Inequality, Control Rights and Rent Seeking:
Sugar Cooperatives in Maharashtra[1]

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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 the effect of local landownership distribution on sugarcane 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.

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1 Introduction

It is increasingly becoming accepted that firms are not merely shells where people meet technology but are in fact domains where disparate interest groups compete over rents and the resulting conflicts are resolved with some, and often considerable, loss of efficiency.[6] Moreover it has been argued that such conflicts may be exacerbated when there is substantial heterogeneity among those who participate in the firm; in particular, the distribution of wealth among principal stakeholders matters.[7] By the very nature of rent-seeking, however, one cannot expect to find direct hard evidence for this view. Instead, one can derive implications of specific rent-seeking mechanisms, and test their validity empirically. This is the strategy pursued in this paper.

The data we use in testing this theory concerns sugar cooperatives in Maharashtra, a state in Western India. India is the world's largest producer of sugar and Maharashtra is India's largest producer. The cooperative sector supplies most of Maharashtra's sugar. Each cooperative is jointly owned by the growers in the local area and owns crushing and processing facilities that convert raw sugarcane, collected from its grower-members, into finished sugar. This sugar is sold on the market and the resulting revenues, net of collection and processing costs, are distributed among the growers. In principle, these revenues are supposed to be paid out to the growers as a uniform price for the cane so that each member's share is proportional to the amount of sugarcane delivered. In practice, we will argue, members who are powerful within the cooperative will try to capture more than their fair share of the revenues. The resulting conflict is the basis of the model developed here.

In particular, our model is based on two key assumptions, both of which we argue (in Section 2) are plausible in the institutional setting of the Maharashtra sugar cooperatives. First, large farmers exert disproportionate control within the cooperative. Second, there are restrictions on lumpsum transfers between members of the cooperative; in particular, all members have to be paid the same price for cane.[8] The model, very simply described, works as follows. Large farmers have the power to extract a part of the surplus that would

[6]Grossman and Hart (1986), Hart (1995), Milgrom and Roberts (1988) and Williamson (1985) are well known examples.

[7]See Bowles and Gintis (1994, 1995) and Legros and Newman (1996), in particular.

[8]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) for worker cooperatives and (in related settings) the recent analyses of Aghion and Bolton (1997), Banerjee and Newman (1993), Banerjee and Ghatak (1996), Bowles and Gintis (1994, 1995), Hoff (1994), Hoff and Lyon (1995), Legros and Newman (1996), Lundqvist (1993), Mookherjee (1997), Piketty (1997), and Ray and Streufert (1993). For related models resting on moral hazard and limited liability constraints, see Shetty (1988) and Laffont and Matoussi (1996). Hart and Moore (1996) present a similar theory of cooperatives where absence of side transfers across members implies that heterogeneity of member preferences have efficiency implications.

have otherwise gone to the small farmers, but cannot force the small farmers to pay them directly. So they use their power over the cooperative to depress the price of sugarcane below its efficient level. This generates retained earnings within the cooperative that they can then siphon off.[9][10]

This basic formulation generates implications for the relationship between the distribution of landholdings within the command area of the cooperative and the price it chooses to pay for sugarcane. 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, whereas underpricing of sugarcane is likely in a heterogenous cooperative. Starting with all 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 then depend on which of these effects is stronger. We show that provided the control of the small growers increases at an increasing rate with respect to their relative numbers, the rent seeking effect initially dominates, but is eventually dominated by the control shift effect. The result is a U-shaped relationship between the sugarcane price and the relative number of small growers in the cooperative.[11]

This relation cannot, however, be tested directly. The distribution of landholdings among the members of the cooperative is endogeneous, being a result of decisions that local farmers of differing size make about whether or not to become members. Consequently the model has to be extended to allow for the endogeneous determination of participation by the growers in the local area. However when we carry out this extension, we still find a U-shaped pattern - though the independent variable is now the share of small farmers *in the area of the cooperative* (rather than among members of the

[9]Of course they also need a way to siphon off the money without being too blatant about it (and running the risk of falling afoul of the law). This gives rise to the odd phenomenon of sugarcane cooperatives in Maharashtra starting and operating temples, schools, colleges and hospitals — we will argue that this enables their controlling members to earn pecuniary and nonpecuniary rents in various forms, while meeting with general social approval.

[10]The efficiency effects of control rights in our model are not, therefore, based on distortions in *ex ante* investments as a result of *ex post* holdup by controlling parties (unlike, for example, in the view of cooperatives developed by Hansmann (1988, 1990, 1995), and Benham and Keefer (1991) and formalized by Dow (1993) and Kremer (1996)). Our theory can, however, be made to include such effects by allowing pricing decisions to be made after members deliver sugarcane to the cooperative, rather than before.

[11]More generally, when the cooperative has all small farmers or all large farmers, there will be no reason to depress the price below its first-best level. On the other hand, when the cooperative is heterogeneous, i.e. when there are both small and large farmers in the cooperative, the price will typically be below its first-best level.

cooperative).

Endogenizing participation also generates implications for the response of participation rates to changes in the relative importance of small growers in the local area. Since small growers care only about getting a higher cane price, their participation should mimic the way the price behaves - i.e. there should be a U-shaped relation between participation of small growers and the relative number of small growers in the local area. The participation-distribution relationship for large growers, by contrast, should have an inverted U-shape, since lower prices are associated with greater rents for large growers, which should encourage higher participation among these growers.

This last implication is particularly striking since it says that the participation rate of large farmers moves in the opposite direction to the price. This is inconsistent with almost any alternative theory which explains higher cane prices in terms of higher productivity rather than rent-seeking, since in that case all classes of farmers should have a stronger incentive to participate in a cooperative that pays a higher price.

These implications from our theory are tested against the data, which covers nearly one hundred Maharashtra sugar cooperatives over a twenty-three year period. Our basic data consists of factory-level cane prices, crushing capacities and recovery rates available annually over the sample-period, 1971-93.[12] These data are matched with district-level land distribution data (available from the Agricultural Census at five points in time over the sample-period), and annual data on the amount of irrigated land in each district.

The basic identification assumption underlying our work is that the district level land distribution is unaffected by whatever happens at the level of the individual cooperative. This is justified by the relative insignificance of any single sugar cooperative in any given district: each district has on average four to five different sugar cooperatives, and the average fraction of irrigated land devoted to sugarcane in any district rarely exceeds one-third.

Before going on to testing, however, we partition the sugarcane growing districts in Maharashtra into two regions: the traditionally 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. This historical background allows us to add further content to the U-shaped prediction described above. Specifically, we would expect the rent-seeking effect to dominate in the East, and the control-shift effect

[12] The recovery rate is defined as the amount of sugar that is obtained from one unit of sugarcane. The recovery rate measures the joint effect of cane quality and crushing efficiency.

in the West.

Our preliminary regression estimates, which controls for district and year fixed-effects, confirm our prior expectation: cane 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 different components of the U-shaped pattern that in the full sample. Nevertheless it is of some independent interest, since it suggests that history long past can continue to affect institutional performance to this day.[13]

Proceeding further, we verify that the price-distribution relationship is robust to the inclusion of additional variables that might be expected to be relevant: crushing capacity, scale of local sugarcane cultivation, local wage rates, transportation cost, cane quality, and the price of competing crops. It is also replicated at the cross-sectional level, where the district-level distribution is replaced by the corresponding variable at the *Taluka* level, which corresponds more closely to the command area of each cooperative.[14]

The implications of the theory concerning capacity levels are also tested. It turns out, reassuringly, that capacity tracks price, with a corresponding U-shaped pattern against distribution. Moreover the difference between the highest and the lowest capacity predicted by the regression is substantial, a difference of 50% within the Western region, 15% within the Eastern region, and over 100% for the full sample, suggesting that the cooperatives at the bottom of the 'U' are significantly less productive.

Finally, we examine the relation between distribution and participation rates defined as the fraction of irrigated land in a given size category devoted to sugarcane. For the small farmers we find, as expected, that participation tracks the price. For large farmers we find that participation moves in exactly the opposite direction as the price - going up in the East and down in the West. We will argue later that this particular piece of evidence is crucial: it allows us to reject almost any alternative to the view proposed here.

