Inequality, Control Rights and Rent Seeking
A Theoretical and Empirical Analysis of Sugar Cooperatives in Maharashtra[1]

Abhijit Banerjee[2], Dilip Mookherjee[3], Kaivan Munshi[4] and Debraj Ray[5]

October 1997

Abstract

This paper presents a theory of rent-seeking within farmer cooperatives in which inequality of asset ownership affects relative control rights of different groups of members. The two key assumptions are constraints on lumpsum transfers from poorer members and disproportionate control rights wielded by wealthier members. Transfer of rents to the latter are achieved by depressing prices paid for inputs supplied by members and diverting resulting retained earnings. The theory predicts that increased heterogeneity of landholdings in the local area causes increased inefficiency, by inducing a lower input price and lower level of installed crushing capacity. Predictions concerning input price, capacity levels and participation rates of different classes of farmers are confirmed by data from nearly one hundred sugar cooperatives in the Indian state of Maharashtra over the period 1971-93.

[1]This paper could not have been completed without the support and encouragement that we received from Shivajirao Patil and Jamsheed Kanga. The staff of the Maharashtra State Federation of Co-operative Sugar Factories, the Directorate of Economics and Statistics, Mumbai, and the Agricultural Census, Shivajinagar, assisted us with the collection of the data. We would like to thank Poorti Marino for excellent research assistance and Jack Porter for many helpful discussions. We received helpful comments from Glenn Ellison, Oliver Hart, Michael Kremer, Michael Manove and seminar participants at BU, Harvard, MIT and Yale. Mookherjee and Ray's research was funded by NSF grant No. SBR-9709254. Research support was also provided by the MacArthur Foundation and the IRIS Center, University of Maryland. We are responsible for any errors that may remain.

[2]MIT

[3]Boston University

[4]Boston University

[5]Boston University

1 Introduction

This paper presents a theory of rent-seeking within farmer cooperatives in which inequality of assets owned affects relative control rights of different groups of members. Implications are derived from the theory relating the distribution of landholdings in an area to the input price set by the local cooperative, the installed crushing capacity and the participation of different classes of growers. These predictions are tested against the data from nearly one hundred sugar cooperative factories in the Indian state of Maharashtra over a twenty-three year period, 1971-93.

Sugar cooperatives consist of crushing and processing facilities that convert raw sugarcane into finished sugar. As discussed in the next Section, a key source of conflict within the cooperative is associated with the price paid to owner-farmers for sugarcane. We argue that this arises due to limitations on direct transfers between members of the cooperative. As a result the price of sugarcane is used as an indirect and inefficient means of transferring surplus from one sub-group of growers to another. Specifically, we argue that it is the large farmers who capture most of the benefits emanating from any retained earnings that the cooperative might have. Therefore the large farmers want to set prices below the break-even price for the cooperative, while small farmers prefer the breakeven price to be selected.[6]

These observations generate implications for the relationship between the distribution of landholdings within the cooperative's command area and the selected sugarcane price. If growers within the local region are relatively homogenous, there is no scope for one group of farmers to exploit another. Hence in such cooperatives there is no underpricing of sugarcane. Starting with a homogenous composition of large growers, an increase in the number of small growers within the region has two principal effects on the selected sugarcane price within the cooperative. The first is the *rent seeking effect*: large farmers will try to depress the sugarcane price, in order to extract rents from the small growers. The second is the *control shift effect*: the control gradually shifts from the large farmers to the small farmers, which leads to a higher sugarcane price. The relation between prices and the distribution of landholdings will of course depend on which of these effects is stronger. Assuming that the control of the small growers increases at an increasing rate with respect to their relative numbers, we show that the rent seeking effect initially dominates, but is eventually dominated by the control shift effect. The result is to predict a U-shaped relationship between the sugarcane price and the relative number of small growers in the local area.[7] The implications from the theory are tested against the

[6]Indeed, the need to find a mechanism for transferring resources to the large farmers also provides an explanation for the odd phenomenon of sugarcane cooperatives in Maharashtra starting and operating temples, schools, colleges and hospitals — which enable their controlling members to earn pecuniary and nonpecuniary rents in various forms, while meeting with general social approval.

[7]The theory provides implications in terms of the distribution of *potential* rather than *participating*

data, which covers nearly one hundred Maharashtra sugar coops over a twenty-three year period. The predicted U-shaped relationship between price and distribution is strikingly borne out in an initial nonparametric regression, which controls for district and year fixed-effects.

We subsequently partition the sample into the two principal sugarcane growing regions of the state: the arid Western region and the relatively fertile Eastern region. The Western region formed part of the Bombay Presidency which was administered under the *ryotwari* land revenue system under the British. The Eastern region was formerly part of the Central Province and the princely state of Hyderabad, which were administered under the *zamindari* system. As we will discuss later, small growers were more numerous, independent and self-reliant under the *ryotwari* system. This is presumably reflected in their interactions with the big growers in the cooperatives today, as well as in the current pattern of landholdings. Motivated by this historical background, as well as the natural differences in soil quality and water availability, we estimate the price-distribution relationship separately in the two regions, with the prior expectation that the rent-seeking effect could dominate in the East, and the control-shift effect in the West.

The regression estimates subsequently obtained confirm this prior expectation: price is declining in the proportion of small growers in the East, whereas this relationship is reversed (for the most part) in the West. As it turns out, the Western region is characterized by a substantially greater proportion of small growers than the Eastern region. In fact, the two regions effectively partition the sample along the distribution variable, almost without overlap. The intra-regional price-distribution relationships thus simply reflect the U-shaped pattern that was obtained with the full sample. This result nevertheless allows us to explain broad inter-regional differences in institutional performance: large growers never lose control of the cooperatives in the East, whereas the proportion of small growers is large enough to wrest control and reduce the scale of inefficient rent-seeking in the West.

Proceeding further, we study whether the price-distribution relationship is robust to the inclusion of the factory's crushing capacity, as a measure of the scale of production, in the price regression. Since it is possible that the factory's crushing capacity is jointly determined with the cane price, and since sugarcane cultivation is possible only on irrigated land, we replace capacity by the level of irrigation as an alternative measure of the scale of operations. The price-distribution relationship described above turns out to be qualitatively unaffected by the inclusion of these additional scale variables in the price regression.

Additional support for our characterization of rent-seeking within the cooperatives is obtained by studying the capacity-distribution and participation-distribution relationships. Capacity tracks price, with a corresponding U-shaped pattern against distribution.

growers, allowing us to avoid a simultaneity problem.

Since small growers receive none (or little) of the retained earnings, their participation also tracks price, with a U-shaped pattern against distribution. In contrast, the participation-distribution relationship for large growers is characterized by an inverted U-shape, since lower prices are associated with greater rents and, consequently, higher participation by large growers. This last implication is particularly striking since it predicts lower participation by large growers as prices increase in the West and greater participation by these growers as prices decline in the East. The predictions of the theory for capacity as well as participation rates are borne out in the data in both the Eastern and the Western regions.[8]

We conclude our empirical analysis by verifying that the price-distribution relationship is robust to alternative construction of the panel data and aggregation bias associated with the use of district-level data. District fixed-effects control for unobserved cross-sectional heterogeneity across districts, allowing us to study the price-response to changes in the district-level distribution *over time.* In contrast, disaggregated *taluka*-level distribution data, corresponding roughly to the factory command area, are only available at a single point in time. We thus study the price-response to cross-sectional variation in the distribution with *taluka* data. The U-shaped price-distribution relationship continues to be obtained, providing independent verification of the results obtained with district data.

Finally, the price-distribution relationship is also shown to be robust to the inclusion of additional determinants of the cane price (local wage rates, transportation costs, the recovery rate and the price of competing crops) in the price regression.[9] While some of these variables (such as transportation costs and the recovery rate) affect the cane price even in a first-best world, a statistically significant role for the wage rate and the price of competing crops in the price regression (which controls for capacity levels) would suggest that inefficiencies typically associated with monopsony power are present. Such additional effects are indeed obtained, providing further support for the rent-seeking hypothesis.

A maintained assumption underlying our theory is that landholding distributions are exogenous, and differences in these distributions can explain key differences in performance of cooperatives, in both cross-section and time series dimensions. For instance, increased fragmentation of landholdings over time had dissimilar effects in the Eastern and Western regions: they served to lower cane prices and capacity levels in the former,

[8]The U-shaped pattern between prices and distribution is consistent with the reverse view that it is the small farmers that enjoy rents at the expense of large farmers. But such a hypothesis would imply a pattern of participation rates that is opposite to that observed in the data.

[9]The recovery rate is defined as the amount of sugar that is obtained from one unit of sugarcane. The recovery rate is a measure of cane quality and depends mostly on agro-climatic conditions, soil quality and varietal choice. While the recovery rate varies across districts, we will see later that it changes very little over time.

and increase them in the latter. One defense for the exogeneity assumption is that the distributional parameter pertains to *potential* rather than *participating* growers in the local area. And less than 40% of irrigated land, on average, is allocated to sugarcane in Maharashtra, so even if the distribution of participating growers does respond to price-changes it is not likely that the effect on the overall distribution (of potential growers) will be significant.

Alternative explanations for the observed price-distribution relationship will typically reverse the direction of causation: exogenous variation in fertility or crushing efficiency leads to a corresponding variation in prices which, in turn, changes the distribution of landholdings. While it is possible to construct an argument based on the consolidation and division of landholdings in response to cane price movements to explain the U-shaped price-distribution relationship, we will argue in Section 6 that such an argument cannot explain the observed participation-behavior of large growers. The observation that the participation of large growers is inversely related to the cane price in both regions, seems hard to explain without recourse to some kind of rent-seeking argument. Moreover, alternative (non-rent-seeking) explanations cannot typically explain other pieces of evidence: e.g., why capacity levels are lower in the East than in the West, or why the wage rate and price of cotton affect the cane price even after controlling for capacity levels. The value of the rent-seeking hypothesis is that it parsimoniously explains all of the available evidence in a consistent framework.

The paper is organized in six sections. Section 2 provides a description of the institutional environment within which the Maharashtrian sugar cooperatives function. This also serves to motivate the key assumptions regarding restricted transfers and control rights underlying our model. Section 3 of the paper develops the theoretical model. Section 4 describes the data and presents the main empirical result: a U-shaped pattern relating price and distribution. Related evidence concerning variations in capacity and participation rates are also provided. Section 5 studies the robustness of the price-distribution relationship estimated in Section 4. Finally, Section 6 concludes by discussing a number of issues ignored in this paper (e.g., potential endogeneity in the distribution of landholdings, or distortions associated with the formation of new cooperatives), and its relation to existing literature.

2 Institutional Setting

The need to crush sugarcane very soon after it is harvested, combined with economies of scale in collection and crushing, implies that any sugar processing firm is likely to enjoy considerable local market power.[10] The inefficiency and inequity associated with this is perhaps the reason that the government of Maharashtra has actively promoted

[10]This issue is discussed in more detail below.

cooperatives in this industry since the 1950s, both by controlling the granting of licenses and by providing loans to sugarcane farmers to set up the factories. Consequently, of the hundred-odd factories currently in operation in Maharashtra, less than ten are privately owned. The significance of the Maharashtra cooperatives is highlighted by the fact that by the early 1980s India emerged as the world's largest producer of sugar, with the state of Maharashtra occupying the leading position within the country in terms of total sugar output.

2.1 Local Monopsony Power

The Maharashtra cooperatives are characterized by a *zone-bandi* (closure) system, wherein each cooperative is legally restricted from collecting cane outside its command area, which covers a fixed radius around the factory. Moreover, different factories are usually spatially separated in such a manner that most growers would incur substantial transport costs in delivering outside their own command area. This suggests that each factory enjoys local monopsony power over its sugarcane suppliers. Entry of new cooperatives is tightly regulated by the government, and as explained later in Section 6, there is little evidence that entry rates were related to the size of rents within incumbent cooperatives. The logic for the creation of such local monopsonies lies partly in economies of scale in crushing, besides the need to crush sugarcane very quickly after it is harvested. These features necessitate efficient scheduling of arrival of harvested sugarcane in each factory, a phenomenon which would be undermined by competition between different crushing factories. Of course, the extent to which the *zone-bandi* system is effectively enforced is debatable: factories do apparently collect outside their command areas at times. However, the large number of legal cases in court challenging the system suggests that it must work, albeit imperfectly, in practice.

