OWNERSHIP FORM AND CONTRACTUAL INEFFICIENCY IN THE INDIAN SUGAR INDUSTRY[1]

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Abstract

This paper examines evidence for contracting distortions in procurement of sugarcane by Indian sugar factories with differing ownership or management. The key incentive problem is that residual claimants to factory profits can exploit their *ex post* monopsony power and underprice cane supplied by farmers. This results in undersupply of cane to factories, the extent of which depends on who controls the factory, and the distribution of land between small and big growers. Predictions of the model are empirically verified for factories and cane growers in the two largest sugar producing Indian states – Uttar Pradesh and Maharashtra. We find that the respective cane price distortions overwhelm the effect of changes in cane quality, technological change, and sugar prices in accounting for differences in growth of the industry between different ownership forms and regions. Privately owned factories exhibit the strongest distortions, followed by government owned or managed factories in UP. The distortions are lowest in farmer-managed cooperatives of Maharashtra.

1 Introduction

Marketing arrangements for agricultural cash crops play an important role in determining incentives for farmers in developing countries to diversify into these crops. Improvements

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in these incentives have the potential of both alleviating rural poverty and promoting growth of agro-processing industries. However, relatively little is known about the implications of differing contractual arrangements for marketing of cash crops for farmer incentives. This paper focuses on the implications of different forms of ownership of sugar factories in India.

The Indian sugar industry is marked by co-existence of different ownership and management structures since the beginning of the 20th century. At one extreme there are privately owned factories in the state of Uttar Pradesh (UP) that procure sugarcane from thousands of neighboring cane growers. At the other extreme are cooperative factories owned and managed jointly by farmers, especially in the western state of Maharashtra. In between are state owned factories in both states and state managed cooperatives in UP. The particular technological characteristics of sugar wherein factories are characterized by significant scale economies, combined with the need to locate farmers right next to the factory to avoid delays in crushing harvested cane, provides factory managers considerable discretion to engage in *ex post* opportunistic hold-up. They can renege on earlier promises with regard to the cane price after the cane has been delivered, the anticipation of which causes farmers to under-supply and under-allocate cultivable land area to sugarcane. The inability of factory managers to commit to treating farmers fairly *ex post* has important potential implications both for under-production in the industry and alleviation of poverty among farmers. In this paper we seek evidence for how this incentive problem varies among differing ownership structures for sugar factories, and its resulting implications.

We focus on the three polar forms observed in the Indian industry: (i) those privately owned and managed but subject to state regulation of the cane price, as in UP; (ii) those cooperatively owned and managed, as in Maharashtra; and (iii) those managed by the government, as in state owned factories or cooperative factories in UP. Each structure is characterized by a different system of incentives for factory managers and state regulators. Building on the earlier work of Banerjee, Mookherjee, Munshi and Ray (BMMR, hereafter) (2001) on the farmer-managed cooperatives of Maharsshtra, the focus of this paper is instead on modeling the private and state-managed sector in UP, and contrasting the three distinct forms. The key assumptions and predictions of this model are tested empirically on the basis of a longitudinal sample of sugar factories and cane farms spanning 1981-91 for UP and Maharashtra. Factory data is available until 1996-97 but data on cane growers in all relevant districts in not available after 1991 and hence most of our analysis uses data until 1991.

The main problem in the empirical analysis is the lack of reliable data on the 'effective' cane price paid to growers (incorporating delays in payment), as well as on the 'first-best' cane price (the true marginal value of cane to factories). This implies that the size of the pricing distortion is not directly observable. Accordingly, the empirical strategy borrows from BMMR the idea of using variations in the land distribution between small and big growers as a source of variation in pricing and cane planting decisions within any given organizational form. All regions studied here witnessed similar changes in the land distribution, in the form of increased fragmentation (i.e, increase in the proportion of land in small holdings, below 2 hectares). The key assumption underlying our analysis is that greater land fagmentation resulted from reasons exogenous with respect to the sugar industry, such as demographic pressures and the breakup of joint families into nuclear families.

Our theoretical model argues that incentives for cane pricing and planting will respond differently to rising land fragmentation in differing organizational forms. These generate different observable responses of cane planting decisions by farmers to rising patterns of land fragmentation over time. In particular, small farmers are assumed to have weaker alternative planting options to sugarcane compared with large landowners, resulting in larger and less price-elastic supply schedules. Rising land fragmentation then encourages opportunistic factory managers to underprice cane more, which in turn lowers the cane participation rate (proportion of land allocated by farmers to sugarcane). The severity of the incentive problem can then be gauged by a negative correlation between land fragmentation and cane participation rates. The greater the incentive problem, the more does rising land fragmentation contribute to a reduction in cane supplied to factories, and ultimately to lower growth of sugar output.

The use of a panel dataset enables us to control for unobserved heterogeneity (e.g., regional differences in soil fertility, cane varieties or industrial infrastructure) across the three different sectors, as well as common time-varying factors (such as changes in world market conditions or government policies) which makes it difficult to evaluate their comparative *levels* of performance. We use the model instead to evaluate their respective growth performances, controlling for region-specific and common time varying factors. We use our model to estimate the contribution of the respective cane price distortions to growth of the different sectors over this period, resulting from changes in the local land distribution, relative to change in factory technology, cane quality or sugar price.

The important identification assumption underlying our analysis is that changes in land fragmentation were exogenous with respect to pricing, planting or technological change in the sugar industry. However, most plausible channels of reverse causation would imply that our estimate of the participation-fragmentation correlation is biased upward, so that the true correlation is even more negative than we find it to be. As explained in further detail in the paper, rising participation rates which could arise from rising profitability of growing sugarcane, are likely to raise profitability of small holdings more than of large holdings (since small growers rely proportionately more on cane compared with other crops). Hence any omitted variable that raises land fragmentation by raising the relative profitability of small holdings, will also tend to raise cane participation rates, whence the omitted variable bias will be positive. This will merely reinforce our conclusion concerning the existence of considerable underpricing in the UP private and state-managed industry.

Section 2 describes the institutional background of the UP and Maharashtra sugar industry. Section 3 provides a theoretical model of the UP industry. Section 4 describes the data and presents the empirical results concerning cane participation. Section 5 presents estimates of factory production functions, and growth implications of the cane pricing distortions for the different sectors. Section 6 concludes. Appendix 1 describes the political economy theory of regulation underlying our model, Appendix 2 lists the sources of data, and Appendix 3 explains the procedure used in the growth decompositions.

2 Background

2.1 Technology

A sugar factory crushes sugarcane for approximately six months of the year, ranging from September until May. The technology is fairly straightforward: cane is crushed to yield juice in the *mill house*, which is evaporated in the *boiler house* and crystallized to yield sugar. As we shall see in Section 5, there are approximately constant returns to scale with respect to cane supply, within the capacity limits of the factory. Capacity limits have increased substantially over the duration of the industry, between 750 tons per day in the oldest factories to 10,000 tons per day in the most recent factories. However capacity levels do not change for the vast majority of factories during the period we study, so they are taken as historically given in our analysis.[3]

Sugarcane procurement constitutes the bulk (60-70%) of the costs of a factory. The harvested cane needs to be crushed within a few hours to avoid loss of sucrose content, necessitating close coordination of harvesting and cane supply with cane crushing operations. Apart from this, the main determinants of factory efficiency are: (i) cane quality, represented by the pol percent which is the sucrose content in the juice (ii) factory recovery rate, in turn the product of rates of mill house and boiler house extraction.

2.2 Marketing

In India the government purchases a fixed proportion of the sugar output of each factory at a controlled price (called the levy price), with the remainder sold in the free market. The sugar so procured is distributed to consumers through fair price shops that serve as outlets of the public distribution system. The levy price is determined on the basis of a cost plus formula, and usually lies substantially below the market price. Owing to progressive 'liberalization' of industrial policy, the government has lowered the proportion

[3]For example, 41 out of 63 UP factories did not change capacity at all between 1981 and 1996. Approximately 20% of the total variation in capacity across factories and years is accounted by changes in capacity within factories, the rest by variation across factories.

of sugar procured at the levy price. This has raised the 'effective' sugar price received by the factories over time, though as we shall see, not at a rate faster than the general rate of inflation. The free market price is subject to considerable fluctuations, being closely linked to the world market price. India has been a net exporter of sugar through most of the past two decades, while resorting to imports in a few years when domestic production slumped.[4] With about four hundred factories operating nation-wide, it is therefore safe to assume that factories have no market power on the output market during the period of our study.[5] This is in contrast to the significant monopsony power exercised by factories over cane suppliers, chiefly on account of the need to crush sugarcane very soon following harvesting.

2.3 Ownership and Management Structures

Uttar Pradesh and Maharashtra are the two leading Indian states with respect to sugar production. The industry in the two states started almost a hundred years ago, with entry of private factories in the 1920s and 1930s. There were 29 factories operating in the country in 1930, which increased to 71 by 1937. Many of these newly entering factories were small in scale and inefficient, and were weeded out in the course of a glut in the industry in the late 1930s. Table 1 provides entry dates of UP and Maharashtra factories still operating during our period of study. It is apparent that UP saw greater entry of viable factories than Maharashtra in the pre-1947 period. Most of these consisted of private factories, concentrated especially in the eastern part of UP where the land distribution was especially fragmented: a region described by a governmental committee report on cane development as follows:

> The eastern districts are notorious for their small holdings and for the poverty of the sugarcane growers. A large number of growers have only half an acre of their own land under sugarcane cultivation, and it is difficult for them to grow three varieties — early, middle and late — on this small piece of land. (quoted in Amin (1984, p.192))

[4] Sawhney (1997, Annexure-H).

[5] However a sugar cartel operated with moderate success in the UP region in the 1930s.

TABLE 1: ENTRY DATES OF SUGAR FACTORIES ACTIVE DURING 1981-97									
	Pre-1947			1947-1990			1991-1997		
	Private	Coop	Public	Private	Coop	Public	Private	Coop	Public
East UP	19	0	13	0	6	1	3	0	0
West UP	14	0	14	5	24	3	9	1	0
UP total	33	0	27	5	30	4	12	1	0
West Maharashtra	7	1	1	3	62	0	0	8	0
East Maharashtra	0	0	0	0	28	1	0	2	0
Maharashtra total	7	1	1	3	90	1	0	10	0

The fact that the land around each factory was settled by tens of thousands of small farmers was the principal factor underlying the reluctance of the government to allow the factories to operate according to a plantation system common in other major sugar producing countries. The plantations in Cuba and the West Indies had historically relied on imported slave labour, while those in Puerto Rico, Colombia, Panama and Java had dispossessed the rural peasantry. The UP government was not inclined to deal with the social unrest that was likely to ensue. Owing to these historical circumstances, the UP private sugar factories represent the sole instance of a major sugar producing center anywhere in the world (even today) characterized by lack of vertical integration, where each private factory has to deal with thousands of small cane farmers.

The monopsony power available to the factories inevitably gave rise to significant conflicts between factory owners and cane growers. Amin (1984, Ch.7–9) provides a vivid account of these, some of which pertained to choice of cane varieties and timing of harvesting, but the majority of which dealt with the price paid by the factory owners for the cane they purchased. The early 1930s saw a *laissez faire* regime in UP and Bihar with minimal regulation of the cane price, but it became progressively clear to the governments that small farmers were being defrauded in a variety of means and paid 'absurdly low prices'.[6] While a minimum cane price was set by the UP government in 1934, it was not enforced very strictly. The factories continued to resort to various means of underweighing of cane, charging unauthorized deductions and commissions.[7]

The tension between the growers and factory owners escalated, especially in the wake of a disastrous glut during 1936-37 when an estimated quarter of the standing crop was burnt by the farmers owing to the uneconomical prices paid (which were insufficient to cover transport costs). Leading politicians in the ascendant Congress party (including the country's future President Rajendra Prasad and Prime Minister Jawaharlal Nehru)

[6] See Amin (1984, p.208).

