynamic contracts are another potential tool for the processor. Given the institutional setting, dynamic contracts are unlikely to dominate the permit system. Consider a dynamic contract based on a simple moving average of cane quality over time. Current quality, not lagged quality, determines processor returns. More cane is produced than the factory's capacity in the absence of a multi-period contract, so there is no gain from securing supply at the expense of attenuating incentives to improve quality. Hence, the processor cannot increase profits by incorporating lagged quality values into the permit allocation system. Long-term contracts would not reduce transaction costs because fieldmen would have to make at least one annual visit to test in-field quality.

theoretical model. Thus, the testable hypothesis is that cultivation costs are higher for farmers who sell to a private factory than for farmers who sell to a cooperative, all else equal.

A second, more nuanced variant of this hypothesis is then tested based on the differences in incentives facing farmers in reserve and non-reserve areas within a private factory's cane-collection area. Due to the greater distance to the factory and the associated decline in cane quality due to the longer transit time, farmers in a private factory's non-reserve area must have higher-quality cane to receive a permit than reserve-area farmers must have. This implies the testable hypothesis that cultivation costs are higher in a private factory's non-reserve area than in its reserve area, which, in turn, has higher cultivation costs than in a cooperative's cane collection area.

The final component of the empirical analysis focuses on the processors themselves. Using factory-level data, this analysis tests the theoretical model's prediction that private factories receive higher-quality cane than do cooperatives due to the incentives facing farmers under the ex post contracts.

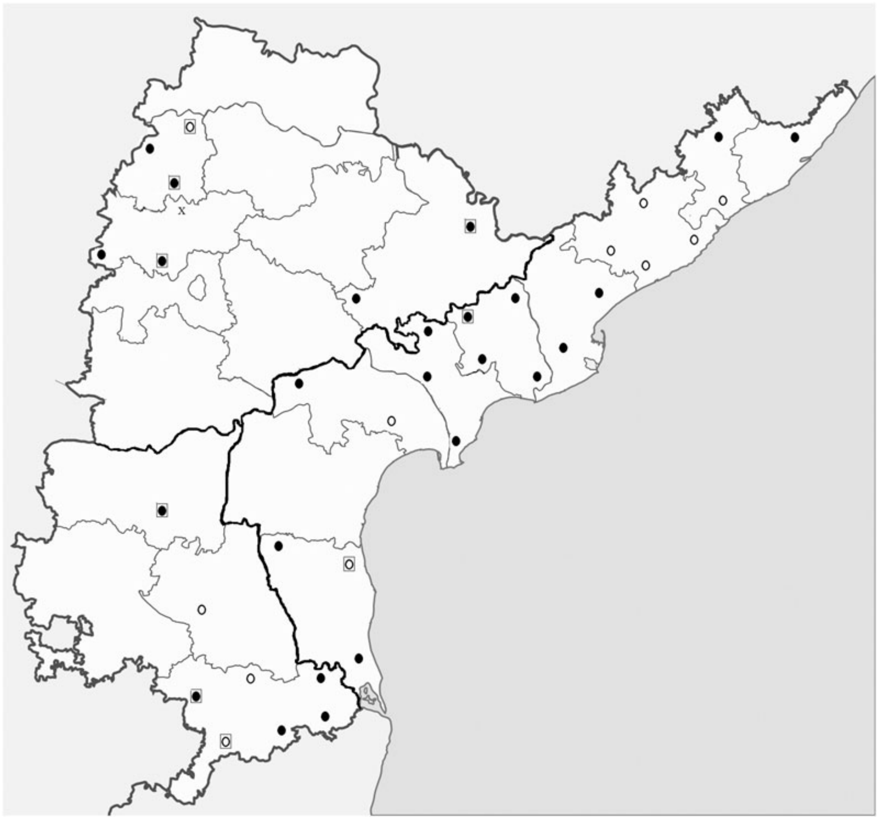
Survey and Data Description

Farm-level data are from a household survey administered in fall 2008. The household survey involved in-person interviews that provided farm-level data for the 2007–8 cropping season. The sample included randomly chosen households from randomly chosen villages within and outside factory reserve areas for nine randomly chosen factories. The number of villages sampled varied with factory crushing capacity. During 2007–8, 37 sugar factories operated in the 14 districts of AP, including 11 cooperatives, 25 privately owned factories, and one factory owned jointly by the state government and private investors (figure 1). The daily cane crushing capacity per factory ranged from 1000 to 8000 metric tons, with an average of 2700 metric tons. Ten households were chosen randomly in each village using the list of households in the village's Public Distribution System records. There were 205 sugarcane farmers in the survey dataset.