2.2 Who Controls the Cooperatives?

The constitution of the Maharashtra cooperatives is heavily regulated by the government. Each cooperative is governed by a Board of Directors who are democratically elected and each member of the cooperative is in principle entitled to a single vote, regardless of his contribution of sugarcane. A member is someone who owns a share in the cooperative. Each share in the cooperative used to be worth Rs 500 and committed the farmer to allocate 0.5 acres of land to sugarcane each year, but more recently the price has been raised to Rs 2000 and the commitment to 1 acre. The factory, in turn, commits to buying the cane grown on that land. The grower can, of course, grow more cane than he has committed to and factories will also collect from non-members when there is a shortage of cane. A member may own a maximum of 50 shares in the cooperative.

While the majority of the growers in most cooperatives are small farmers, formal authority (e.g., embodied by membership of the Board of Directors) tends to rest predominantly with large growers.[11] There are a number of possible reasons for this. First, largeness by itself helps undercut the democratic process. For example, with enough land it is possible to get one's entire family to become members of the cooperative, so that it is no longer one-family-one-vote. Second, cooperatives are typically not managed by small farmers even where the small farmers seem to be in overwhelming majority. The elected leaders are almost always large growers (Attwood, 1993, Chithelen, 1983). This is partly a result of the fact that the people who run the cooperatives have to deal with the outside world. In this respect large growers who have good connections in the government have a real advantage. This is especially so at the stage when the cooperative first gets set up, or when it tries to expand its capacity — licenses have to be obtained, and loans have to be secured from the government — activities where a relatively educated and well-connected large farmer can be invaluable. There is also the sheer political effort of getting ten to twenty-five thousand farmers to join together in a cooperative, which a large farmer with more wealth, connections and leisure is better placed to do. High positions in the cooperative may thus be a reward for contributions to the institution.[12] Finally, getting elected to the Board of Directors is expensive and only the large growers may be able to afford to spend the money and other resources necessary to secure election (Baviskar, 1980). The bargaining power of the large farmers is thus very likely to be out of proportion to their numbers.

Formal authority may not, however, translate into real authority. The directors of a cooperative are subject to periodic election, a process which makes the management accountable in some broad sense to its rank and file membership. The extent to which the electoral process limits the discretionary power of its managers then serves to dilute the extent of effective control wielded by the large farmers. It is plausible, therefore, that this happens to a greater degree in cooperatives in which the smaller farmers are more numerous, i.e., that the relative control rights of the large farmers depends on local landholding patterns.

2.3 Who Wants Low Prices?

A key decision made by the management of a cooperative concerns the choice of the price that the cooperative pays for the sugarcane delivered by its members. This is partly subject to government regulations of various sorts. Part of the factory's production of sugar (approximately 40%) must be sold to the government at a fixed levy-price

[11] See, for instance, Chithelen, 1983.

[12] A director at the Ajinkyatara factory in Satara district described how the founders, who are all large growers, went from village to village in the area for two years, canvassing support for the new cooperative. He seemed to find it natural that the big growers would then occupy important positions in the cooperative once it began to function.

which varies across states. The remaining sugar is sold on the free market. The central government also sets a minimum price on sugarcane, the statutory minimum price (SMP), for each factory each year. In addition, the Maharashtra government sets a state advisory price (SAP) for the factories in the state. The cane price set by factories in Maharashtra typically exceeds the SMP and SAP. In fact, the SMP is usually provided as an initial payment to the grower at the time of collection and the remaining amount returned as a "bonus" at the end of the year. All the revenues from the sale of sugar are, in principle, distributed among the grower-members of the cooperative in proportion to their contribution of sugarcane.

Government regulations forbid the explicit redistribution of profits to the members. The one thing the cooperative can do with the profit is to invest it. Indeed, the sugar cooperatives do engage in a wide range of investments. Some of these are obviously useful for production, e.g., capacity expansion and the building of roads. But there is also an extensively documented practice of cooperatives building local public goods like schools, colleges, hospitals and temples - a practice known as *dharmodaya* (religious and welfare activities). Attwood (1993) provides a detailed break-down of expenditure on activities not directly related to sugarcane cultivation in the Malegaon cooperative factory. He estimates that 7% of the revenue was deducted in 1986-87 for such activities.

Why should the cooperative spend so much of its resources on local public goods instead of paying the farmers higher prices which improve productivity? Our hypothesis is that large growers benefit disproportionately from *dharmodaya*, so these investments serve as a mechanism for transferring resources to the large farmers.[13] These farmers and their (extended) families are more likely to be involved in the construction of new facilities required for these activities. They will also gain a disproportionate share of the new jobs generated. Members of the board of directors, who are invariably large growers, benefit directly from any new construction since under-the-table payments are commonly offered by contractors. In addition, each seat in a medical or engineering college is filled on payment of a "capitation" fee. The capitation fee for a seat in a medical college is currently at least $50,000 (Rs. 15 lakhs). It is not clear where this fee goes but it is a fair guess that the relatives of the large farmers who sit on the boards running these colleges get some part of it. Finally to the extent that these public goods benefit people who are not sugar farmers, being associated with them comes with a substantial political advantage which the politically ambitious larger farmers must value.[14]

[13] A former Registrar of Cooperatives of Maharashtra State, whom we interviewed, felt that *dharmodaya* often amounted to "outright extortion" and mentioned that he had forced cooperatives to return money collected in this manner to the growers on a number of occassions.

[14] The rise of large, wealthy, farmers to positions of power in Maharashtrian politics is well documented in the literature (see, for instance, Lele, 1981, Rosenthal, 1977). The sugar cooperatives also serve as important sources of funds and other resources for their leaders, who often aspire to positions of political power.

Dharmodaya is not the only mechanism for skimming off the profits of the cooperative. For example, roughly 25% of the cooperatives have invested in subsidiary firms like distilleries and other downstream production facilities which utilize by-products from the sugar extraction process. The general perception is that large growers benefit disproportionately from these investments as well. Finally, it is also commonly believed that there is a substantial amount of illegal diversion of funds to political campaign contributions. This is accomplished either by overinvoicing inputs purchased from businesses, which are often owned by relatives and friends of the large growers, or by outright theft.[15] Clearly, large farmers are more able to engage in these forms of diversion, and derive greater benefit from them.

While all this is by its very nature speculative, a former Commissioner of Sugar of Maharashtra State, whom we interviewed, stated emphatically that small growers only wanted high cane prices. He believed that downstream manufacturing facilities, such as the distilleries, do not provide returns to the small growers that are sufficient to compensate them for the revenue retained for their construction. Activities unrelated to the cultivation of sugarcane, such as the establishment of colleges and hospitals, provide even less benefits to the small growers. It thus seems plausible to assume that low prices may be associated with rents accruing to large farmers, controlling for other determinants of the cane price in an area.

2.4 Why Are There No Lumpsum Transfers?

The most efficient way for large farmers with disproportionate control rights to appropriate rents from other members is via direct lumpsum transfers. Why do the cooperatives need to resort to underpricing of cane and *dharmodaya* activities instead to achieve the same objective less effectively? There are a variety of reasons — restrictions imposed by law, enforcement costs, wealth constraints, and informational problems — why lumpsum transfers cannot be employed to expropriate rents from small farmers.

First, the law governing cooperatives in India mandates payment of the uniform unit price for sugarcane delivered by all members, as well as nonnegativity of retained earnings (i.e., the cooperative cannot distribute more than its revenues in the form of remuneration for growers). The uniform price rule is also a natural notion of fair treatment. Hence all that the farmers with control rights can do is determine the allocation of nonnegative retained earnings between projects that benefit different classes of farmers in different indirect ways.

Second, there are problems with enforcing lumpsum levies imposed on a large number of small growers. One way to enforce collection may be to withhold payments from what the cooperative owes the growers for sugarcane delivered by them. Such withholding

[15]Stories documenting diversion of funds routinely appear in local newspapers after every local, state and national election (Carter, 1974, and Baviskar, 1980, provide specific examples of such practices).

runs the risk of being considered in violation of the uniform price payment rule: the small growers can insist on their legal right to have no levies withheld. An additional problem would arise if small farmers have limited wealth, which limits collateral that can be seized by the cooperative for noncompliance with the levies.

One possible objection to the preceding arguments is that small growers may be willing to collectively and voluntarily make a lumpsum payment to the large growers, to 'bribe' them to agree to set the sugarcane price at its efficient level. This may be an 'unofficial' payment which bypasses all legal restrictions. One problem with this in practice is that the coalition of small growers will face the same collection and enforcement problems amongst its own members that the cooperative would itself incur if it were to impose lumpsum levies on them. With a large number of small growers, such a coalition would be vulnerable to internal free riding on such collective 'bribes', in the fashion described by Mailath and Postlewaite (1990). Another problem is that the bribes would have to be offered conditionally on the large growers setting a sugarcane price at its efficient level, i.e., equal to earnings. In practice, large growers that manage the cooperative have private information about earnings (i.e., about the recovery rate and external price received for sugar sales, less transport and other marketing charges). They would thus have an incentive to understate earnings, which would undermine the effectiveness of the bribe as an inducement to set the efficient cane price.

3 The Model

3.1 Technology and Endowments

The cooperative is defined by a fixed area, to be referred to as the *command area*, allocated by the government. This is the area from which it is allowed to collect and process sugarcane. The farmers who own (irrigated) land in this area are its potential members.

Assume, for simplicity, that this land is owned by two types of farmers: *small farmers* who own S units of land and *large farmers* who own B units. Of course, $B > S$. Let M denote the number of small farmers and N be the number of large farmers in the command area, of whom m small farmers and n large farmers participate in the cooperative. For the present, we shall assume that participation decisions are exogenously given. Later we shall extend the model to make these participation decisions endogenous. The total irrigated land available within the command area is $I = MS + NB$, of which $i = mS + nB$ is allocated to sugarcane, both of which are consequently exogenous (for the time being). Also assume that all participating farmers of any given type are homogenous in all respects.

Sugar-cane is produced using two inputs, land and labor (L).[16] Let $f^T(L)$ denote the production function for a farmer with land area $T(= B, S)$, which defines the total amount of sugarcane produced on this area with labor input L. Throughout the paper we make the following assumption about the nature of these production functions:[17]

(A1) For given $T = B, S$, the production function $f^T(L)$ is strictly increasing, strictly concave, thrice differentiable, and satisfies the Inada conditions $f_L^T(0) = \infty, f_L^T(\infty) = 0$.

Labor is available for hire at an exogenously fixed price of w per unit, which is known in advance. We shall assume that the number of members of the cooperative is large enough that each farmer will take the sugarcane price p (to be decided by the cooperative) as given, while deciding on how much labor to hire. The output supply response of a farmer of type $T(= B, S)$ is then described by $f^T(L^T(p, w))$ where the labor demand function $L^T(p, w)$ is obtained by solving the first order condition for individual profit maximization

$$pf_L^T(L^T(p, w)) = w \tag{1}$$

The labor demand function is strictly increasing in p, decreasing in w, twice differentiable, and satisfies $L^T(0, w) = 0$. We can also define the profit function $\Pi^T(p, w) \equiv pf^T(L^T(p, w)) - wL^T(p, w)$ for a farmer of type T.

We now describe what happens following the delivery of sugarcane to the cooperative. Normalize so that a unit of sugar-cane produces a unit of sugar.[18] This sugar is then sold on the outside market at a price p^* which we take to be exogenous and known in advance. There is a fixed crushing cost per unit of cane, and a setup cost for crushing facilities. For the present nothing will be lost by setting these costs equal to zero, but they will matter later and will be reintroduced then.[19]

[16] Labor can be viewed as a proxy for all variable factors of production such as water, fertilizers etc. that define how intensively a given land area is cultivated.

[17] Note that we are abstracting from technological uncertainty, besides price uncertainty as well. It can be shown that the determination of optimal state-contingent contracts under conditions of uncertainty will reduce in any given state exactly to the nonstochastic version we shall consider in this section. As long as each predicted relationship is augmented to include suitable cooperative and year specific shocks that represent information available publicly within the cooperative, the theory extends straightforwardly to accommodate uncertainty. Note also that no assumption is being made concerning returns to scale. In particular, our theory is consistent with heterogeneous output supply responses of the two groups of farmers. However, in the case of constant elasticity production functions, we shall find it convenient to examine a special case where the supply responses of small farmers are not too inelastic, relative to large farmers. If supply functions for each farmer type are linear or concave, then no restrictions need be imposed at all. See assumption (A2) below for details.