[7] For instance, cane weighing was carried out at night in poorly lighted rooms, using manipulated scales. Growers were left waiting through cold nights and days, to induce them to be willing to accept a lower price. Amin (1984, pp. 198-200) lists a large number of such methods used by the factories.

began to represent the interest of the small growers. Eventually by the end of the 1930s the government sponsored a system of regulated cane purchases, more than half of which were mediated by cooperative cane societies. The regime included stronger enforcement of forward contracts and prevention of abuses by factory owners in cane weighing. The cane cooperatives came to be politicized and dominated by richer farmers and bureaucrats.

Following Independence, the government strengthened the regulatory system, limited entry of private factories, set up state-owned factories and encouraged the formation of cooperative factories. The cooperatives in UP that emerged however were started at the initiative of the state rather than the farmers themselves, and continue to be managed by state appointed bureaucrats. Batra (1988) describes the case of a north Indian sugar cooperative in the neighboring state of Haryana, where all effective control rests with the government appointed Managing Director, and growers exhibit almost no participation in management and are paid the state advised price (SAP). All cooperatives in UP have similar management practices, and appear to be indistinguishable in this respect from state owned factories. For this reason, we shall club together state-owned and coops in UP as the category of 'non-private' or 'state-managed' factories. The UP industry can thus be classified into the private and non-private sectors respectively.

The Maharashtra industry in contrast is dominated by farmer-managed cooperatives, a distinct form of management. These started in the 1930s and 1940s in the wake of a rising middle peasantry among low caste farmers, and were actively encouraged with state subsidies following Independence (Charlesworth (1978), Chithelen (1985)). Table 1 shows that the Maharashtra coops grew in number especially between 1947 and 1990. As described in Atwood (1992) and BMMR, they are typically managed by middle and large growers belonging to families that were instrumental in starting the cooperatives. Many of these have used their position in the cooperatives as a base for cultivating local political power, used thereafter as a springboard into state politics. Control over the management of the factory allows the controlling farmers to influence the allocation of revenues of the factory between prices paid to growers, retained earnings, and contributions to numerous local charitable institutions in which these farmers also retain considerable controlling interests. While there are numerous sources of tension between large and small growers concerning the nature of these allocations, by and large the relation between them is described by most observers as harmonious, particularly in contrast to the antagonistic and tense relationship between factory and growers in UP. This is usually attributed to the need for the cooperative to rely on reliable cane supply from the small growers, in addition to the advantages of joint ownership (wherein the factory organizes harvesting and transport of the sugarcane crop to the factory, and assists growers with supply of seeds, credit and new varieties of cane). The West Maharashtra coops in particular are noted by the extensive involvement of small growers in general body meetings of the cooperatives and elections to the Board of Directors. This is argued to be partly an outcome of a more egalitarian agrarian and social structure, where the small growers are less subservient to the large growers. The cooperatives in East Maharashtra are notably less participative, partly owing to a more hierarchical agrarian and social structure.

Table 1 also shows that there were a few private factories in Maharashtra, most of whom had entered the industry before 1947. There were also a number of state owned factories. Hence Maharashtra is characterized by co-existence of three contrasting types of ownership and management: farmer-managed coops, private factories, and state-owned factories. The coops generally dominate, especially in East Maharashtra, where 12 out of 14 districts contained only coops. For this reason most of our focus will be on three different sectors of the industry: UP private factories, UP state-managed factories, and East Maharashtra farmer-managed coops.

Despite the existence of state regulation of the cane price, the UP industry continues to be marked by considerable conflict between factories and growers over payments for cane. These mainly take the form of mounting arrears in factory payments to cane growers for past supplies. With declining sugar prices on the world market and increased exposure to sugar imports, the UP sugar industry has progressively delayed payments to cane growers, giving rise to agitation among cane grower unions, and bailouts from the government to help the private factories to clear these arrears.[8]

2.4 Descriptive Statistics

Table 1 above provided entry periods of factories active during 1981-82 to 1996-97. (The year 1981-82 refers to the financial year–April 1981 to March 1982.) Table 1 excludes numerous factories which entered and exited prior to 1981, which mostly happened during the early 1930s when numerous small private factories entered following granting of tariff protection against sugar imports, and exited within a few years. Nevertheless, despite presenting a partial picture of the evolution of the industry, the overall facts emerge clearly.

There were three main phases. In the first pre-Independence period, most of the factories that entered were private, and this happened particularly in UP, with a bias in favor of East UP bordering Bihar where the land distribution was highly fragmented. In the second post-Independence period upto 1990, the 'socialist' phase of Indian industry,

[8]For instance, an article in the national newspaper *The Hindu*, November 6 2003, describes the threat by the chief of the Bharatiya Kisan (Indian Farmer) Union to 'launch a farmers' agitation if the Centre and the Uttar Pradesh Government did not immediately announce sugarcane procurement price for this season...Not only that, last year's arrears amount to Rs. 208.26 crores and there has been no action against defaulting sugar mills...In the meantime, the Centre announced a bail-out package of Rs 668 crores to enable mills to pay the farmers the difference between the SAP and the minimum price set by the centre (SMP)'. Another article in *The Times of India*, March 2 2004, reports the wooing of cane farmers by the UP chief minister and the Centre by providing a bail-out of Rs. 490 crores for private factories alone.

most factories that entered were cooperatives, and the greater part of the new entrants were concentrated in West Maharashtra. This was the consequence of severe limits on entry of private factories induced by industrial licensing policies. The third phase starts with the deregulation in 1991, when some private factories enter in UP, and cooperatives continue to enter in Maharashtra.

The fact that entry was heavily regulated and exit prevented by state policies, is one of the principal reasons that we shall take the composition of the industry into different ownership types in any given region as exogenous. For reasons explained in the Introduction and later in the paper, we also take the nature of the land distribution between small and large landholdings as exogenous with respect to cane pricing and planting decisions.

Table 2 provides district patterns on characteristics of sugarcane cultivation and the land distribution. Eastern UP is characterized by an exceptionally high extent of land fragmentation (β), with 63-71% of land under 2 hectares, [9] in contrast to 43-52% in West UP, and 15-23% in East Maharashtra. Participation rates of each type of cane grower in a district is defined as the ratio of area devoted to sugarcane by that type of grower to the total irrigated area of all farmers of that type. Both average levels and growth of participation rates have been much higher in UP than in East Maharashtra.

TABLE 2: LAND DISTRIBUTION AND PARTICIPATION RATES 1981-1991

	Land Fragmentation β	Participation Rates: Small Growers	Participation Rates: Large Growers
East UP 1981	.63	.72	.52
East UP 1991	.71	1.22	.74
West UP 1981	.43	.60	.42
West UP 1991	.52	.91	.57
Average	.54	.80	.91
East Mah 1981	.15	.22	.24
East Mah 1991	.23	.24	.24
Average	.20	.24	.25

β is fraction of irrigated land area under 2 hectares

Participation rate is fraction of irrigated land area where sugarcane is planted

Small (resp. Large) growers defined by landholding below (resp. above) 2 hectares

[9] The cutoff of 2 hectares is used by the Agricultural Census to define small farmers.

Table 3 presents factory averages of growth between 1981 and 1991 in sugar output, cane quality (pol%), factory efficiency (recovery rate) and the sugar price.

TABLE 3: GROWTH OF OUTPUT, CANE QUALITY FACTORY EFFICIENCY AND SUGAR PRICE 1981-1991

	UP Pvt	UP Non-Pvt	East UP Pvt	East UP Non-Pvt	West UP Pvt	West UP Non-Pvt	East Mah Coop
Output	24.11	25.09	19.69	29.13	27.86	22.55	33.12
Pol %	-2.71	-3.01	-2.47	-1.84	-2.91	-3.74	5.06
Recovery rate	3.13	1.80	2.45	1.81	3.72	1.80	2.67
Sugar Price	-23.65	-23.65	-23.65	-23.65	-23.65	-23.65	0.75

It is surprising to note that sugar output grew by about 25% over the ten year period in all regions of UP, despite substantial declines in the sugar price received by the factories, and declining cane quality. In East Maharashtra the growth rate was the higher; the price received by the factories increased marginally, and cane quality improved. We shall explore the role of cane supply and pricing distortions in explaining these changes.

3 Theory

3.1 Technology and Endowments

The sugar factory has a fixed *command area*, from which it is allowed to collect and process sugarcane. 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. Normalize total land area $mS + nB = 1$. The distribution of land will be represented by a single variable $\beta \equiv \frac{mS}{mS+nB} \equiv mS$, the fraction of land cultivated by small owners.

Cultivation by any given farmer is subject to constant returns: one unit of land produces one unit of cane. Unlike BMMR, we focus on incentive effects of the cane price only on the extensive margin: we fix cultivation costs and normalize these to zero, so the cane price is the return from growing cane. We assume that farmers have heterogenous alternative options: any given farmer can earn a given amount π from allocating his land to alternate crops. There is a given distribution of these outside options for small and big farmers respectively (which depend on prices of competing crops). Normalizing profits to lie in the unit interval $[0, 1]$, these are represented by cdf's F and G respectively, both defined on $[0, 1]$. These distribution functions are assumed to have continuous, positive density functions f and g respectively.

The key assumptions underlying the model are:

(A1) G first order stochastically dominates F (i.e., $F(\pi) > G(\pi)$ for almost all $\pi \in [0,1]$)

(A2) F has a uniformly lower hazard rate than G (i.e., $\frac{f(\pi)}{F(\pi)} < \frac{g(\pi)}{G(\pi)}$ for almost all $\pi \in [0,1]$)

(A1) says that small growers have less attractive outside opportunities, i.e., their supply function (per unit land area) is shifted to the right relative to big growers. (A2) says that their supply functions are less elastic, in the sense that a unit increase in cane returns elicits a lower proportional supply response from small growers. These assumptions are consistent with what is commonly known by industry experts in UP, and will be empirically tested in the next Section. An example where both these assumptions are satisfied, is the case of exponential distributions, where $F(\pi) = \pi^{\alpha}, G(\pi) = \pi^{\gamma}$, with $0 < \alpha < \gamma$.[10]

Hence if the cane price is p, cane supply to the factory would be

$$mSF(p) + nBG(p) \equiv \beta F(p) + (1-\beta)G(p) \equiv J_{\beta}(p).$$

Assume that one unit of cane produces r units of sugar in the factory, where r denotes the *recovery rate* which we take as given. Let p_s denote the price at which the factory sells sugar, and assume there are no other costs (apart from remunerating cane growers) incurred by the factory. Use $q \equiv rp_s$ to denote the return to the factory from one unit of cane supply, the factory profit equals

$$\Pi(p) \equiv (q-p)J_{\beta}(p).$$

The 'efficient' cane price p^* maximizes the sum of factory profits and grower rents:

$$W \equiv \Pi(p) + \beta[p - E_F(\pi|\pi \leq p)]F(p) + (1-\beta)[p - E_G(\pi|\pi \leq p)]G(p)$$

and it is easy to verify that $p^* = q$, i.e., cane growers should be remunerated the returns to sugar earned by the factory.

3.2 Unregulated Private Monopsony

The unregulated monopsony price p_M with private ownership of the factory maximizes $\Pi(p)$, so satisfies the first order condition

$$(q-p)J'_{\beta}(p) = J_{\beta}(p)$$

[10] Since $\pi \in [0,1]$ we have $F(\pi) = \pi^{\alpha} > \pi^{\gamma} = G(\pi)$ and $\frac{f}{F} = \frac{\alpha}{\pi} < \frac{\gamma}{\pi} = \frac{g}{G}$.

implying

$$q = p_M + \frac{J_\beta(p_M)}{J'_\beta(p_M)} \equiv p_M + \frac{\beta F(p_M) + (1-\beta)G(p_M)}{\beta f(p_M) + (1-\beta)g(p_M)} \tag{1}$$

This implies that cane will be *undersupplied*: $p_M < q$.