Gur prices and factory-specific floor prices for cane were obtained from the National Federation of Cooperative Sugar Factories Limited (NFCSF) Year Books. The factory-specific pol% of cane was obtained from NFCSF and Sugar Technologists Association of India (STAI) annual publications for the 1992–3 through 2006–7 seasons (NFCSF various years; STAI various years).

The nature of sugar cane production and the organization of the sugar processing industry obviate concern about two potential selection issues: self-selection into factory reserve or non-reserve areas and self-selection into cooperative membership. Cane is highly perishable and bulky, so farmers' access to processing outlets is limited geographically. Factories are spatially separated; through the allocation of reserve areas, the government limits competition among processing facilities for raw product. Farmers do not move from their villages to change buyers and/or to locate into a reserve or non-reserve area.

FIGURE 1. Sugar Factories in Andhra Pradesh



Notes: • privately owned factory; o cooperative factory; x jointly owned factory; □ factories in the sample.
Source: Andhra Pradesh Sugar and Cane Commission 2007–8 annual report.

The nature of the cooperative formation process combined with the central government's regulation of entry and location of processing facilities also prevents individual producers' self-selection into processing cooperatives. Cooperative formation was undertaken by local elites who campaigned to convince farmers to join cooperatives, which members of the elite then led. Thus, it was not individual farmers' characteristics that caused them to join cooperatives. Given that a cooperative exists, farmers do not self-select into cooperative membership because factories are not sufficiently close together for them to have a marketing alternative.[11]

11. A referee suggested that cooperatives may have been more likely to form in areas with more productive agricultural lands, thereby lowering production costs in those areas. Placebo tests conducted and reported in table 7 using rice, the main alternative crop grown by survey farmers, show that production costs are not significantly lower within the reserve areas of sugar cooperatives, suggesting that significantly lower costs for cane production in these areas are not due to differences in soil quality.

Descriptive statistics of the household survey administered in fall 2008 are reported in table 1. Consistent with the predictions of the theoretical model, on average, the per unit cultivation cost for survey respondents is highest in private factory non-reserve areas, followed by private factory reserve areas and is lowest in cooperative regions. The difference in the means of the per unit cultivation cost between farmers in private and cooperative factory areas is significant at the 5 percent level.[12] Most of the difference is due to higher costs for hired labor among farms in the private-factory areas.[13] This information is consistent with labor-intensive activities being the main means for farmers to improve cane quality.[14]

In both private factory and cooperative factory areas, cane farmers tended to have slightly larger farms than did farmers who did not grow cane (e.g., 2.79 acres vs. 2.66 acres in cooperative factory areas). Cane farmers also tended to be slightly older than farmers who did not grow cane (49.5 years vs. 48.5 years) in cooperative reserve areas. This was also the case in private factory areas (49.2 years vs. 47.7 years). In both private and cooperative factory areas, cane farmers were slightly more likely to own tractors than non-cane-growing farmers were. Specifically, 12.8 percent (13.3 percent) of cane farmers owned a tractor in cooperative (private) factory areas compared with 7.0 percent (8.3 percent) of non-cane farmers.

Summary statistics for the sugar factories in AP are calculated using data from annual NFCSF and STAI publications (table 2). Factory-specific floor prices are based on prices received by cane farmers for 2007–8 for the nine factories in the survey area. The mean pol% of cane reported in the table is computed across all sugar factories in AP over the 1992–3 through 2006–7 processing years. Privately owned factories have, on average, a higher yield of sugar content than their cooperative counterparts and face a higher floor price.

The hypotheses regarding cane production costs are tested by estimating the farm per unit cultivation cost measured in Rs/metric ton as a function of farm size, factory area-specific dummy variables, and region- or district-specific dummy variables to control variation across different geographic areas. The first two models distinguish between farmers in private factory areas and farmers in cooperative factory areas. The latter two models distinguish among farmers in private factory reserve areas, farmers in private factory non-reserve areas, and

12. A referee suggested the possibility that costs could be lower in cooperative factory regions because cooperatives provided some inputs to their members at volume discounts or subsidized rates, a common practice among cooperatives in developing countries. However, none of the AP sugar cooperatives provided inputs to their members.

