OWNERSHIP FORM AND CONTRACTUAL INEFFICIENCY:

Comparing Performance of Cooperatives and Private Factories in the Indian Sugar Industry[1]

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Abstract

This paper explores the role of differing contractual relationships between sugarcane farmers and sugar factories in India resulting from differing ownership structures. In Maharashtra most sugar factories are cooperatively owned by cane farmers, while in Uttar Pradesh most factories are privately owned and purchase cane from independent peasant farmers. The key incentive problem is that residual claimants to factory profits are inclined to exploit their monopsony power and underprice cane supplied by farmers. This results in undersupply of cane to factories, the extent of which depends on who owns the factory, besides the distribution of land between small and big growers. Predictions of the model are empirically verified from panel data spanning 1982–95 for private and coop factories in the two states. We find that the respective cane price distortions overwhelm the effect of changes in cane quality, technological change, prices or irrigation in accounting for differences in growth of the industry between different ownership forms and regions over this period.

1 Introduction

The role of institutions is now a well-worn cliche in modern development economics. Yet as a concept it frequently resists precise theoretical modelling or empirical quantification. In this paper we examine the role of varying patterns of organization of processing

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and marketing arrangements for sugarcane in India, associated with different forms of onwership of sugar factories. Specifically, we contrast cane supply distortions arising in sugar cooperatives owned collectively by sugarcane farmers, with privately owned sugar factories that purchase their cane supplies from independent cane farmers. We argue that these organizational forms have distinct implications for prices paid for sugarcane by the factories to cane growers, with important consequences for volume of cane supplies to the factories. The key assumptions and predictions of our theoretical model are supported empirically on the basis of a longitudinal sample of sugar factories and cane farms spanning the period 1982-95 for Maharashtra and Uttar Pradesh (UP), the two leading sugar producing states in India. Unobserved heterogeneity of the different locations of these industries makes it difficult to evaluate comparative *levels* of performance of the private or cooperative sectors. However, it is possible to use our model to evaluate their respective growth performances, controlling for unobserved fixed factors that may favor one region over another. We use our model to estimate the contribution of the respective cane price distortions to growth of the private and cooperative factories over this period, resulting from changes in the local land distribution, relative to technological change, growth in irrigation or changes in prices of sugar or competing crops.

Section 2 describes the context within which sugar factories operate, and how they relate to sugarcane growers. A key feature of sugarcane processing is the need to closely coordinate harvesting and crushing operations, in order to limit inversion losses of sugar content in harvested cane. The need to crush cane soon after harvesting necessitates location of sugarcane farms in the immediate proximity of sugar factories, and exclusive supply relationships between cane growers and the factory in their immediate vicinity. The nature of the technology thus confers a 'natural monopsony' power to factories in their procurement of cane: once cane growers bring cane supplies to the factory gate, they are vulnerable to opportunistic price renegotiation by the factory in a variety of forms well documented by industry experts. These include underweighing of the cane, underevaluation of cane juice quality, delays in crushing, and in settlement of cane payments.

In order to limit the scope for such holdups, and to coordinate cane harvesting with crushing operations, the industry is therefore frequently characterized by vertical integration between upstream (cane growing) and downstream (cane crushing) stages of production. This has traditionally taken the form of plantation systems (where factory owners own and manage cane cultivation using hired or slave labor) in major sugar producing centers of the world, especially in colonial times (e.g., Caribbean countries, Africa and Brazil). However the plantation system never arose in India for a variety of historical reasons: unlike many of the other major sugar producing centers of the world, the land was already settled by large number of peasant farmers that the colonial government did not want to displace at the turn of the 19th century. As a consequence in India cane cultivation continues to be carried out by large numbers of independent peasant farmers.

The evolution of the sugar industry took remarkably different forms in the two different sugar producing regions of the country, for a variety of historical reasons elaborated in Section 2. In the central state of Uttar Pradesh (UP) a large mass of small farmers supply the bulk of the cane crushed by sugar factories owned privately by industrialists. The lack of vertical integration in the private UP industry has been associated with an uneasy relationship between the factories and the growers, reflecting problems of supply holdup, underpricing of cane, and poor coordination between harvesting and crushing. In the western state of Maharashtra by contrast, the industry is dominated by cooperatives started and managed by cane growers themselves. Relationships between the factory and cane growers are reported by industry experts as considerably more harmonious compared with the UP private factories, though also subject to considerable acrimony over the setting of cane prices. Banerjee, Mookherjee, Munshi and Ray (2001) (BMMR hereafter) have argued in particular that the Maharashtra cooperatives are subject to conflict between small growers who supply the bulk of the cane to the factory, with large growers that manage the factory and control the allocation of residual profits. They argue that the outcome of this conflict depends on the distribution of land between the two groups.

In Section 3 we present a theoretical model of the cane price distortion in the different organizational forms. The model implies that private non-integrated ownership if unregulated will lead to a larger distortion than cooperative integrated ownership. The fact that residual claimants who set the cane price are cane growers themselves in a cooperative limits the incentive to underprice cane, for two reasons. First, underpricing hurts the managers themselves since they also supply cane to the cooperative. Second, accountability of managers to small shareholders is induced by their need to secure the votes of the latter in order to stay in office.

The model also shows that under a plausible assumption on relative supply patterns for small and large growers, the severity of the cane price distortion in an unregulated private monopsony will be aggravated with increasing land fragmentation (represented by fraction of land in small holdings, denoted β hereafter). The assumption is that small growers have weaker and less elastic outside options relative to large growers (e.g., with respect to growing alternative cash crops that involve scale economies in cultivation and marketing, besides requiring more credit and machinery). With greater land fragmentation, then, private factories have access to a larger and less elastic supply schedule for cane, inducing them to pay a lower cane price. Accordingly, private factories will be more profitable, and growers will receive less remunerative prices, in regions where landownership is more fragmented. This is consistent with the patterns observed in early stages of the industry in UP in the first half of the 20th century, and explains why state regulation evolved in order to represent the interests of small growers.

Even in the presence of regulation, however, our theoretical model shows that the downward sloping pattern of the pricing distortion with respect to land fragmentation may continue to survive, though in a more attenuated form. We adapt the model of Grossman-Helpman (1996) to predict the effect of decisions made by state regulators who are motivated by concern for their re-election prospects, and are subject to the influence of special interest groups. Concern for re-election causes regulators to enforce a higher cane price that would have resulted in the absence of any regulation. If there is a single interest group representing factory owners, then the downward sloping relationship between the cane price and land fragmentation persists. If there is also a competing interest group in the form of a cane grower union, then the relationship is predicted to be either U-shaped or downward sloping. The reason is that if the land is sufficiently fragmented, the growth in numbers of small growers increases the political influence of the cane grower union at a growing rate, thus eventually offsetting the power of the factory owners' lobby.

In the context of cooperatives, it has already been argued by BMMR that a similar U-shaped pattern may be predicted, for related reasons: once the small growers become sufficiently numerous relative to the large growers they exercise increasing control over the management. However, the exact turning point may vary between cooperatives and regulated private monopsonies, owing to the fact that the accountability mechanisms in the former are more direct.

We then turn to empirical testing and estimation of our model, in order to probe the nature of the relationship between the cane price distortion and the extent of land fragmentation in the different organizational forms. Section 4 uses panel data spanning the period 1982–95 for the UP private factories and the Maharashtra coops. While we have data on the cane price paid by the factories, but not the delays that accompanied the payments, nor intentional errors in measurement of cane supply, we do not observe the 'effective' cane price received by the growers. We are thus forced to infer the pattern of effective prices from the planting decisions of farmers in different size categories.

We first verify the underlying assumption of the model for the UP private industry, concerning relative supply patterns of small and large growers. Small growers do indeed supply more cane, and in a less elastic fashion, controlling for determinants of the cane price and of local determinants of cane supply such as irrigation and prices of competing crops. We then estimate the relationship between participation rates (fraction of operational land allocated to cane) and the extent of land fragmentation. The regressions control for unobserved heterogeneity between different districts and factories with respect to soil quality, climate, management practices etc.

The empirical patterns turn out to match the theoretical predictions closely: within UP districts dominated by private sugar factories, participation rates (i.e., the proportion of land area allocated to sugarcane) fell as landholdings became more fragmented over time. Moreover, participation rates of both small and big growers moved downward, in contrast to the pattern observed for the Maharashtra coops. This confirms the central premise of our theory, that the key conflict of interest in the UP private factories is between the factory owners on the one hand, and growers (both small and large) on the other. Whereas in the Maharashtra coops, the main conflict is between the small and the large growers. More generally the conflict is between residual claimants to the factory's surplus and growers who do not have any such claim.

Section 5 explores implications of the cane supply distortion for the respective growth performances of the Maharashtra coops and the UP private factories. We first estimate factory production functions while correcting for potential bias arising from endogeneity of cane supply. The estimated production functions show that changes in cane supply (rather than changing cane quality or factory efficiency) accounted for the bulk of observed growth performance. Hence cane supply distortions are significantly more relevant to growth performance than changes in technology. Using our estimated cane supply functions, we subsequently decompose changes in cane supply into changes resulting from changes in the land distribution, irrigation, and prices of competing crops.

Finally, Section 6 summarizes the implications of our analysis, and some of the principal qualifications. 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, which is evaporated and then 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.

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 two dimensions: the pol (sucrose) percent which is the sucrose content in the juice, and the fibre percent (the residual being 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 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.[3] 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.[4] 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 Historical Origins of the Uttar Pradesh Sugar Industry

While the origins of the industry go back to the 1840s, the Indian sugar industry witnessed substantial entry of private factories mainly in the eastern UP and Bihar region in the early 1930s following protection of the industry from cheap Javanese imports (Commander (1985, p. 510)). There were 29 factories operating in the country in 1930, which increased to 71 by 1937. Many of these newly entering factories were however small in scale and inefficient, and were soon to be 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))

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

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

TABLE 1: ENTRY DATES OF SUGAR FACTORIES ACTIVE DURING 1982–95								
	Pre-1947		1947-1990		1991-1995		Total	
	Private	Coop	Private	Coop	Private	Coop	Private	Coop
East UP	21	0	0	7	4	0	25	7
West UP	16	0	6	24	9	1	31	25
UP total	37	0	6	31	13	1	56	32
West Maharashtra	7	2	3	62	0	9	10	73
East Maharashtra	0	0	0	29	0	6	0	35
Maharashtra total	7	2	3	91	0	15	10	108

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 industry represents 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'.[5] 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.[6]

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

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

[6] 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.

cover transport costs). Leading politicians in the ascendant Congress party (including the country's future President Rajendra Prasad and Prime Minister Jawaharlal Nehru) 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. The state owned units and the cooperatives are significantly less dynamic and vibrant than the private factories in UP, especially in comparison with the Maharashtra cooperatives. Only with the market reforms in the early 1990s were new private factories allowed to enter the industry. In the private factories, tensions between factory owners and cane growers persist to this day, with mounting arrears in payments to cane growers representing a method by which factory owners circumvent the SAP set by the state government, which is above the statutory minimum price (SMP) set by the central government. 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.[7]

2.4 Historical Origins of the Maharashtra Sugar Industry

By the early 1900's a rich strata of peasants emerged in Western Maharashtra villages, owing to a combination of factors: the spread of railways and irrigation in the Deccan

[7]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 difference between the SMP and the SAP to farmers'. 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.

by the British colonial government, and rising commercialization of agriculture driven by rising exports of cash crops (Charlesworth (1978)). These peasants not only owned the lands they cultivated, but were also self-sufficient with respect to ownership of agricultural implements and supply of credit, frequently lending to others. They comprised a number of middle and low castes (e.g., *Marathas* and *Malis*) that achieved significant upward mobility. Moreover the colonial government encouraged formation of village level credit cooperatives from 1904 onwards, partly in response to the Deccan riots in the late 19th century that were instigated by revolt of indebted peasant farmers against professional moneylenders. By the late 1920s a flourishing cooperative credit movement was under way, through which the ascendant *Maratha* peasants acquired increasing influence with Maharashtra politicians. In 1933 the first sugar cooperative was started in Maharashtra by a group of *Mali* farmers, which was to prove quite succcessful and was to be emulated later in the 1950s by numerous other cooperatives.