The first order condition (1) has a unique solution if cane supply to the factory $J_\beta(p)$ satisfies a monotone hazard rate property:[11]

(A3) $p + \frac{J_\beta(p)}{J'_\beta(p)}$ is increasing in p

an assumption which is satisfied in the case of exponential distributions. For that case, the unregulated monopsony price is obtained by solving the following polynomial equation:

$$q = \frac{\beta(1+\alpha)p^\alpha + (1-\beta)(1+\gamma)p^\gamma}{\beta\alpha p^{\alpha-1} + (1-\beta)\gamma p^{\gamma-1}}$$

which admits numerical but not closed-form solutions.

The main comparative static question of interest is the effect of increasing β.

Proposition 1 *(i)* ***(A2)*** *implies p_M is locally decreasing in β.*

(ii) ***(A2)*** *and* ***(A3)*** *imply p_M is globally decreasing in β.*

(iii) ***(A1)*** *implies that monopsony profits $\Pi_M \equiv \Pi(p_M)$ is increasing in β.*

Proof: (i) Using the local second-order conditions, it suffices to show that **(A2)** implies $\frac{J_\beta}{J'_\beta}$ is increasing in β. The latter requires

$$[F - G][\beta f + (1-\beta)g] > [f - g][\beta F + (1-\beta)G]$$

or

$$(1-\beta)(gF - fG) > \beta(fG - gF).$$

This follows from (A2) since it implies $gF - fG > 0$, .

Part (ii) follows from the fact that **(A3)** implies there is a unique solution to the first order condition. Finally to prove (iii), note that **(A1)** implies $J_\beta(p) > J_{\beta'}(p)$ whenever $\beta > \beta'$. Hence by continuity there exists $\tilde{p} < p_M(\beta')$ such that $J_\beta(\tilde{p}) = J_{\beta'}(p_M(\beta'))$. The result follows from the fact that at β the monopsonist has the option of charging $\tilde{p}$ which would generate more profit than at the optimum with β' since cane supply would be larger but the cane price will be lower.

[11] If $q \in (0,1)$ then existence of a solution is assured, since $p + \frac{J_\beta(p)}{J'_\beta(p)}$ is zero at $p = 0$ and exceeds q at $p = q$, so by continuity there exists p_M in $(0, q)$ where the first order condition is satisfied.

This implies that under private unregulated monopsony:(i) rents and participation rates of both small and large farmers are decreasing in β, while cane supply and sugar output comparisons are ambiguous; (ii) if fixed costs of entry or operation are independent of β, the likelihood of a firm entering or being active is increasing in β; (iii) consequently there will be greater inequality between rents of factory owners and growers as β increases; (iv) moreover, a given increase in β will have a bigger adverse impact on rents of small farmers compared with big farmers.[12] These predictions are broadly consistent with the known historical patterns in the early stages of the industry when it was relatively unregulated, i.e, until the 1930s. For instance, Eastern UP in which land was more fragmented (higher β) historically compared to West UP saw greater entry of private factories in the earlier part of the 20th century. At the same time East UP witnessed more reports of exploitation of small growers by factory owners, leading to greater political tension, and demands for regulation of the industry to protect small growers.

3.3 Regulated Private Factories

Now consider the situation where the cane price is regulated by politically appointed regulators. The objectives of politicians is to win elections. Then electoral competition plays an important role in determining the outcome of interaction between cane growers and private factory owners. We argue that the main qualitative property of the price-β relationship in the unregulated case continues to carry over in this case, provided we model the electoral competition in a context where lobbies representing the special interests of factory owners seek to influence policy choices with campaign contributions, in the style of Grossman-Helpman (1996, 2001, Ch. 10). Extensions to the case where farmer interests are also represented by a countervailing lobby is also discussed below.

The Grossman-Helpman model assumes that two parties compete, and voting is probabilistic. Votes can be won by (i) setting cane prices that are supported by a majority of 'informed' voters (ii) securing campaign contributions from lobbies representing special interest groups, and using these contributions to persuade undecided or uninformed voters.[13] Effective political weights of different groups of voters can result from either asymmetric patterns of voter awareness (e.g., a smaller fraction of poorer voters may be 'informed' and vote based on policy issues) or of participation in campaign contributions (e.g., wealthy groups may secure more influence on the basis of their larger capacity

[12]The latter follows from the fact that the effect of a unit decrease in price on farmer profit is proportional to cane supply, which by virtue of **(A1)** is greater per unit land area for small farmers.

[13]For instance, a news item in the *Deccan Herald, January 9 2003, page 1* reported allegations by Samajwadi Party President Mulayam Yadav that the then-UP Chief Minister Mayawati 'had collected about Rs 100 crore from sugar mill owners for not increasing the minimum support price for sugarcane. When the sugarcane farmers protested, there was a police firing in Basti resulting in the death of some of them'.

to make campaign contributions). If so, small growers interests get underrepresented relative to their demographic weight. As we show below, under plausible assumptions the extent of their underrepresentation is increasing in their demographic weight (β). The resulting cane price is set above the unregulated monopsony price (because grower interests are incorporated to some extent), but is nevertheless decreasing in β.

Appendix 1 lays out the details of the Grossman-Helpman model applied to this context. If there is a single interest group representing factory owners, which makes campaign contributions to political parties, the cane price is set by party k (if elected) to maximize a weighted welfare objective of the following form:

$$W_k^P(p) = d\beta R_s(p) + d(1-\beta)R_b(p) + \theta_k(q-p)J_\beta(p) \tag{2}$$

Here $d < 1$ is the fraction of cane growers that are 'informed' voters. The parameter θ is the implicit welfare weight on factory owners rents, which takes the following form for party k:

$$\theta_k(\beta) = 1 + h\chi(\beta)\phi_k$$

where h is the effectiveness of campaign finance in persuading uninformed voters, ϕ_k is the probability that party k wins the election if the two parties select the same policy platforms, and $\chi(\beta) \equiv (1-d)[\frac{\beta}{S} + \frac{1-\beta}{B}]$ is the number of voters that are uninformed. The more uninformed voters there are, the larger the target audience of election campaigns, and the greater the influence of the factory owners' lobby. An increase in β raises the number of growers, and thus expands the bias in favor of owners. Parties that are favored to win the election *ex ante* are subject to greater capture (since they have a higher ϕ_k, factory owners are more willing to contribute to their campaigns), so the extent of capture also depends on how lopsided the electoral contest is.

The objective (2) can be rewritten more simply as

$$W_k^P(p) = (q-p)J_\beta(p) + \frac{d}{\theta_k(\beta)}R_\beta(p) \tag{3}$$

where $R_\beta(p) \equiv \beta R_s(p) + (1-\beta)R_b(p)$ denotes aggregate grower rents. Hence the regulated cane price p^k solves the first order condition

$$q = p + [1 - \frac{d}{\theta_k(\beta)}]\frac{\beta F(p) + (1-\beta)G(p)}{\beta f(p) + (1-\beta)g(p)} \tag{4}$$

Comparing (4) with (1) it is apparent that the regulated cane price lies above the unregulated price (unless all growers are completely uninformed $d = 0$). This owes to the pressure on politicians to secure the votes of informed growers. However, the regulated price continues to lie below the efficiency price q, and is falling in β, just like the unregulated price. This partly owes to the incorporation of the premium on factory owners' profit in the objective of politicians owing to their special interest influence. An added effect is created by an increase in χ, the value of campaign finance, associated with an increase in the fraction of uninformed voters, the audience for election campaigns.

The case of a single interest group representing factory owners thus predicts that the extent to which regulation resolves the cane supply distortion is decreasing in β. Accordingly, participation rates of small and large growers will move in the same direction, and will be decreasing in β. Political parameters such as political awareness among small and large growers, and evenness of the electoral contest between political parties, will also matter.

In practice, however, cane growers may organize to form a rival interest group that countervails the political influence of the factory owners. Cane grower unions have become increasingly vocal and politically active in UP in recent years, following mounting cane arrears owed by factories to growers, and delays by the state government in announcing minimum procurement prices for cane.[14] Appendix 1 describes the implications of presence of a cane growers union, which exerts influence over political parties by delivering votes of its members at a (unit) cost c_n which depends on the size of the grower population n. The larger the number of growers n, the easier it is for the union to deliver any given number of votes, and so c_n is lower.

In this case the policy p^k of party k maximizes the following weighted welfare function:

$$(1 + h\chi\phi_k)\Pi(p) + (d + \frac{\phi_k}{c_n})R_\beta(p). \tag{5}$$

Now the welfare weight of growers is also augmented by the term $\frac{\phi_k}{c_n}$ reflecting the power of their union. With both interest groups operating, we end up with the following expression for the cane price enforced by party k if elected to power:

$$p^k = q - [1 - \frac{d + \frac{\phi_k}{c_n}}{1 + h\chi\phi_k}]\frac{\beta F(p^k) + (1-\beta)G(p^k)}{\beta f(p^k) + (1-\beta)g(p^k)}. \tag{6}$$

This is higher than the price with just the factory owners' lobby, yet still below the efficiency price q. Increasing land fragmentation now has ambiguous effects on the cane price. The two effects operating through the power of the factory owners lobby still exist, and induce p^k to fall in β. This is counteracted by a rise in union power as the size of the grower population increases in β, causing a countervailing tendency for p^k to rise.

[14]For instance, *The Hindu*, November 6 2003, reported that "the Bharatiya Kisan Union chief Mahendra Singh Tikait threatened to launch a farmer's agitation if the Centre and the Uttar Pradesh government did not immediately announce sugarcane procurement price for this season...He said it was nothing but harassment for farmers that while they are supposed to supply cane immediately to mills for crushing, they do not know what price they will get for their produce...Mr Tikait rued that there had hardly been any increase in the SMP (statutory minimum price for cane) while the price of consumer commodities had gone up manifold."

The third effect is however convex in c_n, and therefore also in β if c_n declines linearly in n. Then one would expect a U-shaped or convex pattern of p^k in land fragmentation.

3.4 Cooperatives

How do pricing distortions get modified in a cooperative? BMMR model Maharashtra cooperatives as managed by a coalition of middle and large landowners, as elaborated in Section 2. The coop managers have the ability to divert residual earnings to diverse side enterprises controlled or owned by them, creating an incentive to understate the cane price paid to growers. However, excessive underpricing brings the risk of small growers voting to eject incumbent managers, an effect which gains weight as the fraction of small growers in the coop grows. BMMR assume that the control right of small growers is represented by an implicit welfare weight $\omega(\beta) < \beta$ which is increasing and convex in β. In the current context, this means that the coop managers set the cane price p_c to maximize

$$W^c(p;\beta) \equiv \omega(\beta)R_s(p) + (1-\beta)R_b(p) + (q-p)J_\beta(p)$$

where $R_s(p) \equiv [p - E_F(\pi|\pi \leq p)]F(p)$ and $R_b(p) \equiv [p - E_G(\pi|\pi \leq p)]G(p)$ are the rents of the two categories of growers. The cane price p_c in the coop will be characterized by

$$q = p_c + \frac{[\beta - \omega(\beta)]F(p_c)}{\beta f(p_c) + (1-\beta)g(p_c)}. \tag{7}$$

The cane price will therefore still be distorted downward in the coop, to an extent that depends on $\beta - \omega(\beta)$, the 'voice' of small farmers relative to their demographic weight. Comparing (7) with (1) we see that the distortion will be less than in the unregulated private monopsony case. For values of β near zero, the distortion in the coop will be negligible, unlike the private unregulated case. There are hardly any small farmers for the large farmers to exploit, so they set the cane price efficiently: here joint ownership resolves the inefficiency resulting from rent extraction incentives of private owners. As β increases much depends on how the control right of the small growers varies relative to their demographic weight. If $\beta-\omega(\beta)$ is U-shaped, as BMMR postulate, this will impart a U-shaped pattern in the cane price with respect to variations in β.[15] Therefore the price-β relationship may be qualitatively similar to that in a regulated private factory.

