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ALCOHOL

Demand and Taxation under Monopoly and Oligopoly in South India in the 1970s

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Our first objective, is the investigation of the determinants of recorded demand for alcohol, and particularly arrack, in terms of price and income elasticities, taxation and household characteristics. Second, we develop an analysis of some simple theoretical aspects of the revenue system in Karnataka, involving the auction of the monopoly right to sell legally in a district. This leads to an examination of the theory of taxation in spatial and non-spatial oligopoly. Third, we combine these different elements to comment on policy in Karnataka. We hope to demonstrate some techniques and provide insights which can be productively used for a range of important problems in taxation and demand estimation for developing countries.

1. Introduction

Alcohol is an important element of consumer expenditure and of tax revenue in many countries. In this paper we describe alcohol consumption in one State of Southern India, Karnataka. We discuss alcohol as a source of revenue, estimate price and income elasticities, examine some theoretical aspects of the unusual taxation system that operates in Karnataka and comment on policy in relation to the theory and estimates. Karnataka, with a population of over 40 million, is a big State and the issue is of major importance. Further we hope that the Karnataka system together with the

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approaches we have used may provide useful lessons for the analysis of similar topics in other States and countries.

The main types of alcohol consumed by households are toddy, arrack, beer and Indian made foreign liquor, hereafter IML. Toddy is a fermentation which uses liquids tapped from coconut or palm trees and is popular amongst some poorer groups. Arrack (also called country spirits), the most widespread alcoholic beverage, is a locally produced spirit. Beer and IML are similar to their western counterparts, with IML comprising gin, whisky, rum and brandy.

The taxation of alcohol is the prerogative of the States (rather than the Centre) under the Indian constitution and, in those States where the sale of alcoholic beverages is legal, it is subject to a state excise tax. In terms of tax revenue the relative importance for Karnataka of excise duty on alcohol is shown in table 1 (alcohol is the major source of state excise).

It can be seen that state excise contributes over 20% of state revenue and nearly 23% of indirect tax revenue. This share in indirect revenue has grown from 13% in 1960/61 to 24% in 1975/76. In 1976/77 the share dropped suddenly to 21%, and it was not until 1980/81 that it began to rise back towards the earlier level [Government of Karnataka (1982, pp. 20–21)]. It should be noted that prior to 1969 there was partial prohibition with some dry areas in the State. During the emergency the 1st of every month was a 'dry' day. We have not attempted to incorporate data referring to periods after the Gulati Report [Government of Karnataka (1982), see below] and the present tense refers to 1982 unless otherwise indicated.

Table 1

Karnataka state taxes, 1981/82 (Rs. crores or 10 million).[a]

	Amount	% of total
1. Land revenue	6.50	1.09
2. Agricultural income tax	9.00	1.51
3. Stamps and registration	29.00	4.87
4. Others	9.04	1.51
Sum of 1 to 4	53.54	8.98
Indirect taxes		
5. Sales taxes	307.00	51.51
6. State excise	123.51	20.72
7. Vehicle tax	55.30	9.28
8. Electricity duty	16.00	2.68
9. Entertainment tax	19.80	3.33
10. Others	20.87	3.50
Sum of 5 to 10	542.48	91.02
Total of 1 to 10	596.02	100.00

[a]*Source*: Government of Karnataka (1982, p. 12).

There are a number of reasons one might wish to advance for taxing alcohol and one of these concerns the price elasticity of demand. Goods with inelastic demand are appropriate goods for taxation from the point of view of efficiency, since, crudely speaking, demand patterns are altered less than for goods with high elasticities. A more careful analysis introduces cross-price effects and distributional issues [see, e.g., Atkinson and Stiglitz (1980)]. There is, of course, more to the taxation of alcohol than demand responses and the distribution of income. It could be considered that decreasing the consumption of alcohol was, in itself, desirable and it is likely that the Commissioner for Excise sees this as part of his responsibility. But whatever the aims the magnitude of the price elasticity is likely to be a crucial issue.