[18] Thus changes in the quality of cane or in the efficiency of the extraction process will translate into changes in the effective market price of sugar.

[19] We therefore assume that crushing operations are subject to constant or increasing returns, upto

3.2 Collective Decisions

Given aggregate sugarcane output Q delivered to the cooperative by its members, the gross revenues earned by it equal p^*Q. Part of these revenues are distributed to the members according to the sugarcane price p contractually agreed upon by them at the outset. The level of retained earnings is then equal to $R \equiv (p^* - p)Q$. The cooperative will also decide on what is to be done thereafter with these retained earnings.

As mentioned in the introduction, legal restrictions prohibit direct distribution of retained earnings, though in practice these earnings are diverted in a variety of ways that directly or indirectly benefit members. For the sake of simplicity we shall assume that these ways of diverting retained earnings are equivalent to direct distribution of retained earnings as (discriminatory) lumpsum payments to the two kinds of growers.[20] We are thus abstracting away from the obvious kind of inefficiencies associated with rent-seeking, i.e., the fact that the benefits received are typically smaller than the expenditures incurred by the cooperative on these projects. Incorporating these would lead rent-seeking to generate greater inefficiency in our model, so that the qualitative conclusions would hold with even greater force.

The cooperative therefore decides on a way to allocate retained earnings R between lumpsum transfers R^B and R^S respectively, where

$$R = mR^S + nR^B. \tag{2}$$

The cooperative therefore has to make the following decisions collectively: the sugarcane price p, and the allocation of retained earnings R^B and R^S satisfying the budget balance condition (2). The resulting payoffs for farmers of type T is then :

$$V^T(p, R^T) \equiv \Pi^T(p) + R^T \tag{3}$$

In effect, the cooperative selects a two part tariff for each kind of farmer, where the unit price is constrained to be the same for the two kinds of farmers, but the lumpsum payments can vary arbitrarily across them.

the capacity limit. This assumption seems to us realistic. If there were diminishing returns instead, the marginal value product of sugarcane to the coop would fall below the corresponding average product. Then the uniform (unit) price rule which rules out the possibility of dividends being paid to shareholders, may give rise to oversupply of sugarcane in the cooperative. The predictions of our theory would still remain unaffected, though the normative implications may be different. We are grateful to Michael Manove for this point.

[20] A more realistic representation would involve allocation to different public projects, which are valued differently by the two kinds of farmers. Then R^B and R^S as defined below would represent expenditures on projects favored by the two kinds of farmers respectively. The utility of each kind of farmer would depend on both R^B and R^S, where type T farmers favor a reallocation of expenditures into its preferred project. We are considering the extreme case where type T farmer's utility equals R^T, and is independent of expenditures on the other project.

The first key assumption of our model is a restriction against imposition of lumpsum transfers for small farmers:

$$R^S \geq 0. \tag{4}$$

The rationale for this assumption has already been discussed in Section 2.

3.3 Constrained Efficient Collective Decisions; The Utility Possibility Frontier

We now proceed to describe the class of (constrained) Pareto efficient collective decisions, which maximize the utility of one type of farmer, subject to the constraint of assuring the other type a prespecified utility level, and the restriction on lumpsum transfers (4). Letting $\bar{U}^S$ denote the minimum utility that small farmers must be assured of, the problem is to select the sugarcane price and allocation of retained earning p, R^B, R^S to maximize [21]

$$V^B(p, R^B) \equiv \Pi^B(p) + R^B \tag{5}$$

subject to

$$\begin{aligned} V^S(p, R^S) \equiv \Pi^S(p) + R^S &\geq \bar{U}^S \\ mR^S + nR^B &\leq R \equiv (p^* - p)[mf^S(L^S(p)) + nf^B(L^B(p))] \\ R^S &\geq 0. \end{aligned}$$

Call a collective decision (p, R^S, R^B) *efficient* if it solves the above problem for some $\bar{U}^S$. The *utility possibility frontier (UPF)* of efficient utility combinations of the two types of farmers is traced out by solutions to problem (5) for all possible nonnegative values of $\bar{U}^S$.

We start by describing some properties of efficient collective decisions (the proof of this and subsequent propositions are relegated to the Appendix). For a type T farmer, define $U^{T*} \equiv \Pi^T(p^*)$ to be the level of utility obtained when the price is set at its efficient level p^*, and there are zero lumpsum transfers. The corresponding utility allocation U^{S*}, U^{B*} can therefore be referred to as the *efficient zero transfer (EZT)* point.

Proposition 1 *Efficient collective decisions have the following property: If $\bar{U}^S > U^{S*}$ then $p = p^*$ and $R^S > 0$. If $\bar{U}^S = U^{S*}$ then $p = p^*$ and $R^S = 0$. If $\bar{U}^S < U^{S*}$ then $p < p^*$ and $R^S = 0$.*

It is natural to expect the EZT point to be efficient, i.e., lie on the UPF. The preceding proposition provides some qualitative characteristics of other efficient points on the frontier, which in turn help us deduce the shape of the UPF. When small growers have

[21] Here we suppress the wage rate as an argument of supply responses.

to be assured a utility level greater than at the EZT point, the cooperative continues to distribute all its earnings from sugarcane sales by setting $p = p^*$. This is supplemented by lumpsum transfers from large to small growers. Over this range, therefore, the utility possibility frontier is a straight line, and social surplus continues to be maximized.

When small growers are entitled to a utility level lower than at the EZT point, on the other hand, i.e., the large growers have to be assured a higher utility than at the EZT point, transfers have to flow in the opposite direction. The constraint (4) prevents this from being accomplished via lumpsum transfers. The only way available is for the cooperative to retain some earnings, by setting the sugarcane price below the efficiency level, and than allowing large growers to divert these earnings to their pet projects. Rent extraction therefore results in inefficiency, in the sense of failure to maximize social surplus: the UPF lies below the extension of the straight line segment to the right of the EZT point.

Our assumption concerning disproportionate control rights of large growers (to be made below) will turn out to imply that the cooperative will always operate to the left of the EZT point, where the sugarcane price is depressed below sales. Hence the portion of the UPF to the right of the EZT point is irrelevant. Over the relevant range, therefore, lumpsum transfers to the large growers are positive, and zero for the small growers. For this reason the theory would be entirely unaffected if a lumpsum transfer constraint were also to be imposed on large growers. What really binds is the restriction on the ability of small growers to make lumpsum transfers to the large growers.[22]

The following assumption on the production function turns out to imply that the UPF is concave (and continuous) to the left of the EZT:[23]

(A2). *Either* (i) the production function for each type $T = B, S$ has the property that the marginal product of labor f_L^T is concave, *or* (ii) both types of farmers share a common constant returns Cobb-Douglas production function defined over land and labor: $f(T, L) = AT^{\alpha}L^{1-\alpha}$. [24]

If the marginal product of labor is concave, then so are the related output supply functions. For the case of constant elasticity (hence convex) supply functions, also, the

[22]With a symmetric constraint preventing lumpsum transfers from large growers: $R^B \geq 0$, the only change in the UPF would be to the right of the EZT point, where transfers must flow from the large to the small growers. This would be accomplished by again depressing the sugarcane price below p^*, and diverting the retained earnings to the small growers. Efficient pricing would then prevail only at the EZT point.

[23]The proof of this is straightforward though tedious and is thus omitted.

[24]Assumption (ii) can be generalized to the case where each type of farmer has a (distinct) production function which is Cobb-Douglas in labor input, provided the supply elasticity of small farmers is not too small compared with large farmers. Specifically, the analysis also goes through in the case where a type T farmer has the production function $f^T(L) = \theta_T L^{1-\alpha_T}$, with the induced (constant) supply price elasticities $\epsilon_T \equiv \frac{1}{\alpha_T} - 1$ satisfying $\epsilon_S \geq \epsilon_B - 1$.

same result holds. Under this assumption, the shape of the UPF is exactly as depicted in Figure 1.

INSERT FIGURE 1

3.4 Control Rights

Having described the nature of the UPF, we turn now to an account of how the cooperative makes a selection from this frontier. In general some form of collective choice procedure involving bargaining or voting operates within the cooperative, which balances management control by large growers with their accountability to shareholders. Such procedures effectively induce a set of implicit welfare weights on the utilities of the two groups of farmers. Assume therefore that the outcome of this is represented by the maximization of a welfare function with linear weight λ on the utility of a small farmer relative to that of a large farmer:

$$W = U^B + \lambda U^S \tag{6}$$

Under assumption (A2), the UPF is concave and continuous; hence the set of all efficient collective decisions is identical to those generated by the maximization of welfare for all possible non-negative welfare weights λ. Hence, even if the 'true' welfare function implicitly defined by the collective choice procedure is nonlinear (e.g., as in the case of a Nash bargaining solution, or majority voting) but monotone in payoffs of each type of grower, the outcome will be described by the maximization of a linear welfare function for some welfare weight λ. This weight can then be identified with the relative control rights of small vis-a-vis large growers.

It is natural to suppose that the relative control rights of small growers is increasing in their relative number β within the cooperative: $\lambda = \lambda(\beta)$, a continuous increasing function with the property that $\lambda(0) = 0$. The second key assumption of our model is then the *disproportionate control hypothesis*:

$$\lambda(\beta) < \beta \quad \text{for all } \beta \tag{7}$$

The justification for this has already been discussed in the preceding Section.

Given that small growers have control right represented by welfare weight λ, note that the cooperative will end up selecting a sugarcane price p_λ which maximizes $V^B + \lambda U^S$. To gain further insight into the nature of the resulting pricing decision, the welfare function can be represented as follows.

First define the *rent extraction function* ρ:

$$\rho(p; p^*) = (p^* - p) f^S(L^S(p)) \tag{8}$$

which represents the rent extracted by a large grower from each small grower to the left of the EZT. Also use $\Pi^{T*}(p;p^*)$ to denote the social surplus $p^* f^T(L^T(p)) - wL^T(p)$ resulting from sugarcane supplied by a grower of size T. Then note that a large grower's utility can be expressed as follows:

$$V^B(p;p^*,\beta) = \Pi^{B*}(p;p^*) + \beta\rho(p;p^*). \tag{9}$$

i.e., as the sum of the social surplus generated by the sugarcane supplied by the large growers themselves, and the rent extracted by them from the small growers (weighted by their relative numbers). Intuitively, the rent generated on the sugarcane supplied by the large growers reverts back to them, hence they appropriate the entire social surplus on this component of the supply. This component is accordingly maximized by setting p equal to p^*. But the objective of rent extraction from the small growers would induce them to set p below p^*. The optimal price from the perspective of a large grower, is one which trades off these two effects.[25]

Using expression (9) for the utility of a large grower, the welfare function of the cooperative can be written as

$$W(p;p^*,\lambda,\beta) = \Pi^{B*}(p;p^*) + \beta\rho(p;p^*) + \lambda\Pi^S(p) \tag{10}$$

The first term here is the social surplus generated by the sugarcane supplied by the large growers themselves (maximization of which involves setting p as close as possible to p^*). The second is the rent extracted by the large growers (maximization of which requires setting p as close as possible to the private monopsony price). The third is the utility obtained by small growers, which is always increased by increasing p. These represent three polar forces bearing on the decision concerning distribution of earnings via remuneration for sugarcane supplies. *Ceteris paribus*, an increase in the relative number β of small grower numbers tends to depress the sugarcane price by accentuating the rent-seeking motive of large growers. On the other hand, this also tends to increase the control right of the small growers, which tends to heighten the third force and increase the sugarcane price.

Recognizing that control right λ of small growers is increasing in their relative numbers β, we can finally define the selected sugarcane price as a function only of the latter: $p(\beta)$ which maximizes [26]

$$W(p;p^*,\lambda(\beta),\beta).$$

[25]The rent component is the key externality in the model. In the case of a factory owned by a private monopsonist, the profit of the monopsonist coincides exactly with the rent; such a firm would therefore tend to set the price below that of a comparable cooperative. The logic is exactly analogous to efficiency arguments for employee ownership of firms in Bowles and Gintis (1995) or Legros and Newman (1996), or for owner cultivated farms over sharecropping farms in Mookherjee (1995).

[26]We shall abstract from the possibility of multiple optimal prices, which we know does not arise under assumption (A2).

Use $p_0(\beta)$ to denote the price that is optimal from the standpoint of the large growers, i.e., which maximizes V^B.