The preceding model for coops captures the Maharashtra situation where the coops are indeed started and managed by the cane growers themselves. The UP coops tend to differ in that they tend to be started and managed by the government, so are more akin to public sector factories managed by UP government appointed bureaucrats. It is not clear

[15] The variation in the cane price in the coop does not merely follow the pattern of $\beta - \omega(\beta)$ because β also enters the denominator of (7). This is because we have assumed here that the outside options of small and large growers differ, unlike BMMR who assumed they were the same.

what is an appropriate model for the behavior and motivation of bureaucrats: presumably these will reflect a mixture of personal rent-seeking (arising from their discretionary power over cane pricing and allocation of residual profit) and political pressure from higher politicians (which in turn also respond to rent-seeking motives, besides pressures from lobbies and voters). Since both models of rent-seeking and political pressure generate similar predictions for the price-β relationship, we would expect this relationship to be qualitatively similar to those obtained above from pure rent-seeking and political pressures respectively. However, quantitatively the relationship could differ quite considerably between private factories and coops or public sector factories in UP, implying that the effect of ownership is ultimately an empirical question.

One other implication is worth noting: rents of small and large farmers in real coops could be moving in opposite directions, and this is particularly so if β is large, since in that case large farmers supply a smaller fraction of the cane and assign a higher weight to residual profits of the coop, in which case they increasingly behave like private owners.

4 Empirical Results

4.1 Data

We have available panel data on production and technology details in all sugar factories in UP and Maharashtra for each year between 1981-82 to 1996-97, and on the distribution of land and cropping patterns in three successive Agricultural Censuses of 1981, 1986 and 1991. The last agricultural census was in 1995-96, which has many missing data for the districts that we need. So effectively the census data available is until 1991, which limits our analysis to this period. Data sources are described in more detail in Appendix 2. The annual factory data includes sugar output, quantity and quality of cane crushed, technical efficiency measures such as factory recovery rates, besides information on crushing capacity, year of incorporation and type of ownership. We also have data on the free market price in each state, as well as the levy price (at which the government procures a mandated fraction of annual output), which are used to construct an estimate of the effective price received by a factory in any given year. While these factory data are available annually, the data on the land distribution and cropping patterns is available for only the three Census years, and at the level of the district (which typically contains many factories). Accordingly our regressions for cane participation rates (proportion of irrigated land area allocated to sugarcane) will have to aggregate different factories within the district, and will be restricted to three Census years. Our factory production function estimates in contrast will be able to use annual factory-level information for the entire period. However, the inputs will be instrumented by factory level variables as well as district level variables interpolated between census years.

The main empirical problem is that the actual or effective cane price is not observable, as it includes the effect of delayed payments by factories, weighing distortions and other means that the factory may employ to pay growers less for their cane. So the only reliable way of inferring patterns in the effective cane price is to examine the patterns in actual participation patterns for different size categories of growers. From the Agricultural Census we calculate β in any given district with respect to the fraction of irrigated land holdings under 2 hectares. Participation rates are measured by the fraction of irrigated land devoted to sugarcane. We also utilize data on the price of the chief competing crop which is available on a yearly basis. In the case of UP this price series is available only at the level of the state, whereas for Maharashtra it is available at the district level.

4.2 Testable Predictions and Regression Specification

The assumptions and predictions of the model concerning the cane price-β relationship have to converted into the corresponding predictions concerning the participation rate-β relationship:

(1) Assumption A1 states that participation rates for small growers are higher, at any given cane price. If we combine A1 with the assumption that small and large growers receive the same price $p(\beta)$, then the same ordering of participation rates holds at any given level of β. However it is generally believed that in UP small growers receive a lower effective cane price than do large growers.[16] In that case if we observe that small growers participate at a higher rate at any given level of β, despite receiving a lower price, it further strengthens the evidence in support of A1.

(2) The cane price is predicted to decline in β, which translates into a downward-sloping participation-β relationship. The relationship is expected to be convex, and possibly even U-shaped, as small cane growers become more numerous and politically more vocal at higher levels of β.

(3) Assumption A2 states that participation hazard rates (with respect to the cane price) are lower for small growers. Note that A2 implies that (upon using the Envelope Theorem):

$$\frac{1}{F}\frac{\partial \log F}{\partial \beta} = \frac{f}{F}\frac{\partial p}{\partial \beta} >=< \frac{g}{G}\frac{\partial p}{\partial \beta} = \frac{1}{G}\frac{\partial \log G}{\partial \beta}$$

[16] This point has been stressed by industry experts we have consulted, besides the accounts provided by Amin (1984) and Batra (1988). Small growers are more easily exploited by factories since they are more subject to credit constraints and therefore more impatient to dispose of their crop. In practice there is a rush to sell early in the season, and the small growers often sell their procurement order slips to big growers owing to their greater need to realize cash returns early, and allocate their land to alternate crops.

according as $\frac{\partial p}{\partial \beta} <=> 0$. Hence if the relationship between participation rates and β is downward sloping, then the adjusted participation hazard rate $\frac{1}{F}\frac{\partial \log F}{\partial \beta}$ with respect to β (where the adjustment refers to deflating the hazard rate by the participation rate) of small growers should be negative and higher than for big growers.

(4) Participation rates in the private industry move in the same direction for small and big growers, so that the principal conflict in the UP factories concerns division of rents between growers and factory owners. In the Maharashtra coops by contrast, the main conflict is between small and large growers, as the latter manage the factory in that context. However, the model places no restriction on the relative slopes of participation rates across land sizes.[17]

(5) The extent of monopsonistic under-pricing is likely to be greater when the managers of the factory are more directly linked to residual profits of the factory, and when they (or their regulators) are less accountable to farmer interests. How regulated private factories and government bureaucrat managed firms compare on these dimensions is not clear *a priori*. So there are no clear predictions on the relative slopes of the participation-β relationship between private and state-managed factories. However one would expect farmer-managed factories to be more responsive to farmer interests, and thus characterized by a less steep negative slope between participation rates and β. Since public sector factories and UP coops are all managed by state bureaucrats, we shall club them together and refer to them as 'non-private' or 'state-managed' factories. Maharashtra coops are managed by farmers themselves, and will be referred to as 'coops' or 'farmer managed'.

We now explain the aggregation procedure used for estimating the participation regression. The postulated relationship between participation rate P^g_{it} of grower category $g = s, b$ in year t in command area of factory i and land fragmentation β_{it} takes the form:

$$P^g_{it} = \begin{cases} \mu_g + \nu_i + \eta_t + \gamma^g_P f(\beta_{it}) + \delta^g_P X_{it} + \epsilon_{git} & \text{if } i \text{ is private} \\ \mu_g + \nu_i + \eta_t + \gamma^g_S f(\beta_{it}) + \delta^g_S X_{it} + \epsilon_{git} & \text{if } i \text{ is state-managed} \\ \mu_g + \nu_i + \eta_t + \gamma^g_C f(\beta_{it}) + \delta^g_C X_{it} + \epsilon_{git} & \text{if } i \text{ is farmer-managed} \end{cases} \quad (1)$$

where μ_g is a grower type-specific intercept of the supply curve, ν_i is a area/factory i fixed effect, η_t is a year t effect, f is a quadratic function of β, X_{it} denotes a vector of area and

[17]Since the participation rate of the small grower group is $F(\pi(p(\beta)))$, their supply response would be $f(\pi)F(\pi)\frac{\partial p}{\partial \beta}$, which may be higher or lower than the supply response $g(\pi)G(\pi)\frac{\partial p}{\partial \beta}$ of big growers. This owes to the confluence of two opposing effects: the supply response of small growers would tend to be higher because their participation rate levels are higher to start with, but would tend to be lower because of the lower elasticity.

factory characteristics in year t, such as prices of competing crops, or factory profitability measured by sugar price received by the factory times the mean factory recovery rate in factory (area) i in year t. Since the same year and factory effect applies to different categories of growers, the regression needs to pool data across different grower categories, using a small grower dummy both by itself (to capture differences in the intercept of the supply curve) and interacted with β (to capture possible differences in slope).

The regression (1) cannot be estimated since we do not have data concerning participation rates for each factory area separately, but only at the district level. In UP we only have private and state-managed factories, so have to aggregate across these two categories of factories in any given district. Let α_{dt} denote the fraction of private factories in district d in year t in UP, with $1 - \alpha_{dt}$ fraction constituted of state-managed firms. Aggregating (1) across the two categories of factories in any district, we obtain the predicted participation rate for category $g = s, b$ growers in UP district d in year t:

$$P_{dt}^{g} = \mu_g + \nu_d + \eta_t + [\gamma_S^g + (\gamma_P^g - \gamma_S^g)\alpha_{dt}]f(\beta_{dt}) + [\delta_S^g + (\delta_P^g - \delta_S^g)\alpha_{dt}]X_{dt} + \epsilon_{dt} \qquad (2)$$

where variables with a d subscript denote district d averages of the corresponding factory area variables in district d. Regression (2) amounts to running a regression of district-level participation rates on district β, proportion of private factories in the district, a dummy for the size category of growers, and interactions between these, after controlling for district and year fixed effects, besides prices and factory recovery rates (profitability). In the case of East Maharashtra we shall focus on pure coop districts, so can drop the composition variable α_{dt}.

4.3 Empirical Results for UP

Estimates of this regression for UP districts are shown in Table 4. Implied slopes of participation rates of small and big growers at the observed mean β of 54% are shown in Table 5. The first column in Table 4 uses factory capacity as weights in computing the proportion of private factories in a district, while the second column uses the unweighted proportion. The other difference is that the first regression does not include the proportion alone as a regressor, owing to concerns for possible endogeneity bias.[18] The estimated coefficient of the private proportion is not of intrinsic interest. The second regression shows nevertheless that our results are robust with respect to inclusion of this variable, as well as to choice of weights in the construction of the private proportion.

In order to check for robustness with respect to the functional form, we use the procedure employed in BMMR to estimate the participation-β patterns nonparametrically.

[18] For instance, a decline in cane yields or quality could cause a decline in acreage planted as well as factory profitability, causing a private factory to go bankrupt and be taken over by the government. This would induce a spurious positive correlation of participation rates with respect to the proportion of private factories in the district.

Using the coefficients of the estimated regression above, we construct β inclusive residuals that include all the β effects, by subtracting the parts predicted by all the other variables in the regression (prices, recovery rates, district and year fixed effects). These are then nonparametrically regressed on β using a Gaussian kernel function. The resulting participation patterns are shown in Figures 1-4, with the corresponding (adjusted) hazard rates in Figures 5 and 6.

TABLE 4: UP DISTRICT-LEVEL PARTICIPATION REGRESSIONS

	Capacity weights	Unweighted
No. Observations	204	204
No. districts	36	36
within R^2	0.78	0.78
Small Grower Dummy	45.66	51.00
	(40.56)	(41.24)
Prop. Private	dropped	65.45
		(101.38)
Prop. Private*Small Grower	149.25*	142.76
	(82.62)	(96.99)
β	-4.52***	-3.76**
	(1.34)	(1.48)
β*Prop Private	1.37	-.18
	(1.87)	(2.98)
β*Small Grower	2.51*	2.59**
	(1.28)	(1.28)
β*Small Grower*Prop. Private	-4.72*	-5.22*
	(2.60)	(2.71)
β Square	0.034***	0.028**
	(0.011)	(0.012)
β Square*Prop. Private	-0.013	0.000
	(0.021)	(0.027)
β Square *Small Grower	-0.021*	-0.022*
	(0.012)	(0.011)
β Square*Small Grower*Prop Private	0.038	0.042*
	(0.023)	(0.024)

All regressions include district and year dummies

All regressions include district average sugar price*recovery rate, plus interaction with small grower, proportion private

***: sign. at 1%, **: at 5%, *: at 10%

TABLE 5: IMPLIED MEAN SLOPE OF UP PARTICIPATION RATES		
	Non-Private Factory Area	Private Factory Area
Big Grower	-0.848	-0.882
Small Grower	-0.606	-1.256
All slopes with respect to β, calculated at mean β of 54		
Calculations based on Table 4 column 1 estimates		

Both parametric and nonparametric estimates match the theoretical predictions. Prediction (1) above concerning differences in participation rates between small and large growers is upheld: the coefficient of the small grower dummy is positive, though statistically significant at 10% only in private factory districts. Figures 3 and 4 show sizeable differences between the participation rates of small and large growers at any level of β.