13. Family labor was based upon the reported number of days family members worked on the farm. Family labor was valued using the state government's daily minimum wage for farm labor in 2007–8 of Rs. 85. The minimum wage is strictly enforced by democratically elected village leaders, making it a very accurate measure of unit costs for agricultural labor.

14. Electricity for farming is subsidized by the state government at no cost to farmers, so there is no electricity cost in cane production.

TABLE 1. Cane Farm Summary Statistics for Survey Respondents

		All cane farmers	Farmers in private reserve area	Farmers in private non-reserve area	Farmers in cooperative area
Observations		205	119	39	47
Costs of production (Rs./metric ton)					
Family labor	Mean	104.61	104.06	102.90	107.43
	Std. dev.	9.53	9.33	9.40	9.75
Hired labor	Mean	208.46	214.67	225.22	178.84
	Std. dev.	47.05	43.18	48.94	42.68
Manure	Mean	66.21	65.01	67.61	68.08
	Std. dev.	14.87	14.79	14.65	15.27
Fertilizer	Mean	27.16	25.51	31.70	27.58
	Std. dev.	7.67	6.37	10.15	6.84
Pesticides	Mean	24.44	22.97	30.71	22.96
	Std. dev.	12.28	9.45	16.08	13.60
Water	Mean	15.03	14.79	13.92	16.58
	Std. dev.	10.56	10.20	10.80	11.31
Seed and machinery for land preparation	Mean	70.95	72.84	67.04	69.40
	Std. dev.	39.39	37.81	39.96	43.24
Total cultivation costs	Mean	516.87	519.86	539.10	490.87
	Std. dev.	59.63	51.30	69.51	62.39
Yield(metric tons/acre)	Mean	38.80	39.43	39.08	36.98
	Std. dev.	5.82	5.61	6.54	5.44
Farm size (acres)	Mean	3.23	3.32	3.46	2.79
	Std. dev.	2.57	2.67	2.57	2.29

Source: authors' analysis based on authors' survey data.

TABLE 2. Sugar Factory Summary Statistics

		All AP factories	Private factories	Cooperatives
Factory-specificfloor price 2007-08	Mean	884.8	909.3	835.8
(Rs./metric ton)	Std.dev.	73.32	78.86	22.65
Factory-specific pol% of cane				
	Mean	12.01	12.24	11.66
	Std.dev.	0.77	0.75	0.66

Source: authors' calculations using data from NFCSF and STAI publications.

TABLE 3. Comparison of Floor Prices and Effective Gur Price: 2001–8

Cropping season	Effective price for cane used to manufactured gur (Rs./metric ton)	Average factory-specific floor price for cane (Rs./metric ton)	Difference between floor and gur prices (%)
2001–2	578.42	767.35	32.66
2002–3	433.82	812.27	87.24
2003–4	689.47	842.93	22.26
2004–5	744.70	883.82	18.68
2005–6	672.85	901.62	34.00
2006–7	405.17	906.56	123.75
2007–8	684.02	908.73	32.85
Average	601.21	860.47	43.12

Source: authors' calculations using data from NFCSF and MOFPI.

farmers in cooperative factory areas. In all models, the base factory area is cooperative; the coefficients on the private factory area in the first two models and the coefficients on the private reserve area and private non-reserve area in the latter two models are predicted to be positive. Additionally, the coefficient on the private non-reserve area type is predicted to exceed that for the private reserve areas.

The factory price is announced prior to planting (Siddiqui 1997), and the analysis assumes that farmers have rational expectations regarding the price of gur. To provide some perspective on the expected price difference, the average cane prices in the regulated and unregulated markets for the 2001–2 through 2007–8 cropping seasons are reported in table 3.[15] On average, the floor price is 43 percent higher than the gur price less gur manufacturing costs.