Proposition 2 *Given assumption (7)*

(i) The sugarcane price $p(\beta)$ selected by the cooperative is always set below its efficient level p^*, but at or above $p_0(\beta)$.

(ii) As $\beta \to 0$, $p \to p^*$. If $\frac{\lambda}{\beta} \to 1$ as $\beta \to \infty$ then $p \to p^*$.

(iii) If over some region control rights of small growers do not change with their relative size: $\lambda(\beta + h) = \lambda(\beta), h > 0$, then the price falls over this region: $p(\beta + h) < p(\beta)$.

(iv) If over some region control rights of small growers increases faster than their relative membership size (i.e., $\beta + h - \lambda(\beta + h) < \beta - \lambda(\beta), h > 0$, then the sugarcane price $p(\beta)$ increases over this region: $p(\beta + h) > p(\beta)$.

(v) Suppose (A2) holds, and $\lambda(\beta)$ is strictly convex and twice differentiable. Then the sugarcane price $p(\beta)$ is U-shaped in the sense that there exists β^* such that $p(\beta)$ is strictly decreasing upto β^*, and strictly increasing thereafter.

This proposition collects the key predictions of the model concerning the sugarcane price selected by the cooperative, as a function of the relative weight β of small farmers in its membership. Given disproportionate control held by large growers, they will always be in a position to extract rents, i.e., the price must always be selected below its efficient level. However, the incentive for this form of rent extraction disappears either when the cooperative contains almost no small growers (β is close to zero), or when almost no large growers with any residual control right (β is arbitrarily large, and λ is approximately equal to β).[27] This is the content of parts (i) and (ii) above. Combining this with the fact the selected price must be continuous in p, it follows that the price must be nonmonotone in β.

Parts (iii) onward reinforce this notion: (iii) states that if an increase in the relative number of small members does not increase their relative control right at all, then the price selected by the cooperative must decline. In contrast, (iv) asserts that if their control right increases faster than membership does, then the price must increase. Finally, (v) states that if control rights of small growers is smooth and strictly convex in their size,

[27] Note that when $\lambda = \beta$, the second and the third terms in the welfare function sum to $\beta\rho + \lambda\Pi^S = \beta[p^* - p]f^S + \lambda[pf^S - wL^S] = \beta\Pi^{S*}$. Then the welfare function coincides with first-best surplus.

then the price function is U-shaped: it is initially decreasing and thereafter increasing (see Figure 2).[28]

INSERT FIGURE 2

To see the role of the assumption that λ is strictly convex, note that in the linear case where $\lambda = k\beta$, with $k \in (0,1)$, the price function can never be increasing. This follows by noting in the proof of part (v) that if $p'(\beta^*) = 0$, then $\lambda'' = 0$ implies $p(\beta)$ must be constant for all β thereafter.

A closed form expression for the price can be obtained in the case of constant elasticity supply functions (i.e., the production function takes the form $f^T(L) = AT^{\alpha}L^{1-\alpha}$):

$$p(\beta) = P^* \frac{(1-\alpha)\frac{B}{S} + (1-\alpha)\beta}{(1-\alpha)\frac{B}{S} + (1-\alpha\frac{\lambda}{\beta})\beta} \tag{11}$$

This expression also allows us to verify result (v) above concerning the U-shaped property of the price function, provided the control right λ is a strictly convex function of β.

3.5 Endogenous Capacity

The crushing capacity is likely to be selected by the cooperative based on expected future cane output which, in turn, depends on the cane price. On the other hand, crushing capacity is likely to affect variable crushing costs, and hence the selected cane price. The two variables are thus likely to be jointly determined, though the capacity is probably less affected by transitory shocks than the cane price. We now extend the model to incorporate the capacity decision.

Suppose there is a setup cost for the construction of crushing capacity, which must be incurred upfront (i.e., when the cooperative is set up). For our purposes it is not really relevant where the funds for this come from; they could be upfront payments made by the large growers, for instance, or (as is the more likely case) the setup might be financed by a government loan.

A larger capacity typically lowers the variable cost of processing sugar cane.[29] We may therefore write

$$c = c(K), \tag{12}$$

[28] Strictly speaking, the result is consistent with a monotone decreasing price function, i.e., if $\beta^* = \infty$. Part (ii) of the Proposition provides a condition for β^* to be finite; a weaker condition is that $\frac{\lambda}{\beta}$ converges to a limit which is not too small, as $\beta \to \infty$.

[29] Moreover, more recent vintages of technology tend to be associated with larger capacities. A countervailing tendency would be exerted if increased scale of operation involved collecting sugarcane from a larger command area, thus increasing unit transport costs. We shall assume, as seems natural, that the latter effect is not strong enough to overwhelm the direct economies of scale, so that a larger scale of operation will cause aggregate unit variable costs to fall.

where c is the unit cost of processing, and K measures capacity. By the discussion above, we may take c to be a continuous, decreasing function of K. On the other hand assume that the fixed costs $F(K)$ rise smoothly with capacity, and that both functions are strictly convex.

It is reasonable to assume that the capacity choice takes place first, with full knowledge of the ensuing "subgame" which we have described in the previous section. In other words, members of the cooperative rationally anticipate the sugarcane price which will be set later on, and the resulting supply responses from members. This is described by our analysis above; the only change that we need in the analysis is that p^* should be replaced by $p^* - c$. We continue to assume that participation decisions, and hence the value of β, is taken as given at this stage.

The determination of desired capacity can then be broken down as follows. First, given anticipated output Q, the optimal capacity $K^*(Q)$ is given by minimizing $c(K)Q + F(K)$. Clearly, this is an increasing function.

Next, total output, Q, must be predicted:

$$Q \equiv n[\beta f^S(L^S) + f^B(L^B)].$$

By inserting the expression for farmers' supply responses, we can see that this depends on the sugarcane price, besides the participation decisions: $Q = Q(p; n, \beta)$. Finally the sugarcane price selected by the cooperative will depend on β as well as the capacity choice itself:

$$p = p(K; \beta). \tag{13}$$

In equilibrium, the chosen capacity must satisfy the equation

$$K = K^*(Q(p(K; \beta); n, \beta)).$$

With natural assumptions that impose upper bounds on capacity choices, there will exist a positive equilibrium capacity level (locally) satisfying an equation of the form

$$K = K(\beta, n) \tag{14}$$

With β fixed, an increase in n corresponds to an increase in the command area of the cooperative, so n may be replaced by i, the total irrigated land devoted to sugarcane by member farmers. We then predict capacity levels based on a measure of scale and composition of landholdings in the command area:

$$K = K(\beta, i) \tag{15}$$

Plugging back into the price equation (13), we obtain a reduced form equation for prices that does not treat the capacity level as exogenous:

$$p = p(\beta, i) \tag{16}$$

Consider now the impact of changing the landholding distribution parameter β. One effect operates through the U-shaped influence on the sugarcane price (described in the preceding section), which will tend to impart a U-shaped influence on capacity levels as well. Another effect operates if the participation rates of small and large farmers vary. Then holding i fixed a change in β has effects on the aggregate scale of operations of the cooperative, that depend on the particular pattern of participation rates across different classes of growers. For example, if large growers participate at higher rates, then an increase in β will *ceteris paribus* lower the aggregate supply of sugarcane at any given cane price. This will tend to lower both capacity and the cane price. This second *participation* effect will however be absent if both groups of farmers share the same constant returns to scale technology, so that land redistribution leaves the aggregate supply response unchanged. We would then expect capacity to track price, i.e., both capacity and price will follow a U-shaped relationship with respect to distribution.

3.6 Endogenous Participation

Now consider participation rates. Typically, land that is used for growing sugarcane can have other uses, and the decision to enter the cooperative will be made after consideration of these outside options. The easiest way to capture this is to presume that outside options are heterogenous among each type of grower. For each type T, let $G^T(.)$ represent the distribution function of outside options, captured by payoffs from planting alternative crops (such as cotton) on the land. For simplicity we shall assume that G^T is a continuous function, and each grower either devotes all his land to sugarcane or to cotton. This simplifies the analysis considerably: changes in the extensive margin (i.e., fraction of growers planting sugarcane) that result from changes in profitability of sugarcane cultivation are qualitatively similar to those that would arise additionally on the intensive margin (i.e., where each grower alters the fraction of his land devoted to sugarcane).

We will now need to distinguish between potential growers in the command area and those that actually participate in the cooperative. Remember that the number of *potential* growers is M and N, both of which we take to be exogenous. The number of growers *actually* participating (m and n) will be determined endogenously.

Let Y^S and Y^B be the payoffs to farmers of either type on joining the cooperative. Assume that these are correctly anticipated prior to entry decisions, which requires each potential grower to anticipate the participation decisions of others in the same command area. It follows that the participation rate for type T is simply $G^T(Y^T)$, so that

$$\begin{aligned} m &= MG^S(Y^S), \quad \text{and} \\ n &= NG^B(Y^B). \end{aligned} \tag{17}$$

INSERT FIGURE 3

These payoffs depend on anticipated ratios of small to big growers within the cooperative β: $Y^S = Y^S(\beta)$ and $Y^B = Y^B(\beta)$. Hence the equations for equilibrium participation rates may be written as[30]

$$\begin{aligned} m &= MG^S(Y^S\left(\frac{m}{n}\right)) \quad \text{and} \\ n &= NG^B(Y^B\left(\frac{m}{n}\right)). \end{aligned} \tag{18}$$

To explore the nature of this equilibrium, it is useful to first examine how the payoffs of either type vary with β: see the top panel of Figure 3. Recall that the payoff of a small grower moves monotonically with the price, and hence follows exactly the same U-shaped pattern as does the price function. As β tends to either extreme, the participation rates of the small growers must approach the same limit $G^S(\Pi^S(p^*))$. The pattern of variation of large growers' payoffs is somewhat more difficult to describe. They are increasing in β over the region where the price function is falling.[31] However, over the range where the price function is increasing, large farmers' payoffs may or may not be decreasing.[32] In the case where as $\beta \longrightarrow \infty$, $\frac{\lambda}{\beta} \longrightarrow 1$, however, the price selected converges to p^*, and the large growers' payoff must converge back to its level at $\beta = 0$, so it must eventually be declining as small growers gain control.

Now define a function predicting *relative participation rates*:

$$H(\frac{m}{n}) \equiv \frac{G^S(Y^S(m/n))}{G^B(Y^B(m/n))}. \tag{19}$$

An inspection of equations (17), (18) and (19) readily reveals that the equilibrium ratio of m to n is given by the equation

$$\frac{m}{n} = H(\frac{m}{n})\frac{M}{N}. \tag{20}$$

What does H look like? Given the discussion above, it must be the case that H first decreases, and may later increase as small growers gain sufficient control. But it always satisfies the following property: H is highest at $\beta = 0$. At this point the profit of a small grower is highest (with $p = p^*$), while that of a large grower is at its lowest. Hence the function H is continuous and bounded above by its own value at 0, implying that

[30]To simplify matters we ignore scale effects when determining the payoffs for each size-class.

[31]Since small farmers are worse off from a lower price, the Pareto efficiency of the collective decision must imply that the large farmers are better off.

[32]As the price increases the rent extracted from each small farmer decreases. But there are more small farmers to extract them from, so the total effect can go either way.

there always exists an equilibrium in participation decisions. However, there may be more than one such equilibrium. Small growers may face a problem in coordinating their participation decisions: if they each anticipate a small proportion to join, they expect low profits from joining, as large farmers will acquire most of the control rights.

Consider any (locally stable) equilibrium (i.e., where the H function cuts the 45 degree line from above), and an increase in the exogenous ratio $\frac{M}{N}$ of small to large farmers. Then the curve $H(\frac{m}{n})\frac{M}{N}$ simply shifts up by the same proportionate amount at every point, as the dotted line in the second panel of Figure 3 shows. Consequently, the equilibrium $\frac{m}{n}$ must go up as well. Thus Proposition 2 translates word-for-word into a corresponding statement regarding the effects of a change in $\frac{M}{N}$.[33] In other words, we can replace the proportion of small farmers within the cooperative by the same proportion in the command area, as the principal determinant of the degree of rent seeking.