As Chithelen (1985) recounts, the slump in *gur* (unrefined sugar or jaggery) prices during the 1930s (the principal destination of sugarcane at that time) motivated cane growers to integrate forward to processing of (refined) sugar. The main advantage of shifting to sugar from *gur* was that sugar prices were higher than *gur* prices, and the recovery rates in sugar were twice as high. From 1945 onwards a number of cooperatives were started by *Maratha* farmers, with an initial investment of upwards of Rs 5000 per farmer, and with peasants contributing more than Rs 15000 being nominated to the Board of Directors. The emerging Congress party encouraged the formation of these cooperatives, with the composition of Congress ministries at the state shifting progressively away from urban upper class castes (mostly *Brahmins*) to the rising middle castes in the rural areas. Consequently the cooperatives received a variety of financial subsidies from the state government. This was accentuated in the 1950s following Independence, with the Congress dominated Central government providing industrial licenses only to cooperatives, and furnishing them with substantial contributions to their initial share capital on concessional terms.

The operation of the Western Maharashtra cooperatives is described vividly by Atwood (1992). 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 the 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 itself organizes harvesting and transport of the sugarcane crop to the factory, besides assisting growers with supply of seeds, credit and new varieties of cane). The West Maharashtra coops 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. In fact the cooperatives in East Maharashtra are notably less participative, partly owing to a more hierarchical agrarian and social structure (as argued by BMMR).

2.5 Descriptive Statistics

Table 1 above provided entry periods of factories active during the period we are studying (1981-82 to 1994-95). (The year 1981-82 refers to the financial year–April 1981 to March 1982.) Henceforth, for convenience we denote 1981-82 by 1982 and so on. Table 1 excludes numerous factories which entered and exited prior to 1982, 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, most of the 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.

Consequently in the period we are studying, the UP industry is dominated by private factories, most of which entered in the pre-1947 period. The Maharashtra industry is dominated by cooperatives, which entered after 1947. The cooperatives are primarily located in Western Maharashtra. There are only ten private factories in Maharashtra, and most of them entered before 1947. All the private factories in Maharashtra are located in the Western part.

Table 2 provides data on characteristics of sugarcane cultivation and the land distribution. Eastern UP is characterized by an exceptionally high extent of land fragmentation

(β), with over 60% of land under 2 hectares, [8] in contrast to 40–50% in West UP, 20–50% in West Maharashtra, and 15–25% in East Maharashtra [9]. So UP on average has much higher fragmentation than Maharashtra, consistent with the general impression that UP is characterized by a larger number of poor farmers cultivating small plots of land. The data also shows the extent of land fragmentation increasing over time in all regions, with the highest increases exhibited in West Maharashtra.

Table 2 shows that small growers typically plant sugarcane on a larger fraction of their land in UP. The participation rates of small and large growers in Maharashtra seem comparable. According to most accounts the lower participation rate of large growers in UP is due to their ability to grow a number of alternative cash crops that small growers cannot for lack of credit or marketing access. Participation rates of growers increased substantially over time in UP, particularly for small growers. There was also a sharp rise in participation rates for small growers located in West Maharashtra.

TABLE 2: LAND DISTRIBUTION AND PARTICIPATION RATES 1982-1995

	Land Fragmentation β		Participation Rates: Small Growers		Participation Rates: Large Growers	
	Private	Coop	Private	Coop	Private	Coop
East UP 1982	.66	.61	.72	.67	.56	.40
East UP 1995	.77	.82	1.43	1.25	1.02	.79
West UP 1982	.40	.46	.64	.59	.43	.42
West UP 1995	.54	.49	.99	.87	.62	.52
West Mah 1982	n.a	.24	n.a	.26	n.a	.23
West Mah 1995	n.a	.47	n.a.	.61	n.a	.28
East Mah 1982	n.a.	.15	n.a.	.24	n.a.	.27
East Mah 1995	n.a.	.22	n.a.	.26	n.a.	.28

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

Private (resp. coop) districts denote districts where more than two thirds of factories are private (resp. coop).

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

[9] Participation rates of greater than 100% are possible when more than one sugarcane crop is grown in a year on the same piece of land such as the *ratoon*, which takes six months to mature.

Table 3 presents average per-factory cane supply, quality and recovery rates for the different region-factory types in 1982 and 1995. In UP the private factories operated on a substantially larger scale than the coops, with the converse true in West Maharashtra. The UP private factories and the West Maharashtra coops had the biggest scales, with the former slightly bigger. The East Maharashtra coops were almost half the size of the West Maharashtra coops. Cane quality measured by the pol percent — the single most important determinant of quality, as our production function estimates will show — were generally higher in Maharashtra than UP. In Maharashtra the coops had a higher pol rate than the privates, with the opposite true in UP. A similar cross-sectional comparison emerges for the factory recovery rate. Over time, however, the pol rate tended to decline, while the factory recovery rate improved.

TABLE 3: CANE SUPPLY, QUALITY AND RECOVERY RATES 1982-1995

	Annual Cane Crushed Factory Average ('000 quintals/year)		Pol Rate Factory Average (percent)		Recovery Rate Factory Average (percent)	
	Private	Coop	Private	Coop	Private	Coop
East UP 1982	2260	1018	12.00	11.74	82.48	83.25
East UP 1995	3992	1861	11.69	11.63	84.79	85.75
West UP 1982	4552	2369	12.22	11.65	82.76	84.24
West UP 1995	5968	3260	11.91	11.75	85.93	86.62
West Mah 1982	2824	4173	12.90	13.19	84.25	84.26
West Mah 1995	3153	5035	12.84	12.99	86.15	86.34
East Mah 1982	n.a.	2543	n.a.	12.25	n.a.	83.05
East Mah 1995	n.a.	2777	n.a.	12.16	n.a.	85.04

Finally, Table 4 presents statistics on prices. The sugar price received by factories was estimated by weighting the market price in the leading wholesale market center in the state, with the state procurement price, using the 'levy' ratio of market sales to state procurement as weights. So the sugar price estimated is the same for privates and coops within each state. The Table shows that the (real) sugar price dropped in UP and rose in Maharashtra during this period. The (real) cane price reported is the actual factory average for the Maharashtra coops, while for UP is the state advised price. The UP factories are supposed to pay this price, but often delay payments and accumulate substantial arrears. In Maharashtra the coops paid a higher average cane price than did the private factories. However we know from Table 3 that the coops achieved higher cane quality and recovery rates, so it is not clear if coops paid a better price to their growers than the private factories once quality differences are adjusted for. Over time the statutory cane price in UP did not change in real terms, while the coops in Maharashtra paid better prices. Finally the price of the leading competing crop dropped in all regions, a factor which presumably stimulated growth of cane supplies.

TABLE 4: PRICES 1982-1995					
	Sugar Price Received	Cane Price		Price of Leading Competing Crop	
		Private	Coop	Private	Coop
East UP 1982	82.63	4.59	4.59	23.36	23.36
East UP 1995	71.62	4.56	4.56	21.98	21.98
West UP 1982	82.63	4.59	4.59	23.36	27.36
West UP 1995	71.62	4.56	4.56	21.98	21.98
West Mah 1982	73.18	3.70	4.42	35.34	37.60
West Mah 1995	76.52	3.46	5.27	29.64	27.96
East Mah 1982	73.18	n.a.	3.94	n.a.	48.22
East Mah 1995	76.52	n.a.	4.34	n.a.	33
All prices are in Rs/qntl, deflated using CPI, 1960=100.					
Cane price in Maharashtra: actual cane price paid. In UP: the state advised price.					

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.

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

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

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

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 $gF - fG > 0$, .

[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.

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.

This result has a number of testable implications. Under private unregulated monopsony, holding fixed parameters such as irrigated land area, prices of sugar, recovery rates, and prices of competing crops: (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, prior to 1945. For instance, Eastern UP (resp. Western Maharashtra) has been characterized by greater land fragmentation (higher β) than western UP (resp. eastern Maharashtra), and the early private entrants were concentrated in the former region. Moreover, UP had a higher β than Maharashtra, and seems to have been characterized more by reports of exploitation of small growers by factory owners, leading to political tension.

Real coops are typically started by medium and large farmers with sufficient acumen, political connections and ambitions, and personal wealth. As explained in Section 2, these preconditions were present in Maharashtra, particularly the western part. In eastern UP a vibrant, wealthy middle or large peasantry was lacking. The exploitation of small growers gave rise to political demand for representation of their interests, to which politicians responded in UP by regulating the cane price paid by private factories, and starting government coops.

3.3 Real Coops

A Maharashtra coop is typically 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

[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.

as the fraction of small growers in the coop grows. Following BMMR, we assume that the control right of small growers is represented by an implicit welfare weight $\omega(\beta) < \beta$ which is increasing and convex in the demographic weight of small growers.

So 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. Note that the objective of the coop can be represented as

$$W^c \equiv W - [\beta - \omega(\beta)]R_s(p)$$

i.e., the deviation from social welfare is accounted by the extent $[\beta - \omega(\beta)]$ to which small growers are underrepresented in the coop.

The cane price p_c in the coop will satisfy the first order condition

$$\frac{\partial W^c}{\partial p} = \frac{\partial W}{\partial p} - [\beta - \omega(\beta)]F(p_c)$$

which can be rewritten as

$$q = p_c + \frac{[\beta - \omega(\beta)]F(p_c)}{\beta f(p_c) + (1-\beta)g(p_c)} \tag{3}$$

The cane price will still be distorted downward in the coop, to an extent that depends on $\beta - \omega(\beta)$, on the extent to which the 'voice' of the small farmers count relative to their demographic weight. Comparing (3) 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.[13]

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.

[13] 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 (3). 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.

3.4 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.

One approach associated with Grossman-Helpman (1996, 2001, Ch. 10) is based on two party electoral competition, with probabilistic voting and campaign contributions by special interest groups. In this approach, votes can be won by (i) setting cane prices that are supported by a majority of 'informed' voters (ii) securing campaign contributions from wealthy groups such as factory owners, and using these contributions to persuade undecided or uninformed voters.[14] 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 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:

$$W_k^P(p) = d\beta R_s(p) + d(1-\beta)R_b(p) + \theta_k(q-p)J_\beta(p) \tag{4}$$

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,

[14] For instance, a newsitem 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'.