15. Most farmers manufacture gur themselves, so the effective cane price received by the farmers in the unregulated market is equal to the gur price less all other costs. The NFCSF reports state-level gur prices. The Ministry of Food Processing Industries of India (MOFPI) reports projected costs per unit of gur manufacture, including packing and other non-cane raw materials, utilities, wages, processing and marketing expenses. The average recovery of gur from cane is reported to be 10 percent by the MOFPI. Using this information, the effective price for cane used to manufacture gur is (gur price − non-cane processing costs) × (average recovery rate of gur).

The model predicts that an increase in the expected difference between the floor price and the cane price in the unregulated gur market increases the cultivation costs of farmers selling to private factories that use ex post permits because farmers compete more aggressively to obtain permits as the expected price difference increases. The second set of empirical models tests this hypothesis by estimating the per unit cultivation cost, replacing the factory-type dummy variables with interaction variables for the difference between the cane price in the sugar and gur markets and the factory area type. Farm size and regional fixed effects are also included in these estimations (district-specific fixed effects are not viable in these models because five of the nine factories are the only factory from their district in the sample).

The theoretical model also predicts that the quality of cane purchased by a private factory that uses ex post permits is higher than that of a factory that uses ex ante contracts. To test this hypothesis, the third set of empirics estimates cane quality including a private factory ownership dummy for the crop years 1992–3 through 2006–7. The base factory type is cooperative. The theoretical model predicts that the coefficient on private factory ownership is positive. Regional and year fixed effects control for variations across geographic areas and crop years.

Estimation Results

Based on the results of Breusch-Pagan tests, homoskedasticity of the error terms could not be rejected for any of the empirical model specifications, so all models were estimated using ordinary least squares. In the first two sets of empirical models (tables 4 and 5), which used survey data, the standard errors are cluster-corrected at the village level to account for correlation among respondents from a single village. All of the coefficients have the anticipated signs with one exception, and most of them are significant at conventional levels.

The estimation results for the first set of regressions that include factory area dummies are reported in table 4. Models 1 and 2 use a single dummy variable for a farmer being in a private factory area, and models 3 and 4 use dummies for private factory reserve and non-reserve areas. Models 1 and 3 incorporate regional fixed effects, and models 2 and 4 use district fixed effects (coefficients for regional and district fixed effects are omitted for brevity).

Overall, the results support the predictions of the theoretical model. Including district fixed effects rather than regional fixed effects tends to reduce the magnitude and significance level of the cost increase in private areas. Models 1 and 2 suggest that the unit cost of cane cultivation is significantly higher in private factory areas: 36.75 Rs/metric ton or approximately 7.5 percent in model 1. Models 3 and 4 suggest that the unit cost of cane cultivation is highest in private factory non-reserve areas followed by private factory reserve areas and is lowest in cooperative areas. This result is consistent with the hypothesis that non-reserve area farmers would have to produce the highest quality to obtain a permit because hauling time and quality deterioration would likely be higher for

TABLE 4. Determinants of Cane Cultivation Cost (Rs./acre)

Variable	Model (1)	(2)	(3)	(4)
Intercept	488.94***	476.47***	489.27***	475.80***
	(44.47)	(25.91)	(45.51)	(25.73)
Farm size (acres)	4.22***	4.34***	4.16***	4.28***
	(2.86)	(3.03)	(2.84)	(2.96)
Factory area indicator variables				
Private factory area	36.75***	27.73*		
	(3.49)	(1.85)		
Private reserve area			32.08***	24.08*
			(3.09)	(1.67)
Private non-reserve area			51.13***	41.72**
			(3.91)	(2.51)
Regional effects	X		X	
District effects		X		X
Adjusted R2	0.10	0.12	0.12	0.13
F-test	F(4,37) 5.86***	F(8,37) 4.20***	F(5,37) 5.51***	F(9,37) 7.00***
No. of Observations	205	205	205	205

Notes: t-statistics in parentheses.

Significant at: *10 percent level, ** 5 percent level, *** 1 percent level.