Of additional interest are implications of the theory for participation rates, which can be tested against the data. Note first that the participation rate μ_T for each type T of grower is given by

$$\mu^T = G^T(Y^T(\frac{m}{n}))$$

Since G^T is a given monotone function, *changes in payoffs are mirrored by the corresponding participation rates.* In other words, we can infer changes in patterns of rents from sugarcane membership by examining corresponding changes in participation rates, while controlling for variables that affect outside options (such as cotton prices). Noting that $\frac{m}{n}$ is monotone increasing in $\frac{M}{N}$, it follows from our preceding discussion that our theory predicts that the participation rate μ^S of small growers is U-shaped with respect to $\frac{M}{N}$, following exactly the pattern of variation in the sugarcane price. On the other hand, the participation rate of the large growers is initially increasing with respect to $\frac{M}{N}$, and continues to be so over the range where the price function is falling. Thereafter its behavior is less easy to pin down, though eventually we would expect it to be decreasing in β.

4 Estimation

We begin by discussing the differences between the two regions of Maharashtra, which will suggest the need to partition the sample accordingly.[34] Next, we describe the data used in the analysis. We then turn to the price-distribution relationship which is the focus of the empirical analysis. After presenting initial kernel-regression estimates of the price-distribution relationship, allowing for year dummies and district fixed-effects, we study

[33] This requires that $\frac{m}{n}$ goes to zero (infinity) when $\frac{M}{N}$ goes to zero (infinity), which is easily verified.

[34] In terms of the model in Section 3, the nature of production functions or the pattern of control rights represented by the function $\lambda(\beta)$ could vary across the two regions.

whether this relationship is robust to the inclusion of alternative scale-variables such as the factory's crushing capacity and district-level irrigation in the price regression. Note that we are only interested in verifying the basic predictions of the previous Section here. Robustness of the price-distribution relationship to alternative construction of the data and inclusion of additional determinants of the price is postponed to Section 5. This Section concludes with corresponding estimates of capacity-distribution and participation-distribution relationships.

4.1 The Two Regions of Maharashtra

Figure 4 presents a map of Maharashtra state which divides the principal sugar growing areas of the state into Western and Eastern regions respectively. The Western region, comprising the Pune and Nasik revenue divisions, is arid and rocky. It was known under British rule as the Bombay Deccan, a part of Bombay Presidency. It was traditionally prone to famine and agricultural activity was restricted to the cultivation of jowar (sorghum) and bajra (millet); sugarcane cultivation only began after the British built canals in this area. Most of the rural population consisted of yeomen peasants cultivating their own lands who belonged to a hardy warrior caste, the *Marathas* (Attwood, 1993). It is therefore not surprising that the British when setting up their administrative system in this region found it convenient to choose the *ryotwari* system, under which each individual cultivator dealt directly with the revenue authority.

INSERT FIGURE 4

The Eastern region in contrast is relatively fertile, being endowed with black-cotton soil and watered by a number of rivers.[35] It consists of the Vidarbha and Marathwada revenue divisions, which were formerly part of the British Central Province and the princely state of Hyderabad, respectively. This region comprised huge estates, owned by landlords (called *zamindars*) but cultivated by large numbers of tenants, sub-tenants and share-croppers. After taking control of this region, the British chose to implement the *zamindari* system under which a *zamindar* dealt directly with the revenue authority and was left to deal independently with the peasants on his own lands.[36]

[35]The most important of these is the Godavari river. In terms of rainfall, the Eastern region is classified as an "assured rainfall zone," while much of the Western region is termed a "scarcity zone" (CAP, 1995). Moreover, soil in the Eastern region is mostly classified as "medium black" (plains), whereas the Western region is interspersed with "coarse shallow soils" (high level) and "reddish brown soils" (hill slopes). The reddish brown soils occur in a strip running parallel to the coast in the rain-shadow of the Western Ghats. Chronic famine in this area, just west of Pune, prompted many of the early irrigation projects in the Bombay Deccan.

[36]The choice of revenue settlement under the British appears to have been driven mostly by convenience. When the British arrived in Bengal, important elements of the *zamindari* system were already

Following the discussion above, we would expect the Western region to be characterized by a greater proportion of small growers than the Eastern region.[37] We will observe below that the two regions effectively partition the sample, along the distribution variable, almost without overlap. The distinction between the two regions is further strengthened by the fact that the current relationship between big and small growers may be determined, at least in part, by the land tenure system that was historically prevalent. Small growers in the West dealt directly with government officials under the *ryotwari* system and may be more assertive today in lobbying for their interests within the cooperative. In contrast, the traditionally exploitative relationship between landlord and small peasant under the *zamindari* system is likely to be retained today in some form, generating an unequal relationship between big and small growers in the Eastern cooperatives.

4.2 The Data

Annual data on crushing capacity, recovery rates and the sugarcane price is collected from all operating sugar factories in Maharashtra from 1971 upto 1993. Table 1 provides descriptive statistics for these variables, by district. As of 1993, there were eighty-three cooperatives located in seventeen districts of the state. Factories in the Western region tend to have higher capacities, pay out higher cane prices and obtain higher recovery rates. Figure 5 presents the evolution of these factory-level variables over time, separately across the two regions. Despite the relative fertility of the Eastern region, the factories there are less numerous and region-wide capacity grows more slowly over time. Moreover, most of the growth in the West occurs through capacity expansion of existing factories, whereas growth in the East is principally accounted for by increase in the number of factories. This suggests that the factories in the East were less able to reap

well established, with large landowners responsible for the collection of revenues from small farmers. Rather than unravel this complex system and deal directly with the tiller of the soil, the British preferred to consolidate the existing system by extending ownership rights to the large farmers, in exchange for the obligation to collect revenues from their tenants (Woodruff, 1953). The British subsequently attempted to introduce the *zamindari* system in Madras, with disastrous results since large landowners were not well established in that region. The alternative *ryotwari* system was established in 1812 and later extended to Bombay presidency when the British conquered the Deccan in 1818. In contrast, they chose the *malguzari* system (which is closely modelled on the *zamindari* system) when the Central Provinces were formed in 1861. Once more it appears that the availability of large landlords in the area, who could take responsibility for revenue collection from an entire village, prompted the British choice of revenue settlement (Harnetty, 1988).

[37] The *zamindari* system was abolished in 1952 and many of the large estates were divided up among members of extended families. Further division of landholding probably occurred in the late 1950s and early 1960s when land reform legislation enacted by the Maharashtra government placed a ceiling on individual land ownership. Nevertheless many large estates have survived partly due to loopholes in the land reform legislation.

the advantages of economies of scale inherent in larger crushing capacities. The bottom panel of Figure 5 shows the cane price to be uniformly higher in the West, with a mild upward trend in both regions. Moreover, there is little difference in recovery rates and an almost complete absence of any trend in this variable in either region. Hence changes in the quality of sugarcane are unlikely to account for the change in the cane price or in capacity levels over time. Although not reported here, the distribution variable grows over time in both regions, with a steeper slope in the West.[38]

INSERT FIGURE 5

Ideally the empirical analysis ought to match factory level data on price and capacity to landholding patterns in the corresponding command areas in each year. Annual distributional data at such a disaggregated level are, however, unavailable. Instead, district-level distribution data are obtained from the Agricultural Census at five points in time over the sample-period; 1970-71, 1975-76, 1980-81, 1984-85 and 1990-91. The Agricultural Census also provides the distribution of irrigated land allocated to sugarcane across different size classes. More disaggregated distributional data, at the *taluka* level, is only available for a single year, 1990-91.

To confront these data problems, we proceed in the following manner. Most of the analysis matches factory-level prices and capacity to district-level distributions. Moreover, since district-level distributional data is available from the Agricultural Census only at five yearly intervals, we assume typically that the distribution of landholdings obtained in a given census year remains constant until the next census year. These assumptions allows us to construct a panel data-set covering seventeen districts over a twenty-three year period.[39] Section 5 examines the robustness of our findings to alternative construction of the time-series as well as the aggregation bias associated with the use of district-level distributional data.

To maintain consistency with the two-class assumption of the theory, we choose a cut-off of 2Ha. separating big and small growers. This cut-off is consistent with the classification of small, medium and large growers in the Agricultural Census. The participation regressions, discussed later in this Section, provide additional support for this

[38]The change in the distribution of landholdings over time is most likely due to household partitioning. Attwood (1993) studies changes in the distribution of irrigated land for a sample of households in Malegaon village. Consistent with the state-wide trend he finds that the proportion of irrigated land held by small growers increases. Increased investment in irrigation by the wealthy households in his sample is dominated by household partitioning. Land-market transactions also favor the small growers with purchases tending to be redistributive. Potential endogeneity in the distribution variable will be discussed in Section 6.

[39]Two of these districts were divided during the sample period. Beed was divided and a new district Jalna was created. Similarly, Latur was created from a part of Osmanabad. To maintain consistency we consider the original districts throughout.

classification of big and small growers. Recall that, by our definition, the participation rates of small growers are increasing in the cane price, whereas this relationship is reversed for the large growers. Section 5 also verifies robustness of the estimation results by replacing the 2 Ha. cut-off with a 4 Ha. cut-off . Note that the number of growers, M/N, is unavailable from the Census. What is actually provided is the amount of irrigated land in each size-class, MS/NB. The implications derived in the previous section follow through with this alternative (scaled) measure of the distribution, without modification. What we refer to as M/N is more precisely MS/NB, in the discussion that follows.

4.3 The Price-Distribution Relationship

The construction of a panel data-set allows us to include year dummies and district fixed-effects in the price regression. District fixed-effects control for unobserved cross-sectional heterogeneity across districts and we effectively study the response in price to changes in the distribution over time. Later, in the next Section, we will provide independent verification of the price-distribution relationship by studying the price-response to cross-sectional variation in the distribution, obtained at the disaggregate *taluka* level at one point in time.

Recall that a unit of sugarcane was normalized to produce a unit of sugar in the previous section. Thus changes in the quality of cane or the efficiency of the extraction process translated into changes in the *effective* market price of sugar, p^*. While we explicitly control for changes in the *realized* market price of sugar in the empirical analysis, district fixed-effects must control for unobserved heterogeneity arising from variation in soil quality, cane quality, climatic conditions, infrastructure and other determinants of crushing productivity. Year dummies control for secular changes over time in the wage rate and other omitted variables. Section 5 will later explicitly control for additional determinants of the cane price such as transportation costs, wages and the price of competing crops. We will also verify that the estimated price-distribution relationship is not driven by underlying variation in recovery rates. Before proceeding to the detailed analysis, it is nevertheless useful as a preliminary step to examine the validity of the predicted relationship without explicitly controlling for additional determinants of the cane price.

Since the price-distribution relationship has been predicted to be non-monotonic and highly nonlinear, it is convenient to present estimation results from a nonparametric regression of normalized price, p/p^*, on distribution, after netting out district and year fixed-effects.[40] The estimated $(p/p^*) - (M/N)$ relationship (with corresponding 95%

[40]To difference out the fixed-effects we begin with a flexible parametric regression, including M/N, M/N^2, M/N^3 terms, for the Eastern and the Western region, as well as year dummies and district fixed-effects.The estimated fixed-effects coefficients are then differenced from the (normalized) price variable.

confidence interval band) is presented in Figure 6, which bears out the theoretical prediction of a U-shaped pattern. The difference in cane price between the highest and the lowest point amounts to approximately one-seventh of the average price. With a cut-off size of 2Ha., the up-turn in the U-pattern is observed to occur around 0.4 which, for $S/B = 1/4$, implies that control shifts and prices are forced up when small growers constitute roughly 60% of the population in an area.

INSERT FIGURES 6,7

Kernel regression estimates are presented for the Eastern and Western regions separately in Figure 7. The distribution variable never exceeds 0.4 in the East, whereas the range on this variable extends up to 1.5 in the West. Cane price is decreasing throughout in M/N in the Eastern region whereas, after a brief initial decline, it is increasing in M/N in the West. Note that the up-turn in the price in the Western region occurs around 0.5, which is beyond the maximum of the distribution range in the East. The intra-regional price-distribution relationships simply reflect the U-shaped pattern that was obtained with the full sample. Our results nevertheless suggest that the rent-seeking effect dominates in the East, whereas control shifts to the small growers in the West. Differences in inequality between the two regions provides one explanation for the lower sugarcane prices and capacity levels observed in the East, controlling for other determinants of these variables.

