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Taxation by Auction: Fund-Raising by 19th Century Indian Guilds*

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Keywords: Auctions, Fund-Raising, Indian Guilds, Taxation

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1. Introduction

In recent years economists have increasingly come to recognize the capacity of small communities to develop and implement novel mechanisms and complex contracts outside the purview of the state and formal legal systems, to achieve higher levels of co-operation and societal welfare. Typically, such contracts are enforced *via* the threat of collectively administered punishments. Some of the most creative arrangements pertain to credit and mutual insurance (Platteau 1991, Fafchamps 1992). For instance, after studying rural communities in Nigeria, Udry (1994) showed that it has been possible to enforce contracts involving state-contingent repayment of loans. In a different vein Greif (1993) has shown that close community ties can facilitate long-distance trade; he describes how 11th century Maghribi traders in the Mediterranean used the threat of boycott to discourage cheating by their agents, allowing them to trade with distant regions.

This paper documents another unusual institution which serves a purpose quite different from those discussed above: taxation. We analyze a taxation mechanism used by 19th century Indian (in particular, Gujarati) guilds. These guilds were associations of producers/traders in a common line of business in a city (see Section 2). Like any professional association, they needed to raise funds from their members for various operating expenses; in addition, they sometimes donated to charity. To raise the funds in an equitable manner, many guilds employed a mechanism which the Gazetteer of Surat, a prominent Gujarati trading and manufacturing center, described as follows, in 1877:

> A favorite device for raising money is for men of the craft or trade to agree, on a certain day, to shut all their shops but one. The right to keep open this one shop is then put up to auction, and the amount bid is credited to the guild fund.

We call this mechanism "taxation by auction". Under this scheme, a guild in effect taxed each of its members (barring the winner) a day's profits. A crucial aspect of implementation was ensuring that only the winning firm stayed open on the holiday. This was achieved by the guild members agreeing to impose heavy fines, and even expel, offenders (see Section 2). Thus, the

auction mechanism was supported by the guild's collective enforcement capacity.[1]

Auctions are much in the news these days, as they are being used by governments across the world to divest public assets. The "spectrum auctions" in the US are a prime example. Of course, auctions have long been used by governments and private parties to sell (or lease) commodities as varied as foodgrains, forest timber, paintings, and oil tracts. All these auctions have a common feature – an existing physical commodity is sold to the highest bidder. In a different application, auctions have also been used to award "monopoly rights" to firms and individuals. Many governments have auctioned off "trade quotas" and "licenses" to firms to enter new industries.[2] More creatively, Jain temples in South Asia and elsewhere have auctioned off the rights to perform certain religious ceremonies (Banks (1992)). In principle, both kinds of auctions have served the dual purpose of maximizing "seller revenue" and of allocating scarce resources efficiently.

The guild auctions differ from the above types of auctions in two major ways. First, the item being auctioned is a *monopoly right to work.* Note that this monopoly position was *collectively created* in the first place by the guild members who agreed to give up their individual rights to work on a holiday. This is in contrast to other instances of auctioning off monopoly positions, where these positions came into being as a result of the environment and/or the technology.[3] Second, the aim of the guild auctions was not so much to maximize guild funds, but to collect a desired amount of funds *via* an auction scheme rather than through more conventional forms of taxation.

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[1] Another ingenious method for raising funds for a public good, used in the city-states of ancient Greece, is succinctly described by Moore (1992, p. 195) as follows: "Someone nominated the man who was reputed to be the richest. Let us call him Spyros. Spyros would then have to pay up, or claim "I not the richest, old Timon over there is richer than me." Then Timon was faced with a choice. Either he could pay, or he could insist that Spyros exchange all his wealth with him, after which Spyros would have to pay."

[2] McAfee *et al*. (1999) document auctions held by the New Zealand government to allocate quota licenses in the 1980's. The authors note that apart from raising revenues, such auctions had the potential to determine the "value" of such monopoly positions, which could then be used to convert quotas into "correctly priced" tariffs.

[3] In the case of quotas and licenses, independent economic arguments determined the creation of a monopoly position. In the case of the temples, it was the religious precepts that decreed that a single individual would perform a ceremony. In both cases, an auction was then considered the appropriate way to "sell" the privilege.

In this paper, we present a formal model of a guild consisting of heterogeneous firms. We compare the auction mechanism to conventional forms of taxation and show that under certain conditions, not only will a majority of the guild members prefer to be taxed *via* the auction, this form of taxation will also be more "equitable" than others.

The rest of the paper is organized as follows. In Section 2, we discuss the Indian guild in its historical context, and document the "taxation by auction" arrangement. We present a formal model of a guild's alternative fund-raising mechanisms in Section 3. In Section 4, we compare the "auction tax" to conventional taxation (specifically, to a tax on sales revenue), and establish our central results. We discuss the implications of our analysis in Section 5, and conclude.

2. Fund-Raising by Indian Guilds, c. 1890

The western Indian region of Gujarat has long been a major center of manufacturing and trading. Guilds were active in this region until at least the early twentieth century. In each city, each occupation had its own guild. There would be a grain-dealers' guild, a potters' guild, a tobacco-sellers' guild, a sweet-makers' guild, and so on. In addition, a city-wide organization of merchants' guilds, known as the *Mahajan*, provided important administrative and dispute-resolution functions.

Like guilds elsewhere, Gujarati guilds exercised a great deal of power over their members.[4] They regulated working hours, set prices, and controlled entry. Violation of guild rules led to severe fines, and in extreme cases, devastating social ostracism, which was imposed in collaboration with other guilds. Hopkins (1902, p.195) writes: "If a confectioner should sell his sugar-cakes at less than the permitted rate, the guild that supplied him with sugar would cease to do so; if the tile-maker should work for less wage, the guild supplying him material would boycott him, etc.."