Where illicit sales are prevalent the effect of extra taxation on measured demand will be more complex than simply through the effect of taxation on price. Extra taxation may influence the degree of evasion and the size of the illicit market. This would be of considerable importance not only for its effect on revenue and consumption but also for that on public health since consumption of illicit manufactures or adulterated liquor can be dangerous, or indeed fatal. Thus an examination of the effect of taxation on demand, additional to that of consumer price, will give us an indication of the importance of the illicit market and help in the calculation of revenue effects of extra taxation.

The income elasticity is also of importance. If income elasticity is low for alcohol, or particular types of alcohol then growth in state income may not yield a corresponding growth in excise revenue. The income elasticity will also give us important clues as to the likely impact on consumption of changes in the distribution of income. On the other hand an estimate of the income elasticity is not in itself necessary for the study of the distributional consequences of marginal tax changes if one has data on the actual consumption levels of households. The first purpose of this paper is the estimation of price and income elasticities for alcohol in Karnataka. We shall also be examining the effect of household characteristics on consumption. The relative importance of various types of alcohol in tax revenue can be seen from table 2. Arrack is clearly particularly prominent and therefore much of our analysis below concentrates on this beverage.

Most of the revenue is raised by auctioning the yearly licences to sell arrack and toddy (see table 7 below) in each of the several taluks of the State (a taluk is an administrative area being a sub-division of a district – there are 175 taluks and 19 districts). This is an unusual system of taxation and one that does not fit directly into the standard treatment of indirect taxes in the literature on public finance. Our second purpose in this paper is therefore to provide an analysis of some simple theoretical aspects of such a system together with a discussion of the theoretical results in relation to taxation in Karnataka and to our elasticity estimates. Putting the theory and estimates

Table 2

State excise revenue receipts, 1980/81 (Rs. crores or 10 million).[a]

	Amount
Arrack	60.56
Toddy	15.23
Beer	2.05
IML	14.77
Others	1.14
Total	94.13

[a]*Source*: Government of Karnataka (1982, p. 153).

together leads us to our third purpose which is to comment on tax policy for alcohol in Karnataka. We shall see (section 4.2) that the auction component in revenue increased substantially in the 1970s.

Our study is greatly facilitated by the recent Report of the Karnataka Taxation Review Committee chaired by Professor I.S. Gulati [Government of Karnataka (1982)], hereafter the Gulati Report. This was a very thorough examination of state taxes in Karnataka and provides a wealth of data, institutional description and careful analysis. This was supplemented by data collection in Karnataka between October 1981 and February 1982 and we are particularly grateful to Mr. S.K. Bhattacharya, the Commissioner for Excise at that time, for his guidance.

In the next section of the paper we examine the data which are available for estimating price and income elasticities. These are time-series data using the aggregate state consumption figures and National Sample Survey data on a sample cross-section of individual households for two specific years. The data sets have different strengths and weaknesses and these are discussed. The third section contains our elasticity estimates using these sources.

The fourth section is devoted to taxation. We first discuss the theory of a system which includes the auction of licences to sell alcohol and then relate our estimates to this theory and to standard theory in the context of Karnataka. The final section contains concluding comments.

2. Data

All empirical studies face data limitations but they can be particularly severe with alcohol in particular, and less developed countries in general. This study is no exception and doubtless much of the production and consumption is concealed from the revenue authorities and data collectors. We use two data sets, an annual time series with observations from 1971/72

to 1980/81 and cross-section data from the National Sample Survey (NSS), 28th round, 1973/74, and the 32nd round, 1977/78. Since the origins of these data sets are very different and one involves aggregate figures over time and the other data from individual households, they allow different questions to be posed and require different methods of analysis.