Overall, we feel that the evidence presented in the paper provides strong support for the two claims we set out to establish: that rent-seeking is an important phenomenon within the Maharashtra sugar cooperatives, and that as a consequence, asset inequality

[13]Indeed while these regressions do not say anything about the level of prices in the East vis a vis the West, our data shows that prices are lower in the East and crushing capacities are smaller. This is surprising given that the East has more rain and is more fertile. Officials in the State Cooperative Federation suggest that this is a result of "management problems" in the East. Our work can be seen as an attempt to locate this problem.

[14]This assures us that aggregation bias in the construction of the distribution variable is unlikely to be the source of the U-shaped relationship.

has significant efficiency implications.

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 summarizing the main results, and 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).

2 Institutional Setting

This section describes the institutional setting of the Maharashtra sugar cooperatives, with particular attention to the validity of the key assumptions of our theory.

2.1 Local Monopsony Power

Over 90% of the sugar output of the state is produced by the cooperatives, most of which were set up with the encouragement and support of the state government since the 1950s. An important reason for the active role of the government is the local monopsony power of a sugar processing firm with respect to sugarcane growers. This monopsony power stems from economies of scale in collection and refining, and the need to crush sugarcane very soon after it is harvested. The expectation was that cooperatives, being controlled by growers, would not exploit this monopsony power. This expectation combined with the desire to avoid possible inefficiencies stemming from *ex post* competition between different factories, presumably motivated the creation of the zone-bandi (closure) system. In this sytem, each cooperative is effectively given monopsony power over (by making it illegal for cooperatives to buy outside) its command area, which covers a fixed radius around the factory. As things stand now, there is little scope for competition: factories are usually spatially separated in such a manner that most growers would incur substantial transport costs in delivering outside their own command area. Entry of new cooperatives is tightly regulated by the government: as explained later in Section 6, there is little evidence that rates of entry of new cooperatives were related to the size of rents within incumbent cooperatives.[15]

[15]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

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. Members can purchase up to 50 shares each, but are entitled to a single vote. A share commits the farmer to allocate a certain amount of land to sugarcane every year, and 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.

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 (Chithelen (1983)). 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.[16] 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 likely to be out of proportion to their numbers.

Formal authority does not always 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 serves to dilute the extent of effective control wielded by the large farmers. It is plausible, therefore, that

challenging the system suggests that it must work, albeit imperfectly, in practice.

[16]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.

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.[17] While the law forbids cooperatives from distributing profits to their members, this is *de facto* possible with an upward adjustment in the cane price. Alternatively, the cooperative can retain earnings and invest them. 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).[18]

Why should the cooperative spend so much of its resources on local public goods instead of paying the farmers higher prices which would give them the incentive to 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.[19] These disproportionate benefits accrue in a variety of ways: the large growers (or their friends and relatives) are frequently owners of downstream construction firms given building contracts, and they control the allocation of the new jobs generated. Further opportunities to skim off rents arise from charging steep 'capitation' fees for seats in educational institutions.[20] Moreover, 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.[21]

Besides *Dharmodaya* , a significant fraction (roughly one quarter) of the cooperatives have invested in subsidiary firms like distilleries and other downstream production facili-

[17] While the central government tries to regulate this price through a statutory minimum price (SMP) and the Maharashtra government sets a state advisory price (SAP), the cane price set by factories in Maharashtra almost always exceeds the SMP and SAP. Price regulation is therefore largely irrelevant.

[18] 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.

[19] 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 occasions.

[20] The capitation fee for a seat in a medical college is currently at least $50, 000 (Rs. 15 lakhs).

[21] 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.

ties 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 for a variety of purposes including 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.[22]

2.4 Why Are There No Lumpsum Transfers?

The most efficient way for the large farmers to appropriate rents from other members is to demand direct lumpsum transfers. Why then do the cooperatives resort to underpricing of cane and *dharmodaya?*

One reason is that the law governing cooperatives in India mandates payment of a uniform unit price for sugarcane. The price itself could not therefore be used to transfer among the members.

Second, lump sum levies on small growers would be difficult to enforce. The law does not permit withholding from payments for sugarcane delivery at a discriminatory rate. So any special levies would have to be collected directly, the scope for which is limited by the large numbers of small farmers involved, their limited wealth, and the lack of any legal basis for such levies. Conversely, voluntary collective payments by small farmers to the managers of the cooperative – paid conditional on selection of an efficient sugarcane price by the latter – would be subject to free-riding among the small growers (as in Mailath and Postlewaite, 1990), as well as opportunistic manipulation by the managers on the basis of their private information concerning market conditions and costs of complementary inputs.

3 A Model of Sugar Cooperatives

3.1 Technology and Endowments

The cooperative is defined by a fixed *command area*. 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.

Sugar is grown using a production technology that exhibits constant returns in irrigated land (which is fixed for the farmer once his participation decision is made) and a variable input, labor, available at some fixed wage per unit. Let l denote per-acre labor

[22] 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).

input and $f(l)$ the per-acre production function, which is smooth and satisfies $f'(l) > 0$, $f''(l) < 0$ for all $l > 0$.[23]

We assume that land is owned by two types of farmers: *small farmers* who own S units of land and *large farmers* who own $B(> S)$ units. Let M denote the number of small farmers and N the number of large farmers in the command area, of whom m small farmers and n large farmers participate in the cooperative. To begin with, we shall assume that participation decisions are exogenously given. Let β denote $\frac{m}{n}$, the fraction of small to big growers actually participating, while $\hat{\beta}$ denotes $\frac{M}{N}$, the corresponding fraction of growers in the region that are potential participants.

Thus $mS + nB \equiv A$ acres out of the $MS + NB \equiv \hat{A}$ potential acres are allocated to sugarcane, and for the time being we assume m, n and A are exogenous.

Once delivered to the cooperative, sugarcane is crushed to produce sugar, which is sold on the outside market at a price p^* which we take to be exogenous and known in advance. Normalize so that a unit of sugar-cane produces a unit of sugar.[24]

A larger crushing capacity (denoted by K) typically lowers the variable cost (denoted c) of processing sugarcane: hence we assume $c = c(K)$, a strictly decreasing function. At the same time a higher capacity entails a higher setup cost $G = G(K)$, so $G(.)$ is a strictly increasing function. The set of potential capacity levels is denoted $\mathcal{K}$, which may be a discrete or continuous set.[25]

3.2 Individual Decisions

The individual member has only one decision to make: how much sugarcane to produce and deliver to the cooperative. If p is the price paid for sugarcane, then for each acre of land, l is chosen to maximize $pf(l) - wl$. Suppressing the wage argument for ease of notation, let $l(p)$ denote the labor demand for each price p and $\pi(p)$ the resulting value of profits.

3.3 Collective Decisions

If Q is the amount of sugar produced by the members of the cooperative, gross revenues equal p^*Q. The bulk of these revenues are paid out for sugarcane delivered at the agreed-

[23] Note that we are abstracting from technological and price uncertainty. It can be shown that the determination of optimal state-contingent contracts under uncertainty will reduce in any given state to exactly the nonstochastic version we consider. Thus, 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.

[24] 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.

[25] In the case where capacity is a continuous variable, we shall assume c is a smooth function of K, with $c'(K) < 0$ and $c''(K) > 0$, while setup costs are also smooth, with $G'(K) > 0$ and $G''(K) > 0$.

upon price p. Part of the revenues pay for the crushing costs ($c(K)Q$) and for the fixed capacity costs ($G(K)$). *Retained earnings* are then equal to $R \equiv [p^* - c(K) - p]Q - G(K)$.

As mentioned above, a variety of legal restrictions and practical problems rule out the direct distribution of the retained earnings of the cooperative. However, 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 directly distributing the retained earnings in the form of (discriminatory) lumpsum payments to the two kinds of growers.[26] Consequently, retained earnings R are allocated between (per-farmer) lumpsum transfers R^B and R^S respectively, where $R = mR^S + nR^B$.

The cooperative therefore has to make the following collective choices: the sugarcane price p, and the allocation of retained earnings R^B and R^S. The resulting payoffs for farmers of type T, where T is either B or S, is $u^T \equiv T\pi(p) + R^T$. In effect, the cooperative selects a two-part tariff for each kind of farmer. As discussed in the previous Section, the main institutional constraints are that the unit price is constrained to be the same for the two kinds of farmers, and a restriction on lumpsum transfers *from* small farmers:

$$R^S \geq 0. \tag{1}$$

3.4 Efficient Outcomes

Let q denote the price of sugar *net* of crushing costs. That is, $q = p^* - c(K)$. Denote the per-acre *social profit* of the cooperative (not factoring in the fixed payments) by $\sigma(q, p) \equiv qf(l(p)) - wl(p)$. The aggregate income of all farmers can then be written as, $A\sigma(p^* - c(K), p) - G(K)$. It follows that the efficient value of p should be precisely $p^* - c(K)$.[27]Moreover, since, $\sigma(p^* - c(K), p^* - c(K)) = \pi(p^* - c(K))$, the efficient level of capacity should be chosen to maximize $A\pi(p^* - c(K)) - G(K)$.