Prediction (2) concerning the slope and convexity of the participation-β relationship is also verified. For instance the coefficient of β alone is negative and significant, while that of its square is positive and significant. Ignoring interaction effects (i.e., focusing on the response of big growers in non-private districts) the turning point is at $\beta = 66\%$. Figures 1–4 show that the nonparametric participation patterns for both big and small growers is U-shaped, with the bottom of the U between 65–70%. The participation rates of the two groups move parallel to one another, also consistent with the assumption that both groups respond to the same changes in the cane price.

Prediction (3) concerning the adjusted participation hazards can be verified from Figures 5 and 6: the adjusted hazard rate of small growers is closer to 0 than that of the big growers. Hence the key assumptions A1 and A2 concerning relative supply levels and elasticities of small *vis-a-vis* large growers are both verified.

Concerning (4), the comparison of participation rate patterns between private and non-private factories, recall that the theory did not make any definite prediction. The nonparametric plots show that participation rates are uniformly higher in pure private districts than pure state-managed districts, while their slopes are similar (with the exception of Figure 1 which shows a steeper negative slope for small growers in pure private districts). Table 5 presents the slopes implied by the parametric results, calculated at the mean $\beta = 54$ in UP. This also shows the slope is steeper for pure private districts, especially so for small growers. However, since the level of farmer participation is a better indicator (than its slope) of the size of the welfare benefit accruing to farmers, it would appear that farmers do uniformly better under private ownership. However, this conclusion is vulnerable to possible endogeneity bias, as areas with higher yields or qualities of cane may be characterized by higher entry and lower exit rates of private factories compared with state-managed factories.

Can it be argued that the observed relationship between participation rates and β may also be characterized by biases resulting from omitted variables or reverse causality?

The most plausible channel of indirect influence would be through the effect of the (unobserved) cane price on β. The direction of this bias is likely to be positive: since small growers devote a larger fraction of their land to cane, they benefit proportionately more than large growers from a higher cane price. Hence a higher cane price would, if at all, encourage greater land fragmentation, i.e., a higher level of β. This channel cannot therefore explain the observed negative relationship between participation rates and β, and suggests that the true relationship may involve an even steeper negative slope than we have estimated. Nevertheless, since land fragmentation tends to reflect broad aspects of demographic change such as rising population and household subdivision, and tends to occur slowly over time owing to lags in the Indian courts that register land transactions, we do not expect it to react to variables that affect contemporaneous cane participation decisions. Note also that secular changes in land fragmentation that are uniform across different districts of a state are captured by the year effects in the regression. So we think it is a plausible hypothesis that (differences across districts in) changes in β were exogenous with respect to changes in profitability of cane cultivation for different classes of growers.

5 Participation Results for Maharashtra Coops

It is interesting to contrast the patterns obtained above for the UP industry with those for farmer managed coops in Maharashtra. In UP we effectively have two types of management. But Maharashtra has all the three types, which will double the number of coefficients to be estimated. At the same time there are half as many districts in Maharashtra compared with UP. To avoid the problem of insufficient data, and to in order to focus on the farmer-managed factories as a contrast to management forms in UP, we consider East Maharashtra only, which has no private factories, and in which 88% of all factories are farmer-managed coops. Moreover, 12 out of its 14 districts only have farmer-managed coops.

Table 6 presents the participation rate regression applied only to East Maharashtra districts. We restrict it further to the 12 districts of this region which contain only farmer-managed coops, where there is no need to include the proportion of coops as an independent variable (along with its interactions with β and the small grower dummy). Figures 7 and 8 present the corresponding nonparametric and parametric plots of participation rates with respect to β, after controlling for district, year fixed effects, sugar prices and recovery rates.

TABLE 6: EAST MAHARASHTRA DISTRICT-LEVEL PARTICIPATION REGRESSIONS	
No. Observations	46
No. districts	12
within R^2	0.76
Small Grower Dummy	-55.04
	(57.11)
β	0.73
	(1.24)
β*Small Grower	-1.14*
	(0.59)
β Square	0.018
	(0.036)
β Square *Small Grower	0.015*
	(0.009)
District and year dummies included	
District average sugar price*recovery rate included	
***: sign. at 1%, **: at 5%, *: at 10%	

It is evident that farmer-managed coops exhibit substantially different participation patterns: they rise for both small and large growers as β rises. This is despite the substantially smaller fraction of small growers (β) in East Maharashtra: an average of 20% as against 54% for UP. Recalling the finding of BMMR that farmer interests were better represented in West Maharashtra compared with East Maharashtra (in the form of a steeper positive slope for participation rates with respect to β), it would appear that the findings for East Maharashtra understate the same phenomenon for all Maharashtra farmer-managed coops. Hence there seems to be a sharp contrast with private and state managed factories of UP.

6 Growth Implications

In this section we discuss implications of the preceding results concerning comparative cane supply patterns of the different sectors. We start by examining the nature of the technology employed by the factories for processing cane into sugar. Table 7 presents estimated Cobb-Douglas production functions for the three sectors. The three factors are the quantity of cane crushed, its quality (the pol rate), and the factory recovery rate. Ordinary least squares estimates of this regression would be likely to be inconsistent, owing to the endogeneity of cane supply, and also possibly of cane quality or the recovery rate. For instance if there are important unobserved determinants of factory productivity, such as the ability of the management, environmental or infrastructural factors that change over time and impact both output level and cane price offered, it would result in a biased estimate of the elasticity of output with respect to cane supply. In addition if the pol rate or recovery rates depend on capacity utilization rates, these fluctuations would also bias their respective estimated elasticities.

Our model suggests appropriate instruments for cane supply: agricultural variables that shift cane supply but not factory productivity. These include parameters of the land distribution (β and its square), irrigated land, and the price of key competing crops. Under the theory that endogeneity of the pol rate and the recovery rate arises only via variations in capacity utilization, we can use determinants of cane supply also as instruments for these variables. In addition we can use factory cane crushing capacity as a determinant of the pol and recovery rates. Higher capacity plants are typically of a more recent vintage, which can achieve higher sugar extraction rates from cane suggesting age of factory as another valid instrument. Conditional on cane crushed, quality and factory recovery rates, it is plausible that fluctuations in capacity will have no independent effect on sugar output.[19]

Table 7 presents two sets of IV production function regressions with year and factory fixed effects for UP private and non-private factories and East Maharashtra coop factories. One predicts log of annual output; the other predicts yield (sugar output divided by cane crushed). We include the latter to check for constancy of returns to scale with respect to cane.

[19]Relatively few factories changed their capacity during this period, and the most important causes were likely to be changes in the cost of capital, freer availability of machinery imports owing to liberalization of import policies, all of which are external to the factories in question. Note also that our regression includes factory fixed effects, therefore controlling for efficiency factors that do not change over time. Capacity would not be a valid instrument only if it were correlated with unobserved changes in managerial or operational efficiency that change factory productivity in ways other than changing pol or recovery rates. In any case the results we obtain do not change much if we drop capacity as an instrument, and rely only on agricultural determinants of cane supply as instruments.

TABLE 7: FACTORY PRODUCTION FUNCTIONS (INSTRUMENTAL VARIABLE ESTIMATES)						
	UP Pvt Log Output	UP Pvt Log Yield	UP Non-Pvt Log Output	UP Non-Pvt Log Yield	EMah Coop Log Output	EMah Coop Log Yield
No. observations	372	372	517	517	214	214
No.factories	42	42	63	63	29	29
within-R^2	.99	.80	.98	.51	.99	.80
Log Cane	1.066***	.066**	.961***	-.039	1.016***	.010
Crushed	(.032)	(.032)	(.082)	(.082)	(.050)	(.050)
Log Pol	1.210***	1.210***	2.311***	2.311***	2.166***	2.166***
	(.294)	(.294)	(.788)	(.788)	(.565)	(.565)
Log Rec Rate	.682	.682	-.145	-.145	.515	.515
	(.612)	(.612)	(.895)	(.895)	(.580)	(.580)
Instrumented: Log Cane, Log Pol, Log Recovery Rate						
Factory and Year dummies included in the regression						

Table 7 shows that the hypothesis of constant returns to scale with respect to cane cannot be rejected. Yields do not vary with the extent of cane crushed except slight variation in UP privates, suggesting the absence of capacity constraints in most ownership forms. There is also hardly any variation in the elasticity of output with respect to cane across the different sectors. Pol matters for all types of factories but its elasticity is almost half for UP privates than for the other type of factories. Recovery rate does not seem to matter for any of the sectors.

Table 8 uses the estimated production functions to decompose growth in output between 1981-91 in the three sectors into parts explained by growth in cane crushed, cane quality and factory efficiency. It shows that almost all the growth in UP is explained by changes in cane supply. In East Maharashtra though cane supply explains most of the growth, cane quality also has had a significant impact whereas factory efficiency account for almost no change in factory output. Hence technological change with respect to cane quality or factory technology account for almost none of the observed growth performance in UP. Consistent with the assessments of many authors, growth in cane supply is the single sole determinant of growth in the industry.

TABLE 8: DECOMPOSITION OF FACTORY OUTPUT GROWTH RATES 1981-91							
	UP Pvt Factories	UP Non-Pvt Factories	East UP Pvt Factories	East UP Non-Pvt Factories	West UP Pvt Factories	West UP Non-Pvt Factories	East Mah Coop Factories
Observed growth rate	24.10	25.10	19.69	29.13	27.86	22.54	33.12
predicted by:							
Growth in Cane Crushed:	25.67	24.42	21.10	30.33	27.33	18.61	24.00
Growth in Pol:	-3.28	-6.96	-1.81	2.81	-4.84	-7.77	10.95
Growth in Recovery Rate:	2.13	-0.262	4.03	0.853	3.73	-1.77	1.38

Given that growth in the industry is largely accounted by changes in cane supply, we can estimate growth implications of the cane pricing distortion in different sectors. As noted in Section 2, land fragmentation rose over time in all three regions. Owing to the different systems determining cane prices in the different sectors, a given rise in β will have different implications for cane supply. Table 9 presents estimated changes in cane participation rates resulting from the observed rise in β between 1981-91 facing each type of firm in their district of location. The effect of the observed change in β is decomposed into (i) a direct effect resulting from higher participation rates among small growers for any given level of β, and (ii) the indirect effect of the change in β on participation rates of any given type of grower which reflects the change in the magnitude of the cane pricing distortion. The average effects for each type have been computed by averaging the effect of the change for all factories of that type. Appendix 3 describes the details of the decomposition procedure further.

TABLE 9: DECOMPOSITION OF PREDICTED PARTICIPATION CHANGES RESULTING FROM RISING β							
	All UP Pvt Districts	All UP Non-Pvt Districts	East UP Pvt Districts	East UP Non-Pvt Districts	West UP Pvt Districts	West UP Non-Pvt Districts	East Mah Coop Districts
Direct Effect	3.08	2.95	2.62	3.34	3.60	2.72	-0.39
Indirect Effect (Pricing Distortion)	-7.12	-5.70	-0.56	-0.43	-14.45	-8.79	7.35
Observed Change	37.8	29.9	49.2	42.9	25.1	22.4	21.1

In UP the direct effect of rising land fragmentation was positive, while the indirect effect owing to the pricing distortion was negative. The model predicts that participation rates declined by seven percentage points owing to a worsening distortion; given the production function estimates this suggests that output in the average UP private factory would have grown by seven percentage points more in the absence of any distortion. The negative effect of the pricing distortion was slightly greater in private compared with non-private UP districts. The results are sharper when we focus on Western UP districts, where the pricing distortion was more severe (owing to a lower β average of approximately 40%, compared with over 60% in East UP, combined with the U-shaped feature of the distortion). The pricing distortion accounts for a predicted decline in participation by over 14 percentage points in a West UP private district. In a non-private West UP district the decline is about 9 percentage points. These help explain much of the observed difference in aggregate participation rates between West and East UP that is shown in the last row of Table 9.

Note also that the pricing distortion was reduced in East Maharashtra as a result of rising β, inducing a predicted rise of approximately 7 percentage points in participation. Contrasting ownership patterns thus did have significant implications for growth owing to the pricing distortion.