[4] For an overview of European guilds in the Middle Ages, see Thrupp (1965). For a recent interpretation of the merchant guild as a mechanism that allowed rulers to commit to the security of merchants, see Greif *et al*. (1994).

Decision-making in a guild was to a large extent collective, and there is some evidence of majority voting. Discussing guilds in the city of Ahmedabad, the Imperial Gazetteer of India (vol. V, p.101; cited in Coomaraswamy, 1909, p.8) writes: "Each of the different castes of traders, manufacturers, and artisans forms its own trade-guild, to which all heads of households belong. Each member has the right to vote, and decisions are passed by a majority." Furthermore, it is clear that the guilds desired to maintain equity. In the interest of equity, many guilds fixed not only prices, but also the quantities that could be sold, and working hours (see footnote 7). Indeed, some British officials accused the Gujarati guilds of "communism."

Like any professional association, the guilds sought to raise funds from their members for internal use, such as (say) organizing dinners for guild members. In addition, the richer guilds collected funds to provide various community-wide public goods and services. Guild funds were used for charitable donations to religious institutions, and for public institutions like animal hospitals. Businessmen of the Jain faith continue to support animal hospitals, known as *pinjrapole*, to this day.

To raise funds from their members, the guilds used some conventional methods such as entry fees and taxes. Besides these, many observers noted the widespread use of the "taxation by auction" mechanism described earlier. Apart from the Gazetteer of Surat (1877), the use of such auctions by Gujarati guilds is also documented by the Gazetteers of Broach (1877) and Ahmedabad (1879), and by Desai (1932). An important source for this paper is Hopkins (1902), who, in 1896, conducted an "informal conference" with the heads of merchant and artisan guilds in Ahmedabad, Gujarat's most prominent manufacturing center. Hopkins (p.190) describes the auctioning of the right to stay open on a holiday as a "prime source" of revenue for "most guilds." Similar auctions were also used by guilds in parts of South India, including the city of Madura (Mukerjee 1923, p. 287; 1922, p. 182).

The success of the auction scheme depended on a guild being able to ensure that the winning firm alone stayed open on a holiday. Often, shops of guild members were in close proximity, sometimes even on the same street (Haynes 1991, p.69). So it was easy for a guild to observe which

shops were open. Given that, the fear of punishment ensured that the holiday was observed by all except the winning firm. Hopkins (1902, p.190) describes the treatment of firms which stayed open in violation of a guild's dictates: "The fine is heavy…; and if the offence is repeated the delinquent is sometimes expelled rather summarily."

It should be clear from the above description that the auction scheme was a form of taxation, where every firm was taxed a day's profit (except for the winning firm, which got to keep some "information rents") in order to raise money for the guild as a whole. The rationale for this arrangement must therefore be sought by comparing it with other methods of taxation. This is what we do in the following analysis. Specifically, recognizing the guilds' proclivity towards collective decision making and their concern for equity, we address the following questions in a formal model: Given that a guild wants to raise a certain sum of funds, when is it the case that a majority of the guild members will prefer the use of the auction scheme as opposed to any other tax scheme? When will the auction scheme be more equitable than other kinds of taxes?

We start with the following premise: To raise a specific amount of funds, a guild would consider an appropriate proportional profit tax to be the "ideal" equitable way to tax its heterogeneous members. However, we recognize that every guild probably faced the following information constraint – it could not perfectly observe the realized profits of its members. Even if sales could be observed, the actual costs incurred by a firm within a specific time interval were likely to have been private information (especially given that "family labor" was an important input, whose opportunity cost at any point in time could hardly be commonly known). Then, a tax on sales revenue would have been more feasible than a proportional profit tax. In our formal analysis, we focus primarily on the comparison between the auction scheme and revenue taxation.[5]

[5] Many Indian guilds *did* use conventional taxes like sales and input taxes to raise funds. Mukerjee (1922, p.182) reports on the custom of *mahimai* among guilds in Madura, where the guilds levied "fees on the quantity of merchandise purchased and sold"; he also mentions (p. 184) the use of a tax on "sale proceeds" by the *Sourashtra Sabha*, a community association in Madura, which contained members of various textile-related occupations.

At the outset, recognize that these two forms of taxation will be *equivalent* when both the following conditions hold: (*a*) all firms in a guild are completely *identical* in terms of costs incurred and revenues generated, and (*b*) the aggregate profits generated by the guild members over any time interval is *independent* of the actual number of firms in operation. If these conditions hold, then it is easy to see that if, for example, profits are half the sales revenue for each firm, a ten percent tax on the yearly sales revenue of each firm will generate the same collection for the guild as when it employs the auction scheme for one-fifth of the days in a year.[6]

However, the above conditions are very stringent. It is natural to expect that there was "some" heterogeneity among guild members. Further, there is no reason to expect that on any given day, if only one firm operated, it could serve the entire market and generate the same amount of profits as when all guild members operated simultaneously. Therefore, in our formal analysis, we study the efficacy of "taxation by auction" when there is heterogeneity among guild members, and when aggregate profits depend on the number of operating firms.

3. Fund-Raising Mechanisms: A Formal Model

Consider a guild of N (≥ 2) firms. These firms can operate at each instant in a time interval [0, 1]. For any firm i, its instantaneous cost function is $C_i(q) = \theta_i.q^{\gamma}$, where θ_i is an efficiency parameter privately known by firm i, and γ (≥ 1) is a commonly known returns-to-scale parameter. It is common knowledge that $\{\theta_1, \ldots, \theta_N\}$ are independently and identically drawn from a *symmetric* distribution function $F(.)$ on an interval $[\theta^-, \theta^+]$, with $\theta^- > 0$. We let $E\theta$ denote the mean of each θ_i.