We wish to relate alcohol consumption to price and income. The time-series data contain price variation and thus permit the estimation of price responses, whereas in the cross-section data we do not have reliable information on prices and so cannot (without very restrictive assumptions on preferences) estimate price elasticities of demand. Our focus in the cross-section data will be on the effects of household characteristics, aspects which cannot be examined from the time-series.

The time-series data are from a variety of sources. State domestic product (SDP) at current prices and constant prices was obtained from the Bureau of Economics and Statistics of the Government of Karnataka. Revenue receipts of different types and for different beverages under state excise are from the Gulati Report. Our consumer price index was obtained by taking a simple average of three of the important price indices for Karnataka. These are consumer price indices for urban manual workers, agricultural labourers and urban non-manual employees. They are all from the Indian Monthly Bulletin of Statistics. The data for the price of arrack were kindly supplied by the Commissioner for Excise. We used the following measure of arrack consumption. The Commissioner for Excise produced consumption figures from 1976/77 to 1980/81 and for 1971/72 to 1974/75 we used production figures from 1971 to 1974. The production figures are from the Statistical Abstract of Karnataka (1976/77) and were selected as a proxy since production in the years 1975 to 1976 was very close to consumption in 1975/76 and 1976/77. Per capita figures were obtained by dividing by population figures as reported by the Bureau of Economics and Statistics. As can be seen in these figures we have a sharp drop in consumption in 1976/77.

Our per capita income figures at constant prices are then, dependent on three separate series, the money income, the population figures and the price index. Our money income series seems to be consistent with series recorded elsewhere, i.e., Government of India (1980) and the Gulati Report. The population figures use the 1980/81 census (these show a slightly higher population and so lower per capita figure than earlier estimates used by the State government which were based on the 1970/71 census). Substantial differences in per capita income at constant prices arise from the use of different price indices. The implicit deflator for SDP shows a rise of 102% over the ten year period while the consumer price index rises by 117%. We used the consumer price index for our demand estimation as we are trying to measure spending power by consumers (and we comment briefly on results using the SDP deflator – see next section). The steep price rise, together with

a high income in 1971/72 and low income in 1980/81 (associated with good and poor agricultural output, respectively) gives a declining per capita income. Karnataka seems particularly vulnerable to droughts and most of the fluctuations in the series seem to be caused by changes in agricultural income (about one half of state income).

Data on IML amounted to just six annual observations and left too few degrees of freedom for time-series estimation. It is interesting to note that consumption of IML rose by over 50% between 1979/80 and 1980/81 so it may be that factors other than price and income affected recorded consumption. The source of data was the same as for arrack (Commissioner for Excise). The data on consumption, prices and income for the 1970s are set out in table 3.

The advantage of the time-series data is that they provide fairly reliable information on official prices and quantities. Disadvantages are the small number of observations and the absence of information on illicit purchases. However, we shall be looking at substitutability between the two sectors, at least implicitly, below.

The cross-section data available to us from the National Sample Survey (NSS) provide observations on 990 households in Karnataka from October 1973 to June 1974, of which 369 are urban households and 621 rural, and 3284 observations from July 1977 to June 1978, of which 1277 are urban households and 2008 rural. We are very grateful to the National Sample Survey Organisation for allowing us to work on these data. For each household there is information on quantity and value consumed of toddy, arrack and IML. In the 1973/74 survey 45 households reported consumption of arrack, 42 toddy and just 4 IML. In the 1977/78 survey there were 130 households who reported consumption of arrack, 174 toddy and 16 IML. Some relevant statistics from the NSS data are shown in table 4.

In the 28th round there is just one household reporting consumption of both arrack and toddy, whereas in the 32nd round we have 12 consuming toddy and arrack, 3 consuming arrack and IML and 2 toddy and IML. In both surveys approximately 9% of households report alcohol consumption. This is rather lower than the 28% found in the survey of 3404 Karnataka households for May 1974–April 1975 described in Thimmaiah and Sharma (1978). However, they classified drinking households as those with non-zero consumption during the whole year whereas the NSS covers only the month prior to the interview. Given that much drinking is seasonal (festivals, etc.) the NSS figures for drinking households would be substantially lower with the difference in period. And there was some weighting in the Thimmaiah/Sharma sample towards drinking households. Nevertheless the use of local teachers rather than external investigators (as in the NSS) may well have made households more willing to report on this sensitive subject.