7 Conclusion

The role of 'institutional' factors in the growth process is manifested by the contrasting responses of factories and growers to changing patterns of landownership. Owing to differences in their respective cane pricing patterns, these changes induced distinct output responses in the farmer-managed coops and private as well as state-managed factories. The rise in land fragmentation induced opposite effects on the extent of cane pricing distortion in the Maharashtra coops and in the other two types of factories in UP, causing their growth performances to diverge. Had the private sugar factories in UP been organized and managed the same way as the Maharashtra cooperatives, rising land fragmentation would have caused cumulative output growth over the period 1981-91 to be higher by 14 percentage points.

We did not find evidence of significant differences in the pricing distortion between private and state-managed factories in UP, as measured by its contribution to growth implications of rising β. This is particularly true in East UP, where land fragmentation was high enough for the cane distortion to not change much with rising β. In West UP, however, rising fragmentation was associated with a significantly lower growth of cane supply in private factories compared with state-managed factories. In general, however, cane participation rates change with respect to changes in β in a fairly similar fashion across the two sectors, while levels of participation are uniformly higher in the private factory areas. This suggests that farmers are better off in the private factory areas compared with the state managed areas. However, the extent to which this difference is caused by the difference in ownership as against other region-specific factors is something we cannot identify. Nevertheless the interesting fact that does emerge is that state-managed factories seem prone to the same kind of cane underpricing as private factories, despite their stated aim to reduce the severity of the incentive problem inherent in a private monopsony.

It would be interesting to probe further the political economy of cane price determination in the regulated private factories, drawing on the model described in Appendix 1 (and summarized in equation (6)). In particular, do literacy levels and nature of political competition affect participation rates? Another question raised by our analysis but not addressed satisfactorily by our analysis is the understanding of changes in land fragmentation over time, so as to aid more precise identification of the effects of increasing fragmentation on participation rates.

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Appendix 1: Interest Group Model for Regulated Private Industry

There are two parties $k = A, B$, both of whom are opportunistic and want to maximize the probability of being elected. Party A's true vote share is denoted V_A, and wins with probability $\phi(V_A)$, where $\phi(.)$ is a strictly increasing, continuous function from $[0, 1]$ to itself.

Each party selects a policy representing the cane price p that it will enforce. There are three classes of voters: shareholders of the private cane factories ($i = o$), small cane growers ($i = s$) and big cane growers ($i = b$). Let $U_i(p)$ denote the payoff of category i voters. A fraction $d < 1$ of growers are *informed* or *aware* voters, the rest are uninformed. All factory owners are informed, since they tend to be better educated and have more at stake than growers.

An informed voter in category i votes for party A if $U_i(p^A) + \epsilon_i^A > U_i(p^B)$, where ϵ_i^A is the loyalty of the voter to party A relative to B, which is distributed uniformly with a constant density f and mean μ.[20] On the other hand, an uninformed voter of category i votes for A based on their loyalties and relative campaign sizes C^A, C^B of the two parties. Specifically an uninformed voter of type i votes for A if $h[C^A - C^B] + \epsilon_i^A > 0$, where $h > 0$ is a parameter representing effectiveness of campaign spending.

Given these assumptions, the vote share of party A can be expressed as a function of policy positions and campaign sizes:

$$V^A = \frac{1}{2} + f\mu + f[\chi(C^A - C^B) + \Pi(p^A) - \Pi(p^B) + d\{R_\beta(p^A) - R_\beta(p^B)\}] \qquad (A1.1)$$

where R_β denotes average grower rents $R_\beta(p) = \beta R_s(p) + (1 - \beta)R_b(p)$, $\chi \equiv h(1 - d)m$ denotes the overall effectiveness of campaign finance in securing votes, and m denotes the fraction of all voters that are cane growers. Note that the number of cane growers n (and hence m) is an increasing function of β, since higher β is associated with a larger number of cane growers for a given land area.[21] (A1.1) implies that party k's objective is to maximize

$$\chi C^k + \Pi(p^k) + dR_\beta(p^k). \qquad (A1.2)$$

Factory owners and cane growers are represented respectively by two interest groups or lobbies. The factory owners' lobby seeks to influence the policy of each party k by making a campaign contribution C^k conditional on the policy of that party. This lobby maximizes the expected profit of a representative owner, less the cost of the campaign contributions

$$\phi_A \Pi(p^A) + (1 - \phi_A)\Pi(p^B) - C^A(p^A) - C^B(p^B) \qquad (A1.3)$$

[20] The distribution of loyalties is assumed identical across all voter categories purely for simplicity, and is quite inessential to the results.

[21] Recall that there are $\frac{\beta}{S}$ small growers and $\frac{1-\beta}{B}$ big growers. So $n = \frac{\beta}{S} + \frac{1-\beta}{B}$. The total number of growers is rising in β since $S < B$.

If factory owners form the sole interest group, and if the only motive for their campaign contributions is to influence policy choices (i.e., they do not additionally seek to manipulate electoral probabilities of winning), then equilibrium policy choice of party k is easily seen to maximize

$$[1 + \chi\phi_k]\Pi(p) + dR_\beta(p) \tag{A1.4}$$

i.e., a weighted sum of payoffs of owners and growers, where the owners receive an additional welfare weight owing to the influence exercised by their lobby. Here ϕ_k denotes the probability that party k would win if there were no interest groups at all, i.e., the two parties chose identical policies and had zero campaign spending. This is determined entirely by the mean loyalty μ of voters to party A, so can be taken to be a parameter representing how biased the electoral contest is in favor of party A. Hence the additional premium placed on the factory owners' payoffs by party k is increasing in the *ex ante* probability that party k wins, and the effectiveness of campaign finance.

Now suppose that cane growers also form a rival interest group, which we call the growers' union. The union derives its influence from its ability to 'deliver' votes to parties, conditional on their policy platforms. Union leaders can use a variety of methods of persuading union members to vote in favor of a directed party, ranging from canvassing effort, and selective inducements of various sorts. Delivering v votes involves a cost $c_n v$ to the union: the unit cost c_n depends on the size of the membership, i.e., the number n of growers. One particular 'technology' for vote delivery is where there is a given cost c of 'persuading' any given voter to vote in a way specified by the union bosses, with c drawn in an *i.i.d.* fashion from a given distribution $L(.)$. Then $c_n v$ is the sum of the v lowest realizations from n independent draws from the distribution L, which will thereby be falling in n. We assume that the 'delivered' voters are randomly allocated across small and big growers.

The cane growers union recovers its costs from uniform lump sum fees levied on its members. It maximizes the expected utility of a representative member:

$$\phi_A R_\beta(p^A) + (1 - \phi_A)R_\beta(p^B) - c_n[v^A + v^B]. \tag{A1.5}$$

In this context, expression (A1.1) for vote shares has to be modified, to take account of grower votes delivered by the union. It can be checked that the vote share of A will be a monotone increasing function of [22]

$$v^A - v^B + f[\chi(C^A - C^B) + (\Pi(p^A) - \Pi(p^B)) + d(R_\beta(p^A) - R_\beta(p^B)) - \mu(v^A - v^B)] \tag{A1.6}$$

so the objective of party A will now be to maximize

$$\chi C^A + \Pi(p^A) + dR_\beta(p^A) + v^A(\frac{1}{f} - \mu). \tag{A1.7}$$

[22] In the following expression we assume that factory owners constitute a negligible fraction of all voters.

Intuitively, of the votes v^A delivered by the union, a fraction $f\mu$ would have come to party A anyway in the absence of any union action, owing to the loyalty of cane growers to party A. So the net increment in vote share of A per vote delivered by the union is $(1 - f\mu)$, which to be compared with the expression for welfare of informed voters has to be normalized by dividing through by f. So the net value of each delivered votes (relative to welfare of informed voters) is $(\frac{1}{f} - \mu)$.

At the first stage of the game, each interest group will independently choose its influence activity (campaign finance for the owners' lobby, votes for the growers union) conditional on the policy platform of each party. Then at the second stage each party will select its policy platform. At the third stage, elections will take place. Using standard methods of common agency to solve for this game, marginal contributions of each interest group will equal their respective marginal valuations of party policy. Hence for the owners' lobby the marginal contribution to party k solves:

$$\frac{\partial C^k}{\partial p^k} = \phi_k \Pi'(p^k) \qquad (A1.8)$$

while for the union:

$$c_n(\frac{1}{f} - \mu)\frac{\partial v^k}{\partial p^k} = \phi_k R'_\beta(p^k) \qquad (A1.9)$$

Finally, party k chooses p^k to maximize $\Pi(p) + \chi C^k(p) + dR_\beta(p) + (\frac{1}{f} - \mu)v^k(p)$, implying that the equilibrium policy satisfies

$$\frac{\partial \Pi}{\partial p^k} + \chi\frac{\partial C^k}{\partial p^k} + dR'_\beta(p^k) + (\frac{1}{f} - \mu)\frac{\partial v^k}{\partial p^k} = 0.$$

Using (A1.8) and (A1.9) above, this reduces to

$$(1 + \chi\phi_k)\frac{\partial \Pi}{\partial p^k} + (d + \frac{\phi_k}{c_n})R'_\beta(p^k) = 0. \qquad (A1.10)$$

Hence the policy p^k of party k maximizes the following weighted welfare function:

$$(1 + \chi\phi_k)\Pi(p) + (d + \frac{\phi_k}{c_n})R_\beta(p) \qquad (A1.11)$$

i.e., where utilitarian welfare weights of informed voters are augmented by the influence weights of their respective interest groups. We end up with the following expression for the cane price enforced by party k if elected to power:

$$p^k = q - [1 - \frac{d + \frac{\phi_k}{c_n}}{1 + \chi\phi_k}]\frac{J'_\beta(p^k)}{J_\beta(p^k)}. \qquad (A1.12)$$

Expression (A1.12) for the regulated cane price is easily seen to reduce to the expression (6) in the case where factory owners constitute the sole interest group, when the growers union is completely ineffective $c_n = \infty$. Note also that the profit markup for the factory owners is less compared with the case of an unregulated industry, i.e., the regulated price lies above the unregulated monopsony price. Regulation is effective in this sense, despite being subject to 'capture' by interest groups.

Of key interest for us are the effects of raising β. This has three effects on the regulated price:

(1) The monopsonistic cane price distortion effect, represented by the term $\frac{J_\beta(p^k)}{J'_\beta(p^k)}$, which is increasing in β, thus causing the cane price to fall;

(2) The campaign influence effect, represented by the term χ which is increasing in β. A higher β results in an increase in the number of uninformed voters, causing campaign finance to become more effective, and thus the owners' lobby to acquire more influence. This effect also causes the cane price to fall.

(3) The cane grower union effect, represented by the term c_n. An increase in β increases the size of the union, and its effectiveness in delivering votes, causing the growers to acquire greater political influence through their union. This effect causes the cane price to rise in β, counter to the first two effects.

In the case where only the owners' lobby is the sole interest group, the third effect is absent, and the cane price is declining in β, just as in the case of an unregulated monopsony. Note that the third effect operates through the term $\frac{\phi_k}{c_n}$, and is thus convex in c_n. If c_n is declining linearly in n, the third effect is convex in n, and thus in β. In other words, it acquires increasing importance as β rises. One would therefore expect either a U-shaped or a convex, declining pattern of the cane price as β rises.

Appendix 2: Data Sources

The annual factory level data on sugar output, quantity and quality of cane, crushing capacity, year of incorporation, and technical efficiency measured as reduced overall recovery rate (denoted as factory recovery rate in the paper) were obtained from The sugar Technologists' Association of India, Year Book & Directory of Indian Sugar Factories, for various years.

Free market sugar prices for UP and Maharashtra are taken as the annual average (average of monthly prices) prices prevailing in the markets of Kanpur, and Kolhapur respectively and were obtained from Co-operative Sugar Directory and Year-Book, a publication of National Federation of Cooperative Sugar Factories Ltd., New Delhi.