The instantaneous market demand is given by $Q(P)$. The price that any firm can charge at

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Hopkins (1902, pp. 190-191) describes the use of conventional taxes by Gujarati guilds: a confectioner might be taxed on his purchase of milk, and for each cart of grain brought into the city a few handfuls may be taken as tax. The coexistence of the auction and such conventional taxes makes our exercise of comparing these different forms of taxation all the more relevant.

[6] To see this, suppose that the total revenue generated on each day is S. Then the guild will collect $36.5S$ under the revenue tax. This amount can be raised by holding an auction for 73 "holidays", since on each holiday, a particular

any instant is fixed by the guild at P_0, and we normalize the corresponding demand, $Q(P_0)$, to be unity. When multiple firms charge P_0, they share the market equally.[7] We assume that P_0 is large enough so that at any instant, each firm is willing to meet its demand, no matter what its efficiency parameter is and no matter how many other firms are operating concurrently.[8] Then, if m firms (with $1 \leq m \leq N$) operate at any instant, the instantaneous profit of any firm i is $\pi(\theta_i \mid m) \equiv P_0/m - \theta_i(1/m)^\gamma$. This is also firm i's aggregate profit if the m firms operate for the entire time interval.

Let R be the amount that the guild wants to collect (in expected terms). In its fund-raising effort, the guild faces the information problem that it cannot observe the realized efficiency parameters of the N firms. Recognize that if it could indeed observe (and verify) θ_i for every firm i, the guild could require each firm to donate x^* fraction of its realized profits, where

$$x^* = R / N\pi(E\theta \mid N). \quad (1)$$[9]

Then each firm i would pay $x^*\pi(\theta_i \mid N)$, and the guild would collect R (in expectation). As stated before, we consider this to be the ideal equitable mechanism. Using this as a benchmark, we study alternative fund-raising schemes that the guild can implement, given its information constraints.

At this point, three comments about our model are in order. First, as discussed in Section 2, we have modeled a guild consisting of heterogeneous members, where the precise differences across

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firm will win the auction by paying $S/2$ (since the winning firm will generate this amount as profits). Note that the contributions made by each firm will also be identical under the two schemes.

[7] Hopkins (1902, pp.194-195) reports that the craft guilds routinely fixed prices, as did the grain guilds. There is also evidence that the craft guilds tried to allocate the demand among different members. Hopkins (1902, p.197) writes: "…The rates of sale and amount of marketable material which can be made by each artisan are always settled in advance by the respective guilds." According to the Ahmedabad Gazetteer (1879, p. 110) "… at the opening of the season the aldermen of the city tile-makers prescribe exactly how many thousand tiles each member may make, and the minimum rate at which he may sell them." One way to think of the price P_0 is to suppose that it is a "collusive" price that maximizes the *ex ante* expected joint profits of the guild members: $P \cdot Q(P) - N \cdot E\theta \cdot [Q(P)/N]^\gamma$.

[8] When there are no taxes, the condition is satisfied for $P_0 \geq \gamma\theta^+$. We assume that P_0 is bigger than this threshold so that the condition is satisfied even when there are "small" taxes imposed by the guild.

[9] We take R to be small in relation to firm profits; specifically, we assume that R is less than the profits to the highest-cost firm ($\pi(\theta^+ \mid N)$). This ensures that x^*, and the "auction tax" rate t^* defined in (2), are between 0 and 1.

them are not commonly known. The posited cost asymmetry among firms captures this. However, while θ_i affects firm *i*'s costs (and thus profits) in a specific way in our model, it can be thought of more generally as any privately observed variable that affects firm payoff within the time interval. Second, our aim has been to model a scenario where a single firm cannot generate the same profits that many firms operating concurrently can. One obvious reason for this is diseconomies of scale in production. In addition, other factors like consumer transportation costs, product differentiation, and client loyalty will also imply that a single firm can serve only a part of the market. For the sake of brevity, we have summarized these factors in a single returns-to-scale parameter γ.

Finally, our "single time period model" can be extended to study a dynamic environment where the firms are in business over a sequence of time periods $\{\tau_1, \tau_2, \dots\}$ (e.g., calendar years), where the guild wants to collect *R* in each period. In that scenario, we can think of firms having "permanent" cost differences, as well as period-specific shocks to their costs. While we do not formally analyze this extended model, we subsequently discuss (see Section 4) how our results shed light on this dynamic environment.

We now analyze, in turn, the auction tax and conventional tax schemes. In each case we identify the amount of tax paid by firm i, and the extent to which this deviates from what it would have paid under an equitable allocation (in which each firm each paid the same share of profits). These results then facilitate the comparison of the auction tax and conventional tax schemes, in the following section.