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 (4) can be rewritten more simply as

$$W_k^P(p) = (q-p)J_\beta(p) + \frac{d}{\theta_k(\beta)}R_\beta(p) \tag{5}$$

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

$$q = p + [1 - \frac{d}{\theta_k(\beta)}]\frac{\beta F(p) + (1-\beta)G(p)}{\beta f(p) + (1-\beta)g(p)} \tag{6}$$

Comparing (6) 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 (unlike the case of the coops), and will be decreasing in β.* Political parameters also matter: such as political awareness among small and large growers, and evenness of the electoral contest between political parties.

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.[15] Appendix 1 describes the implications of

[15] 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."

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:

$$(1 + h\chi\phi_k)\Pi(p) + (d + \frac{\phi_k}{c_n})R_\beta(p). \tag{7}$$

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:

$$p^k = q - [1 - \frac{d + \frac{\phi_k}{c_n}}{1 + h\chi\phi_k}]\frac{\beta F(p^k) + (1-\beta)G(p^k)}{\beta f(p^k) + (1-\beta)g(p^k)}. \tag{8}$$

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. 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.

4 Empirical Testing of the Model

In this section we test the following assumptions and predictions of our model:

(1) Assumption A1 states that participation rates for small growers are higher, at any given cane price. This was used to derive a downward sloping relationship between cane price and land fragmentation in the private UP industry. 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.

[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.

(2) Assumption A2 states that participation hazard rates (with respect to the cane price) are lower for small growers, also used to derive the downward sloping relationship between cane price and β in the context of the private industry. If we continue to assume that small and large growers receive the same cane price $p(\beta)$, and that this relationship is downward sloping, then the participation hazard with respect to β will be negative for both types of growers, and higher (i.e., closer to zero) for small growers.[17]

(3) Participation rates in the private industry are predicted to decline in β, reflecting the worsening monopsonistic distortion when land is more fragmented. The relationship is expected to be convex, and possibly even U-shaped, if cane growers become politically organized.

(4) Participation rates in the private industry move in the same direction for small and big growers, so that the principal conflict over division of rents is between growers and factory owners.

(5) In contrast, in the Maharashtra coops, the participation rates of small and big growers may move in opposite directions as land fragmentation rises. Following the results of BMMR we may expect that in East Maharashtra (where land is less fragmented) that the cane price will decline in β, resulting in falling participation rates for small growers, and possibly rising participation rates for large growers (since they would be accruing higher rents at the expense of the small growers). In West Maharashtra where β is higher and there is a tradition of assertive and participative behavior among small growers in the operation of the cooperatives, we would expect participation rates of small growers to be rising in β, while the participation response of large growers is ambiguous (since residual profits decline but the returns from supplying cane rise).

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 infering patterns in the effective cane price is to examine the patterns in actual participation patterns for different size categories of growers.

[17]This follows from the fact that $\frac{\partial F(p(\beta))}{\partial \beta} = \frac{f(p(\beta)}{F(p(\beta))}.p'(\beta)$. If small growers receive a different cane price $p_1(\beta)$ from large growers $p_2(\beta)$ then we additionally need the assumption that the cane price for the small growers falls faster or at the same rate: $p_1'(\beta) \leq p_2'(\beta)$. This assumption is consistent with the model: if the supply of the small growers is less elastic and the factories could price discriminate, then the monopsonistic problem is likely to be more severe for the small growers. Alternatively, since small growers supply more cane per unit land area than large growers, the problem of oversupply is more likely to occur when β rises, whence the gap between the effective prices received by small and large growers is likely to grow.

Data for distribution of agricultural operational land holdings is available from the state Agricultural Censuses every five years. We utilize data from the 1981, 1986 and 1991 censuses: the results of the 1996 Census are yet to be released. From the 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. The Census data is interpolated between the three Census years in order to create a annual series for participation rates and β in each district. In UP we select districts where private factories constitute more than two thirds of all factories located in the district. For each district we combine the Census data with factory data, and calculate average recovery rates for private factories located in that district. 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. Besides the price of competing crops, we also include percent irrigated area as an additional determinant of the decision to participate in growing cane, owing to differences in irrigation-intensity of different crops.

Table 5 below provides regression results for participation patterns in UP private districts, West and East Maharashtra coop districts (where coop factories constitute more than two third of factories as opposed to private or public factories). We include terms in β and its square, to incorporate the anticipated nonlinearity in participation patterns with respect to β. We will later show corresponding nonparametric results for these patterns, in order to check for more complicated nonlinearities. The β variable is interacted with a dummy for small growers, so as to allow participation patterns of small and large growers to differ. The regression controls for percent area that is irrigated, as well as its interaction with the dummy for small growers. The regression incorporates district and year fixed effects, common for both categories of growers. In the case of Maharashtra, we include the price of competing crops since annual data on this variable is available at the district level.

TABLE 5: PARTICIPATION REGRESSIONS				
	UP Private Districts All Years	UP Private Districts Census Years	West Mah Coop Districts All Years	East Mah Coop Districts All Years
No. Observations	178	42	204	260
No. districts	12	11	8	13
within R^2	0.92	0.88	0.41	0.60
Small dummy	97.11***	78.83**	-28.09	13.34***
	(17.57)	(30.46)	(36.54)	(3.20)
β	-6.05***	-5.64*	2.84**	.57**
	(0.98)	(3.11)	(1.36)	(.26)
β*Small	-2.02***	-1.89	0.74	-1.17***
	(.59)	(1.11)	(1.39)	(.23)
β Sq.	.039***	.069**	-.001	.013***
	(.007)	(.025)	(.016)	(.003)
β Sq.*Small	.018***	.018*	-.001	.013***
	(.005)	(.01)	(.018)	(.003)
% Area Irrigated	-1.16***	-1.03***	.47	-.36***
	(.09)	(.24)	(1.11)	(.09)
% Area Irrigated*Small	-.30***	-.18	1.86***	0.31***
	(.07)	(.17)	(.55)	(.10)
Price Competing	–	–	-1.60*	-.06
Crop			(.87)	(.10)
Price Competing	–	–	-0.28	.00
Crop*Small			(.52)	(.04)
All regressions include district and year dummies				
***: sig. at 1%, **: at 5%, *: at 10%				

The first column in Table 5 shows results of the regression for UP private districts applied to annual data interpolated between Census years. The coefficient on the small grower dummy is significantly positive, confirming prediction (1) above. With respect to β the pattern of participation is U-shaped for both small and big growers. The predicted patterns are plotted in Figure 1, which shows that the participation rates were falling for both small and large growers over most of the observed values of β in West UP, while it tended to flatten out and turn upward slightly in East UP. So predictions (3) and (4) above are supported for the UP private industry.

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.

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 (irrigation, district and year fixed effects). The residuals are rescaled to be positive. These are then nonparametrically regressed on β using a Gaussian kernel function. The resulting pattern is shown in Figure 2. Here the downward sloping pattern for participation is reinforced relative to the parametric results. But the U-shaped pattern is qualitatively similar. Hence we find support in favor of hypothesis (3) above.

We also check prediction (2) by plotting the corresponding participation hazard rates with respect to β for both categories of growers in Figure 3. Consistent with the hypothesis, participation hazard rates are negative for both, and higher for the small growers (i.e., closer to zero).

We thus confirm the basic assumptions of the model applied to the UP private industry: that the supply function of the small growers lies to the right of that for the large growers (A1), and is less elastic (A2). This is consistent with our interpretation that the cane price is subject to a monopsonistic distortion which worsens as the land distribution gets more fragmented.

Column 2 of Table 5 shows results for the same regression using only data from the three Census years. This is because the regression in the first column uses only data from the Censuses, and does not contain any regressor which varies annually by district. The reduction in sample size naturally increases the standard errors, but the coefficients remain statistically significant at 10%. The only qualitative change in the estimated pattern is that the coefficient on the square of β is now higher, implying that the upturn in participation rates now occurs earlier. But the basic U-shaped pattern continues to be obtained.

Columns 3 and 4 of Table 5 present the participation regressions for West and East Maharashtra coop districts respectively. [18] Here we have annual district-wise data on the price of the chief competing crop, so the regressions are reported only for annual data. Figures 4 and 5 (resp. 6 and 7) show the corresponding parametric and nonparametric plots of predicted participation rates for West (resp. East) Maharashtra. In the West we find that participation rates for both small and big growers were rising in β, particularly for the small growers. In contrast in the East their participation rates moved in opposite directions (over the relevant range, as the interquartile range for β was 15–25, and the median was 17). These findings are consistent with prediction 5 above, and also with the principal findings in BMMR (which covered a different period 1970–93, and fewer districts in East Maharashtra).

[18] Even though the number of factories is higher in the West it has a smaller number of districts and hence smaller number of observations.

Tables 6 and 7 check robustness of the preceding results with respect to alternative specifications and definitions of size categories. The theory suggests that an important determinant of the cane price will be the variable q, the product of the price of sugar received by the factory, and the factory recovery rate. The regressions reported in Table 6 include this variable, and its interaction with the small grower dummy. The reason this variable was not included in the base regressions in Table 5 is that the factory recovery rate may be endogenous with respect to cane supply. It is conceivable that large increases in cane supply cause factory efficiency to decline as capacity is overutilized. If this is the case one would worry about possible omitted variable biases when factory efficiency is not controlled for in the participation regression. It is possible that a negative bias is imparted to the coefficient of β, as rising β increases cane supply which could cause a drop in factory efficiency, which in turn lowers factory profitability and therefore the cane price paid by the factory. In that case a declining pattern in participation rates as β rises may owe to this bias, rather than a worsening monopsonistic distortion. So it is necessary to check if the results of Table 5 continue to hold when we control for the factory recovery rate. Table 6 shows that this is indeed the case. Controlling for factory recovery rates (interacted with the price of sugar, as the theory suggests) reinforces the pattern of falling participation rates in the UP private industry, and rising rates in West Maharashtra. In East Maharashtra the pattern is almost unchanged.