Table 4 based on the NSS data shows a dramatic drop in arrack

Table 3

Time-series data for Karnataka.[a]

	71/72	72/73	73/74	74/75	75/76	76/77	77/78	78/79	79/80	80/81
Consumption										
Arrack (million litres)	21.08	24.42	28.63	37.41	32.69	29.72	30.38	28.57	31.56	37.94
Arrack (litres per capita)	0.72	0.81	0.93	1.18	1.01	0.89	0.89	0.82	0.88	1.03
IML (million litres)					2.71	3.74	2.72	3.06	3.90	5.92
Beer (million litres)					6.01	7.76	12.31	14.35	14.57	14.02
Prices										
Arrack (Rs. per litre)	9.99	10.55	10.81	12.71	14.79	15.80	18.04	19.38	20.85	24.06
Arrack (75/76 = 100)	67.6	71.4	73.1	86.0	100.0	106.9	122.1	131.1	141.1	162.8
IML (75/76 = 100)					100.0	101.1	101.6	102.7	108.4	123.0
Consumer prices (71/72 = 100)	100.0	111.9	138.5	166.6	161.5	163.5	167.0	166.8	188.1	217.0
Implicit prices (71/72 = 100)	100.0	110.9	132.5	151.5	140.2	155.0	153.3	153.9	174.3	201.9
Tax										
As proportion of value of arrack sales	0.70	0.76	0.81	0.68	0.73	0.76	0.69	0.73	0.73	0.66
Income										
Per capita state domestic product – current prices	697	710	967	1067	992	982	1108	1106	1206	1311

[a]*Sources*: Consumption: supplied by the Commissioner for Excise (Karnataka), except 1971/72–1974/75 which are taken from the Statistical Abstract Karnataka 1976/77 (see text). Prices: alcohol prices from the Commissioner for Excise (average across districts weighted by the population). Consumer prices are from the Indian Statistical Abstract, average of index for non-manual urban, manual urban and agricultural workers. Implicit prices are derived from income figures from the Bureau of Economics and Statistics, Bangalore. Tax: from the Gulati Report. Income: from the Bureau of Economics and Statistics, Bangalore.

Table 4

Alcohol consumption from NSS.[a]

	28th round (1973/74)	32nd round (1977/78)
Mean per capita total expenditure (rupees/month)		
All households	64.91	81.66
	(46.06)	(68.25)
Toddy consumers	54.70	65.83
	(23.05)	(37.10)
Arrack consumers	72.24	90.42
	(76.03)	(83.90)
IML consumers	136.30	264.22
	(108.43)	(181.00)
Non-zero households: arrack consumption		
Mean quantity (litres/month)	7.16	4.00
	(14.45)	(7.55)
Mean value (rupees/month)	14.55	22.30
	(22.03)	(27.80)
Implicit price (rupees/litre	2.03	5.55
Non-zero households: toddy consumption		
Mean quantity (litres/month)	9.10	14.77
	(8.81)	(23.17)
Mean value (rupees/month)	7.69	18.61
	(6.94)	(28.38)
Implicit price (rupees/litre)	0.85	1.26
Non-zero households: IML consumption		
Mean quantity (litres/month)	2.98	1.45
	(3.22)	(1.27)
Mean value (rupees/month)	17.63	36.27
	(10.64)	(27.66)
Implicit price (rupees/litre)	5.92	25.01
Consumer price index	100.00	120.58

[a]Numbers in parentheses are the standard deviations. All data are in current prices. 28th round is October 1973 to June 1974, 32nd round is July 1977 to June 1978. For numbers in sample, see text.

consumption, while the value has risen strongly. This is consistent with the aggregate figures for 1974 and 1978 (table 3). The price rise indicated by table 4 suggests that there may have been a substitution of toddy for arrack (again see table 3).