Taxation by Auction

We model the auction scheme as follows: Given the time interval [0,1], the guild declares a sub-interval *t* ($0 < t < 1$) to be a "holiday", and decrees that *one* firm will have to acquire the right to operate during this period by winning an auction (with the proceeds from the auction going to the

guild fund).[10] We study this scheme under the assumption that it is an open ascending auction with zero reserve price.[11] We also assume that the winning firm is required to charge the price P_0 for the time interval t.[12]

For a given t, the value of winning the auction to any firm i is $t\pi(\theta_i|\ 1)$. Given $\{\theta_1, \ldots, \theta_N\}$, let $\theta^{(k)}$ denote the k'th order statistic (i.e., the k'th lowest draw). Standard results in auction theory (see McAfee and McMillan (1987)) tell us that the most efficient firm with $\theta = \theta^{(1)}$ will win the auction paying $t\pi(\theta^{(2)}|\ 1)$, which is the value of winning to the second-most efficient firm. The guild's expected collection will thus be $tE^{(2)}[\pi(\theta^{(2)}|\ 1)]$, where $E^{(2)}[\cdot]$ is the expectation operator with respect to the distribution of $\theta^{(2)}$. So, to collect R, the guild will set the duration of the holiday at

$$t^* = R / E^{(2)}[\pi(\theta^{(2)}|\ 1)]. \tag{2}$$

The auction mechanism involves implicit taxation. *Ex post*, the most efficient firm pays a tax of $\{t^*\pi(\theta^{(1)}|\ N) - t^*[\theta^{(2)} - \theta^{(1)}]\}$, while all other firms j pay $t^*\pi(\theta_j|\ N)$. Evaluated at the "interim stage" (i.e., when each firm knows its "type" θ), the expected tax for firm i, denoted by $\rho^{AUC}(\theta_i)$, is

$$\rho^{AUC}(\theta_i) = t^*[\pi(\theta_i|\ N) - \beta(\theta_i)], \text{ where } \beta(\theta_i) = Prob[\theta_i = \theta^{(1)}]\{E^{(2)}[\theta^{(2)}|\ \theta^{(1)} = \theta_i] - \theta_i\}. \tag{3}$$

Thus the auction scheme involves a proportional tax t^* on the realized profits of firm i less a "tax credit" $t^*\beta(\theta_i)$. $\beta(\theta_i)$ is the expected information rent to firm i from participating in the auction, i.e.,

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[10] In a dynamic scenario where there are successive periods, it will be appropriate to suppose that the guild declares a fraction of time t in each period (e.g., t days in a year) to be a holiday, and at the beginning of each period, auctions off the right to remain open on the holiday to a single firm.

[11] We have found no evidence suggesting the use of reserve prices. Given that, note that many different forms of auction will yield the same expected contribution (by the Revenue Equivalence Theorem).

[12] We consider this a plausible assumption for two reasons. First, for many commodities raising the price would merely lead to consumers postponing their purchases. Second, the guild was accountable to the community for the price of its product. A price increase that was perceived as unfair would be resented and resisted. Indeed, even the guild as whole could not always arbitrarily increase its price. The Ahmedabad Gazetteer (1879, p.109) documents an instance in which the potters' guild in Ahmedabad was forced to rescind a price increase under pressure from the

the probability that firm *i* wins times its winning payoff. The expected information rent is positive for all firms with $\theta < \theta^+$, it is strictly decreasing in θ, and is arbitrarily small for high values of θ for large N.[13]

Compared to a hypothetical situation where all firms are taxed t^* fraction of their profits, the auction tax involves "higher-than-average cost firms" (i.e., firms with $\theta > E\theta$) "cross-subsidizing" low-cost firms.[14] For any firm i with $\theta_i > E\theta$, we measure the extent of this cross-subsidy by:

$$\sigma^{AUC}(\theta_i) = t^*\{\beta(E\theta) - \beta(\theta_i)\}, \tag{4}$$

which is the difference in tax credit received by the "average-cost firm" (with $\theta = E\theta$) and firm *i*.

Conventional Tax Schemes

We have noted earlier that some Indian guilds did use sales and input taxes to raise funds (see footnote 5). We now formalize these conventional tax schemes. Given that the guild knows each firm's instantaneous sales revenues, consider a scheme where the guild allows all N firms to operate over the time interval [0,1], and taxes R/P_0 fraction of each firm's revenues. Under this "revenue tax scheme", each firm makes a lump-sum contribution of R/N, and the total collection is R. [15] As compared to the ideal proportional profit tax described at the beginning of this section, the revenue tax involves high-cost firms cross-subsidizing low-cost firms. To see this, note (from the definition of x^*) that the contribution made by firm *i* under the revenue tax scheme, denoted by $\rho^{REV}(\theta_i)$, can be written as:

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merchants' guilds. Having said that, we note that our results will hold with greater force in the case where the winning firm is free to set a monopoly price; see footnote 19.

[13] Note that $Prob[\theta = \theta^{(1)}] = [1 - F(\theta)]^{N-1}$. Further, from the theory of order statistics, $E^{(2)}[\theta^{(2)} | \theta^{(1)} = \theta] = \{(N-1)/[1 - F(\theta)]^{N-1}\} \cdot \int_\theta^{\theta^+} y[1 - F(y)]^{N-2} f(y) dy$. Thus, $\beta(\theta) = (N-1)\int_\theta^{\theta^+} y[1 - F(x)]^{N-2} f(y) dy - \theta[1 - F(\theta)]^{N-1}$. It follows that $\beta(\theta) > 0$ for all $\theta < \theta^+$ with $\beta(\theta^+) = 0$, and that $\beta(\theta)$ is a strictly decreasing and a strictly convex function.

(5) $$\rho^{REV}(\theta_i) = x^*[\pi(\theta_i|\, N) - \alpha(\theta_i)], \text{ where } \alpha(\theta_i) = (E\theta - \theta_i)(1/N)^{\gamma}.$$

Under the revenue tax scheme, each firm i is taxed x^* fraction of its realized profits less a tax credit $x^*\alpha(\theta_i)$. The tax credit which is decreasing in θ, is positive for $\theta < E\theta$, and negative for $\theta > E\theta$. For any higher-than-average cost firm i, we define:

(6) $$\sigma^{REV}(\theta_i) = x^*\{\alpha(E\theta) - \alpha(\theta_i)\} = -x^*\alpha(\theta_i).$$

This difference in the tax credit received by the average-cost firm (which is zero by construction) and firm i is a measure of the cross-subsidy that firm i provides under revenue taxation.