TABLE 6: PARTICIPATION REGRESSIONS WITH FACTORY RECOVERY				
	UP Private Districts All Years	UP Districts Census Years	West Mah Coop Districts All Years	East Mah Coop Districts All Years
No. Observations	178	42	204	260
No. districts	12	10	8	13
within R^2	0.92	0.94	0.42	0.65
Small dummy	108.36***	112.33***	-19.09	16.42***
	(21.79)	(30.70)	(40.08)	(5.89)
β	-6.47***	-9.59***	3.01**	.51**
	(0.99)	(2.93)	(1.38)	(.25)
β*Small	-2.11***	-2.02**	0.78	-1.17***
	(.60)	(.80)	(1.40)	(.22)
β Sq.	.04***	.07**	-.02	-.009***
	(.007)	(.03)	(.016)	(.003)
β Sq.*Small	.019***	.02**	-.002	.013***
	(.005)	(.01)	(.019)	(.003)
% Area Irrigated	-1.13***	-1.02***	.59	-.315***
	(.09)	(.23)	(1.13)	(.09)
% Area Irrigated*Small	-.31***	-.16	1.91***	0.32***
	(.08)	(.14)	(.56)	(.10)
Price Competing	–	–	-1.50*	-.06
Crop	–	–	(.89)	(.10)
Price Competing	–	–	-0.29	.00
Crop*Small	–	–	(.52)	(.04)
Sugar Price*	1.65**	8.28**	-1.36	-1.24***
Rec. Rate	(.73)	(3.78)	(1.31)	(.24)
Sugar Price*	-.15	-0.51	-0.17	-0.05
Rec. Rate*Small	(.18)	(.32)	(.31)	(.09)
All regressions include district and year dummies				
***: sig. at 1%, **: at 5%, *: at 10%				

Table 7 shows the effect of using alternative size categories of growers in Maharashtra. The Census data for UP is coarser and does not permit this variation. The first and third regressions explain participation rates of small (less than 2 ha.), middle (2-10 ha.) and big (bigger than 10 ha.) growers, using additional interaction effects of β (still defined using the 2 ha. cutoff) and its square with a dummy for big growers. The corresponding nonparametric regressions of participation of small and big growers with respect to β

are shown in Figures 8 and 9 respectively. The second and fourth regressions in Table 7 redo the regressions, dropping the middle sized growers. Figures 10 and 11 display the corresponding nonparametric participation regressions.

TABLE 7: PARTICIPATION REGRESSIONS FOR MAHARASHTRA WITH ALTERNATIVE SIZE CATEGORIES				
	West Mah Coop Districts All Years	West Mah Coop Districts All Years	East Mah Coop Districts All Years	East Mah Coop Districts All Years
No. Observations	306	204	390	260
No. districts	8	8	13	13
within R^2	0.47	0.47	0.46	0.47
Small dummy	-24.55	-28.21	11.26**	22.24***
	(32.56)	(38.50)	(5.39)	(6.23)
Very big dummy	3.66	–	-10.98**	–
	(32.56)	–	(5.39)	–
β	3.50***	1.41	.55	1.11**
	(1.11)	(1.44)	(.39)	(.51)
β*Small	.35	2.62*	-1.07***	-1.67***
	1.24	(1.47)	(.39)	(.46)
β*Very big	-2.28*	–	.60	–
	(1.24)	–	(.39)	–
β Sq.	-0.03	.002	-0.01	-.02***
	(.01)	(.017)	(.005)	(.007)
β Sq.*Small	.003	-.02	.01*	.03***
	(.02)	(.02)	(.006)	(.007)
β Sq.*Very big	.02	–	-0.016***	–
	(.02)	–	(.006)	–
% Area Irrigated	.11	1.47	-0.57***	.33*
	(.84)	(1.17)	(.15)	(.19)
% Area Irrigated*Small	2.06***	.27	.44**	-0.47**
	(.49)	(.58)	(.18)	(.21)
% Area Irrigated*Very big	1.80***	–	.91***	–
	(.49)	–	(.18)	–
Price Competing Crop	-1.33**	-1.46	.05	.18
	(.67)	(.93)	(.15)	(.21)
Price Competing Crop*Small	-0.25	-0.73	.01	-.05
	(.47)	(.55)	(.07)	(.08)
Price Competing Crop*Very big	.48	–	.06	–
	(.47)	–	(.07)	–
Definition of small: less than 2 ha.; 'very big': more than 10 ha.				
All regressions include district and year dummies				
***: sig. at 1%, **: at 5%, *: at 10%				

It is evident from Table 7 that the earlier patterns we found for small growers continue to hold when we use a different definition of big growers. There are however differences between participation patterns of middle and big growers. In the West, the participation of medium growers rises in β, just as for the small growers, while that of the very big growers grows much more slowly. This is consistent with the BMMR theory that the very big growers have a more significant stake than medium growers in the residual profits of the cooperative, which decline as the small growers become more numerous and powerful. In East Maharashtra we find that the participation rates were highest for the small growers, intermediate for middle growers and lowest for big growers, consistent with the UP pattern in which wealthier farmers were less reliant on sugarcane. As β rose, participation rates of small and very big growers were declining, while remaining stationary for the medium growers.

We now turn to potential econometric problems with our preceding results. A key premise underlying our analysis is that changes in the land distribution were exogenous with respect to the organization of the sugar industry, or cane pricing policies of the factories. It is well known that increasing land fragmentation is a phenomenon commonly occurring throughout different Indian states in the late 20th century, owing partly to a host of demographic and sociological changes (such as rising population pressure, and splitting of joint families into nuclear families). All the regions we study experienced increasing land fragmentation, we suspect mainly for this reason.

However, changing patterns of returns to agriculture for different size holdings may also induce changes in land distribution — e.g., rising productivity on small farms relative to large farms may induce greater splitting of larger holdings into smaller ones. In that case there is a risk of an endogeneity bias in the participation-β relationship. For reasons explained in earlier sections, improved cane prices are likely to raise returns of small landholdings relative to larger ones, and thus induce greater land fragmentation. This would impart an upward bias to the regression coefficient of β in the participation regression.

The presence of such bias would further strengthen our results pertaining to the UP private districts, since there we found a significantly negative regression coefficient. Correcting for the bias would imply that the true relationship is even more sharply negative than our estimates indicate. The same is true for the East Maharashtra participation patterns, in which we found that participation rates correlated negatively with land fragmentation. In the case of West Maharashtra, however, our results would be weakened in the presence of such a bias. We therefore need to explore the possibility that the positive correlation between participation rates and β in West Maharashtra may have resulted from such an endogeneity bias.

It is reasonable to suppose that the change in land fragmentation between year t and the next $t+1$ depends on the cane price in year t and prior years. Changes in ownership of land take some time to be affected, especially with the slow-moving system in the Indian courts and land registration process. Tenancy agreements have to be negotiated at least a year in advance. Hence it is unlikely that a rise in the cane price in year $t+1$ can induce a change in the distribution of operational landholdings in the same year itself. In that case, our estimates are not biased under the assumption that temporal shocks in the participation regressions are serially uncorrelated, i.e., all the autocorrelation in participation rates are captured by district fixed effects. Controlling for the fixed effect, unobserved components of shocks in participation rates in the current year would then be uncorrelated with shocks in previous years, and the current land fragmentation would be correlated only with the latter. It is only in the presence of serial correlation in the yearly shocks that our estimates would be biased, because the land distribution in t which is correlated with participation in $t-1$ will then be correlated with the error in t.

One way to check for bias in the results for West Maharashtra is the following. If we assume that autocorrelations in the yearly shocks to participation rates are limited to successive years, the one-period lagged value of land distribution will be uncorrelated with the shock in t. So one could replace the current value of β by the one year lagged value, and check whether the results are significantly altered. However, we cannot implement this because we do not have yearly data on the land distribution. So the only way to proceed is to confine the regression to Census years only, in which case the bias is absent as long as the shocks to participation rates across five or more years are uncorrelated. We have already seen in Table 5 that for UP the qualitative results did not change by restricting the regression to Census years only. We do the same for Maharashtra and estimate the participation equations for census years alone. The resulting participation patterns for the small and big farmers in the two regions predicted by the parametric model are plotted in figures 12 and 13.[19] For the West, the participation of the small farmers is still upward sloping in β while for big farmers it rises way past the median of 33 (the interquartile range being 27-44). The slope of the latter is quite flat as in our earlier results from Table 5. For the East, the participation of the small and big are slightly apart with the participation of the big farmers rising and that of the small farmers falling as before in the relevant range (the interquartile range for β was 15-25 (median 17)). So the main results obtained earlier continue to hold when the sample is confined to the Census years. This indicates that our results do not seem attributable to serial correlation in temporal shocks (i.e., endogeneity in β)) or measurement error owing to interpolation.

5 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

[19]We do not show the corresponding nonparamteric patterns because of the smallness of the sample.

technology employed by the factories for processing cane into sugar. Table 8 presents estimated Cobb-Douglas production functions for the three sectors. The three factors are the quantity of cane crushed, 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.[20] 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 otherwise ought to have no impact on 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. We also use the capacity level of the factory as determinants of the pol and recovery rates: capacity affects output primarily by improving sugar extraction rates from cane, besides allowing larger quantities of cane to be crushed. So conditional on these three variables, it is plausible that fluctuations in capacity should not be associated with fluctuations in output.[21]

Table 8 presents two sets of IV regressions for each sector, predicting log of annual output and of yield (sugar output divided by cane crushed). We include the latter to check for constancy of returns to scale with respect to cane. The regressions include factory and time dummies, to incorporate all other sources of unobserved heterogeneity across factories that do not change over time, besides those factors that affect all factories in the same way over time (such as availability of new varieties of cane, or government policies that may have affected productivity).

[20] Fibre content as a measure of cane quality turned out to have an unstable and insignificant (t-value well below one) elasticity in all cases and hence was dropped from the estimated equations.

[21] 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 8: FACTORY PRODUCTION FUNCTIONS (INSTRUMENTAL VARIABLE ESTIMATES)						
	UP Prv Log Output	UP Prv Log Yield	WMah Coop Log Output	WMah Coop Log Yield	EMah Coop Log Output	EMah Coop Log Yield
No. observations	534	534	843	843	324	324
No. factories	50	50	72	72	33	33
within-R^2	.99	–	.99	.83	.99	.48
Log Cane	1.039***	.039	.997***	-.003	1.003***	.004
	(.080)	(.080)	(.029)	(.029)	(.064)	(.064)
Log Pol	4.301	4.301	1.102	1.102	2.548**	2.548**
	(4.551)	(4.551)	(.802)	(.802)	(1.184)	(1.184)
Log Rec Rate	1.868	1.868	1.273**	1.272**	1.745	1.745
	(3.957)	(3.957)	(.617)	(.617)	(1.305)	(1.305)
Instrumented: Log Cane, Log Pol, Log Recovery Rate						
Factory and Year dummies included in the regression						

Table 8 shows that the hypothesis of constant returns to scale with respect to cane cannot be rejected. The elasticity of output with respect to cane is almost 1, and does not vary significantly across the different sectors. This results continue to obtain if we treat the recovery rate as exogenous. Elasticities with respect to the pol rate and factory efficiency do however differ significantly: the former matters more in UP than Maharashtra, and the converse is true for the recovery rate. They are also quite sensitive to the estimation procedure, and differ considerably between formulations that treat them as exogenous or endogenous.

Table 9 uses the estimated production functions to decompose growth in output in the three sectors into parts explained by growth in cane supply, quality and factory efficiency. It shows that almost all the growth is explained by changes in cane supply: changes in cane quality or factory efficiency account for almost no significant change in factory output. This result carries over if we use the production function estimated treating recovery rates as exogenous. Hence technological change with respect to cane quality or factory technology account for almost none of the observed growth performance in the industry. Consistent with the assessments of many authors, cane supply is the single sole determinant of the industry's growth performance. Once one interprets the supply patterns of cane growers as the result of alternative forms of monopsonistic distortions inherent in the different sectors — as we have done so far in this paper — institutional determinants of growth appear far more important than technological change.