This is the socially efficient outcome. However, because there are constraints on lumpsum transfers as expressed by (1), the efficient outcome will, in general, not be an equilibrium. We now turn to a description of equilibrium outcomes.

3.5 Control Rights and Equilibrium Outcomes

The decision-making process within the cooperative balances the demands of the large growers (who typically control the management of the cooperative) against the demands

[26]We therefore abstract 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.

[27]Differentiating σ with respect to its second argument p, and using the first-order condition from maximization of each grower's profit, it is evident that this derivative has the opposite sign to $p - p^*$.

of the small growers (who perhaps control a majority of the votes in the cooperative). We assume that the outcome of this is represented by the maximization of a welfare function

$$W = u^B + \lambda u^S, \tag{2}$$

where the weight λ is identified with the relative control rights of small growers vis-a-vis the large.

It is natural to suppose that the relative control rights of small growers is increasing in their relative number β within the cooperative: $\lambda = \lambda(\beta)$ is a continuous increasing function with the property that $\lambda(0) = 0$. As explained in Section 2, the second key assumption of our model is the *disproportionate control hypothesis*:

$$\lambda(\beta) < \beta \quad \text{for all } \beta. \tag{3}$$

Proposition 1 *Under (1) and (3), it must be the case that* $R^S = 0$ *(i.e., all retained earnings go to large growers).*

The reasoning is simple. If small farmers enjoyed positive retained earnings, these could be transferred from small to large growers at a per-capita conversion rate of β, which is larger than the welfare weight of the small growers.[28]

It follows that the net payoff for a small farmer is simply his private profit from cultivation: $u^S = S\pi(p)$. For a representative large farmer, the net payoff is the sum of private profit, $B\pi(p)$, and share R^B of the retained earnings of the cooperative. Let $\rho(p, p^*; K)$ denote $[p^* - c(K) - p]f(l(p))$, the rent generated per unit acre of land devoted to sugarcane. Then the large grower's payoff can be written as[29]

$$u^B = B\sigma\left(p^* - c(K), p\right) + \beta S\rho(p, p^*; K) - \frac{G(K)}{n}, \tag{4}$$

i.e., as the sum of the social profit generated from the cane delivered by the large growers themselves, and the rent extracted from the cane delivered by the small growers, less the setup capital costs. The second term on the right-hand-side of (4) is the key rent-seeking

[28] The essence of the argument in no way relies on the assumed linearity of the welfare function. For instance, begin with any symmetric additively separable strictly concave welfare function, and weigh the welfare indicator for the small farmer by λ: i.e., suppose the objective function for the cooperative is $\phi(U^B) + \lambda\phi(U^S)$, where ϕ is an increasing, concave function. Then the same result would hold. However, some of the subsequent results of the model do depend on the linearity assumption.

[29] Using the budget constraint for the cooperative, $R^B = [p^* - c(K) - p][B + \beta S]f(l(p)) - \frac{G(K)}{n}$. To gain insight, it is useful to decompose this further as follows. Separate rents generated from the cane delivered by the big grower himself, from that delivered by small growers. Adding the former to the private profit from cane cultivation, we obtain the social profit generated by the large grower's cane supply $B\sigma(p^* - c(K), p)$. Then the remaining components of the large grower's payoff is the rent generated on the small growers' supply $\beta[p^* - c(K) - p]Sf(l(p))$, less their share of setup costs.

term in the model. In its absence large growers would prefer to set the cane price p at its efficient level $p^* - c(K)$. They would then earn no rents. In order to capture rents from the cane delivered by the small growers, they would want to lower the cane price below the efficient level, trading off the loss of social profit on their own supply with increased rents captured from cane supplied by the other group.

Adding expressions for u^S and u^B, the latter weighted by λ, we obtain the following expression for objective function of the cooperative:

$$W = B\sigma\left(p^* - c(K), p\right) + \beta S\rho(p, p^*; K) + \lambda S\pi(p) - \frac{G(K)}{n} \tag{5}$$

Here there is clearly a tension between the interests of the large and small growers over selection of the cane price: the former would prefer to depress it below its efficient level to capture rents, while the latter would prefer it to be set as high as possible. This is expressed as the tension between the second and third terms in (5) above. The relative weights on these two terms are β and $\lambda(\beta)$ respectively; these express the relative intensity of the *rent-seeking effect* and the *control-shift effect*.

To capture the result of the conflict between these two effects, it is convenient to use a related expression for W. Note that u^B can also be expressed as $u^B = \{[B + \beta S]\sigma\left(p^* - c(K), p\right) - \frac{G(K)}{n}\} - \beta S\pi(p)$, i.e., as the *entire* social profit from the operation of a cooperative, less the drain of private profit into the hands of small farmers, which the large grower fails to capture. Using this, we obtain

$$W = [B + \beta S]\sigma\left(p^* - c(K), p\right) - [\beta - \lambda(\beta)]S\pi(p) - \frac{G(K)}{n}. \tag{6}$$

The second term in this expression thus captures the entire source of divergence of the cooperative's objective from social profit, resulting from the tension between the rent-seeking and control-shift effect. We turn now to examine the distortions generated by this.

3.6 Price Behavior Conditional on Capacity and Participation Decisions

In part because it is simpler to do so, we first report on equilibrium outcomes when capacity K is exogenously given. Indeed, aside from the greater tractability of this case, the assumption of an exogenous capacity may not be off the mark. It is quite possible that capacity choices are decided when the setup loan is obtained, and the size of the loan may be more a bureaucratic or a political outcome rather than an economic choice. If this is the case, variations in capacity choice may be thought of as exogenous without causing much harm to the validity of the theory or the empirical analysis.

It will also simplify the exposition to start by describing the price resulting from a given composition of the cooperative, i.e., for a given value of β. In the next subsection we shall endogenize participation rates. Treating β, K as exogenous, the resulting price is denoted $p(\beta, K)$, and obtained as the solution to the maximization of (6) with respect to p alone. It will be convenient to write $q \equiv p^* - c(K)$ (the net price from production) and $\gamma \equiv \frac{B}{S}$ (a measure of the inequality in landholding size). Dividing (6) through by $B + \beta S$, dropping the term involving setup costs from that maximization problem, and setting

$$\tau(\beta) \equiv \frac{\beta - \lambda(\beta)}{\beta + \gamma}$$

we see that the cooperative sets price $p(\beta, K)$ as if to maximize

$$\sigma(q, p) - \tau(\beta)\pi(p) \tag{7}$$

This gives us a convenient insight into equilibrium price. First note that if $\tau(\beta)$ equals zero, price would be chosen to maximize social profit per acre (σ), which simply means that it is set equal to q. But when is $\tau(\beta) = 0$? Given assumption (3), it is certainly positive for any finite and positive value of β. But it must be zero when $\beta = 0$, and it is also zero as $\beta \to \infty$, provided that in the limit, marginal additions to β provide equivalent marginal increases in control: that is, if $\lambda'(\beta) \to 1$ as $\beta \to \infty$. Thus price-setting behavior becomes efficient as the cooperative becomes more homogeneous.

Inefficiency arises, however, for heterogeneous cooperatives. To see this, observe from (7) that evaluated at $p = q$, the second term $-\tau(\beta)\pi(p)$ continues to provide a negative marginal impact of price-raising. Thus price must be shaded downwards from q. Moreover, it is intuitive that the larger is $\tau(\beta)$, the larger this effect (the appendix provides the formal details). It follows that equilibrium price is negatively related to the value of $\tau(\beta)$.

In fact, $\tau(\beta)$ neatly captures the joint impact of the rent-seeking effect and the control shift effect. For instance, imagine that with an increase in β, λ increases very little or not at all. Then the rent-seeking effect dominates the control shift effect, $\tau(\beta)$ rises, leading to a fall in equilibrium price. Likewise, suppose that over some range $\lambda(\beta)$ rises "sufficiently sharply" with β (see condition (8) below). Then the control shift effect overcomes the rent seeking effect: this implies a fall in the value of $\tau(\beta)$ and a consequent increase in price.