We now proceed to include alternative measures of the scale of production, as determinants of the cane price, in the price regression. We begin by including crushing capacity as the scale-variable, corresponding to equation (13). Estimation results with this specification are presented in Table 2, Column 1. All the distribution coefficients (on $M/N, M/N^2, M/N^3$) in both regions are statistically significant. It is difficult to visualize the price-distribution relationship when higher-order distribution terms are included in the regression equation. We consequently experiment with a nonparametric regression of (normalized) price on distribution and capacity, differencing-out district and year fixed-effects as before.[41]

INSERT FIGURE 8

We assume here that the parametric specification is flexible enough to capture the basic features of the price-distribution relationship, providing us with consistent estimates of the fixed-effects. All the nonparametric regressions in this paper utilize the Epanechnikov kernel function. Pointwise confidence intervals are computed using a method suggested by Härdle (1990). Note that the estimated fixed-effects may be treated as "fixed" when computing the nonparametric confidence intervals since the kernel estimates converge much more slowly than the fixed-effects.

[41]Specifically, we difference-out fixed-effects estimated in the parametric regression presented in Column 1 of Table 2. As before we assume here that the parametric specification in Table 2 is flexible enough to capture the basic features of the price-distribution relationship, providing us with consistent estimates of the fixed-effects.

Kernel regression estimates of the price-distribution-capacity relationship are presented in Figure 8 separately for the Eastern and Western regions. Price is declining in M/N in the Eastern region, whereas this relationship is reversed in the West, after an initial decline. This is consistent with the results obtained earlier in Figure 7. Inclusion of capacity as an additional regressor therefore does not appear to qualitatively affect the estimated price-distribution relationship.

While we do not interpret the capacity-distribution interaction term in the price regression, the analysis in Section 3 predicts a positive correlation between cane price and the factory's crushing capacity. The coefficient on the capacity term is indeed positive and statistically significant in the Western region. Similar results are obtained later in Section 5 when we test the robustness of the price regression. In contrast, a negative capacity-effect is observed in the Eastern region. While the estimated capacity coefficient is statistically insignificant in Table 2, with district data, it is more precisely estimated and continues to remain negative with *taluka* data in Section 5. One possible reason for this perverse sign is omitted variable bias: recall from the previous discussion that the installed capacity depends on the (correctly predicted) cane price that will be set by the cooperative. All determinants of the price then belong in the reduced-form capacity function. Any omitted determinant of the price will thus be correlated with the capacity term in the price regression, resulting in failure of the orthogonality condition. Since capacity is correlated with distribution, the estimated price-distribution relationship will also be biased.

To examine this further, we replace crushing capacity, K, by district-level irrigation, I. That is, we estimate the reduced form for the price equation (equation (16)). District-level irrigation is available annually over the entire sample-period. The level of irrigation thus provides us with an arguably exogenous measure of the scale of production. Regression estimates replacing K with I in the price regression are presented in Column 2 of Table 2. The price-distribution relationship appears to be robust with respect to this alternate measure of scale. The potential *participation* effect, described earlier, which gives rise to an independent distribution effect in the reduced-form price regression does not appear to be significant in this case. Nonparametric estimates of the price-distribution-irrigation relationship, netting out year dummies and fixed-effects as usual, are presented in Figure 9 separately for the Eastern and Western regions. It is apparent that the price-distribution relationship remains similar to what was obtained earlier in Figure 7 and Figure 8.

INSERT FIGURE 9

One possible objection to the use of irrigation as a scale variable in the price regression is that it may also be partially endogenous. Irrigation can be classified as surface (canal) and well irrigation. Canal irrigation projects are vast undertakings that typically require many years to complete. In contrast, individual farmers can always sink tube-wells when economic conditions are favorable. Well irrigation could consequently respond quite swiftly to upward shifts in cane prices, biasing our estimates of the price function. As a check, we nonparametrically regress irrigation on distribution, netting out year dummies and fixed-effects as usual. While the results are not reported here, the only correlation that we observe is between total irrigation and distribution in the Western region. It is possible that well irrigation responds to increasing prices in that region. As a final robustness test for the price regression, we therefore replace total irrigation by the level of surface irrigation, which is also available annually at the district level. It is apparent from Column 3 in Table 2 that our results are robust to this final alternative measure of scale.

4.4 Capacity-Distribution and Participation-Distribution Relationships

The theory generated a reduced-form expression for the capacity as a function of the distribution and the level of irrigation. Ignoring the *participation*-effect which arises when big and small growers have differential participation rates, we would expect a U-shaped pattern in capacity as well, tracking the cane price. The estimated reduced-form capacity regression is presented in Column 4 of Table 2. This includes distribution and irrigation as regressors, besides year dummies and district fixed-effects. Since the analysis is now at the district level, the average crushing capacity of the factories in a district-year is treated as the dependent variable. Most of the distribution coefficients are statistically significant and the average capacity is weakly increasing in the level of irrigation in both regions. To visualize the capacity-distribution relationship we consider a one-dimensional kernel regression of capacity on distribution, netting out year dummies and district fixed-effects as before. The regression estimates, presented in Figure 10, show capacity declining in M/N in the East and increasing in M/N in the West. Capacity tracks cane price, which is precisely what our model predicted.

INSERT FIGURE 10

Turning finally to the implications for participation, the model predicted that the participation rate for small growers should track the cane price. Their participation should consequently be declining in M/N in the East and increasing in M/N in the West. In contrast, participation by large growers should be increasing in M/N in the Eastern region since lower cane prices are associated with greater rents. Implications for their participation in the Western region were shown to be ambiguous. However, a decline in participation as prices increase in M/N in the West would provide strong support for the hypothesis that control is shifting and rents are declining in M/N in that region.

The results of the participation regressions are presented in Table 3. Participation rates, m/M and n/N, are available at the district level from the Agricultural Census. We consider the reduced-form participation regression which includes distribution and irrigation as determinants. The remaining determinants of the pay-off (and the price) are as usual assumed to be captured by the year dummies and the district fixed-effects. We previously chose 2 Ha. as the cut-off separating big and small growers. In the participation regressions we consider a finer partitioning of land-sizes; $<$ 2 Ha., 2-4 Ha., 4-10 Ha. and $>$10 Ha.. Since participation and distribution data are only available in Census years, at five points in time, the participation-distribution relationship is estimated with a substantially reduced sample. The estimation results are nevertheless broadly consistent with the predictions from Section 3, in both regions.[42] Participation is increasing in M/N in the Western region for the smallest growers ($<$ 2Ha.), whereas the participation-elasticity is very weak for the corresponding growers in the East. This is perhaps one reason why controlling large growers are able to depress cane prices substantially in that region without losing a large share of their supply. While no participation-distribution relationship is discernible for growers with 2-4 Ha. of land in either region, the next higher (4-10 Ha.) category displays a strong participation-distribution relationship, with opposite signs as predicted in the two regions. Participation of this group is inversely related to price in both regions, which suggests that growers in this size-class are in a position to extract rents from the cooperative. Finally, we observe that the participation of the largest growers ($>$10 Ha.) is declining in M/N in the West as predicted. Participation is uncorrelated with distribution for the largest landlords in the Eastern region, who perhaps extract their share of the rent regardless of the composition of members in the cooperative. To aid visualization, Figure 11 nonparametrically estimates the participation-distribution relationship, separately for small growers ($<$ 2Ha.) and large growers (4-10 Ha.) in each region, after differencing out the irrigation terms, fixed-effects and year dummies from the estimated parametric regressions. The observation that participation declines in price for large growers in both regions, for the most part, provides very strong support for our characterization of rent-seeking behavior within the cooperatives.

INSERT FIGURE 11

[42]Note that participation and distribution at the district level are obtained as the average values over the cooperatives in the district. We consequently weight observations by the number of factories in each district-year in the participation regressions.

5 Robustness of the Price-Distribution Relationship

As mentioned earlier, verification of the U-shaped price-distribution relationship is the main focus of the empirical analysis. In this Section we study whether our results are robust to the assumptions made earlier when constructing the data. We also assumed in Section 4 that year dummies and district fixed-effects were able to control for inter-district heterogeneity as well as variation in wages, transportation costs and the price of competing crops over time. In this Section we explicitly include these additional determinants of the price to verify the stability of the price-distribution relationship. We treat the price regression in Column 1 of Table 2 as the *base* (reference) specification. The estimated price-distribution relationship obtained earlier in Section 4 remains stable across all the specifications that we experiment with in this Section.

5.1 Alternative Construction of the Data

The following assumptions were made earlier when constructing the panel data-set. First, we assumed that the distribution obtained in a given census year remained unchanged until the next census. Second, we assumed that aggregate district-level distribution data could be matched with price and capacity data from multiple factories within each district. Third, we defined 2Ha. as the cut-off landholding size separating big and small growers. We now consider each of these assumptions in turn.

First, we consider alternative construction of the time-series in Columns 1 and 2 of Table 4. Annual district-level distributions are computed by linear interpolation between successive census-year levels in Column 1. Alternatively, the distribution is assumed to remain fixed for a block of time *around* each census year. The point-estimates obtained with this alternative construction of the data are very similar to those obtained with the base-specification, particularly with linear interpolation, and most remain statistically significant.

Second, we re-estimate the price regression with dissaggregate *taluka* data in Column 4 of Table 4 to allow for intra-district variation in the distribution variable. The *taluka* lies one administrative level below the district and there are approximately eighty *talukas* corresponding to the seventeen districts in our sample. Each *taluka* contains one or two factories and so the *taluka* distribution will roughly correspond to the distribution in each factory's command-area. *Taluka* data are only available from the most recent Census, 1990-91, so we run the price regression over a six year period, 1988-93. While statistically significant coefficients continue to be obtained with the taluka regressions in the Eastern region, less precise estimates are obtained in the West.[43] There is, however, no change in the basic pattern of the price-distribution relationship in the two regions. Turning

[43]One possible reason is that the M/N ratio had increased sufficiently by the late 1980's, and particularly so in the Western region, to eliminate most of the price-distortion.

to Figure 12, which nonparametrically estimates the price-distribution relationship after differencing out the capacity terms, year dummies and district fixed-effects from the estimated parametric regression, we observe that price declines in M/N in the East, after a brief increase, while this relationship is reversed in the West. As mentioned earlier, this is an important result since it provides us with essentially independent verification of the price-distribution relationship obtained earlier with district data. In contrast with the district regression which effectively captured the effect of changes in the distribution over time on price, the taluka regressions pick up the effect of cross-sectional variation in distribution, controlling for unobserved variation in productivity with district fixed-effects.

INSERT FIGURE 12

Third, we study the price-distribution relationship with the cut-off for small and large growers set at 4Ha., rather than 2Ha. Coefficient estimates with this final specification, using taluka data in Table 4, Column 5, are very tightly estimated. The corresponding estimates with district-level panel data are less precise but qualitatively similar and are not reported here to preserve space. While these results suggest that the price-distribution relationship may not be sensitive to the precise cut-off separating small and large growers, additional support for our choice of cut-off was obtained with the participation regressions in the previous Section.

5.2 Additional Determinants of the Price

It was assumed in Section 4 that year dummies and district fixed-effects controlled for variation in recovery rates, wages, transportation costs and the price of competing crops, across districts and over time. We now proceed to include these variables directly in the price regression. An additional reason for doing this is to note that in a first-best world, agricultural wage rates or prices of competing crops should have no impact whatsoever on the cane price, if one controls for capacity levels.[44] Dependence of cane price on these variables is evidence of inefficiencies typically associated with monopsony power or, in our case, rent-seeking behavior.

It is useful in this connection to review the predictions of our model concerning the effects of these auxiliary variables. To simplify the comparative static exercises, we assume (A2) throughout this section. First, it is evident that the chosen price will depend on p^*, which incorporates both the market price for sugar, as well as the quality of the

[44] In the first-best setting, the cane price should be set at a level p^* which effectively pays out all earned revenues net of crushing costs to growers. This level depends on recovery rates, transportation costs etc. but not on agricultural wage rates or prices of competing crops. An indirect relationship between these latter variables and the cane price could arise in a first-best world via induced effects on capacity, which is why the need to control for capacity levels arises.

cane and the efficiency of the extraction process. It is easy to see that $p(\beta)$ is strictly increasing in p^*, since it maximizes expression

$$W(p,p^*,\lambda,\beta) \equiv \Pi^{B*}(p,p^*) + \beta\Pi^{S*}(p,p^*) - (\beta-\lambda)\Pi^S(p), \tag{21}$$

and $\frac{\partial \Pi^{T*}}{\partial p} = wL_p^T[\frac{p^*}{p} - 1]$ is strictly increasing in p^*. Hence increases in sugar price or the recovery rate will cause the sugarcane price to increase, as will reductions in unit crushing costs or transportation costs. Of course, this would also be the case in a first-best setting.