TABLE 9: DECOMPOSITION OF FACTORY OUTPUT GROWTH RATES			
	UP Private Factories	West Mah Coop Factories	East Mah Coop Factories
Observed annual growth rate	4.76	9.08	18.95
predicted by:			
Growth in Cane:	4.56	8.16	16.80
Growth in Pol:	-0.69	0.19	1.99
Growth in Recovery Rate:	0.69	0.72	1.06

To pursue this point further, we use our estimated participation patterns (from Table 5) to decompose changes in cane supply to a representative factory in each sector, into those associated with rising land fragmentation (β), changes in irrigated land area, and prices of competing crops. 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. In the UP private industry the monopsonistic distortion is aggravated, resulting in declining participation rates for both categories of growers — causing cane supply to shrink. In the West Maharashtra coops on the other hand, the distortion is mitigated as the small growers gain increasing control, which has the reverse effect: cane supply rises. In East Maharashtra the effects are more complex: the small growers participate less and the big growers participate more, so the overall effect is indeterminate.

Table 10 presents decomposition of changes in aggregate proportion of irrigated land that was devoted to sugarcane in the three sectors. In all three cases we see that aggregate participation levels rose by comparable magnitudes, between 20–30%, with higher increases in Maharashtra (about 30%, as against 24% in the UP private districts). As explained in more detail in Appendix 3, we decompose this into (i) the direct effect of changing β, owing to the possibility that participation levels vary between small and large growers (at any given level of β, irrigation and competing crop prices), as estimated by the coefficient estimate of the dummy for small growers in the participation regression); (ii) the indirect effect of changing β owing to the cane price distortion, as represented by the effect of changing β on participation rates of different size categories of growers; (iii) effects of changing proportion of area in the district that was irrigated; (iv) effects of changing prices of competing crops. We aggregate the effects on participation rates on different categories of growers, using the 1982 size distribution as weights.

Table 10 shows that the growth effect of the cane price distortion differed substantially between the three sectors. In the private UP districts, rising land fragmentation induced an aggregate drop of about 10% in area devoted to sugarcane, owing to the distortion effect. In West Maharashtra on the other hand, it caused a 110% increase. In East Maharashtra it caused almost no change. In UP and West Maharashtra, the cane price distortion dominated the effect of changing irrigation or prices of competing crops. In combination with the preceding results concerning the importance of cane supply in explaining growth in sugar output, these estimates indicate that the cane price distortions inherent in the respective institutional settings had significant growth implications. Assuming a unit elasticity of sugar output with respect to cane supply, growth in UP sugar output in districts where private factories predominated would have been significantly higher, had the factories been organized and managed the same way as the West Maharashtra cooperatives. If land fragmentation had changed by the same magnitude in that case (which would be true if changes in the land distribution were indeed exogenous with respect to the organization of the sugar industry), cumulative output growth would have been 40–60% higher (in absolute terms) than the observed growth of 24%.[22] On the other hand if they had been organized like the East Maharashtra coops, the growth performance would not have improved much.[23] So the effect of ownership differences depends importantly on the prevailing wealth distribution.

TABLE 10: DECOMPOSITION OF PARTICIPATION CHANGES

	UP Private Districts	West Mah Coop Districts	East Mah Coop Districts
Percent change in agg participation	23.98	26.71	30.61
predicted by:			
Changing β: (Cane Price Distortion)	-9.88	110.90	0.34
Changing β: (Direct Effect)	1.77	-1.30	0.03
Change in Irrigation	6.28	19.34	-1.43
Change in Price of Competing Crops	–	34.51	1.05

[22] Table 2 shows that the increase in β in UP was of the order of 7–8 percentage points, as against an increase of 16–18% in West Maharashtra. So if we divide the 120% difference by a factor of between two or three, we obtain a predicted 40–60% growth difference.

[23] Tables 9 and 10 shows that the actual growth performance of the East Maharashtra coops was greater than either the West Maharashtra coops or the UP private factories. The source of this remains unexplained, as it is not accounted for by changes in prices of competing crop prices, irrigation, or the land distribution.

6 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, technology and prices. The period since the early 1980s has seen changes in factors arguably exogenous to individual sugar factories: increasing fragmentation in the land distribution (rise in β), a fall in the real price of sugar and of crops competing with sugarcane. Owing to differences in their respective cane pricing patterns, these changes induced distinct output responses in coops and private factories. The rise in land fragmentation induced opposite effects on the extent of cane pricing distortion in the Maharashtra coops and UP private factories, causing their growth performances to diverge. The cane supply decomposition results show that owing to different systems by which cane prices get determined, increasing land fragmentation was associated with strikingly different implications for output growth in the different sectors. Had the private sugar factories in UP been organized and managed the same way as the West Maharashtra cooperatives, rising land fragmentation would have caused cumulative output growth over the period 1982-95 to be significantly higher. Assuming that a different organization of sugar factories would not have altered the change in land fragmentation, the growth in the UP private industry would have been higher by approximately 40–60% (as against an actual growth of 24% experienced by this sector).

However, not all cooperatives perform as well as do the West Maharashtra ones. The evidence indicates that the monopsonistic distortions in the East Maharashtra coops were significantly greater than those in West Maharashtra, and closer to those in the UP private industry. Our decomposition results indicate that if the UP private industry were organized and managed like the East Maharashtra cooperatives, the cumulative growth performance resulting from increased land fragmentation would be higher by only about 10%. According to our model (and consistent with BMMR), the East Maharashtra coops did not perform quite as well as the West Maharashtra coops owing to the comparative lack of control rights exercised by small growers (in turn due to the greater land inequality in Eastern Maharashtra, compared with the West).

In future work, we intend to shed light on the political economy of cane price determination in the regulated private factories, drawing on the model described in Appendix 1 (summarized in equation (8)). In particular, do literacy levels and evenness 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. Finally incorporation of the 1996 Agricultural Census results when they are released will add considerably to the size of our sample.

References

Amin, S. (1984), *Sugarcane and Sugar in Gorakhpur: An Inquiry into Peasant Production for Capitalist Enterprise in Colonial India*, Oxford University Press, Oxford.

Attwood, D.W. (1992) , *Raising Cane: The Political Economy of Sugar in Western India*, Oxford University Press, New Delhi.

Banerjee A.V., Mookherjee Dilip, Munshi Kaivan and Ray Debraj (2001), "Inequality, Control Rights and Rent-Seeking: Sugar Co-operatives in Maharashtra," *Journal of Political Economy*,109(1), 138-190.

Batra, S. M. (1988) , "Agrarian Relations and Sugar Cooperatives in North India" in *Who Shares?* ed. D. W. Attwood and B. S. Baviskar, Oxford University Press, New Delhi, 91-111.

Charlesworth, N. (1978), "Rich Peasants and Poor Peasants in Late Nineteenth Century Maharashtra" in *The Imperial Impact: Studies in the Economic History of Africa and India* ed. C. Dewey and A. G. Hopkins, Athtone Press, London.

Chithelen, I.(1985), "Origins of Co-operative Sugar Industry in Maharashtra," *Economic and Political Weekly*, 10, 604-12.

Commander, S. (1985), "Proto-Industrial Production as a Barrier to Industrialisation ? Case of North Indian Sugar Industry, 1850-1980, " *Economic and Political Weekly*, 10, 505-17.

Grossman, G. and Helpman, E. (1996), "Electoral Competition and Special Interest Politics," *Review of Economic Studies*, 63, 265-86.

Grossman, G. and Helpman, E. (2001), *Special Interest Politics*, MIT Press, Cambridge.

Sawhney, D.M. (1997), "The Indian Sugar Industry—A Complex, Yet Increasingly Prominent Force on the World Sugar Scene", mimeo, International Society of Sugar Cane Tecnologists, New Delhi.

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.[24] 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.[25] (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

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

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

[25] 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

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

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:

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

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 [26]

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

so the objective of party A will now be to maximize

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

[26] 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, 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 whereas in Maharashtra it was 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.

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, p^c_{it}: price of competing crops; I_{it}: proportion of operational land that is irrigated; δ_t common time dummy for year t in farmer participation rates; γ_i factory i command zone fixed effect in participation.

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:

$$Y_{it} = A_t v_i C^{\alpha_1}_{it} P^{\alpha_2}_{it} r^{\alpha_3}_{it} \qquad (A3.1)$$

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 is

$$p^g_{it} = \gamma_i + \delta_t + \gamma^g + \gamma_1 \beta_{it} + \gamma_2 \beta^2_{it} + \gamma_3 P^c_{it} + \gamma_4 I_{it} \qquad (A3.2)$$

The cane price distortion effect of changing land distribution on cane supply is represented by the terms $\gamma_1 \beta_{it} + \gamma_2 \beta^2_{it}$, 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) Cane Price Distortion Resulting from Changing Land Distribution:

$$\beta_{ik}[\gamma_1^s[\Delta\beta_i] + \gamma_2^s[\Delta\beta_i^2]] + (1 - \beta_{ik})[\gamma_1^b[\Delta\beta_i] + \gamma_2^b[\Delta\beta_i^2]] \qquad (A3.3)$$

(2) Direct Effect of Changing Land Distribution (resulting from higher participation rate of small farmers):

$$[\Delta\beta_i][(\gamma^s - \gamma^b) + (\gamma_1^s - \gamma_1^b)\beta_{it} + (\gamma_2^s - \gamma_2^b)\beta_{it}^2 + (\gamma_3^s - \gamma_3^b)q_{it} + (\gamma_4^s - \gamma_4^b)P_{it}^c] \quad (A3.4)$$

(3) Effect of Change in Price of Competing Crop:

$$[\beta_{ik}\gamma_3^s + (1 - \beta_{ik})\gamma_3^b][\Delta P_i^c] \qquad (A3.5)$$

(4) Effect of Change in Irrigation:

$$[\beta_{ik}\gamma_4^s + (1 - \beta_{ik})\gamma_4^b][\Delta I_i] \qquad (A3.6)$$

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 10.