Next, suppose that the guild can observe the purchases of a *subset* of a firm's inputs (e.g., inputs bought from another guild with which it has a long-term relationship), and levies a common unit tax on these inputs. It is easy to see that if high cost firms use greater quantities of the inputs to produce the same output, the "input tax scheme" will be more inequitable than revenue taxation in that the high-cost firms will be cross-subsidizing the low-cost firms to an even greater extent.[16] Given that, in what follows, we compare the auction scheme to a revenue tax scheme.

4. Taxation by Auction *vs.* Revenue Taxation

In this section, we compare the "taxation by auction" mechanism to revenue taxation with respect to "majority preference" (i.e., when a majority of firms will prefer one scheme over the other), and "equity" (i.e., the extent of cross-subsidy provided by high-cost firms under each scheme).

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[14] As will be made clear subsequently, we will compare the "equity properties" of one tax scheme *vis-a-vis* another by comparing the extent of cross-subsidies provided by the higher-than-average cost firms in the two schemes.

[15] Note that a "unit tax on output" that collects R in the aggregate will be identical to the revenue tax.

[16] To see this most clearly, consider the hypothetical case where the guild can observe *all* the inputs used by a firm, but not its sales revenue. Suppose that it imposes a common unit tax $z^* = R/\,(E\theta)(1/N)^{\gamma-1}$ on all inputs. Then each firm i pays $z^*C_i(1/N) = (R/N).(\theta_i/E\theta)$, as opposed to R/N under revenue taxation, and the expected collection is R.

Majority Preference

In our single time period model, we study the issue of majority preference both *before* each firm learns about its efficiency parameter – the "*ex ante* stage", and after it does so – the "interim stage". We then discuss how this analysis clarifies choices in a dynamic environment.

The difference in firm *i*'s (expected) payments under revenue taxation and the auction is:

$$(7) \qquad \Delta(\theta_i) \equiv \rho^{REV}(\theta_i) - \rho^{AUC}(\theta_i) = (x^* - t^*)\pi(\theta_i | N) - x^*\alpha(\theta_i) + t^*\beta(\theta_i).$$

$\Delta(\theta_i)$ is also the difference in firm *i*'s "expected residual profits" under the auction and revenue taxation. At the interim stage, firm *i* will prefer the former over the latter if and only if $\Delta(\theta_i)$ is positive. *Ex ante*, all firms will have the same preference over the two schemes, and will prefer the auction if and only if the unconditional expectation of $\Delta(\theta)$ is positive.

An important factor in determining the sign of $\Delta(\theta)$, and its expected value, is the relative magnitudes of the two "tax rates", x^* and t^*. In comparing these two rates, the basic issue to consider is the following: Given the fixed price P_0, are the aggregate industry profits bigger when one firm is operating (as in the case of an auction) or when all N firms operate (as in the case of a revenue tax)? That is, does the auction have an "efficiency effect"?[17] Note that if all firms had the same costs, the answer would be negative under decreasing returns to scale ($\gamma > 1$). However, when firms are heterogeneous, and it is a question of letting one low-cost firm operate *vs.* letting all N firms operate, the answer depends on the relative magnitudes of the returns-to-scale parameter γ and the relative efficiency of the low-cost firms. Note that $(x^* - t^*)$ has the same sign as the difference in the two profit levels $E^{(2)}[\pi(\theta^{(2)}| 1)]$ and $N\pi(E\theta|N)$. We assume that $N >> 3$ so that that $E^{(2)}[\theta^{(2)}] < E\theta$. Then, given the extent of cost asymmetry among firms, there exists a critical value of the

[17] In the Industrial Organization literature, the "efficiency effect" refers to the fact that when firms are strategic competitors, the aggregate industry profits are decreasing in the number of operating firms.

returns-to-scale parameter γ^* (> 1), defined by (8), for which the two profit levels are equal:

(8) $$(1/N)^{\gamma^*} = E^{(2)}[\theta^{(2)}]/N.E\theta.$$[18]

The difference ($x^* - t^*$) falls as γ increases, and is zero at $\gamma = \gamma^*$. The auction has a positive efficiency effect if and only if $\gamma < \gamma^*$.

We are now in a position to make the *ex ante* comparison between the two schemes. From (7), note that $E[\Delta(\theta)] = (x^* - t^*)\pi(E\theta|\, N) + t^*E[\beta(\theta)]$ (since $E[\alpha(\theta)] = \alpha(E\theta) = 0$). While the first term is positive if and only if the auction has a positive efficiency effect, the second term is always positive since the expected information rents for any firm from participating in the auction is positive. Defining γ^{ANT} to be that value of γ for which $E[\Delta(\theta)] = 0$, we have the following result:

PROPOSITION 1. There exists $\gamma^{ANT} > \gamma^*$ such that *ex ante,* all guild members strictly prefer the auction to revenue taxation if and only if the returns-to-scale parameter γ is smaller than γ^{ANT}.[19]

Recognize that $E[\Delta(\theta)]$ is the expected net surplus generated by the auction relative to revenue taxation, this surplus arising due to the efficiency effect and the information rents effect. Proposition 1 asserts that the firms' *ex ante* choices depend only on whether this surplus is positive or not.[20] Thus, the auction is "*ex ante* Pareto superior" to revenue taxation if and only if $\gamma < \gamma^{ANT}$.

In contrast to the *ex ante* choice where all firms have the same preferences, there can be a

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[18] γ^* depends on N; how γ^* changes as N increases is not *a priori* clear since $E^{(2)}[\theta^{(2)}]$ falls when N increases.