Levy prices were also obtained from the above publication. Levy ratio for the various years and states were obtained from the Indian Sugar Mills Association's Hand Book of Sugar Statistics, 1998. The sugar price received by factories is then given by the convex combination of the free market price and the levy price.

Annual prices of competing crops were obtained at the district level from various issues of Farm Harvest Prices of Principal Crops in India published by the Ministry of Agriculture, Govt. of India. In each district, the competing crop chosen was the crop other than sugarcane grown on the largest irrigated area since sugarcane is also commonly grown in irrigated areas. In UP it turned out to be paddy for all distrcits and hence we do not have variation in price of the main competing crop across districts whereas in Maharashtra the competing crop was either paddy, wheat or Jowar.

Irrigated area and its size distribution by district was obtained from each state's agriculture census at five year intervals, 1980-81, 1985-86 and 1990-91. Data from the 1995-96 census is not yet available. Area on which sugarcane is grown and its size distribution was obtained for Maharashtra from its agriculture census department whereas from UP it was obtained from the Board of Revenue. This in turn implied the participation rates for large and small growers.

Appendix 3: Growth Decomposition Procedure

We use the following notation: for factory i or district i in year t: Y_{it} denotes output, C_{it}: cane crushed, p_{it}: cane pol percent, r_{it}: factory recovery rate (ror) ; v_i factory productivity fixed effect; q_{it}:sugar price*ror, β_{it}: land fragmentation, P^g_{it}: participation rate of group $g = s, b$ farmers; η_t common time dummy for year t in farmer participation rates; μ_{gi} factory i command zone fixed effect in participation for group g growers .

Participation rates are measured at the district level, production levels at the factory level, so the production function and participation equations are estimated at different levels of aggregation. In the above notation for participation, i connotes the district in which i is located.

The estimated production function is Cobb-Douglas:

$$Y_{it} = A_t v_i C_{it}^{\alpha_1} p_{it}^{\alpha_2} r_{it}^{\alpha_3} \qquad (A3.1)$$

This is estimated using factory data. We use this to decompose the rate of growth of sugar output into the sum of growth of cane supply, pol rate, and recovery rate, weighted by their respective elasticities estimated from (A3.1). This is averaged across factories for each region-organizational type, and reported in Table 9.

The estimated participation regression for group g farmers may be compactly written as

$$P^g_{it} = \mu_g + \nu_i + \eta_t + \gamma^g_1 \beta_{it} + \gamma^g_2 \beta^2_{it} + \gamma^g_3 X_{it} \qquad (A3.2)$$

The cane price distortion effect of changing land distribution on cane supply is represented by the terms $\gamma^g_1 \beta_{it} + \gamma^g_2 \beta^2_{it}$, and we are interested in estimating its contribution to growth in sugar output, relative to the direct effect of changing land fragmentation resulting from higher participation rates of small growers, and effects of changing prices of competing crops and irrigation. Since the production function is estimated at the factory level and the participation regression at the district level, and one is log-linear and the other is linear, we cannot match up the two decompositions exactly. So we report them separately.

The decomposition of cane supply growth is calculated as follows, using the estimated coefficients of (A3.2). Consider the change in cane supply ΔC in district i between year t and year k. It is the sum of the following terms:

(1) Direct Effect of Changing Land Distribution:

$$[\Delta\beta_i][(\mu_s - \mu_b) + (\gamma_1^s - \gamma_1^b)\beta_{it} + (\gamma_2^s - \gamma_2^b)\beta_{it}^2 + (\gamma_3^s - \gamma_3^b)X_{it}] \qquad (A3.3)$$

(2) Indirect Effect of Changing Land Distribution Owing to Pricing Distortion:

$$\beta_{ik}[\gamma_1^s[\Delta\beta_i] + \gamma_2^s[\Delta\beta_i^2]] + (1 - \beta_{ik})[\gamma_1^b[\Delta\beta_i] + \gamma_2^b[\Delta\beta_i^2]] \qquad (A3.4)$$

where year k is used as the base.

This decomposition is worked out for each district and then averaged across the districts for the given organizational form/region. The resulting averages are reported in Table 9.

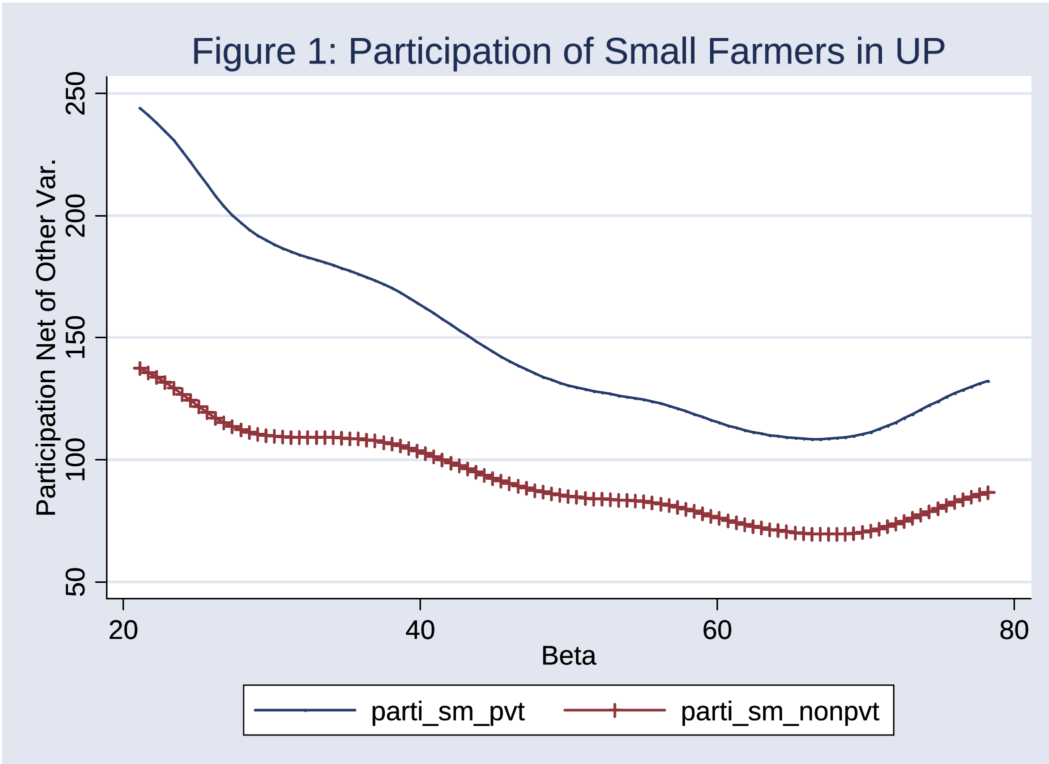
Figure 1: Participation of Small Farmers in UP
Participation Net of Other Var.
250
200
150
100
50
20
40
60
80
Beta
parti_sm_pvt
parti_sm_nonpvt

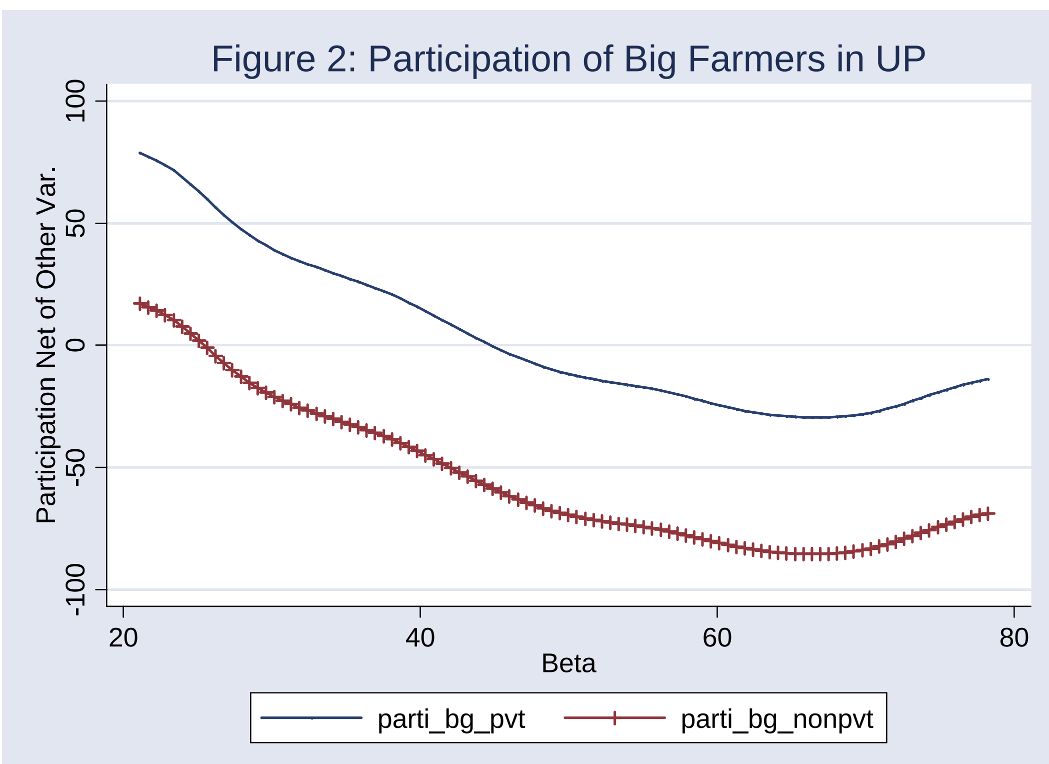
Figure 2: Participation of Big Farmers in UP
Participation Net of Other Var.
100
50
0
-50
-100
20
40
60
80
Beta
parti_bg_pvt
parti_bg_nonpvt

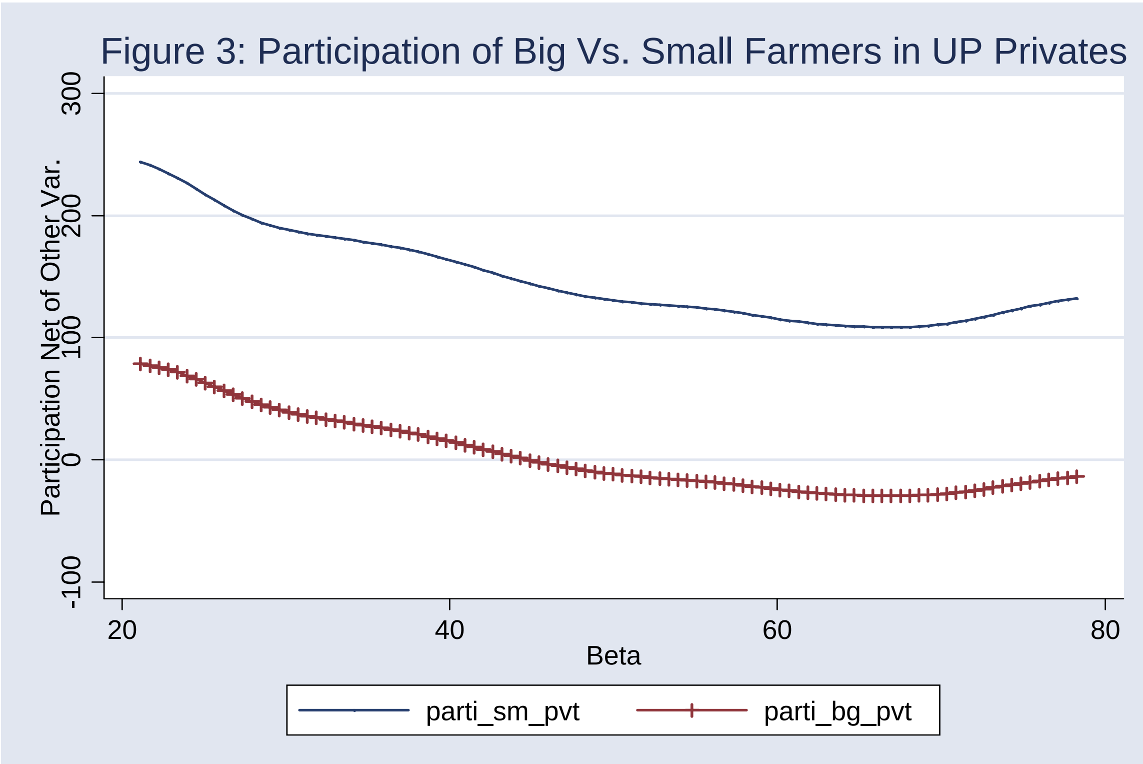
Figure 3: Participation of Big Vs. Small Farmers in UP Privates
Participation Net of Other Var.
-100
0
100
200
300
20
40
60
80
Beta
parti_sm_pvt
parti_bg_pvt