We may take the argument of the preceding paragraph one step further. If initially the rent-seeking effect dominates, and later the control shift effect dominates, price will follow a U-shape in β, converging to the efficient value at both ends of the β-spectrum. All this is summarized in the following result.[30]

[30] It refers to 'the' equilibrium price, whereas equilibrium may be nonunique. However, the result below applies to any arbitrary selection from the equilibrium correspondence.

Proposition 2 *Under (1) and (3) with β and K exogenously fixed:*

(i) In any "heterogeneous" cooperative with $0 < \beta < \infty$, the sugarcane price $p(\beta, K)$ selected by the cooperative is set strictly below its efficient level $q = p^* - c(K)$.

(ii) However, as the fraction of small farmers becomes negligible ($\beta \to 0$), the price tends to the efficient price. This is also the case when the fraction of large farmers becomes negligible, as long as $\lambda'(\beta) \to 1$ as $\beta \to \infty$.

(iii) Equilibrium price is locally nondecreasing in β if and only if the marginal gains in control of small farmers are sufficiently large:

$$\lambda'(\beta) \geq \frac{\gamma + \lambda(\beta)}{\gamma + \beta}. \tag{8}$$

(iv) If $\lambda(\beta)$ is convex, and $\lambda'(\beta) \to 1$ as $\beta \to \infty$, then the sugarcane price $p(\beta)$ is U-shaped with respect to β, in the sense that there exists β^* such that $p(\beta)$ is nonincreasing upto β^*, and nondecreasing 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 $f(l) = l^\alpha$, with $1 > \alpha > 0$):

$$p(\beta, K) = \frac{\alpha q}{\alpha + (1-\alpha)\tau(\beta)} \tag{9}$$

The assertions of the proposition is clearly illustrated by the price function in this special case.

3.7 Price Behavior With Endogenous Participation

Now continue to suppose that capacity levels are exogenously fixed in a newly formed cooperative, but allow growers to decide whether to join the cooperative. We shall assume that growers rationally forecast the price that will result conditional on a given composition (as represented by the function $p(\beta, K)$). Whether any representative farmer should devote his land to sugarcane clearly depends on alternative uses to which it can be put. We assume outside options are heterogenous among each type of grower. For each type T, let $H^T(.)$ represent some (continuous) distribution function of outside options, positive whenever outside options have positive value.[31] We suppose that each grower either devotes all his land to sugarcane or to the alternative activity.[32]

[31] These conditions guarantee the existence of equilibrium; see the appendix.

[32] This simplifies the analysis considerably: changes in the extensive margin (i.e., the fraction of growers planting sugarcane) that result from variations in sugarcane profitability 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.

Letting u^S and u^B be the (rationally anticipated) payoffs to farmers of either type on joining the cooperative, the participation rate for type T is simply $H^T(u^T)$, so that

$$\begin{aligned} m &= MH^S(u^S), \quad \text{and} \\ n &= NH^B(u^B). \end{aligned} \tag{10}$$

INSERT FIGURE 1

These payoffs depend on anticipated ratios of small to big growers within the cooperative β: $u^S = u^S(\beta) = S\pi(p(\beta, K))$ and $u^B = u^B(\beta) = [B + \beta S]\sigma(p^* - c(K), p(\beta, K)) - \beta u^S(\beta) - \frac{G(K)}{n}$. Hence, suppressing dependence on the capacity level K, the equations for equilibrium participation rates μ^S, μ^B may be written as

$$\begin{aligned} \mu^S \equiv \frac{m}{M} &= H^S(u^S\left(\frac{m}{n}\right)) \quad \text{and} \\ \mu^B \equiv \frac{n}{N} &= H^B(u^B\left(\frac{m}{n}\right)). \end{aligned} \tag{11}$$

To explore the nature of this equilibrium, it is useful to first examine how the payoffs of either type vary with $\beta \equiv \frac{m}{n}$: see the top panel of Figure 1. 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 $H^S(S\pi(p^* - c(K)))$. 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.[33] However, over the range where the price function is increasing, large farmers' payoffs may or may not be decreasing.[34] In the case where as $\beta \to \infty$, $\frac{\lambda}{\beta} \to 1$, 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*:

$$h(\frac{m}{n}) \equiv \frac{H^S(u^S(m/n))}{H^B(u^B(m/n))}. \tag{12}$$

[33] 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.

[34] 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.

An inspection of equations (10), (11) and (12) reveals that the equilibrium composition β is given by the equation

$$\beta = h(\beta)\hat{\beta}, \tag{13}$$

where it may be recalled $\hat{\beta}$ denotes $\frac{M}{N}$, the ratio of small to large growers in the region.

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 $p = p^* - c(K)$), 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 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 $\hat{\beta}$ of small to large farmers. Then the curve $h(\beta)\hat{\beta} \equiv h(\frac{m}{n})\frac{M}{N}$ simply shifts up by the same proportion at every point, as the dotted line in the second panel of Figure 1 shows. Consequently, the equilibrium β must go up as well. Thus Proposition 2 translates word-for-word into a corresponding statement regarding the effects of a change in $\hat{\beta}$.[35] 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. This relationship is important for the empirical exercise that follows: the inequality variable in our regressions pertains to the *potential* distribution of small and large farmers, proxied here by $\hat{\beta}$. This is the correct choice of exogenous variable, whereas β is clearly jointly-determined with the price.

Of additional interest are implications of the theory for participation rates, which can be tested against the data. Recall that the participation rate μ_T for each type T of grower is given by $\mu^T = H^T(u^T(\beta))$. Since H^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. Noting that β is monotone increasing in $\hat{\beta}$, it follows from our preceding discussion that the theory predicts that the participation rate μ^S of small growers is U-shaped with respect to $\hat{\beta}$, 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 $\hat{\beta}$, 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. Here the behavior of the large

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

growers is particularly striking since the participation rate and price move in opposite directions. Finally, the effect of increasing capacity on cane price and participation rates is ambiguous.[36]

3.8 Endogenous Capacity

We now extend the preceding theory to the case where the cooperative can also select the capacity level, besides the cane price. As before, we first consider the case where the composition β of the cooperative is given.

We model price and capacity as being chosen simultaneously.[37] Rewriting (6) with the new notation already introduced, the solutions $p(\beta)$ and $K(\beta)$ must then jointly maximize

$$\sigma\left(p^{*}-c(K), p\right)-aG(K)-\tau(\beta)\pi(p) \tag{14}$$

where we define $a \equiv A^{-1}$, and use the fact that $\frac{1}{n}=a(B+\beta S)$. Consider first the problem of selecting an optimal capacity level $K(p)$, *conditional* on a given price decision p:

$$\Delta(p) \equiv \max_{K\in\mathcal{K}}\{\sigma\left(p^{*}-c(K), p\right)-aG(K)\} \tag{15}$$

Using (15), the problem of joint maximization of (14) may be represented as the choice of price p alone, with the capacity choice selected according to $K(p)$, to solve:

$$\max_{p}\{\Delta(p)-\tau(\beta)\pi(p)\}. \tag{16}$$

Now note that the problem (15) of selecting the optimal capacity function $K(p)$ is independent of β, as long as the change in β keeps a (the reciprocal of total landholdings), unchanged. Hence:

Proposition 3 *Price and capacity move in the same direction as β changes, controlling for total acreage in sugarcane. Moreover, the capacity choice is efficient if the cane price is at the efficient level. If capacity is a continuous variable, the converse is also true: capacity choice is efficient only if the cane price is efficiently set; otherwise it is set below the efficient level.*

[36] Higher capacity levels generate economies of scale, thus tending to generate a higher price and encouraging the participation of both small and large growers. However it is difficult to predict how higher capacity affects the *relative* participation rates of the two kinds of growers, i.e. the effect of higher K on β, given $\hat{\beta}$. Hence, the overall effect on p cannot be signed.

[37] It would perhaps be realistic to model capacity and price choices *sequentially*, where capacity is chosen by the cooperative in anticipation of the ensuing price decision. However the results from this case are very similar.

The fact that price and capacity move together rests crucially on the observation that the two arguments that enter into the social profit function $\sigma(q, p)$ are *complementary.*[38] Intuitively, higher cane prices are associated with higher output, which makes higher capacity more desirable.