Source: authors' analysis based on data described in the text.

them than for farmers located in the reserve area. As predicted, the coefficient on the farm-size variable is positive and statistically significant, likely reflecting the moral hazard problem associated with hired labor.[16]

Table 5 presents the estimation results including the interaction variable for the factory area type and the difference between the cane price and the unregulated gur price, a price difference that has consistently been positive in AP (e.g., table 3). As predicted, the coefficients on the interaction variable between the price difference and the cooperative factory area are insignificant in all models. In models 5 and 6, which omit regional fixed effects, the coefficients on the interaction variables for the price difference and the private factory areas are positive and significant at the one percent level. Including regional dummies slightly reduces the magnitudes of the coefficients, although all of them remain positive in sign (models 7 and 8). The levels of significance for some variables decline, although only the coefficient for the price-private reserve area interaction variable in model 8 becomes insignificant. On balance, these results support the

16. The model in table 4 was rerun using labor cost as the left-hand variable. Coefficients on the indicator variables for private factory area (models 1 and 2) and private reserve area and private non-reserve area (models 3 and 4) were positive and statistically significant and of a comparable magnitude to the coefficients for these indicator variables in table 4, thus confirming that farm labor is the primary source of the cost difference for farmers in these areas compared with farmers in cooperative factory areas. Similarly, the comparable regressions for all costs except labor revealed no statistically significant difference between cooperative and private factory areas.

TABLE 5. Determinants of Cane Cultivation Cost with Interaction Variables for Price Difference and Factory-Area Type (Rs./acre)

	Model			
Variable	(5)	(6)	(7)	(8)
Intercept	480.25***	480.57***	489.79***	491.06***
	(37.27)	(42.14)	(19.95)	(20.59)
Farm size (acres)	4.27***	4.16***	4.29***	4.18***
	(2.91)	(2.82)	(2.91)	(2.81)
$(p_f - p_g)$ * private factory area	0.14***		0.12*	
	(2.96)		(1.69)	
$(p_f - p_g)$ * cooperative factory area	−0.016	−0.016	−0.06	−0.06
	(−0.15)	(−0.17)	(−0.40)	(−0.45)
$(p_f - p_g)$ * private reserve area		0.12***		0.10
		(3.25)		(1.50)
$(p_f - p_g)$ * private non-reserve area		0.19***		0.17**
		(3.92)		(2.36)
Regional effects			X	X
Adjusted R2	0.10	0.10	0.11	0.12
F-test	F(3,27)	F(4,37)	F(5,37)	F(6,37)
	9.75 ***	9.29***	6.26***	8.23***
No. of Observations	205	205	205	205

Notes: t-statistics in parentheses.

Significant at *10 percent level, **5 percent level, ***1 percent level.

Source: authors' analysis based on data described in the text.

TABLE 6. Determinants of Cane Quality (pol%)

Variable	(9)	(10)
Intercept	11.899***	11.128***
	(89.01)	(84.4)
Factory type: Private	0.514**	0.489***
	(3.20)	(3.84)
Production year effects	X	X
Regional effects	X	
District effects		X
Adjusted R^2	0.34	0.54
No. of Observations	391	391

Notes: t-statistics in parentheses; standard errors are clustered by factory

Significant at: *10 percent level, **5 percent level, ***1 percent level.

Source: authors' analysis based on data described in the text.

hypothesis that farmers under ex post permits invest more in quality-enhancing production practices as the expected difference between the floor price and the price in the unregulated market increases.

The estimation results for the cane quality models are presented in table 6. Factory-specific data from annual NFCSF and STAI publications are used to estimate these models (NFCSF various years; STAI various years). The coefficient on the private factory variable is positive and statistically significant, consistent with the hypothesis that these processors benefit from receiving increased cane quality under ex post permits.

The preceding results suggest that the AP permit system decreases the overall efficiency of sugar production and processing. The sugar processor's average cost of cane per metric ton of sucrose content is Rs. 7,367.19. The estimated increment in the sucrose content in the cane (pol%) due to a factory being private is 0.514 percent. This increment reduces the private factory's cane cost to 7,260.46 Rs./metric ton of sucrose content, a reduction of 106.73 Rs./metric ton. This reduction in processor cost is lower than the increase in the farmer's production cost of the cane per metric ton of sucrose content, which is Rs. 221.41 to Rs. 293.44. The ex post permit system thus decreases economic efficiency relative to alternative procurement methods within the framework presented here.[17]

Robustness and Placebo Tests

A number of alternative specifications of the models reported in tables 4 and 5 were also estimated, including ones that added variables for farmer demographics (age, education, caste), variables to account for capital inputs owned by the farmer (tractor, bullocks), variables to account for outside income (such as from livestock) available to the farmer, and a variable to measure the distance from a farmer's village to the processing plant. The only such variable that was statistically significant in some specifications was farmer age, which showed that older farmers tended to have lower costs, but the effect was most significant at the 10 percent level. More importantly, in all of these cases, the coefficients on the indicator variables for private factory area, private reserve area, and private non-reserve area were very robust to these alternative model specifications.