[19] We emphasize two points. First, recall that γ is "summary parameter" which stands for all factors that prevent a single firm from generating the same amount of aggregate profits as the N firms. That should be kept in mind while interpreting this and subsequent propositions. Second, suppose that in contrast to our assumption, the auction winner is free to charge a monopoly price $P_m > P_0$ during the holiday. Then the efficiency effect will be bigger for every value of γ. This will make the auction more attractive to firms, both *ex ante* and at the interim stage.

[20] The surplus is positive if and only if $t^*/x^* < \pi(E\theta|\, N)/\{\pi(E\theta|\, N) - E[\beta(\theta)]\}$, where the RHS is greater than one. The information rents arise due to the auctioneer's inability to extract the winning firm's full surplus. If an auction could be so designed where a firm had to pay its own value, the guild would collect $E^{(1)}[\pi(\theta^{(1)}|\, 1)]$. Then the guild would set the auction tax rate at $t' = R/E^{(1)}[\pi(\theta^{(1)}|\, 1)]$. In that case, the surplus would arise exclusively due to the efficiency effect, and the firms would *ex ante* prefer the auction if and only if this effect was positive.

conflict in the "interim choices" of firms with different efficiency levels. For a firm that knows its "type" θ, three effects operate in determining its interim preference. First, since every firm expects information rents from the auction, all firms prefer it *ceteris paribus*. This is the last term in the RHS of (7). Second, as the revenue tax involves cross-subsidization by high-cost firms, that, *ceteris paribus*, makes low-cost firms prefer revenue taxation and high-cost firms the auction. This is the middle term in the RHS of (7). Finally, any firm *i* will have an additional reason to prefer the auction if it has a positive efficiency effect, in which case the first term in the RHS of (7) is positive.

Recognize that when the efficiency effect is zero, all higher-than-average cost firms will strictly prefer the auction, both for the information rents effect and the cross-subsidization effect. So, when $\gamma = \gamma^*$, there exists (by continuity) a cut-off efficiency level $\theta^0 < E\theta$, such that firms with types $\theta > \theta^0$ will prefer the auction. See Figure 1. However, a subset of firms with low θ might in fact prefer revenue taxation to the auction.[21] While these firms are certainly more likely to win the auction, they will be heavily cross-subsidized under the revenue tax and that is why they might prefer it. The set of such firms will be smaller (resp., larger) for lower (resp., higher) values of γ. Define γ^{INT} to be that value of γ for which the measure of the set of θ (under F) for whom $\Delta(\theta) > 0$ is half. The above arguments, and the fact that F is symmetric, imply that $\gamma^{INT} > \gamma^*$. We thus have:

PROPOSITION 2. There exists $\gamma^{INT} > \gamma^*$ such that in the interim stage, a "majority of the firm types" (all higher-than-average cost firms, and some low-cost firms) will prefer the auction to revenue taxation if and only if the returns-to-scale parameter γ is smaller than γ^{INT}.[22]

$\Delta(\theta)$ is the net surplus generated by the auction relative to revenue taxation for a *particular*

[21] It can be shown that $\Delta(\cdot)$ is a strictly convex function, with $\Delta'(\theta^-) < 0$ and $\Delta'(\theta^+) > 0$. These properties of $\Delta(\cdot)$ are depicted in Figure 1, where, when $\gamma = \gamma^*$, $\Delta(\theta) < 0$ for $\theta \in (\theta', \theta^0)$ and $\Delta(\theta) > 0$ for all other values of θ.

[22] Of course, for a *finite N*, this does not necessarily mean that once the θ's are realized, there will *ex post* be a majority of firms who prefer the auction when $\gamma < \gamma^{INT}$. However, this event is more likely than its complement. If we had considered a guild with a *continuum* of firms (which is certainly unrealistic), then by the law of large numbers, we could assert that *ex post* a majority of the firms would indeed prefer the auction when $\gamma < \gamma^{INT}$.

firm of type θ. Proposition 2 states that when $\gamma < \gamma^{INT}$, this surplus is positive for a majority of the firm types. A natural question is how this condition relates to the condition under which the expected net surplus generated by the auction is positive. Note that when the expected net surplus is zero ($\gamma = \gamma^{ANT}$), the "median" (i.e., the average-cost) firm will prefer revenue taxation to auction; however, that does not mean that a majority of firms types will do so, since preferences *are not* "single peaked" in the type space in the current model (see Figure 1).[23] Consequently, no general result can be stated in this regard without more precise information about firm profit functions.

Finally, what does the above analysis imply about the choices of the guild members in a dynamic environment, where they do business over successive time periods? Suppose the cost parameters faced by a firm are generated by the following process: $\theta_{it} = \lambda\eta_i + (1-\lambda)\varepsilon_{it}$, where λ lies in [0, 1]. The term η is a "permanent" firm-specific efficiency parameter, and ε_{it} is a period and firm specific cost shock. Every firm is privately informed about its η (which is drawn from a symmetric distribution G) at the beginning of time. Then in every period each firm privately observes its ε_{it} and thus its θ_{it}. The ε_{it} are i.i.d. across firms and over time and drawn from some symmetric distribution H. What arrangement will be chosen at the beginning of time, when each firm is privately informed about its η?