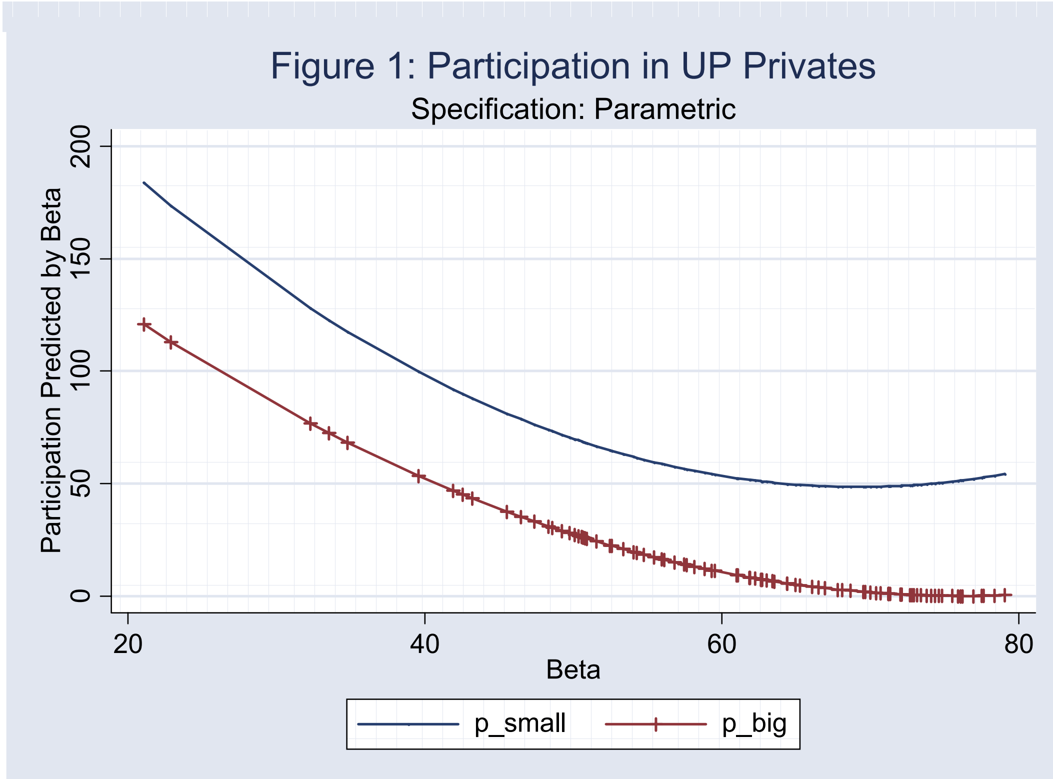
Figure 1: Participation in UP Privates
Specification: Parametric
Participation Predicted by Beta
0
50
100
150
200
20
40
60
80
Beta
p_small
p_big

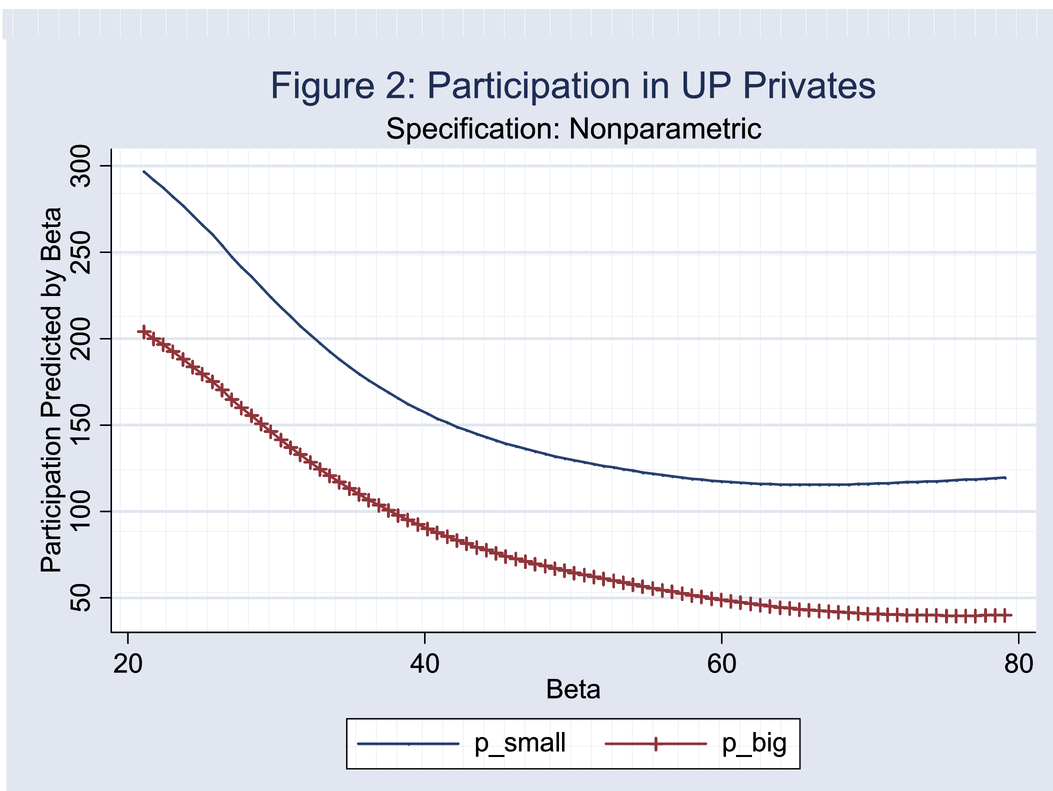
Figure 2: Participation in UP Privates
Specification: Nonparametric
Participation Predicted by Beta
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150
200
250
300
20
40
60
80
Beta
p_small
p_big

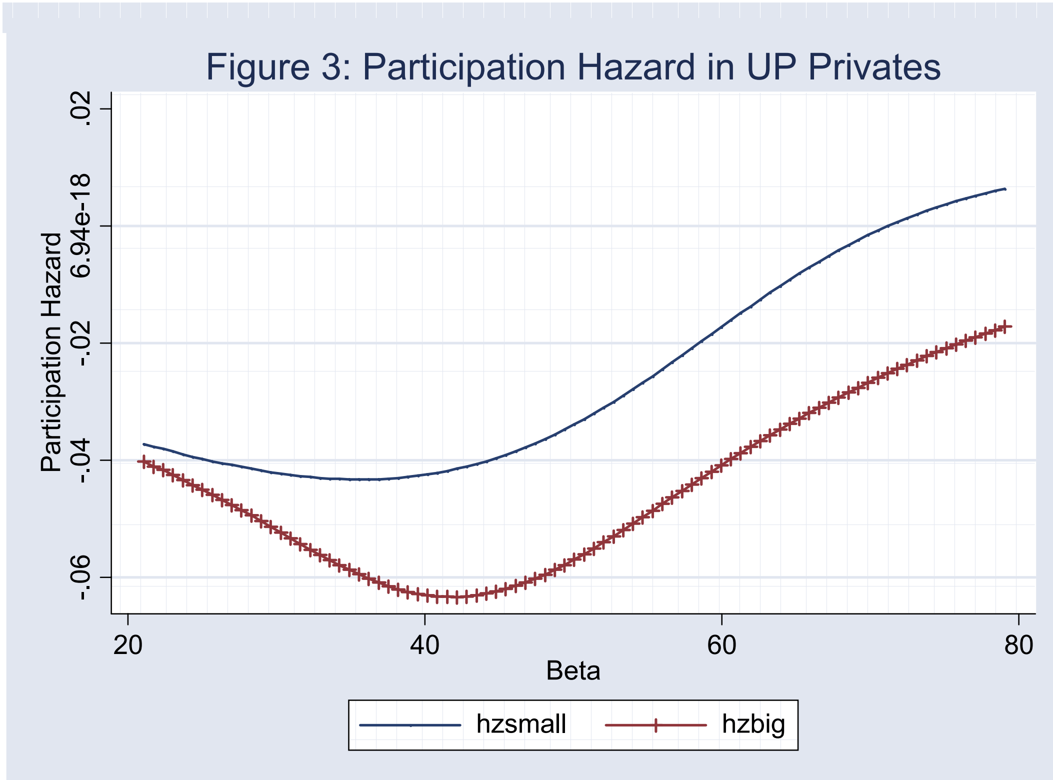
Figure 3: Participation Hazard in UP Privates
Participation Hazard
.02
6.94e-18
-.02
-.04
-.06
20
40
60
80
Beta
hzsmall
hzbig

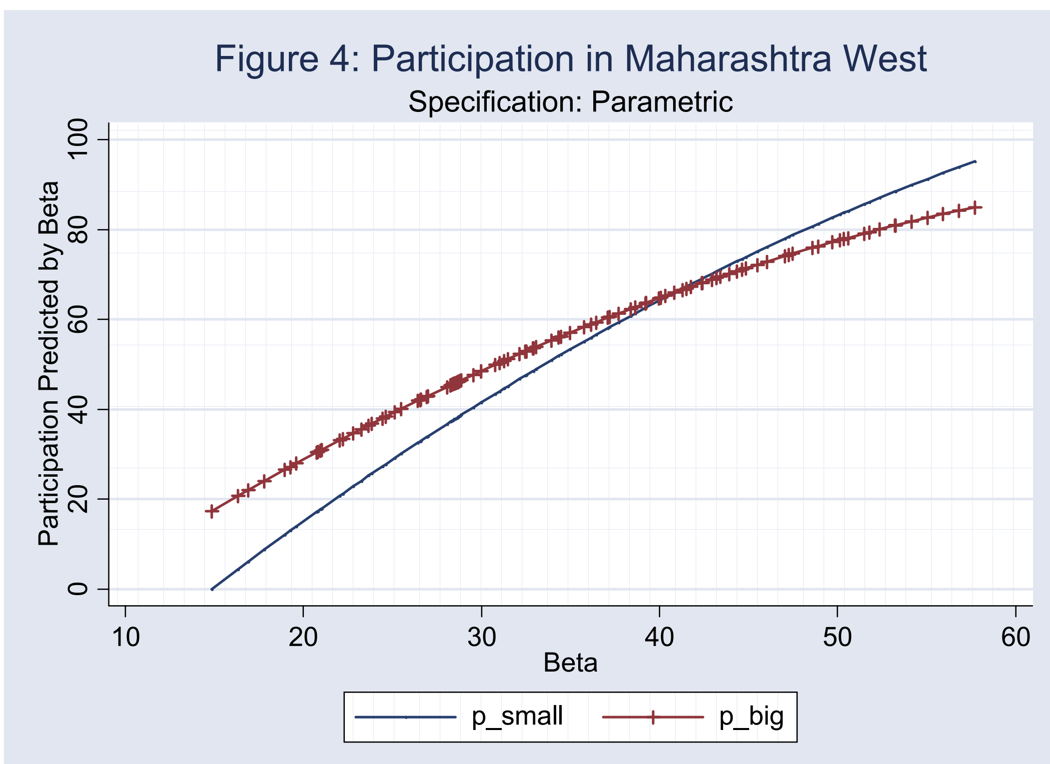
Figure 4: Participation in Maharashtra West
Specification: Parametric
Participation Predicted by Beta
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80
60
40
20
0
10
20
30
40
50
60
Beta
p_small
p_big