Note that the optimal price is selected to maximize (16), which, given that, $\Delta(p)$ is independent of β, is exactly analogous to the objective function with exogenously fixed capacity (7). Hence the same arguments used to prove Proposition 2 can be used to establish

Proposition 4 *Suppose that we consider variations in β that leave total acreage in sugarcane unchanged.*

Then equilibrium prices have the same qualitative features as in Proposition 2, even when capacity is endogenous. Moreover, by Proposition 3, equilibrium capacity must have the same properties as well.

In particular, under the conditions of part (iv) of Proposition 2, both price and capacity exhibit a U-shape in β, converging to the efficient choices as the proportion of small growers converges to zero or infinity.

The analysis so far is in terms of β, which, of course, is endogeneous. However as long as we hold the acreage fixed, an argument exactly parallel to that in subsection 3.7 establishes that β is increasing in $\hat{\beta}$,[39] so that all the results in the previous propostion also hold when stated in terms of $\hat{\beta}$. Matters are somewhat more complicated when acreage is also endogenously determined. This case is analyzed in some detail in a previous version of this paper: it turns out that with acreage endogeneous, it is theoretically possible that β and $\hat{\beta}$ move in opposite directions, and stronger assumptions are required to rule out such a possibility. In our data it turns out that the $\beta - \hat{\beta}$ correlation is 0.95 in the Western region and 0.85 in the Eastern region. We therefore find it reasonable to apply Proposition 4 even in the case where capacity and acreage are both treated as endogenous variables.

4 Estimation

The empirical analysis closely follows the discussion in the previous Section and is straightforward to implement. Factory-level price and capacity are matched with district-level distribution and irrigation to construct a panel data-set covering ninety-six factories over a twenty-three year period. We use this data-set to test the price-distribution,

[38] To see this, recall that $\sigma(q, p) = qf(l(p) - wl(p)$, so that $\sigma_1(q, p) = f(l(p))$. Therefore $\sigma_{12}(q, p) = f'(l(p))l'(p) > 0$.

[39] To see this observe that with capacity endogeneous, Equation (13) is correctly written as, $\beta = h(\beta, K(\beta, a))\hat{\beta}$ and that at any "locally stable" solution of this equation, β is increasing in $\widehat{\beta}$.

capacity-distribution and participation-distribution relationships that were derived in the previous Section.

4.1 The Two Regions of Maharashtra

In most of the analysis that follows, the state is partitioned into the Eastern and Western regions since they appear to be distinct in terms of geography and socio-economic composition. Figure 2 presents a map of Maharashtra which divides the principal sugar growing areas of the State into the two regions. The Western region, comprising the Pune and Nasik revenue divisions, is arid and rocky and 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) and the British when they took over the revenue administration of the area, adopted the *ryotwari* system - under which each individual cultivator dealt directly with the revenue authority - for collecting revenues in this area.

INSERT FIGURE 2

The Eastern region in contrast is relatively fertile, being endowed with black-cotton soil and watered by a number of rivers (CAP, 1995). 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, subtenants 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.[40]

It is not surprising, therefore, to find that the Western region is characterized by a greater proportion of small growers than the Eastern region: the two regions effectively partition the sample, along the distribution variable, almost without overlap.[41] The

[40]The choice of revenue settlement under the British appears to have been driven mostly by convenience. The British preferred to consolidate the existing *zamindari* system in Bengal, which was already well established when they arrived there, by extending ownership rights to the large farmers in exchange for the obligation to collect revenues from their tenants (Woodruff, 1953). Much later they implemented the *malguzari* system, which is closely modeled on the *zamindari* system, when the Central Provinces (our Eastern Region) were formed in 1861, since the large landlords in the area were capable of collecting revenue from entire villages (Harnetty, 1988). In contrast, the absence of large landowners prompted the British to establish the alternative *ryotwari* system in Madras (in 1812) and the Bombay Deccan (our Western Region), which they conquered in 1818. The revenue authority dealt directly with the tiller of the soil under the *ryotwari* system.

[41]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

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 up to 1993.[42] 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.[43] Factories in the Western region tend to have higher capacities, pay out higher cane prices and obtain higher recovery rates. Figure 3 presents the evolution of these factory-level variables over time, separately for 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 the advantages of economies of scale inherent in larger crushing capacities. The bottom panel of Figure 3 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 average recovery rates and an almost complete absence of any trend in this variable in either region.[44] Hence changes in the quality of sugarcane or crushing efficiency 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.[45]

individual land ownership. Nevertheless many large estates have survived partly due to loopholes in the land reform legislation.

[42]The recovery rate reflects a combination of cane quality and crushing efficiency.

[43]There are a total of ninety-six factories in our sample. However, not all these factories were in operation throughout the sample-period, 1971-93. Some factories were built during this period and others closed down.

[44]Cane quality depends mostly on agro-climatic conditions, soil quality and varietal choice, while crushing efficiency depends on the crushing technology, management efficiency and availability of complementary inputs. It is therefore plausible that the recovery rate will vary relatively little over time for any given cooperative, while it may vary substantially across different cooperatives.

[45]It is well known that land markets are extremely thin in rural India. The increase in the proportion of small growers over time is most likely due to household partitioning (see Foster and Rosenzweig, 1996,

INSERT FIGURE 3

To estimate the price-distribution, capacity-distribution and participation-distribution relationships, we match factory-level price and capacity with district-level irrigation and distribution. The ninety-six factories in our sample are located in seventeen sugarcane growing districts.[46] While most of our data are available annually, over the 1971-93 period, district-level distribution is obtained from the Agricultural Census at five points in time; 1970-71, 1975-76, 1980-81, 1984-85 and 1990-91. The Agricultural Census also provides information on participation, measured as the proportion of irrigated land allocated to sugarcane, across different landholding size-classes.

To complete the time-series for the distribution variable we will assume for most of the analysis that the distribution obtained in a given census-year remains constant until the next census year. The results will be shown to be robust to alternative construction of the distribution time-series in Section 5. We also assume that aggregate district-level data can be matched with price and capacity data from multiple factories within each district. To rule out aggregation bias as a source of spurious correlation we will replace district-level distribution with the corresponding *taluka*-level statistic in Section 5. The *taluka* approximately matches the factory command area and information at this dissaggregate level is available at one point in time, from the 1990-91 Agricultural Census.

To maintain consistency with the two-class assumption of our theory, we choose a cut-off of 2 hectares (Ha.) separating big and small growers. This cut-off is consistent with the classification of small, medium and large growers in the Agricultural Census. Section 5 verifies robustness of the estimation results by replacing the 2 Ha. cut-off with a 4 Ha. cut-off .

The ratio of small to large growers in the local region $\hat{\beta}$ is unavailable from the Census: it provides only the amount of irrigated land in each size-class, i.e., MS and NB. The implications derived in the previous section follow through with the alternative (scaled) measure of the distribution $\frac{MS}{NB}$, without modification. What we refer to as $\hat{\beta}$ in the ensuing discussion is therefore actually $S/B * \hat{\beta}$.

4.3 Testing the Theory

We now proceed to collect implications from the theory, derived in Section 3, and organize them in a framework suitable for empirical analysis. Proposition 2 derived a U-shaped

for an empirical analysis of the incentives for families to split).

[46]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.

price-distribution relationship, treating the factory's crushing capacity, K, and the distribution of participating growers, β, as exogenous:

$$p = P_1(K, \beta) \tag{17}$$

We subsequently endogenized the participation decision in Section 3.7, still treating K as exogenous, to show that β tracks $\hat{\beta}$. A U-shaped price-distribution relationship was obtained, providing us with the basic specification of the price equation used for much of the empirical analysis.

$$p = P_2(K, \hat{\beta}) \tag{18}$$

Equation (18) above can be estimated using OLS if we assume that K is exogenous. As we mentioned earlier, this assumption may not be entirely implausible. This represents the first set of regressions reported below.

We subsequently allowed for the possibility that price and capacity were jointly determined. We saw in Proposition 3 that capacity tracks price, controlling for total acreage allocated to sugarcane, A:

$$K = K_1(p, A) \tag{19}$$

If price p and capacity K are jointly determined, OLS estimation of the price equation is no longer appropriate. The standard solution in this case is to instrument for capacity. It is easy to see that in our model the area under sugarcane must be determined by the two exogeneous variables - total irrigated area and its distribution: $A = A(\hat{\beta}, \hat{A})$.[47] Substituting in equation (19), $\hat{A}$ appears as an exogenous determinant of K. This variable does not directly enter the price equation and is therefore a valid instrument in this case. The second set of price-distribution regressions, corresponding to equation (18), uses Instrumental Variable (IV) estimation treating K as endogenous.