The price will also be related to the wage rate for agricultural labor, since this affects the profits earned by sugarcane farmers. Remember that the selected price maximizes (21), and hence satisfies the first order condition

$$w[\frac{p^*}{p} - 1][L_p^B + \beta L_p^S] - (\beta-\lambda)f^S = 0. \tag{22}$$

Under assumption (A2(i)), L_p^T is nondecreasing in w. Hence (22) implies that the selected price will be *increasing* in the wage rate. In the constant elasticity case (A2(ii)), it can be verified this continues to be true. The first-best price in contrast equals p^*, and therefore must be independent of the agricultural wage rate. It could be argued however that p^* is decreasing in factory wages, which in turn are (positively) correlated with agricultural wages. Given absence of data on factory wages, the agricultural wages might therefore enter the price equation even in a first-best world. Alternatively, higher agricultural wages reduce cane supplies, and thus cause small capacity levels to be selected, implying low cane prices. Notice, however, that the price-wage relationship would be *negative* in either of these cases, since high wages increase crushing-costs. So a positive price-wage relationship would be evidence in favor of underpricing of cane.

Finally note that the theory does not predict anything about the effect of the cotton price. One direct influence of a higher cotton price is to shrink participation rates of both groups of farmers. This would reduce capacity levels, and hence depress the cane price. However, the effect on relative participation rates of the two groups cannot be predicted and so neither can the effect on the cane price. Nevertheless, the existence of a significant effect (after controlling for capacity levels) is evidence in favor of a pricing distortion.

District fixed-effects and year dummies, particularly the latter, are generally statistically significant across all the alternative specifications in Table 2 and Table 4. We saw earlier that recovery rates do not vary appreciably over time. District fixed-effects are thus likely to capture most of the variation in soil quality, climatic conditions and varietal choice, which determines the recovery rate and through it the price. However, to ensure that the price-distribution relationship is not driven by unobserved variation in recovery rates we replace price by the recovery rate, as the dependent variable in Column 3 of Table 4. It is reassuring to observe absolutely no correlation between recovery rates and distribution, in both regions.

The regression specifications in Table 2 and Table 4 omit transportation costs, wages and cotton prices from the price function. These variables are only available at the district level over a limited period, 1971-87. We exploit the full time-series, 1971-93, for most of the empirical analysis, assuming that variation in these omitted variables is captured by district fixed-effects and year dummies. To ensure that this assumption does not significantly affect our results, we re-estimate the price regression over the 1971-87 period, introducing the omitted variables one at a time. Estimates with the base-specification are presented in Column 1 of Table 5. Column 2 introduces road surface area as an (inverse) measure of the transportation cost. An increase in road surface area increases cane price as predicted in the Western region. The transportation effect is surprisingly negative, but very weak, in the East.

Turning to the second omitted variable, we experiment with rural population in Column 3 and the number of agricultural laborers in Column 4 as potentially exogenous determinants of the supply of labor and, hence, the wage rate.[45] Recall that the selected cane price is increasing in the wage rate when rent-seeking is present. We would expect an increase in labor supply to reduce the wage and, hence, the cane price. Both these variables indeed have a negative effect on the cane price, even after controlling for capacity levels. As explained above, this is further evidence in favor of our hypothesis of underpricing. A possible reason for stronger transportation and wage effects in the Western region is that increased efficiency in cane collection does not fully translate into higher cane prices in the East, since controlling large growers appropriate a larger part of additional revenues in that region.

Finally, Column 5 includes the price of cotton, the chief competing cash crop in the region, in the price regression. Despite controlling for capacity levels, a negative and statistically significant price-effect is obtained in the cotton-growing Eastern region, whereas cotton prices appear to have little effect on cane prices in the West.[46] The price-distribution relationship remains robust across all the specifications we experiment with in Table 5.

6 Concluding Comments

The empirical analysis in preceding sections explored the possibility that the U-shaped price-distribution and capacity-distribution relationships may have arisen owing to various sources of bias, ranging from endogeneity of capacity levels to omission of key vari-

[45]This is a convenient way of avoiding simultaneity problems in examining the effect of local wage rates on the cane price.

[46]One explanation for this result is that high cotton prices eliminate (potential) cane growers with large supply elasticities from the market. A lower cane price will then be set by surplus-maximizing large growers in the Eastern region. This simply extends the standard result that a monopsony will set a lower price as the supply-elasticity declines.

ables. The possible endogeneity of the distribution variable itself, however, has not been explored. Could an alternative hypothesis, for instance one which reverses the direction of causation, explain the data equally well? We conclude the paper with a discussion of this issue, besides others ignored by our analysis so far, and the relation of our work to existing literature.

6.1 Endogenous Distribution and Other Sources of Bias

One possible hypothesis that reverses the direction of causation, is the following. Assume that the observed cane price simply reflects the (exogenous) suitability of an area to sugarcane cultivation. In particular suppose that no rent-seeking phenomena were at play, so that the cooperatives selected a first-best cane price for their growers.[47] It is possible that the distribution of landholdings responds to the cane price, through induced incentives for plot splitting or consolidation. There could be two competing effects here. First, assuming scale economies in sugarcane cultivation, households will consolidate their landholdings to lower the cost of cultivation. Since the incentive to consolidate is greatest where sugarcane cultivation is most suitable, high cane prices will be associated with a large proportion of big growers. This is consistent with the observed price-distribution relationship in the Eastern region. Second, high cane prices in areas suitable for sugarcane cultivation raise household incomes, with a resulting tendency for household division (Foster and Rosenzweig (1996) describe this effect). High prices would then be associated with a greater proportion of small growers, which is consistent with the observed price-distribution relationship in the Western region. The two effects described here work in opposition to each other, not unlike the tension between the rent-seeking and control-shift effects in our analysis. With this alternative interpretation, the *division-effect* would dominate the *consolidation-effect* when scale economies are relatively weak; as, for instance, in the rocky, mountainous, Western region.

The efficiency argument outlined above allows us to interpret the U-shaped price-distribution relationship without requiring inefficient rent-extraction within the cooperative. This explanation, however, would lead one to expect higher capacity levels in the East compared with the West, besides higher recovery rates as well, both of which are contrary to the observed facts. Implications for the patterns of participation rates are also revealing. Recall that the participation rate of the small growers is increasing in the price, whereas this relationship is reversed for big growers, in both regions of the state. Intra-district heterogeneity in the suitability of land for sugarcane cultivation could explain this pattern in the Western region. Household division responds to high prices in this region, with a corresponding increase in the participation of small (divided) households. The large landholdings that remain are increasingly unsuitable for sugar-

[47] Of course, independent evidence against this hypothesis is available from the dependence of the cane price on local wage rates and on the price of cotton.

cane cultivation, with a commensurate decline in their participation. Participation in the Eastern region, however, is less easy to reconcile with the data. If households consolidate to take advantage of scale economies when prices are high, then participation of the large growers must be increasing in the price. As we discussed in the previous Section, precisely the opposite pattern is obtained in the data: participation by the large growers declines as their share of the irrigated land and the price increase. The same fact also serves to rule out explanations based on unmeasured (but exogenous) differences in efficiency of crushing operations within the coop that drive the cane price.

It is also worth mentioning here that participation rates are relatively low in both regions; on average 27% of irrigated land is allocated to sugarcane in the East, while this figure increases to 37% in the West. While participation rates vary a lot in the West, extending above 90% in some district-years, they never exceed 50% in the East. Even if cane prices affect the distribution of landholdings of participating growers, they are unlikely to significantly affect the overall distribution of landholdings in the district, particularly in the East. Recall that the distribution of *potential* rather than *participating* growers is used as our measure of distribution in the empirical analysis. It therefore appears difficult to reconcile observed price-distribution and participation-distribution relationships without invoking some sort of rent-extraction argument.

An alternative potential criticism of our theory is that landholding distributions ought to be endogenous owing to induced incentives for land sales. One would expect land sales to occur in a manner which enables purchasers to consolidate their control right within the cooperative. This would give rise to an incentive for the splitting of large plots in the Western region, but conversely to consolidation of small plots in the East. What is actually observed over time is increased fragmentation of landholdings in *both* regions. This suggests that alternative exogenous factors, such as the splitting of families, played a dominant role in the evolution of landholding distributions throughout Maharashtra.

Another issue ignored in our paper concerns formation of new cooperatives and competition among existing cooperatives. In a first-best world each factory's command area and, hence, the number of factories in a district, will be determined by the trade-off between transportation costs and scale economies in crushing. Coalitional instability and the excessive entry of new factories (split-ups) could, however, occur when large growers are extracting rents from the cooperative. Such entry distortions are presumably most severe where prices are lowest. Regression results, not reported here, find no relationship between the number of factories and distribution in the Eastern region, where excessive entry is most likely to occur.[48] The number of factories is weakly increasing in the pro-

[48]There is also no evidence of the related investment distortion caused by entry-deterrence. Non-parametric capacity regressions described earlier reveal no unexplained increase in capacity as prices decline in the Eastern region. Capacity utilization also appears to be unrelated to distribution in that region. In contrast, capacity utilization is declining in the proportion of small growers in the West, as price and the number of factories increases. This over-capacity may be simply in anticipation of higher

portion of small growers (and the price) in the West, but this may be simply a response to increased transportation costs as well irrigation expanded in the region.

Finally, we tested for the effect of possible competition among cooperatives by including the number of factories in the district in the reduced-form price regression. While the results are not reported here, the basic price-distribution relationship is unaffected by the inclusion of this additional variable in the price regression. In general, we find no evidence of distortions unrelated to the pricing of sugarcane.

6.2 Related Literature

In relating our work to the received literature, it should be mentioned that the notion of control rights in our theory is identified with relative bargaining power of each farmer group; specifically, with their implicit welfare weight in collective decisions resulting from some (unspecified) bargaining or voting process. In particular, we do not need a notion of control rights which is identified with residual rights of control in the sense of Grossman-Hart (1986). We have in mind the looser notion that those who have greater control are more able to manipulate the collective outcome in their favor. This allows for the possibility that people can have control even in a complete contracting setting - simply by virtue of the fact that at the contracting stage they are able to make sure that they get the bulk of the rents.

In our theory, the allocation of bargaining power has efficiency implications, owing to restrictions on lumpsum transfers across different farmer groups. In pursuing the efficiency implications of limited transfers within cooperatives and emphasizing that the distribution of wealth can have efficiency effects, our work follows the classic work of Ward (1958) and more directly, the recent analyses of Aghion and Bolton (1994), Banerjee and Newman (1993), Bowles and Gintis (1994,1995), Legros and Newman (1996), Mookherjee (1995) and Piketty (1996).[49] Hart and Moore (1994) present a similar theory of cooperatives with majority voting over setting of a uniform price for members, and over allocation of expenditures across diverse projects. Given the absence of side transfers across members, increased heterogeneity of member preferences in their model leads to greater inefficiency under cooperative ownership, in contrast to a monopolistic distortion in the case of outside ownership. The restriction on transfers implies that these models do not require distortions in *ex ante* investments as a result of *ex post* holdup by controlling parties — as in Hansmann (1988, 1990, 1995) and Benham and Keefer (1991), and formalized by Dow (1993) and Kremer (1996). Nevertheless, our theory is also consistent with such a view, e.g., where pricing decisions are made after members

future cane supply as well irrigation expands in the region.

[49] For related models resting on moral hazard and limited liability constraints, see Shetty (1988), Holmstrom and Tirole (1994) and Laffont and Matoussi (1996).

deliver sugarcane to the cooperative, rather than before.[50]

We believe the main contributions of the paper to be the following. First, it provides an empirical test of theories of the effects of wealth inequality on the organization of firms, the first that we are aware of. These theories have important implications for our understanding of the role of different ownership patterns in organizational performance. It also provides a concrete illustration of the importance of agricultural landholding patterns not only on agricultural productivity, but also in related processing industries. Similar models have been argued to help understand the effects of land reforms of various kinds on agricultural productivity (Mookherjee (1995), Banerjee and Ghatak (1996)).

Second, the paper provides an empirical methodology for identifying the existence of rent-seeking and its efficiency implications. Direct evidence on the presence of rents is notoriously difficult to document, for obvious reasons. Appropriation of earnings can often take the form of wholly illegal diversion of funds by various accounting contrivances or outright fraud and embezzlement. Reliance on accounting figures for retained earnings are therefore of limited relevance. Our approach is to use theory to seek indirect evidence from implied patterns in observable variables such as sugarcane prices or capacity levels with respect to landholding patterns.