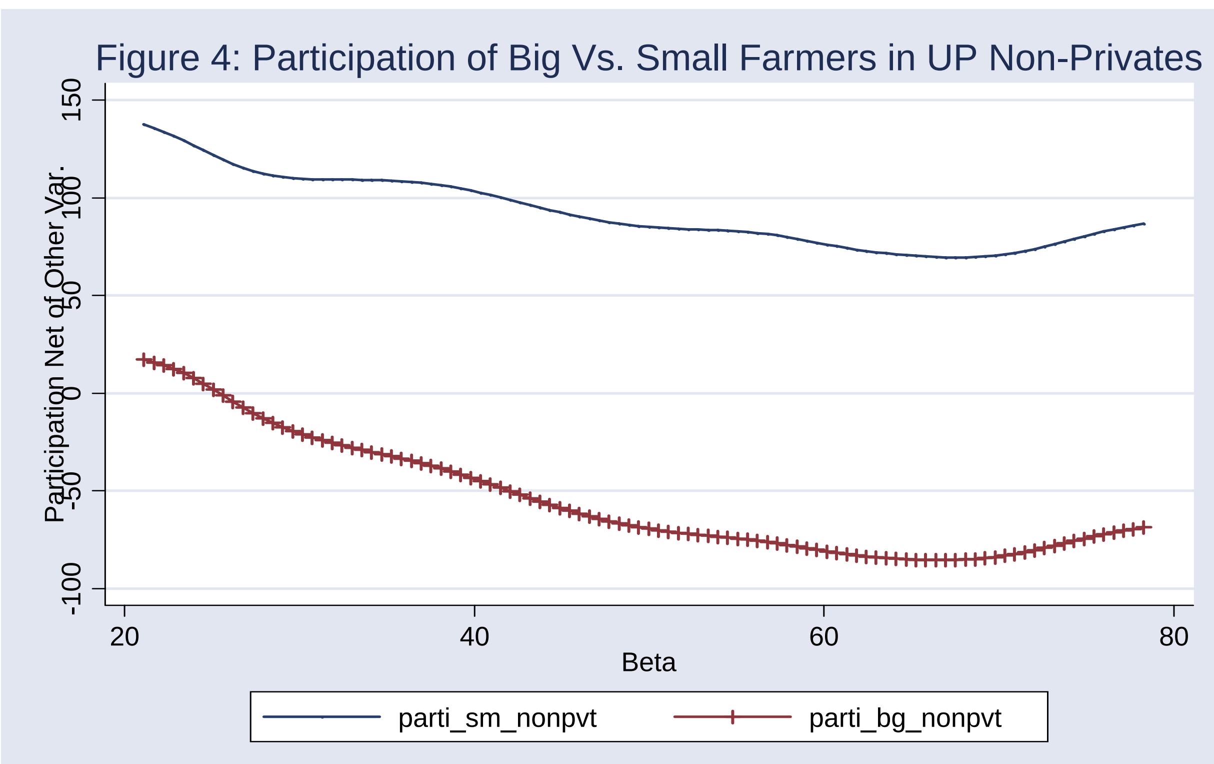
Figure 4: Participation of Big Vs. Small Farmers in UP Non-Privates
Participation Net of Other Var.
-100
-50
0
50
100
150
20
40
60
80
Beta
parti_sm_nonpvt
parti_bg_nonpvt

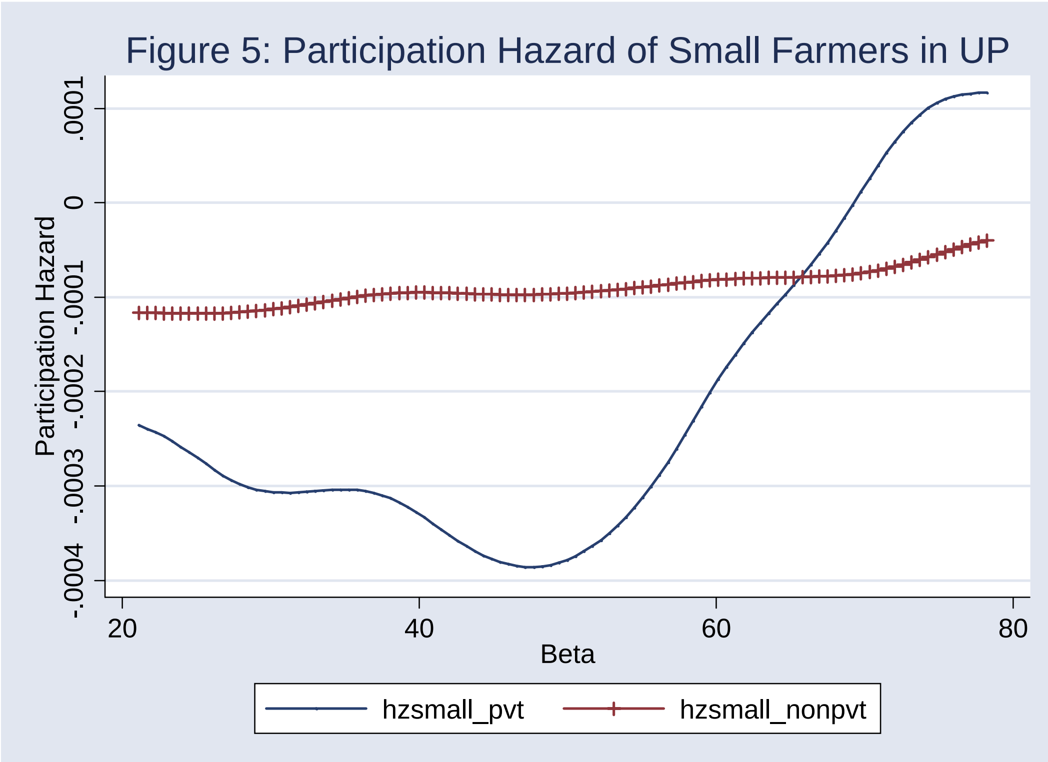
Figure 5: Participation Hazard of Small Farmers in UP
Participation Hazard
-.0004
-.0003
-.0002
-.0001
0
.0001
20
40
60
80
Beta
hzsmall_pvt
hzsmall_nonpvt

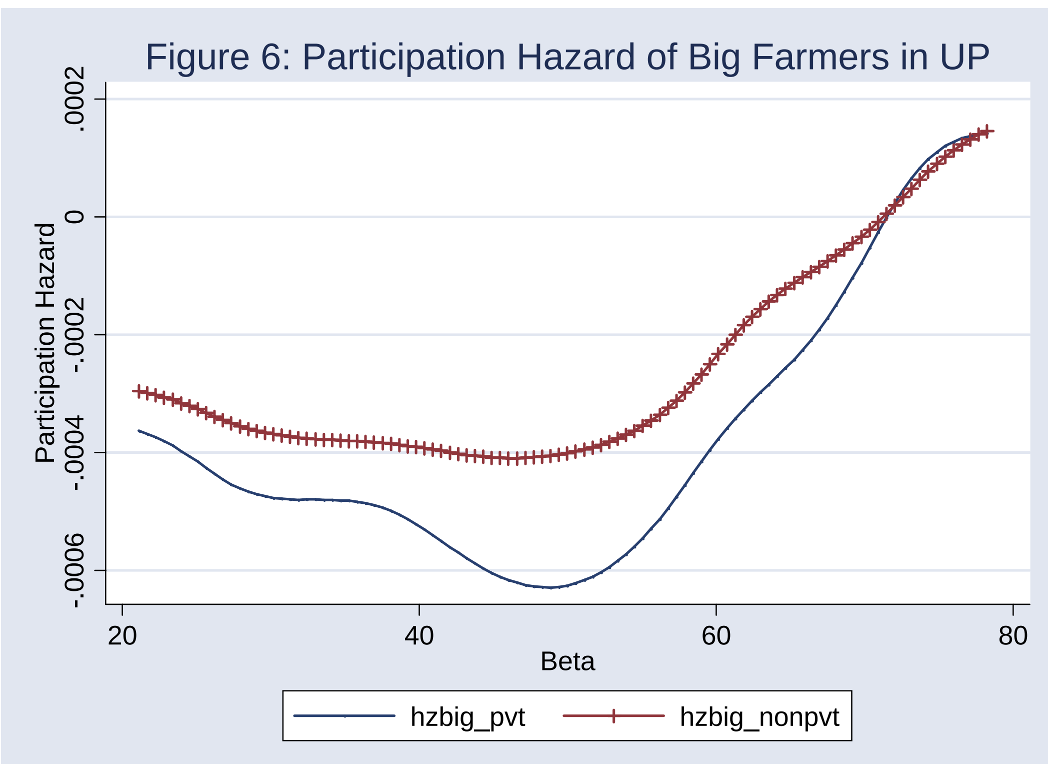
Figure 6: Participation Hazard of Big Farmers in UP
Participation Hazard
-.0006
-.0004
-.0002
0
.0002
20
40
60
80
Beta
hzbig_pvt
hzbig_nonpvt

Figure 7: Participation Hazard of Private Farmers in UP

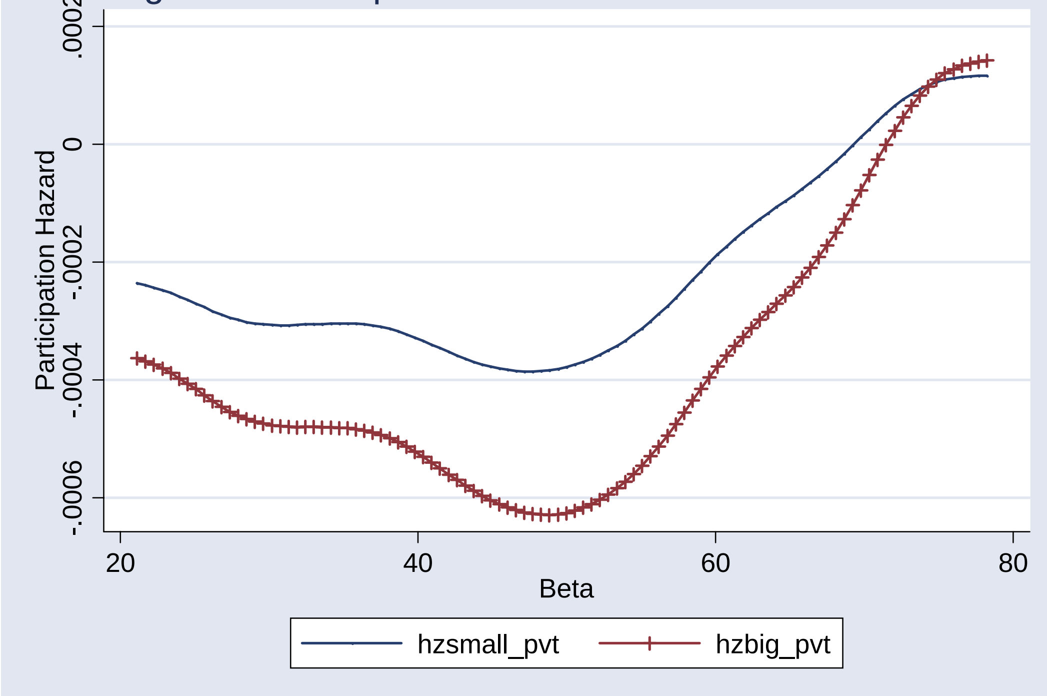

Figure 8: Participation Hazard of Non-Private Farmers in UP