A third approach is to estimate the reduced-form price equation. Using the expression for A from above and substituting from equation (19) in equation (18) we obtain

$$p = P_3(\hat{\beta}, \hat{A}) \tag{20}$$

Note that $\hat{\beta}$ affects capacity through the A term in equation (19). Thus when we replace K with $\hat{A}$, we include an additional role for $\hat{\beta}$ in the reduced- form price equation. $\hat{\beta}$ now also captures a scale-effect on the price when big and small growers have different participation rates. If this effect is strong enough, the reduced form relation between the price and β may no longer be U-shaped. Note however that this creates no problems with the IV estimates since the factory's crushing-capacity K appears directly in the price equation and we will see that the OLS, IV and reduced-form estimates of the price

[47]More generally p, K and A may also be affected by characteristics of the cooperative that are unobservable to us. However even in that case $\hat{A}$ will remain a valid instrument for K in the price equation.

equation are very similar. This suggests that the scale-effect described above probably does not vitiate the validity of the reduced form relationship.[48]

While the price-distribution relationship is the central piece of evidence, we are also interested in estimating the capacity-distribution and participation-distribution relationships. The specification of the capacity regression, corresponding to equation (19), was derived in Proposition 3. Since the area under sugarcane is evidently endogenous, we estimate a reduced-form specification of the capacity equation, replacing A with the total irrigated area $\hat{A}$. Similarly, we derived the $m/M - \hat{\beta}$, $n/N - \hat{\beta}$ relationship in Section 3.7, holding capacity K constant. Since the capacity is also endogenous, we estimate reduced-form participation equations, treating the total irrigated area $\hat{A}$ as an exogenous measure of the scale of production.[49]

4.4 The Price-Distribution Relationship

We first present the price-distribution correlation without controlling for capacity. Thereafter we introduce capacity in the price equation, estimating an OLS regression corresponding to equation (18). Factory-level price and capacity are matched with district-level distribution to construct a panel data-set. Construction of a panel data-set allows us to include district fixed-effects and year dummies in the price regression. Year dummies control for secular changes over time. District fixed-effects control for unobserved cross-sectional heterogeneity, so we effectively study the response in price to changes in the distribution *over time*.[50] Recall that a unit of sugarcane was normalized to produce a unit of sugar in Section 3. 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^*. We treat the normalized cane price, p/p^*, as the variable of interest throughout the empirical analysis. What we subsequently refer to as the price, p, is more correctly the normalized price, p/p^*. While we explicitly control for changes in the *realized* market price of sugar in the empirical analysis, district fixed-effects 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. We will include additional determinants of the cane price such as transportation costs, recovery rates, wages and the

[48]Recall that it was the same effect that created complications with the $\beta - \hat{\beta}$ correlation when A was allowed to be endogenous. We saw earlier that this was not a cause for concern in this setting since the estimated $\beta - \hat{\beta}$ correlation was positive in both regions.

[49]We could as well have used $\hat{A}$ as an instrument for A and K in the capacity and participation regressions. The advantage of the reduced-form specification is that it allows us to subsequently present the nonparametric estimates, which are very useful in visualizing the capacity-distribution and participation-distribution relationships.

[50]Later in Section 5 we will study the cross-sectional price-distribution relationship using dissaggregated *taluka* data.

price of competing crops in the price equation later in Section 5.

4.4.1 The Price-Distribution Correlation

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 price, p, on distribution, after netting out district and year fixed-effects.[51] The estimated $p - \hat{\beta}$ relationship (with corresponding 95% confidence interval band) is presented in Figure 4, 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 sugar price. This appears quantiatively significant, especially considering that this is estimated from the response of the cane price to changes in landholding distribution within the same district over time. 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 4,5

Kernel regression estimates are presented for the Eastern and Western regions separately in Figure 5. 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 $\hat{\beta}$ in the Eastern region whereas, after a brief initial decline, it is increasing in $\hat{\beta}$ 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 thus turn out to form different segments of a common U-shaped pattern in the full sample. Our results 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.

[51] To difference out the fixed-effects we begin with a nonparametric series approximation, including $\hat{\beta}$, $\hat{\beta}^2$, $\hat{\beta}^3$ terms, for the Eastern and the Western region, besides year dummies and district fixed-effects. The estimated fixed-effects coefficients are then differenced from the price variable (following an approach suggested by Porter, 1996). We assume here that the first stage 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). Under standard panel asymptotics the standard errors would not be consistent. In this case, however, the number of time-periods is large relative to the number of cross-sectional units, so we can treat the estimated fixed-effects as "fixed" when computing the nonparametric confidence intervals since the kernel estimates converge much more slowly than the fixed-effects.

4.4.2 The OLS Price-Distribution Regression

We now proceed to include crushing capacity, K, in the price regression. This specification corresponds to equation (18) in Section 4.3. Estimation results with this specification are presented in Table 2, Column 1. All the distribution coefficients (on $\hat{\beta}, \hat{\beta}^2, \hat{\beta}^3$) 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 price on distribution and capacity, differencing-out district and year fixed-effects as before.[52]

INSERT FIGURE 6

Kernel regression estimates of the price-distribution-capacity relationship are presented in Figure 6 separately for the Eastern and Western regions. Price is declining in $\hat{\beta}$ 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 5. Inclusion of capacity as an additional regressor therefore does not appear to qualitatively affect the estimated price-distribution relationship.[53]

Since the distribution variable is measured at the district level, it is convenient to estimate the price equation at that level of aggregation as well. The district-average of the price in each year now appears as the dependent variable and the factory's crushing-capacity is replaced by the corresponding district-average. The price regression with these aggregated variables is presented in Column 2 of Table 2. The coefficients on the distribution terms are very similar to the corresponding estimates obtained with factory-level data in Column 1.

4.4.3 The IV Price-Distribution Regression

Next, we use total irrigated land area in the district (referred to as the irrigation variable in the tables) as an instrument for capacity in the price-distribution-capacity regression. The result is reported in column 3 of Table 2.[54] Since we are using district-level variables

[52] 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.

[53] We noted in Section 3.7 that the sign of the coefficient on the capacity variable in the price equation is ambiguous. We consequently do not discuss this coefficient in the discussion that follows.

[54] Both capacity, K, as well as capacity interacted with the distribution, $\hat{\beta} * K$, are potentially endogenous in the price equation specified in Column 1. Later we will include $\hat{\beta}, \hat{\beta}^2, \hat{\beta}^3, \hat{A}, \hat{A}^2, \hat{\beta} * \hat{A}$ as determinants in the reduced-form capacity equation. Since $\hat{\beta}, \hat{\beta}^2, \hat{\beta}^3$ already appear in the price equation, we include $\hat{A}, \hat{A}^2, \hat{\beta} * \hat{A}$ as instruments for K. For $\hat{\beta} * K$ we include $\hat{\beta}^4, \hat{\beta}^2 * \hat{A}$ as additional instruments.

as instruments for the capacity it is convenient to estimate the price equation at the district-level. A comparison of Column 2 and Column 3 shows that the OLS and IV estimates are very similar. Endogeneity in the capacity does not appear to bias the estimated price-distribution relationship in either region.

One possible objection to the use of irrigated land area as a scale variable in the price regression is that it may also be partially endogenous. Irrigation can be classified into 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. We consequently replace total irrigated land area by the level of area receiving surface irrigation as the instrument for capacity in column 4 of Table 2. A comparison of columns 2, 3, and 4 shows that the price-distribution relationship is robust across all these specifications.

4.4.4 The Reduced-Form Price-Distribution Regression

We now turn to reduced-form estimation of the price equation, with capacity replaced by total irrigated land area in column 5 of Table 2.[55] Since irrigated land area is measured at the district-level, we estimate the district-level price equation once more with the district-average of the price as the dependent variable. The price-distribution relationship continues to remain U-shaped, although the estimated upward trend in the Western region is now weaker. Nonparametric estimates of the price-distribution-irrigation relationship that net out the year dummies and fixed effects, are shown in Figure 7 separately for the Eastern and Western regions. It is apparent that the price-distribution remains qualitatively similar to that in Figures 5 and 6.