The cross-section data have the advantage of allowing examination of the effects of household characteristics and the distribution of income, but the disadvantage that there is no information on price variation. It is clear that the large number of zeros will play a central role in the statistical analysis. The implicit price of arrack in table 4 is very much lower than the price in table 3. This may be partly because they buy from illicit and cheaper sources. The NSS data will be used below largely in terms of whether or not expenditure is positive. We shall be paying little attention to quantity figures which are probably unreliable. It does seem safe to assume that households reporting non-zero expenditure really do contain drinkers.

The NSS data contain no information on incomes; we utilise per capita expenditure in our estimation in section 3.2.

3. Estimates

3.1. Time series

The major constraint on the time-series estimation of the determinants of consumption and tax revenue was the small number of observations. We had to keep explanatory variables to a minimum in order to preserve degrees of freedom, and we concentrated on price and income. We experimented with a number of functional forms including both the linear and the share formulation (expenditure share as a function of the logarithm of income) but the functional form that seemed most appropriate in terms of explanatory power was the double log function. This has the added advantage that the elasticities appear simply as the coefficients.

Serial correlation appeared to be present in most of the simple regressions and we used a maximum likelihood procedure, due to Beach and MacKinnon (1978) for the treatment of first-order auto-correlation. The Beach–MacKinnon method provides an estimate of the auto-correlation parameter ρ and utilises fully the first observation (in contrast to some least squares methods based on first differences). They argue that in small samples, the procedure can be considerably more efficient than the traditional methods.

The definitions of the variables are as follows:

A – per capita consumption of arrack,
M – per capita state domestic product at constant prices,
P – market price of a litre of arrack at constant prices,
τ – tax expressed as the proportion of the market price,

ρ – first-order serial correlation parameter,
ln denotes the logarithm.

The estimated demand equation using the Beach–MacKinnon method is

$$\ln A = \underset{(2.42)}{5.78} - \underset{(1.48)}{0.56}\ln M - \underset{(7.90)}{1.10}\ln P + \underset{(5.74)}{0.044}\ \text{time},$$

$$\rho = \underset{(1.38)}{-0.47}, \quad \text{log likelihood} = 17.43. \tag{1}$$

Number of observations = 10, t statistics are in parentheses.

All the coefficients except income are significant. The price elasticity is around -1, indicating that a 1% rise in price will reduce consumption by 1%. The income coefficient is negative suggesting inferiority. The use of the alternative real income series (deflating by the SDP deflator instead of the consumer price index) makes little difference to these results – the income coefficient is still insignificant and the estimated price elasticity is 1.18. We comment briefly on the effect of income when we discuss the cross-section results.

It should also be noted that if price is determined through monopoly then the simple estimates of demand parameters are likely to be biased and inconsistent. In the usual way monopoly price is marginal cost times $(1-1/\varepsilon)$ where ε is the demand elasticity. Hence in a time series marginal cost and price will be correlated. If, for example, marginal cost depends on quantity then we shall have a simultaneous equations bias. If marginal cost increases with quantity then price and the error term are positively correlated in equations such as (1) and we shall overestimate $(-\varepsilon)$ or underestimate ε. Similarly if the demand curve is linear the monopoly price is positively related to the intercept and we would again underestimate ε. The same type of consideration would arise with many oligopoly models (see section 4 for some examples).