The most common alternative crop raised by the 205 sugarcane farmers in the survey was rice, which was produced by 69 of the farmers. The same models as specified in table 4 for the cost of producing sugar cane were estimated for the cost of producing rice. The results of these placebo estimations are presented in table 7. Unlike the results for cane, the results for the factory area indicator variables for rice production costs are sensitive to whether regional or district fixed effects are used. However, the only instance in which a factory area indicator variable is statistically significant is model 3, wherein rice farms in cane private non-reserve areas have significantly *lower* production costs than do rice farms in cooperative factory areas. As was true for cane, the point estimates suggest that unit costs for rice are increasing in farm size, although the effect is statistically significant only in model 3. Thus, the placebo tests reveal no consistent or significant cost advantage to farmers in cooperative factory areas in producing rice.

17. A referee noted that a possible cost of the permit system that is not accounted for in this analysis is a loss in utility to risk-averse farmers from the price uncertainty introduced by the permit system.

TABLE 7. Determinants of Rice Cultivation Cost

Variable	Model			
	(1)	(2)	(3)	(4)
Intercept	499.61***	393.33***	485.46***	406.75***
	(9.25)	(4.29)	(8.82)	(4.58)
Farm size (acres)	20.28	18.19	23.08*	20.77
	(1.56)	(1.39)	(1.80)	(1.60)
Factory area indicator variables				
Private factory area	−11.34	60.45		
	(−0.38)	(1.20)		
Private reserve area			9.73	73.21
			(0.31)	(1.35)
Private non-reserve area			−122.19*	−54.52
			(−2.00)	(−0.67)
Regional effects	X		X	
District effects		X		X
Adjusted R^2	0.17	0.23	0.23	0.28
F-test	F(4,31) 3.35**		F(5,31) 3.32**	
No. of observations	69	69	69	69

Notes: t-statistics in parentheses.

Significant at: *10 percent level, **5 percent level, ***1 percent level.

Source: authors' analysis based on data described in the text.

Alternative Hypotheses Regarding the Permit System and Cane Production Costs

The results of the empirical analysis are consistent with the hypothesis that the ex post permits system exists to induce farmers to produce higher-quality cane than they would under an ex ante contract and to increase processor profits accordingly. This section discusses alternative hypotheses that could explain either the permit system or the econometric results.

There are at least two alternative explanations for the existence of the ex post permit system. First, the processor may capture rents by paying below-market wages to fieldmen, who can then collect bribes from farmers in exchange for permits. Bribes are common, with 64 of the 158 farmers in private factory areas reporting having paid a bribe at least once within the last five years. However, the amounts are low, with the yearly average bribe per metric ton of cane ranging between Rs. 0.32 and 1.34. These amounts are negligible compared with floor prices, which ranged between Rs. 850 and 1150 per metric ton.[18] The total

18. A referee noted that these bribes seemed low relative to the value of a permit. However, bribes are illegal, and processors are required by law to take action against fieldmen who are reported to have accepted bribes. In this environment, it may be optimal for fieldmen to request and accept only small bribes that are unlikely to be reported.

amount of rents that could be transferred from bribes of this magnitude is negligible. Further, the use of bribes rather than superior quality to obtain a permit is not consistent with the econometric results reported here.

A second alternative hypothesis is that the probabilistic permit system may ensure that a sufficient quantity of cane is produced in the factory's procurement area to meet its capacity requirements and does not affect farmers' choices of cane quality. If a processor chooses to use pre-planting contracts, it must consider processing capacity because it cannot assign contracts for more raw product than the factory can handle. If contract farmers fail to meet the requirements of the factory due to a bad crop year, the processor must depend on the spot market.

However, depending on the spot market is problematic. If the processor assigns the contract quantities necessary to meet the requirements of the factory, other farmers' production decisions depend only on the expected cane price in the unregulated market, which is lower than the factory's floor price. Thus, cane production by non-contracted farmers is expected to be lower. In the event that the processor has to depend on the spot market, there may not be enough cane available.