Consider two extreme cases. When $\lambda = 0$, the *ex-ante* analysis of our single period model applies. When $\lambda = 1$, the analysis of the interim case applies. Of course, the most realistic case is where firms are partially (and privately) informed about the future ($0 < \lambda < 1$). Here our analysis of the interim case suggests that, after privately observing their η, there can be a conflict among members' preferences, with some firms with "good" signals (i.e., that they will be efficient) preferring revenue taxation, and all others preferring the auction. As long as the extent of scale

[23] It can be shown that when $\gamma = \gamma^{ANT}$, $\Delta(E\theta) = t^*\{\beta(E\theta) - E[(\beta(\theta)]\}$, which is negative since $\beta(\cdot)$ is a strictly convex function. Thus, some firms with $\theta > E\theta$ prefer revenue taxation when $\gamma = \gamma^{ANT}$. However, since $\Delta(\cdot)$ is

diseconomies is not very large, a majority of the guild members will prefer the auction scheme. Further, it can also be the case that once the auction scheme has been adopted by the guild, it will be a "stable" institution in the sense that in every subsequent period, a majority of the firms, after observing their efficiency parameters for the period, will indeed want to be "taxed" *via* the auction (by Proposition 2).

Equity

We now consider the equity properties of the auction *vis-à-vis* revenue taxation. Specifically, we compare the cross-subsidies paid by the higher-than-average cost firms under the two schemes. Note that *ex post,* such firms pay no cross-subsidy in the auction – all firms except the winner pay t^* fraction of their realized profits. So, in *ex post* terms, the auction is certainly more equitable than a revenue tax. (As all firms are symmetric *ex ante*, there is no issue of inequity at that stage.)

In terms of "interim payoffs", the higher-than-average cost firms do pay cross-subsidies under both schemes. For any firm i, the difference in the cross-subsidies under the two schemes is:

$$(9) \qquad \sigma^{REV}(\theta_i) - \sigma^{AUC}(\theta_i) = x^*(\theta_i - E\theta)(1/N)^{\gamma} - t^*[\beta(E\theta) - \beta(\theta_i)].$$

If this difference is positive for higher-than-average cost firms, we will say that the auction scheme is more equitable than the revenue tax scheme.[24]

By definition, the cross-subsidy difference is zero for an average-cost firm. Further, when the number of guild members N is large, $\beta(\theta)$ is arbitrarily small for all firms with $\theta \geq E\theta$, since the probability of winning for these firms is very small (for $N = 20$, the probability that $E\theta$ wins is 2 in a million under uniform distribution). So, for any θ discretely bigger than $E\theta$, the arbitrarily small

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convex, there may be enough low-cost firms who prefer the auction so that a majority of types prefer it..

[24] A stricter notion of the auction "being more equitable" would require the following: $[\sigma^{REV} - \sigma^{AUC}]$ be positive for all $\theta > E\theta$ and negative for all $\theta < E\theta$. An equity ranking of the two schemes satisfying this definition is not always possible. While σ^{REV} is linearly increasing in θ, σ^{AUC} is a strictly concave, increasing function of θ. So, some highly efficient firms can be getting a larger tax break under the auction *vis-à-vis* revenue taxation.

second term in the RHS of (9) will be dominated by the positive first term, especially if $x^* \geq t^*$.

PROPOSITION 3. When the guild size N is large, the auction will be more equitable than revenue taxation in the following sense: there will exist a θ^e greater than $E\theta$ but arbitrarily close to it, such that the cross-subsidies paid by all firms with $\theta \geq \theta^e$ will be smaller in the auction. The smaller is γ in relation to γ^*, the closer will θ^e be to $E\theta$.[25]

Recognize that the smaller is the extent of scale diseconomies, the bigger will be the efficiency effect of the auction, and the greater will be the inequality inherent in a revenue tax as compared to the auction. Propositions 1–3 indicate the important role played by the efficiency effect of an auction in determining its desirability. When this effect is positive, and when the guild size is large, (*a*) the firms will prefer the auction over a revenue tax both *ex ante* and in the interim, and (*b*) the auction will be more equitable than revenue taxation in terms of interim payoffs.[26]

5. Concluding Remarks

In this paper we have documented a novel mechanism used by 19th century Gujarati guilds to raise funds. They implicitly taxed their members by auctioning off the right to remain in business on a holiday to a single firm. Such auctions have been described as a "prime source" of funds for "most guilds". At the same time, some guilds did use conventional forms of taxation (like sales and input taxes) to raise a part of their funds. Recognizing this, we have compared these different forms of taxation in a formal model of a guild.

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[25] This is a *sufficient* condition for the auction to be more equitable. As σ^{REV} is linear in θ while $\sigma^{AUC}(\theta)$ is strictly concave, a necessary and sufficient condition is that the slope of σ^{REV} be greater than that of σ^{AUC} at $\theta = E\theta$. This condition can hold even when $\gamma \geq \gamma^*$ (so that $t^* \geq x^*$); when $\gamma = \gamma^*$, the condition requires that $\Delta'(E\theta)$ be positive.

[26] In this context, the following question naturally arises: If there is indeed a positive efficiency effect from letting only the most efficient firm operate, why did the guilds not exploit it more to increase the aggregate earnings of all members? Recognize that in order to do that, a guild would have to (*a*) identify the most efficient firm in each period, and (*b*) coerce it to share profits with the "sleeping" guild members. We have no evidence to suggest that the Indian guilds could achieve that amount of collusion, or wield that kind of power.

Our analysis has identified some of the conditions that make an auction scheme a "better" mechanism for fund-raising, as compared to conventional taxes. The latter are regressive – they involve high-cost firms cross-subsidizing low-cost ones. The extent of regressivity is much less in an "auction tax". This makes the auction scheme more equitable; it comes closer to allocating taxes in proportion to profits. In addition, the auction can generate a surplus *vis-à-vis* conventional taxation, in part because it shifts production to the most efficient firm – an "efficiency effect". The smaller is the extent of scale diseconomies in production, the bigger is this effect. Whenever the auction generates a positive expected surplus, all guild members prefer it *ex ante*. Further, the bigger the surplus, the more likely is it that once the firms know their "types", a majority of them (all higher-than-average cost firms and some low-cost firms) will continue to prefer the auction.