INSERT FIGURE 7

4.5 Capacity-Distribution and Participation-Distribution Relationships

4.5.1 The Capacity-Distribution Relationship

The estimated reduced-form capacity regression is presented in column 6 of Table 2. The regression is estimated at the district-level with the district-average of the capacity in each year as the dependent variable. Total irrigated land area is included as a measure of the scale of operations, and year dummies and district fixed-effects are included as usual. While it is difficult to visualize the capacity-distribution relationship from the point-estimates in Column 6, we see from the corresponding kernel regressions that a

[55] Capacity, K, and distribution interacted with capacity, $\hat{\beta} * K$, are replaced by $\hat{A}, \hat{A}^2, \hat{\beta} * \hat{A}$.

U-shaped pattern is obtained. Year dummies and fixed-effects are netted-out as usual and the capacity-distribution-irrigation relationship is presented in Figure 8. Capacity is declining in $\hat{\beta}$ in the East and increasing in $\hat{\beta}$ in the West. Capacity tracks cane price, which is precisely what our model predicted.

INSERT FIGURE 8

4.5.2 The Participation-Distribution Relationship

The results of the participation regressions are presented in Tables 3 and 4. 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 total irrigation as determinants. Year dummies and district fixed-effects are included as usual. 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.. As usual we difference-out the district fixed-effects, year dummies, and irrigation variables, to nonparametrically estimate the price-distribution relationship in Figure 9.

Starting with the Eastern region, we see in Figure 9 that participation is increasing in $\hat{\beta}$ for all size-classes, especially so for the larger growers. Notice also that the coefficient on the quadratic term $\hat{\beta}^2$, is increasing in land-size. Recall that price was declining in $\hat{\beta}$ in the Eastern region, so we confirm the prediction of the model that the participation of the large growers runs in opposite direction to the cane price. On the other hand the model predicts decreasing participation rates for small growers for the Eastern region, contrary to the observed pattern. Notice, however, that the coefficient on the quadratic term (which seems to be driving participation in this region) is very imprecisely estimated for the smaller growers.

Turning to the Western region, participation is increasing in $\hat{\beta}$ for the small growers ($< 2Ha., 2-4Ha.$), whereas this pattern is reversed for the large growers ($4-10Ha., > 10Ha.$). Recall that price was increasing in $\hat{\beta}$ in this region, so the participation behavior for the different size-classes is precisely what the model would predict. These participation patterns are relatively precisely estimated. Specifically, note that the coefficient on the linear $\hat{\beta}$ term in Table 9 is positive and significant for the smaller growers; this coefficient appears to be driving the upward trend in their participation. For the large growers it is the coefficient on the cubic $\hat{\beta}^3$ term that dominates. It is also larger and more precisely estimated for the larger size-classes in Table 3. This coefficient appears to form the basis of the striking result that participation runs opposite to the price for the large growers in the Western region as well.

Since the participation data are available only in Census years we completed the time-series for this variable by assuming that the district-level participation in a given census-year remains constant until the next census-year. The same method was used to construct the distribution variable. The advantage of this approach is that we are estimating the participation regression with the same observations that were earlier used to estimate the price-distribution and capacity-distribution relationships. However, price and capacity vary at the district level from one year to the next. Since this is not the case with the participation variable, we also estimate the participation-distribution relationship with a reduced sample, using data from the five census-years only.

The sample-size is now very small and we were unable to estimate the higher-order distribution terms with any precision. We consequently consider a modified version of the participation equation in Table 4, omitting higher-order terms for the distribution variable. We are mainly interested at this point to verify that the general patterns in Figure 9 are robust to the reduction in sample-size. Starting with the Eastern region, the coefficient on the distribution variable is positive for all size-classes, consistent with what we observed previously. However, this coefficient is imprecisely estimated, except for the $4-10$ Ha. category. Recall that it was this category that showed the sharpest participation-response to changes in $\hat{\beta}$ in Figure 9. The increased participation for these large growers, running against the change in price, provides strong support for the rent-seeking view in the Eastern region.

For the Western region the distribution coefficient is positive for the < 2 Ha. and $2-4$ Ha. categories, whereas the sign is reversed for the $4-10$ Ha. and > 10 Ha. categories. The estimated coefficients in Table 4 are once more broadly consistent with the patterns in Figure 9. Participation for the small growers is increasing in $\hat{\beta}$, together with the price, while participation for the large growers declines. With the exception of the $2-4$ Ha. category, all the distribution coefficients in the Western region are statistically significant. The declining participation of the large growers in the Western region provides strong support for the view that control within the cooperatives was shifting, with a corresponding decline in the rents that accrued to the large growers.

INSERT FIGURE 9

5 Robustness of the Price-Distribution Relationship

In this Section we examine whether our results are robust to changes in the assumptions that underlay the previous section. We consider a number of alternative estimates of the OLS price-distribution regression in column 1 of Table 2.

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 2 Ha. 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 5. Annual district-level distributions are computed by linear interpolation between successive census-year levels in Column 1. In Column 2 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 6 of Table 5 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, the sign of the coefficients in the Eastern region is reversed when compared with the corresponding estimates obtained with district data. There is, however, no change in the basic pattern of the price-distribution relationship in the two regions. Turning to Figure 10, 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 continues to decline in $\hat{\beta}$ in the East, after a brief increase, while this relationship is reversed in the West. 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 10

Third, we study the price-distribution relationship with the cut-off for small and large growers set at 4Ha., rather than 2Ha. We saw with the participation regressions, particularly in the West, that the < 2 Ha. and $2 - 4$ Ha. size-classes behave in a similar fashion, while the $4 - 10$ Ha. and > 10 Ha. categories track together. Less than 4 Ha. may therefore represent a more appropriate classification for small growers in this case. Returning to the district-level data, the price regression with this alternative classification of big and small growers is presented in column 4 of Table 5. The point-estimates cannot be compared with the corresponding coefficients with the 2 Ha. cut-off. However, they remain fairly precisely estimated and the pattern of coefficients in the two regions remain unchanged.

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. District fixed-effects and year dummies, particularly the latter, are generally statistically significant across all the alternative specifications in Table 2 and Table 5. 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 its influence on the cane price. However, to ensure that the price-distribution relationship is not driven by unobserved variation in recovery rates we replace cane price by the recovery rate, as the dependent variable in Column 5 of Table 5. It is reassuring to observe no correlation between recovery rates and distribution, in both regions.

The regression specifications in Table 2 and Table 5 omit transportation costs, wages and cotton prices from the price equation. 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 in column 3 of Table 5 with the additional regressors. Some of these regressors, such as transportation costs and wages are potentially endogenous. It is entirely possible that district-wages respond to cane prices. Investment in roads and other infrastructure could also respond to the performance of the cooperatives in a district. Since valid instruments are unavailable, we include these variables nonetheless. It is evident, by inspection of the distribution variables, that the $p - \hat{\beta}$ relationship remains essentially unchanged. Coefficients on the additional variables, estimated separately in each region, are not reported in Table 5 and are mostly insignificant (with the exception of transportation cost in the Western region).

6 Concluding Comments

We have interpreted the evidence presented here as strong evidence for the view that rent-seeking by the large farmers is an important determinant of cooperative performance. To conclude we now briefly consider potential alternative interpretations of the same evidence.

One possibility is the opposite kind of rent-seeking: small farmers setting a low price in order to exploit the large farmers. This would generate exactly the same U-shaped pattern for prices and capacity, since our model then applies *in toto* with the roles of small and large farmers reversed. However it would predict that the participation of the large farmers will always move with the price while that of the small farmers will, over a range, move in the opposite direction. As noted, this is the opposite of what we find.

A second possibility is that the land distribution variable is picking up the effect of some omitted determinant of land producitivity that changes over time. It is possible that there are certain kinds of public goods that influence producivity (other than the most obvious ones, which we have included). Whether or not these public good are supplied could depend on the political economy of the region, which in turn is affected by the amount of differentiation among the farmers. If increased heterogeneity reduces the scope for collective action, it would render the cooperatives less productive, generating a U-shaped price-distribution relationship. However, this theory, perhaps like any other theory based on unmeasured differences in productivity across cooperatives, is inconsistent with the evidence on participation rates. Why should large farmers be reluctant to participate in more productive cooperatives?