This alternative hypothesis was analyzed by examining factory capacity utilization. Similar to the ex ante contract system, cooperatives' cane acreage allocation is associated with the factory's capacity. If capacity utilization by private factories is significantly higher than that by cooperatives, this would support the alternative hypothesis that the probabilistic permit system increases cane supply to the factory.

The Andhra Pradesh Sugar and Cane Commission reports each factory's capacity utilization and sugar recovery rates annually (APSCC various years). The difference in capacity utilization between private and cooperative factories is statistically insignificant. Hence, increasing the quantity of cane as the reason for the use of ex post permits is not supported by the data. In contrast, private factories achieved significantly higher sugar recovery rates than cooperatives did, consistent with the predictions of the theoretical model.

Finally, cooperative members represent an imperfect proxy for the ideal control group, namely farmers with an ex ante contract to sell to private factory processors. Such farmers, of course, were unavailable in AP. Both farmer types share the characteristic that is essential for the purposes of this study: neither has to compete through production practices to obtain an outlet for cane. However, there may be other aspects of cooperative membership for which this study cannot control and that could account for cooperative members having lower costs. Some of these possibilities have been considered and rejected, including the possibility that cooperatives supply inputs to members at reduced cost. Others, however, cannot be rejected as readily, such as the possibility that elites chose to form sugar cooperatives in areas best suited to sugar production or that there has been a diffusion of knowledge regarding superior production methods among cooperative members that has not diffused to the general population of cane farmers. Nonetheless, the placebo tests for rice constitute at least weak evidence against the hypothesis that cooperative members are concentrated on the most productive land.

Why are Ex Post Permits Unique to AP?

The sugar processors in AP have used this permit system for almost three decades. However, processors in other major sugar-producing states do not follow this method. If the ex post permit system is profitable for processors in AP, why has it not been adopted by cane processors in other states?

The top six sugar producing states, Maharashtra, Uttar Pradesh, Karnataka, Tamil Nadu, Andhra Pradesh, and Gujarat, account for more than 90 percent of total sugar production in India. Processors' cane procurement methods vary across these states and are highly influenced by linkages among social classes, the distribution of land among these social classes, and average farm size. Other important factors include the nature and extent of competition for cane and state-specific marketing institutions.

Under the Industrial Act (1956), cooperatives were given first preference in the application process for new factory licenses. Thus, in states where socio-economic conditions are favorable for the formation of sugar cooperatives, opportunities for private firms to enter sugar processing are limited. In India, important factors that encourage the formation of sugar cooperatives are that the majority of farmers belong to a dominant caste in the region and/or have relatively large farms. When both large and small farmers belong to the dominant caste, this enables close bonding among all sizes of groups of farmers within each village. This situation facilitates the formation of sugar cooperatives, as in Maharashtra, where a single dominant caste, 'Marathas', constitutes the majority of farmers (Attwood 1992). Cooperative members grow most of the cane. All cane is processed into sugar, and 90 percent of the sugar is produced by cooperatives. A second consideration is that the cooperatives harvest and transport cane for the farmers. This enables the efficient management of cane delivery, resulting in better-quality cane. In turn, the development of this system is linked to the alignment of the interests of the farmers and the factory through cooperative ownership (Attwood and Baviskar 1987).

Regardless of caste, farmers with larger operations have more options for credit and are more willing to invest in the production and processing of commercial crops such as sugarcane through the formation and operation of cooperatives. This is the case in Gujarat. Gujarat has the highest average farm size (5.56 acres) among the major cane-producing states, and cooperatives account for all cane processing.

Even where sugar production is dominated by cooperatives, private factories could still use ex post permits. However, a factor that is crucial for the feasibility of using ex post permits is the availability of supply at the floor price in excess of the factories' crushing capacities. In Maharashtra and Gujarat, there is no gur or khandsari manufacturing, and cane is utilized only for sugar. Thus, there is no surplus cane available above the factories' capacity limit. Consequently, private factories in these states are unable to use this ex post procurement method.

Two southern states, Tamil Nadu (TN) and Karnataka, produce more cane than the states' total crushing capacities and are not dominated by cooperatives.