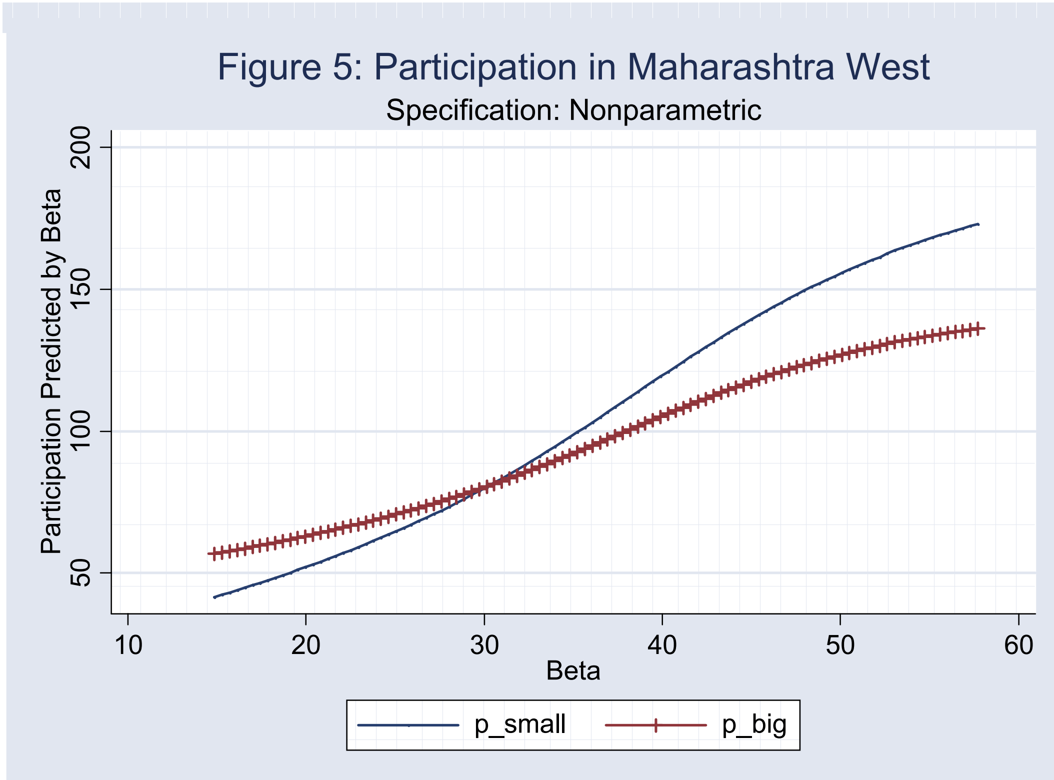
Figure 5: Participation in Maharashtra West
Specification: Nonparametric
Participation Predicted by Beta
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150
200
10
20
30
40
50
60
Beta
p_small
p_big

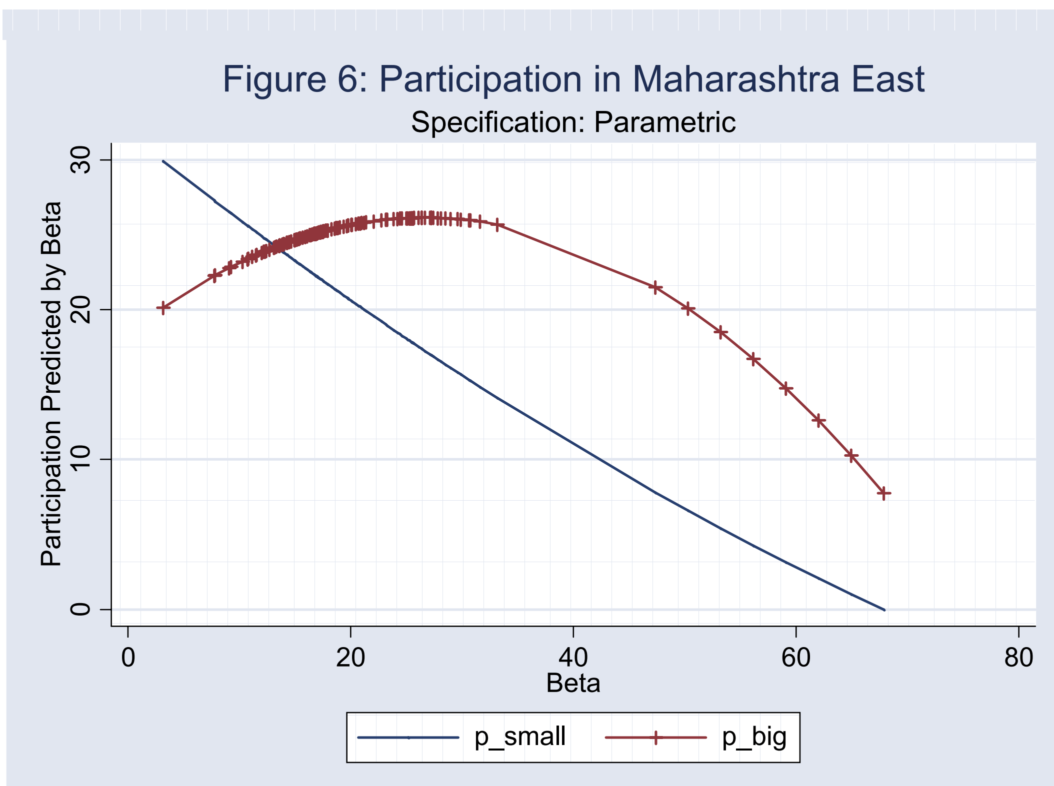
Figure 6: Participation in Maharashtra East
Specification: Parametric
Participation Predicted by Beta
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10
20
30
0
20
40
60
80
Beta
p_small
p_big

Figure 7: Participation in Maharashtra East
Specification: Nonparametric

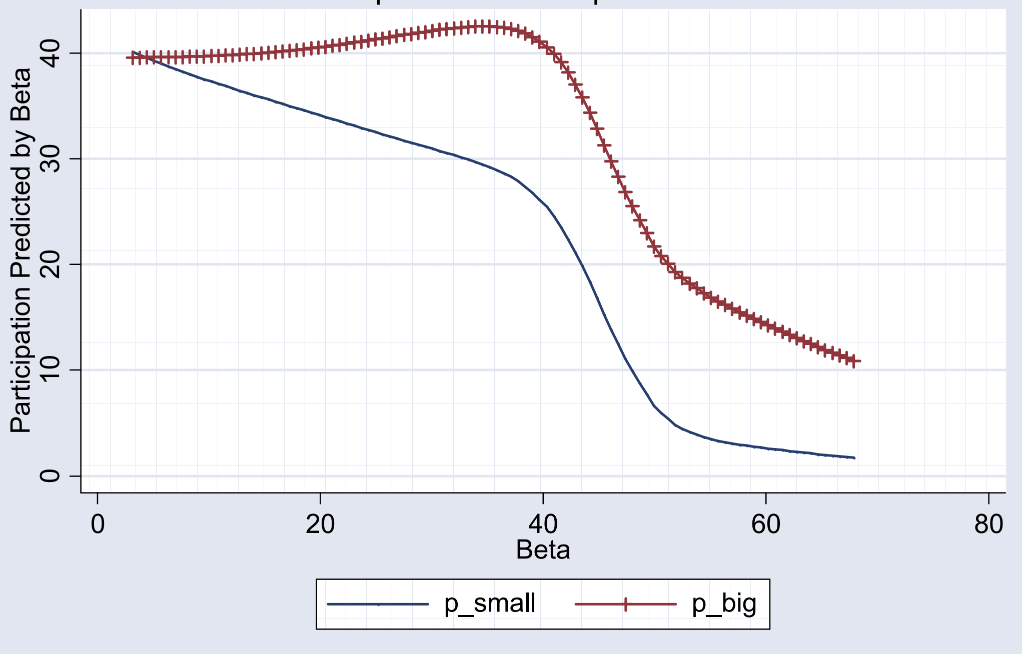


Figure 8: Participation in Maharashtra West--3 Groups
Specification: Nonparametric