Of course, there could be other reasons which make the auction scheme desirable, that we have not considered. One reason could be that even though a guild implicitly taxed all its members *via* the auction, *ex post*, only one firm (the auction winner) made the entire contribution to the guild funds. If guild members derived utility from such overt and visible acts of altruism, that would tend to make the auction scheme more popular.[27] Another reason could be that while conventional taxes *can* cause quantity distortions in firm decisions, the auction tax does not create any such distortion. This may lead to the auction generating a bigger surplus than conventional tax schemes.[28]

Our study has highlighted the features that need to be present for the auction scheme "to work well", and thus indicated why it may not be the mechanism of choice in all cases. First, we have emphasized that a crucial issue is whether a single firm can replicate the earnings of all guild firms operating together. The extent of scale diseconomies plays an important role in determining

[27] Though if guild members wanted to demonstrate altruism, they could surely have done so without resorting to such a complicated auction scheme.

[28] If guilds fixed quantities, conventional taxes would not have a distortionary effect. Moreover, given that the guild's collections were small in relation to member earnings, even if conventional taxes distorted choices, these distortions would be small. That is why we have ignored this issue in our formal analysis.

this (as do factors like the spatial dispersion of customers, the extent of their "brand loyalty", etc.). Thus, the auction scheme would be more suitable for traders than for craftsmen; scale diseconomies are likely to set in much quicker for a potter than for a grain-dealer. Second, the auction scheme requires that the guild members collectively create a monopoly position which can then be auctioned off. The Gujarati guilds could create such a position, but this may not have been feasible in other associations.[29] Finally, guilds in larger cities with geographically dispersed members would find it harder to monitor whether a firm stayed open on a holiday in violation of guild rules. The monitoring problem, along with the fact that a single firm could possibly serve only a small portion of a large market, would limit the desirability of the auction. Not surprisingly, Hopkins (1902, p.190) found that "this custom of auctioning off the right of not keeping a holiday is more common in the smaller towns."

In conclusion, we note that that the scheme of auctioning off the rights to stay open on a holiday to a *single* firm may not have been the "optimal" fund-raising mechanism for the Gujarati guilds. If diseconomies of scale were indeed a primary reason to not use the auction, then it might have been better to have more than one firm win such an auction (especially in large markets). While the Gujarati guilds might not have been ingenious to such an extent, there is no denying that the idea of collecting funds by "selling" a collectively created monopoly right to work was a very clever one.[30] We suspect that many guilds and associations across the world stuck to conventional taxation, rather than exploit this profitable idea, simply because they did not have the ingenuity to conceive of it!

[29] Consider, for instance, a church which needs to raise funds from its diverse congregation. Its members, taken collectively, may not have a monopoly in any occupation. Then an income tax will be more feasible than an auction/holiday scheme. Indeed, as is well-known, tithes (a 10% income tax) have been widely used, especially by the Catholic church.

[30] And some guilds "sold" this right more cleverly than others. While we have focused on the guilds that auctioned off this right, Hopkins (1902) documents that some other guilds sold this right for a "fixed fee".

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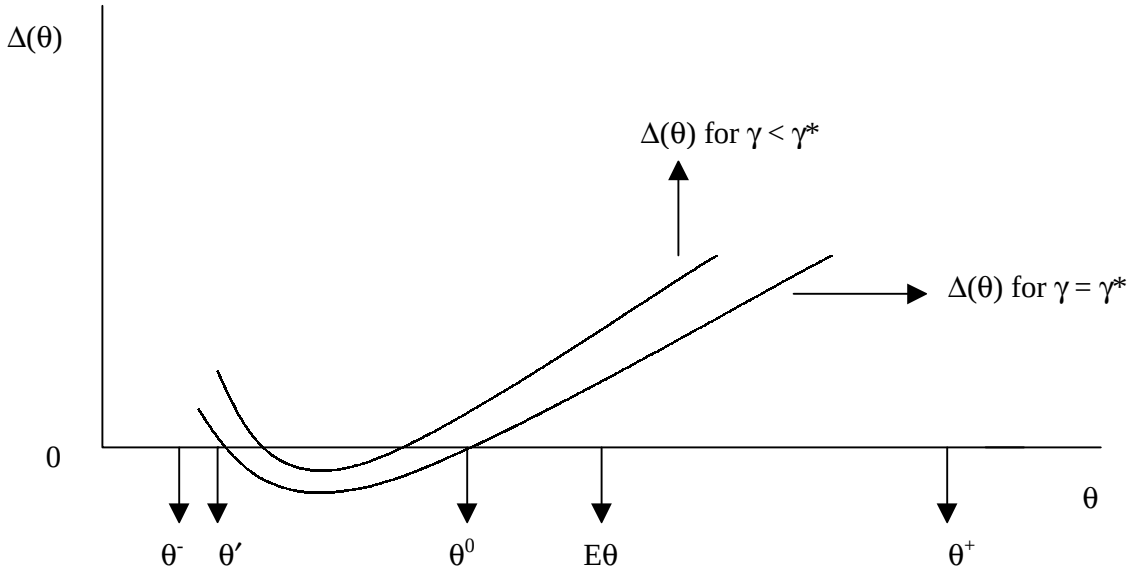
Figure 1



Δ(θ) shows the extent (positive or negative) to which a particular type of firm θ prefers the auction