However, although statewide production is greater than crushing capacity, there is no surplus cane available to the sugar factories at the floor price because they face much more competition for cane outside their reserve areas than factories in AP do. In TN, there is high demand for gur and a correspondingly high price, so cane growers prefer manufacturing gur to selling their cane to the sugar factories (Lakshmanan 2003). In Karnataka, most of the cane is produced in the northwestern region bordering Maharashtra, and processors face competition from Maharashtran sugar cooperatives. The cooperatives send their own harvesting and transport team for cane collection, providing tough competition for private factories. The importance of the Maharashtran cooperatives as competitors is demonstrated by the fact that the private factories in northwestern Karnataka pay cane transportation costs, unlike private factories elsewhere. These competitive forces explain the non-utilization of ex post permits in these states.

The third important factor in the use of ex post permits is the institutional relationship between farmers and the factory. For private factories, having access to a supply greater than their capacity at the floor price is a necessary but not sufficient condition to use the permit system. The processor must also be able to administer the permit system. In Uttar Pradesh (UP), government-mandated 'Cane Societies' organize cane deliveries. Consequently, the factory's interaction with farmers is limited to the time of purchase (Siddiqui 1997; Jeffrey 2002). UP has the lowest average farm size (1.98 acres) and the lowest literacy rate (46 percent) among the major cane-producing states. Dealing with thousands of illiterate small farmers involves relatively high transaction costs. Elected members and officials of the cane societies work with state staff to assign delivery quotas, so these transaction costs are absorbed in part by the state and in part by the farmers through lobbying and bribes (Jeffrey 2002). The formal quota assignment process considers the needs of the processor, the farmer's historical deliveries, and his current production (Jeffrey 2002). Cane quality is not considered. Under these institutional arrangements, private factories in UP are unable to manage the delivery process and must accept cane in its order of delivery.

Unlike the other major sugar-producing states, private processors in AP can benefit from using ex post permits due to three factors: the existence of only a limited number of sugar cooperatives; access to surplus cane above their crushing capacity limits at the floor price; and the absence of government-mandated marketing institutions that leave no scope for a processor to use ex post permits.

Conclusion

This article has analyzed sugarcane procurement in Andhra Pradesh (AP), India and investigated the novel ex post permits system used in this state. The Indian government imposes factory-specific floor prices for sugarcane used for sugar processing; cane prices for other uses are unregulated. In AP, the unregulated market price for cane is determined by its value in gur production and is consistently below the floor price for a specified base quality level. Government policy for the cane/sugar sector also specifies reserve areas for each factory wherein the factory is granted a first right of refusal for all cane produced within this area.

The theoretical model of the procurement market showed how the Indian government's sugar policy creates an incentive for a processor to utilize ex post permits to purchase cane. It compared a processor's profits under the probabilistic ex post permit system and a hypothetical system involving the use of ex ante production contracts. The model showed that ex post permits were used to create competition among farmers to increase cane quality and, hence, the probability of receiving a permit. The model showed that the ex post permit system increased the processor's profits and farmers' costs, but it did not increase farmers' price under the price-floor policy.

The theoretical model also predicted that as the expected difference between the floor price and the price in the unregulated gur market increases, farmers have a greater incentive to invest in costly quality-enhancing production practices. Finally, the model predicted that private factories in AP utilizing ex post permits receive cane of higher quality than comparable factories, such as cooperatives, that utilize an alternative procurement model analogous to ex ante contracts.

These hypotheses were tested and not rejected using primary data from a survey of 205 cane farmers and secondary data as needed. Specifically, cane farmers in areas served by private factories had significantly higher per-unit production costs than their counterparts in cooperative factory areas. This cost difference increased in the gap between the price floor and the unregulated market price for cane utilized to manufacture gur. Finally, private factories received cane of significantly higher quality than their cooperative counterparts.

Higher overall cane quality is achieved through the use of ex post permits. However, this analysis suggests that the permit system reduces the overall efficiency of the sugar sector because the value of the extra sugar yielded to private factories from higher-quality cane is less than the farmers' incremental costs of producing it. Only the processor benefits from this system, whereas farmers face price uncertainty and bear the extra costs of quality enhancement without any commensurate gain in the price they receive.

In short, although the mix of government regulations regarding the sugarcane market is intended to protect the interests of both processors and farmers, the market conditions in AP enable processors to capture additional rents through the ex post permit system at the farmers' expense. This system thus illustrates a classic unintended consequence of government regulation.

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