Third, the paper provides insights into the organization of the Indian sugar industry. The rent-seeking we identify in the cooperatives is shown to be a weaker form of the standard monopsony distortion, which suggests that a private factory in the same situation is likely to set lower prices and have lower productivity than these cooperatives. This is one reason why the subsidies to the cooperatives may actually be justifiable in efficiency terms and why private factories have not prospered more than the cooperatives have in the sugar industry. At the same time it also suggests that where the distribution of land is very unequal the cooperatives may not function much better than a monopsony and therefore there may be reasons to not subsidize them in such regions. Particularly striking in this respect is the contrast between sugar cooperatives in the Eastern and Western regions of Maharashtra with differing systems of land tenure and ownership patterns. In particular, our theory suggests that these institutional factors help explain the dynamics of capacity choices in the two regions, i.e., why capacity levels rise over time in the West, but fail to do so in the East.

7 Appendix:Proofs

Proof of Proposition 1: Note first that the budget balance condition (2) must bind exactly, so we can solve for $R^B = (p^* - p)[f^B + \beta f^S] - \beta R^S$, where β denotes $\frac{m}{n}$, the ratio of the number of small to large growers. Hence we can express the utility of a big grower as

$$V^B(p, R^B) \quad = pf^B - wL^B(p) + (p^* - p)[f^B + \beta f^S] - \beta R^S \quad = \mathcal{S}(p; p^*, \beta) - \beta V^S(p, R^S)$$

[50] A model along these lines with similar qualitative conclusions is available on request from the authors.

where $\Pi^{T*}(p;p^*)$ denotes the social surplus $p^* f^T - wL^T$ accruing from the sugarcane supplied by growers of type T, and $\mathcal{S} \equiv \Pi^{B*} + \beta\Pi^{S*}$ the aggregate social surplus within the cooperative, per large-grower-member. The latter is maximized by setting the sugarcane price p equal to its efficiency price p^*, since the first-order condition (1) implies

$$\frac{\partial \Pi^{T*}}{\partial p} \quad = p^* f_L^T L_p^T - wL_p^T \quad = w\frac{p^* - p}{p} L_p^T$$

so that

$$\frac{\partial \mathcal{S}}{\partial p} = \frac{p^* - p}{p} w[L_p^B + \beta L_p^S]. \tag{23}$$

Morever, (23) implies that social surplus increases whenever the sugarcane price moves closer to its efficiency level.

We first show that (a) $p \leq p^*$ in any efficient collective decision. Take any $p > p^*$. Then lower p slightly, and increase R^S correspondingly to leave the utility of small growers unchanged. From (23) and (23) it follows that the large growers are strictly better off, while the limited liability constraint (4) continues to be met. Hence we have a Pareto improvement.

Next we show that (b) $R^S > 0$ in any efficient decision implies $p = p^*$. If $R^S > 0$ the limited liability constraint does not bind. Hence if we can move p closer to p^*, we can adjust R^S in the opposite direction to leave V^S unchanged, and generate an increase in V^B.

(c) We now show that $p < p^*$ implies $\bar{U}^S < U^{S*}$. By (a) and (b) above, it follows that $p < p^*$ implies $R^S = 0$. Hence $\Pi^S(p^*) > V^S = \Pi^S(p) \geq \bar{U}^S$. Next we show that $p = p^*$ implies $\bar{U}^S \geq U^{S*}$. Now $p = p^*$ implies $V^S = \Pi^S(p^*) + R^S \geq \Pi^S(p^*) = U^{S*}$. It therefore suffices to show that the minimum utility constraint binds exactly: $V^S = \bar{U}^S$. If not, p can be lowered slightly from p^*, while R^S is left unchanged. The reduction in $\mathcal{S}$ is second-order, but the reduction in V^S is first-order. Hence (23) implies that large growers are strictly better off, while the minimum utility constraint continues to be met. Moreover, it is evident that $p = p^*$ if and only if $\bar{U}^S \geq U^S$.

Finally, if $\bar{U}^S \geq U^{S*}$, then (c) implies $p = p^*$. Hence R^S is positive or zero according as $\bar{U}^S$ is bigger than, or equal to U^{S*}. Part (c) implies that if $\bar{U}^S < U^{S*}$ then $p < p^*$, and then by part (b) we have $R^S = 0$. ∎

Proof of Proposition 2: (i) follows from the assumption of disproportionate control rights of the large growers: $\beta - \lambda(\beta) > 0$, hence maximization of (21) must involve setting p below p^*. That it cannot be set below p_0 follows from expression (10) of the cooperative's objective function, and the fact that $\lambda \geq 0$. (ii) follows from the fact that $p(\beta)$ is continuous, and that with either $\beta = 0$ or $\lambda = \beta$ the selected price will be p^*. (iii) follows from a standard revealed preference argument applied to the objective function (10), combined with the fact that $p(\beta) > p_0$ which implies that ρ must be strictly decreasing at $p(\beta)$. A similar revealed preference argument applied to expression (21) for the objective function yields (iv).

To prove (v), note that (A2) implies that the price is described uniquely by the first order condition (from maximization of (10):

$$\frac{\partial \Pi^{B*}}{\partial p} + \beta \frac{\partial \rho}{\partial p} + \lambda(\beta) \frac{\partial \Pi^S}{\partial p} = 0. \tag{24}$$

Differentiating this first order condition, and using the corresponding second-order conditions, $p'(\beta)$ can be seen to have the same sign as $q(\beta) \equiv \lambda'(\beta) f^S + \rho_p$. Since $\lambda(\beta)$ is twice differentiable, the function q is differentiable, with slope equal to

$$q'(\beta) = \lambda''(\beta) f^S + l(\beta) p'(\beta) \tag{25}$$

where $l = [\lambda' - 2] f_L^S L_p^S + (p^* - p)\{f_{LL}^S (L_p^S)^2 + f_L^S L_{pp}^S\}$. Now we know that $p(\beta)$ must be locally decreasing at $\beta = 0$, hence q is negative in a neighborhood of 0. Either q stays negative for all β, in which case $\beta^* = \infty$, or it equals 0 at some $\beta^* < \infty$. Then $p'(\beta^*) = 0$. From (25), and the strict convexity of λ, it follows that $q'(\beta^*) > 0$, so q must be positive in a positive neighborhood of β^*, i.e., the price function must be rising in such a neighborhood. We next argue that $p(\beta)$ is nondecreasing for *all* $\beta > \beta^*$. If not, let $p(\beta)$ be decreasing at some $\tilde{\beta} > \beta^*$. Then there exists $\beta^{**} > \beta^*$ such that q is 0 at β^{**} and negative between β^{**} and $\tilde{\beta}$. But using the same argument as at β^*, (25) implies that $p(\beta)$ must be strictly increasing in a positive neighborhood of β^{**}, which contradicts the hypothesis that it is negative on $(\beta^{**}, \tilde{\beta})$.

Finally, to prove that $p(\beta)$ is strictly increasing (i.e., q is strictly positive) for all $\beta > \beta^*$, suppose q equals zero at some $\beta^{**} > \beta^*$. Then β^{**} is a local minimum for q, and $p'(\beta^{**}) = 0$. The former implies that $q'(\beta^{**}) = 0$. Then (25) and the strictly convexity implies that $q'(\beta^{**}) > 0$, a contradiction. ∎

References

Aghion Phillipe and Patrick Bolton (1994), "A Trickle Down Theory of Growth and Development," forthcoming, *Review of Economic Studies.*

Attwood Donald (1988), "Social and Political Pre-conditions for Successful Cooperatives: The Co-operative Sugar Factories of Western India," in *Who Shares? Co-operatives and Rural Development*, D. Attwood and B. Baviskar (eds.), Delhi: Oxford University Press.

———— (1993), *Raising Cane: The Political Economy of Sugar in Western India*, New Delhi: Oxford University Press.

Baviskar B. (1980), *The Politics of Development: Sugar Co-operatives in Rural Maharashtra*, Delhi: Oxford University Press.

Banerjee Abhijit and Andrew Newman (1993), "Occupational Choice and the Process of Development," *Journal of Political Economy*, 101(2), 274-298.

Banerjee Abhijit and Maitreesh Ghatak (1996), "Empowerment and Efficiency: The Economics of Tenancy Reform," mimeo, Department of Economics, MIT.

Benham, Lee and Philip Keefer. "Voting in Firms: The Role of Agenda Control, Size and Voter Homogeneity," *Economic Inquiry* 29 (October 1991):706-719.

Bowles Samuel and Herbert Gintis (1994), "Efficient Redistribution: New Rules for Markets, States and Communities," Working Paper 1994-7, Department of Economics, University of Massachusetts, Amherst.

———— (1995), "The Distribution of Wealth and the Assignment of Control Rights," mimeo, Department of Economics, University of Massachusetts, Amherst.

Carter Anthony (1974), *Elite Politics in Rural India: Political Stratification and Political Alliances in Western Maharashtra*, London: Cambridge University Press.

Chithelen Ignatius (1985), "Origins of Co-operative Sugar Industry in Maharashtra," *Economic and Political Weekly*, Vol. XX, No.14.

Dow Gregory K. (1993), "Why Capital Hires Labor: A Bargaining Perspective," *American Economic Review*, Vol. 83(1).

Commissionerate of Agriculture, Pune (1995), *Districtwise Agriculture Statistical Information of Maharashtra*, Part II, 1993-94 and 1994-95.

Foster Andrew and Mark Rosenzweig (1996), "Household Division and Rural Economic Growth," mimeo, Department of Economics, University of Pennsylvania.

Grossman Sanford and Oliver Hart (1986), "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration," *Journal of Political Economy*, 94(4), 691-719.

Hansmann Henry (1988), "Ownership of the Firm," *Journal of Law, Economics and Organization*, 4(2), 267-304.

———— (1990), "The Viability of Worker Ownership: An Economic Perspective on the Political Structure of the Firm," in *The Firm As A Nexus of Treaties*, Masahiko Aoki, Bo Gustafsson and Oliver Williamson, eds. (London, Sage Publications, 1990).

———— (1995), "Employee Owned Enterprises: Basic Benefits and Costs," draft chapter.

Härdle Wolfgang (1990), *Applied Nonparametric Regression*, Econometric Society Monographs, Cambridge: Cambridge University Press.

Harnetty Peter (1988), "Land Policy and Agriculture in Eastern Vidarbha, c.1867-1947," in *City, Countryside and Society in Maharashtra*, D. Attwood, M. Israel and N. Wagle (eds.), South Asian Studies Papers, No.2, University of Toronto, Centre for South Asian Studies.

Hart Oliver and John Moore (1994), "The Governance of Exchanges: Members Cooperatives vs. Outside Ownership," Harvard University and London School of Economics, mimeo.

Holmstrom Bengt and Jean Tirole (1994), "Financial Intermediation, Loanable Funds and the Real Sector," Working Sector, IDEI, University of Toulouse.

Laffont Jean-Jacques and M. Matoussi (1995), "Moral Hazard, Financial Constraints and Sharecropping in El Ouja," *Review of Economic Studies*, 62(3), 381-400.

Legros Patrick and Andrew Newman (1996), "Wealth Effects, Distribution and the Theory of Organization," *Journal of Economic Theory.*

Lele Jayant (1981), *Elite Pluralism and Class Rule: Political Development in Maharashtra, India*, Toronto: University of Toronto Press.

Mailath George and Andrew Postlewaite (1990), "Asymmetric Information Bargaining Problems With Many Agents", *Review of Economic Studies*, 57(3), 351-368.

Mookherjee Dilip (1995), "Informational Rents and Property Rights in Land," in *Property Rights, Incentives and Welfare*, J. Roemer (ed.), Macmillan Press, forthcoming.

Piketty Thomas (1996) "The Dynamics of the Wealth Distribution and the Interest Rate with Credit Rationing," forthcoming, *Review of Economic Studies.*

Rosenthal Donald (1977) *The Expansive Elite: District Politics and State Policy-Making in India*, University of California Press.

Shetty Sudhir (1988), "Limited Liability, Wealth Differences and Tenancy Contracts in Agrarian Economies," *Journal of Development Economics*, 29(1), 1-22.

Ward Benjamin (1958), "The Firm in Ilyria: Market Socialism," *American Economic Review*, 48, 566-589.

Woodruff Philip (1953), *The Men Who Ruled India, Vol.1: The Founders*, London: the Alden Press.