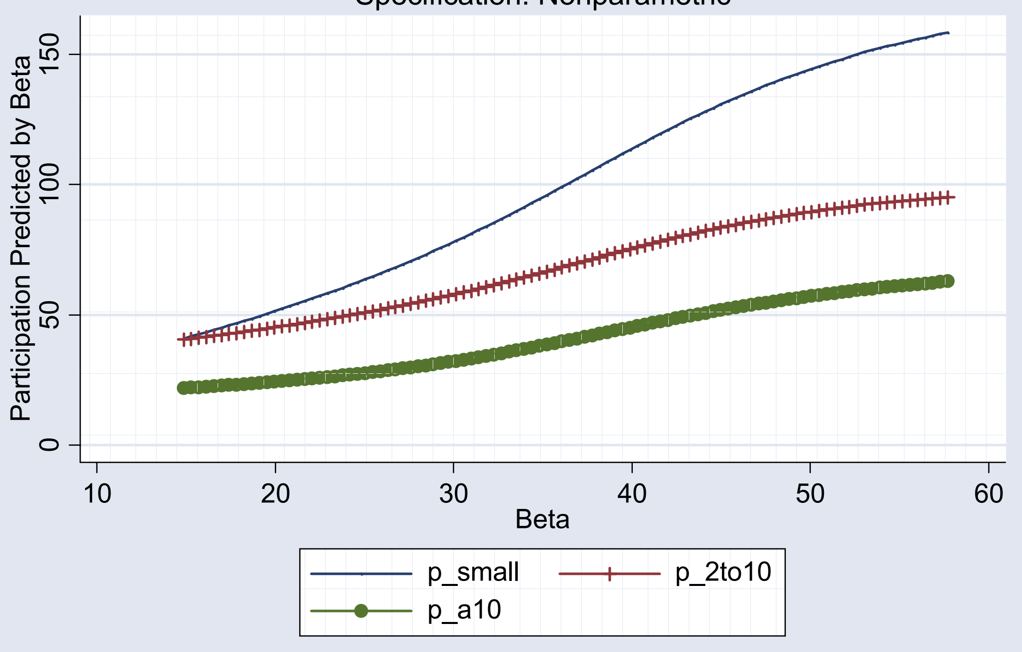


Figure 9: Participation in Maharashtra East--3 Groups

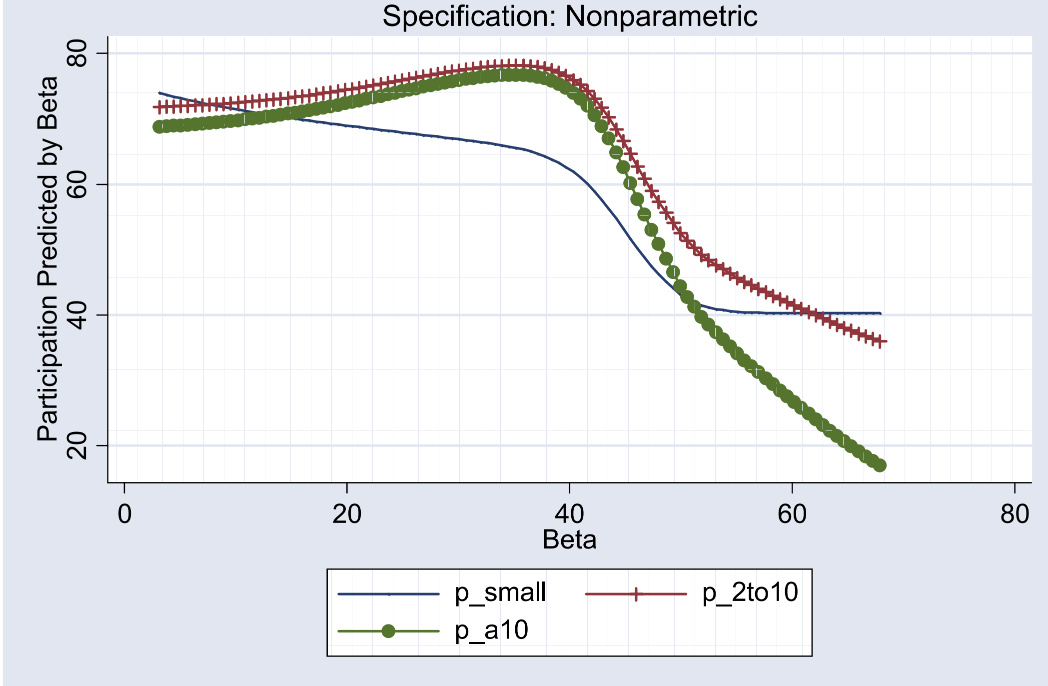
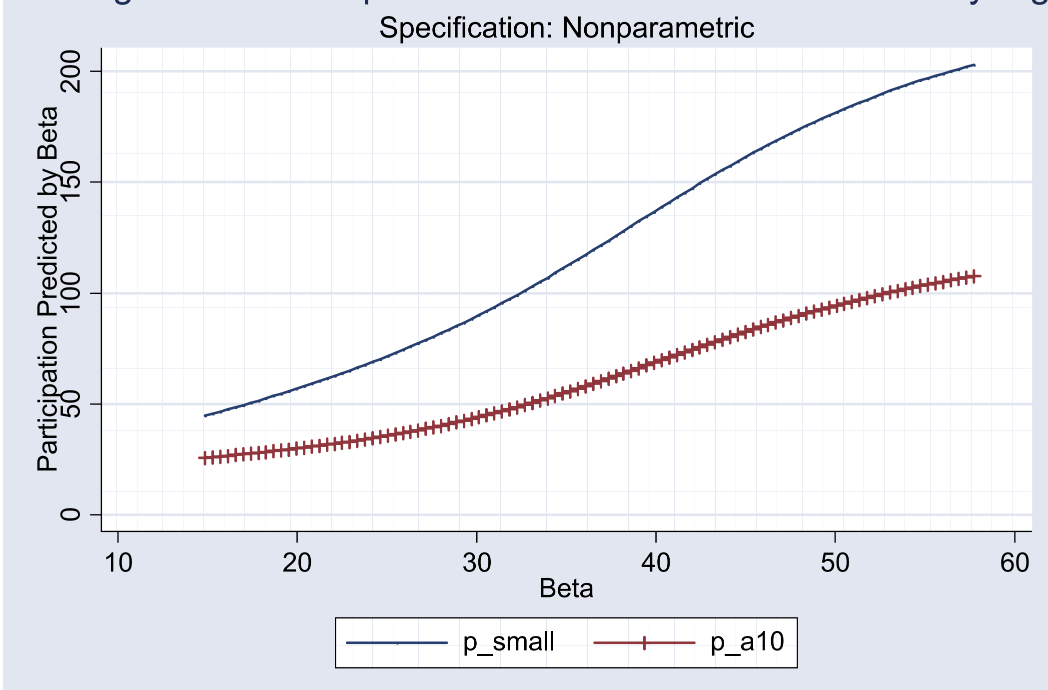


Figure 10: Participation in Maharashtra West With Very Big



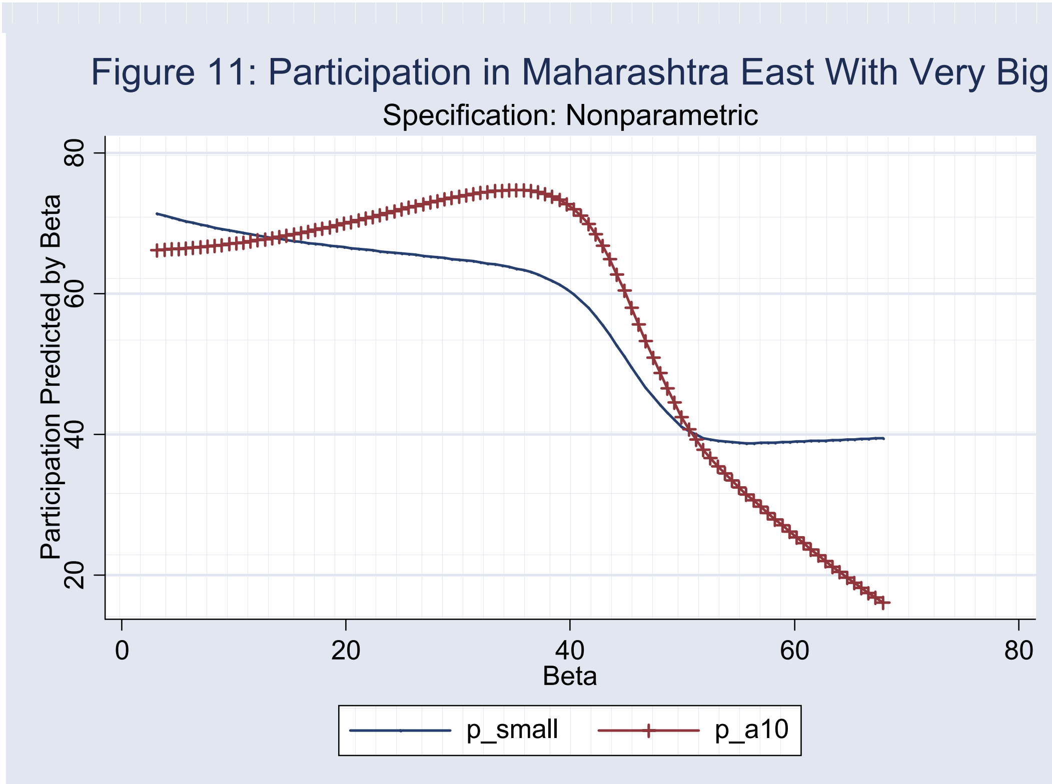


Figure 11: Participation in Maharashtra East With Very Big
Specification: Nonparametric
Participation Predicted by Beta
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40
60
80
0
20
40
60
80
Beta
p_small
p_a10

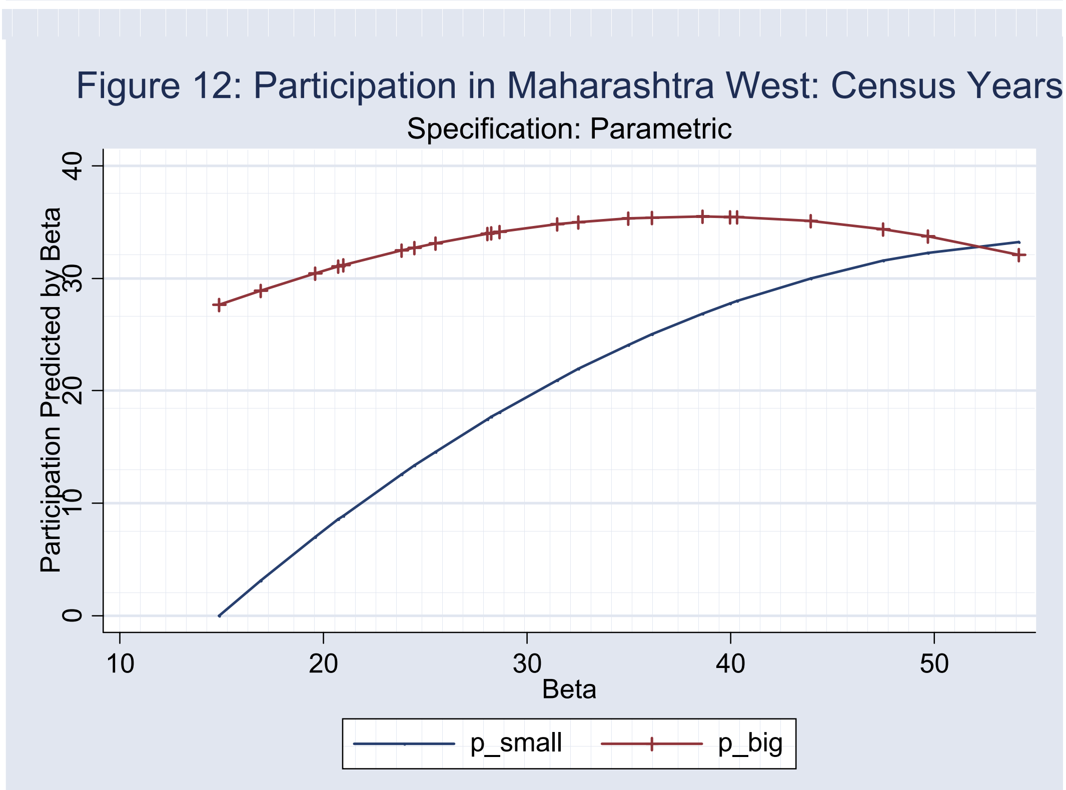
Figure 12: Participation in Maharashtra West: Census Years
Specification: Parametric
Participation Predicted by Beta
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20
30
40
10
20
30
40
50
Beta
p_small
p_big

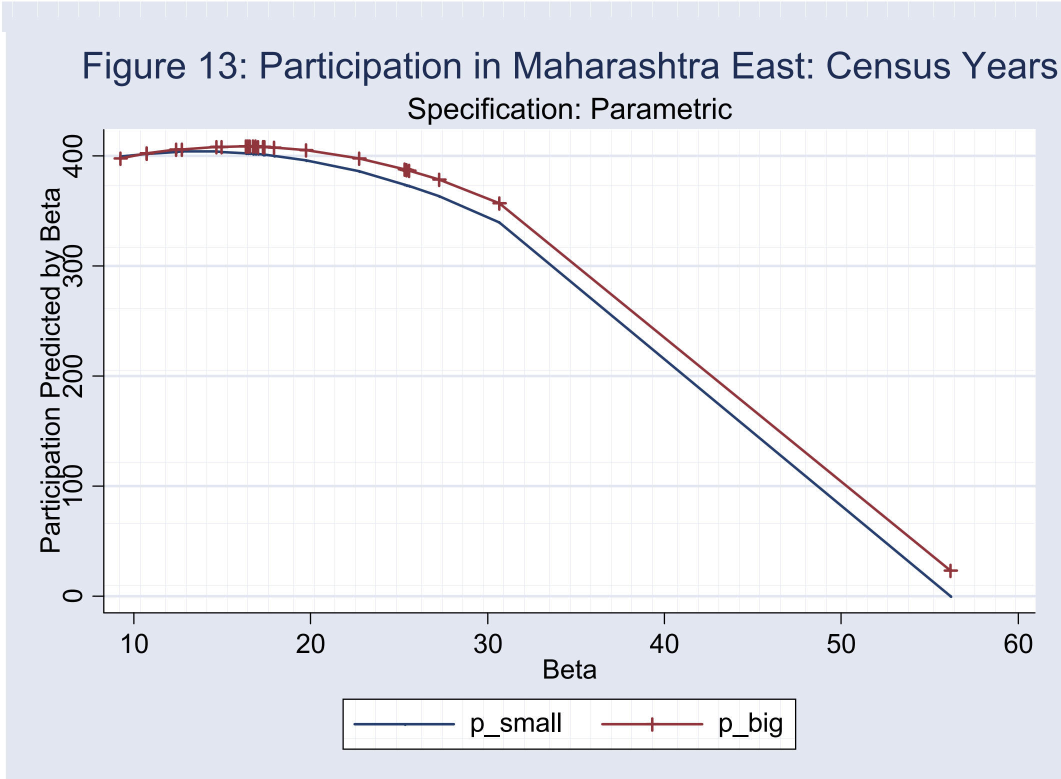
Figure 13: Participation in Maharashtra East: Census Years
Specification: Parametric
Participation Predicted by Beta
0
100
200
300
400
10
20
30
40
50
60
Beta
p_small
p_big