A final, less specific, possibility is that the land distribution itself is endogeneous, and reflects the influence of some omitted variable. However, as we noted above, our land distribution variable is measured at the district level. At such a high level of aggregation, it is less likely to be affected by changes inside specific cooperatives. Moreover, only a small fraction of the land area is devoted to sugarcane; on average 27% of irrigated land is allocated to sugarcane in the East, and 37% in the West. 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. Changes in the distribution over time are more likely due to other exogenous factors such as the splitting of families; increased fragmentation of landholdings is observed over the sample-period in *both* regions of the State.[56] Our empirical analysis indicates that this was associated with greater inefficiency in the East, by lowering price and capacity levels there relative to the rest of the sample, and at the same time *higher* participation rates by the large growers. Exactly the opposite pattern was observed in the West. An alternative theory which does not rest on rent-seeking behavior by the large growers

[56] See Foster and Rosenzweig (1996) for an empirical analysis of incentives for families to split.

would be hard placed to explain these, in particular why the pattern is asymmetric between the East and the West, and why the participation of large growers moves in opposite direction to price and capacity levels.

An issue ignored in the paper concerns the role of competition among existing cooperatives (or potential entrants) for purchase of sugarcane from growers. We believe that these did not play a significant role. Regression results, not reported in the paper, found no relationship between the number of factories and distribution in the Eastern region, where excessive entry is most likely to occur. We also found no evidence of the related investment distortion caused by entry-deterrence. Non-parametric capacity regressions revealed no unexplained increases in capacity as prices declined in the Eastern region. Capacity utilization also appeared to be unrelated to distribution in that region. In contrast, capacity utilization was declining in the proportion of small growers in the West, as the cane price and the number of factories increased. 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 was unaffected by the inclusion of this additional variable in the price regression. The *zone-bandi* system thus appears to have effectively prevented competition between factories. Overall, therefore, the only significant distortions appeared to be related to the underpricing of sugarcane, owing to the nature of interest conflicts within the cooperatives.

7 Appendix 1: Proofs

Proof of Proposition 1. Suppose, on the contrary, that $R^S > 0$ at some equilibrium payoff vector (u^S, u^B). Consider a new payoff pair $(\hat{u}^S, \hat{u}^B)$ such that $\hat{u}^S = u^S - \epsilon$, and $\hat{u}^B = u^B + \beta\epsilon$, for some $\epsilon \in (0, R^S)$. Because there are β small farmers for every large farmer, this new payoff pair must be feasible. But it is easy to see, using (3), that

$$\hat{u}^B + \lambda\hat{u}^S > u^B + \lambda u^S,$$

a contradiction. ■

Proof of Proposition 2. The following preliminary result will be useful:

Lemma 1 *Consider the maximization problem:*

$$\max_p A(p) - t\pi(p) \tag{21}$$

where $\pi(p)$ is a strictly increasing function, and suppose that a maximum exists for every value of $t \geq 0$. We claim that if $t > t'$, and p solves (21) under t while p' solves (21) under t', then $p \leq p'$.

Proof. Consider (p, t) and (p', t') satisfying the conditions of the lemma. Then

$$A(p) - t\pi(p) \geq A(p') - t\pi(p'),$$

while

$$A(p') - t'\pi(p') \geq A(p) - t'\pi(p),$$

Adding these two inequalities and transposing terms, we see that

$$(t - t')[\pi(p') - \pi(p)] \geq 0,$$

and recalling that π is strictly increasing, it follows that $p' \geq p$. ■

In proving the proposition, set $A(p) \equiv \sigma(q, p)$.

Part (i) of the proposition can be proved by appealing to the lemma, setting t equal to $\tau(\beta)$, and $t' = 0$. Not also that t positive implies that the optimal price must be strictly less than $p^* - c(K)$, using a standard Envelope argument: otherwise the optimal price is $p^* - c(K)$, and a small reduction in the price will have a zero first-order effect on the social surplus term, but a positive first order effect on the rent term, in the expression for W.

Part (ii) of the proposition from the fact that $\tau(\beta) \to 0$ as $\beta \to 0$. Moreover, if $\lambda'(\beta) \to 1$ as $\beta \to \infty$, $\tau(\beta)$ also converges to zero when $\beta \to \infty$. To see this, simply apply L'Hospital's Rule to the fraction

$$\frac{\beta - \lambda(\beta)}{\beta + \gamma}$$

as $\beta \to \infty$, and use the assumption that $\lambda'(\infty) = 1$.

The first part of Part (iii) is a direct consequence of Lemma 1. To prove the second part, note that

$$T'(\beta) = \frac{(\beta + \gamma)[1 - \lambda'(\beta)] - [\beta - \lambda(\beta)]}{(\beta + \gamma)^2} \tag{22}$$

which is nonnegative if and only if (8) holds.

To establish (iv), note from (22) that

$$\text{Numerator } T'(\beta) = [\lambda(\beta) - \beta\lambda'(\beta)] + \gamma[1 - \lambda'(\beta)]$$

which is clearly positive for β close to zero (use (3) and the convexity of λ to see that $\lambda'(0) < 1$).

Next, it is easy to see (again using (3) and the convexity of λ) that $\lim_{\beta \to \infty}[\lambda(\beta) - \beta\lambda'(\beta)] < 0$. Recalling that $\lambda'(\infty) = 1$ by assumption, it follows that $T'(\beta) < 0$ for β sufficiently large. To complete the proof, note that

$$\frac{d}{d\beta}[\text{Numerator } T'(\beta)] = -(\beta + \gamma)\lambda''(\beta) \leq 0.$$

■

Proof of Proposition 3. Consider the sub-problem of maximizing

$$\sigma\left(p^* - c(K), p\right) - aG(K) \tag{23}$$

with respect to K, assuming that price p has already been chosen. This is equivalent to maximizing

$$[p^* - c(K)]f(l(p)) - aG(K)$$

with respect to K. Given our assumptions, there is a unique solution $K(p)$ to this problem, which is a strictly increasing function of p. Because a is taken to be independent of β, β enters nowhere in this relationship. So any change in β that leaves cane acreage unchanged moves capacity and price in the same direction.

We know that capacity choice is efficient when p is chosen at the efficient level (compare (23) with the discussion in Section 3.4). Because capacity is strictly increasing in p, it can be efficient nowhere else. ■

Proof of Proposition 4. Use Lemma 1 with $A(p)$ set equal to $\Delta(p)$ and go through exactly the same arguments as in the proof of Proposition 2. ■

References

Aghion Philippe and Patrick Bolton (1997), "A Trickle Down Theory of Growth and Development," *Review of Economic Studies* 64, 151–172.

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 (CAP) (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.

Hart Oliver (1995), *Firms, Contracts and Financial Structure*, Clarendon Lectures in Economics, Oxford and New York: Oxford University Press, Clarendon Press.

Hart Oliver and John Moore (1996), "The Governance of Exchanges: Members Cooperatives versus Outside Ownership," *Oxford Review of Economic Policy*, 12(4), Winter 1996, 53-69.

Hoff, K. (1994), "The Second Theorem of the Second Best," *Journal of Public Economics,* 45, 223-242.

——— and A. Lyon (1995), “Non-Leaky Buckets: Optimal Redistributive Taxation and Agency Costs,” *Journal of Public Economics.*

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.

Lundqvist, L. (1993), “Economic Underdevelopment: The Case of a Missing Market for Human Capital,” *Journal of Development Economics* 40, 219–239.

Milgrom Paul and John Roberts (1988), “An Economic Approach to Influence Activities in Organizations,” in Sherwin Rosen and Christopher Winship (Ed.) Organizations and Institutions: Sociological and Economic Approaches to the Analysis of Social Structure, *American Journal of Sociology*, vol. 94, supplement. Chicago: University of Chicago Press.

Mookherjee Dilip (1997), “Informational Rents and Property Rights in Land,” in *Property Relations, Incentives and Welfare*, J. Roemer (ed.), Macmillan Press.

Piketty Thomas (1997) “The Dynamics of the Wealth Distribution and the Interest Rate with Credit Rationing,” *Review of Economic Studies* 64, 173–189.

Porter Jack (1996) *Essays in Econometrics,* unpublished MIT Ph.D. dissertation.

Ray, Debraj and Peter Streufert (1993), “Dynamic Equilibria with Unemployment due to Undernourishment, *Economic Theory* 3, 61–85.

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.

Williamson Oliver (1985), *The Economic Institutions of Capitalism.* New York, Free Press.