The arrack consumption figures came from the tax collecting office and it is possible that they understate the true figure. On the other hand the official figures are of interest in their own right as a tax base whether or not they reflect consumption. And it is important to try to examine the influence of evasion and illicit sales for public health as well as revenue reasons. With these considerations in mind we included the proportion (τ) of tax in the price of the good in addition to the price variable. If the equation represents simply the response of actual consumption to prices then the tax variables should be insignificant – the consumer would be concerned with the market price and not with its breakdown into different elements. Where taxes are high, however, it is possible that seller and consumer collude to conceal the

sale and this would depress the figures. Note that the tax element includes as a major constituent the 'shop rent' which is the licence to sell (purchased at the auction). This is a fixed cost in the short run and should not in this sense affect the financial incentive to conceal sales. The fixed cost can be avoided by unlicensed sellers and thus if the shop rent is higher there may be more illicit sales and lower legal sales. It is also possible that the attitude of the seller may be more hostile to the authorities (there is the specific duty per litre to be collected) if he has had to pay a high price for the licence, and he may wish to conceal the extent of market demand to keep down bids at the next year's auction. Or he may have arranged with the authorities that if he puts in a high bid then they will take a lenient attitude to tax, quantity and quality control [see Bhaktavatsala (1981a, b, 1983)]. The interpretation and use of the elasticity estimates will be discussed further in section 4 when we have looked at some theoretical models of taxation.

The results from including $\ln \tau$ are given in eq. (2),

$$\begin{aligned} \ln A = {} & 4.75 - 0.42 \ln M - 1.14 \ln P - 0.83 \ln \tau + 0.040 \text{ time}, \\ & (4.75)\ (2.65) \qquad (20.12) \qquad (5.18) \qquad (12.52) \\ \rho = {} & -0.62, \quad \log \text{likelihood} = 26.52. \\ & (2.08) \end{aligned} \tag{2}$$

Number of observations = 10, t statistics are in parentheses.

The coefficient on $\ln \tau$ is significant and negative in (2), as is that on $\ln M$, and the fit is much better than for (1). Twice the difference between the log-likelihood in (1) and (2) is 18.18 which may be compared with the 1% level for Chi-square with one degree of freedom of 6.64. Thus we would emphatically reject the null hypothesis that the model of (1) is correct and there does appear to be evidence that a higher level of taxes leads to concealment of sales. The estimate of ρ, the serial correlation parameter, is close to significance. Again use of different deflators and money income figures made little difference.

The estimated price elasticity is now higher and both the tax elasticity and price elasticity are significant and fairly close to unity. The combination of price and tax effects may be illustrated as follows where for the sake of the example we take both elasticities to be unity. Let us suppose that τ is 0.75 (see table 3). If τ consisted entirely of specific taxes an increase in 1% in these taxes would imply an increase of 0.75% in the official price assuming it were all passed on. The proportion shifted to the consumer may be more or less than one depending on the shape of the demand curve and market structure (see section 4). The fall in measured or taxed demand would then be 1.75% with 1% of the fall from the price effect and 0.75% from the tax effect. Tax revenue would fall by 0.75% since we would have a 1% increase in the tax

and a 1.75% fall in the tax base. The effect on real consumption would depend on the workings of the illicit sector in relation to the official sector. The empirical results therefore draw attention to the possibility that increases in specific tax rates may decrease revenue and increase illicit consumption. Generally, under specific taxation, if the price elasticity is ε_1 and the tax elasticity ε_2 the percentage fall in measured demand from a 1% increase in the specific tax would be $\tau\varepsilon_1 + \varepsilon_2$ and the percentage fall in revenue $\tau\varepsilon + \varepsilon_2 - 1$, where τ is the proportion of specific tax in price.

The results raise the interesting possibility that the elasticity as perceived by a private monopoly licence holder setting only the price would be lower than that perceived by a government monopoly which would draw no distinction between revenue from tax and that from price (the illegal sector is present for both but the difference is that the monopolist is not interested in tax revenue).

However, the form of the implied relationship between tax and tax revenue will depend on the mechanism by which revenue is raised and cannot in this context be derived simply as a fixed tax rate times the quantity. The determinants of tax revenue will be discussed further in section 4.2 after we have examined the theoretical properties of a revenue system, such as that in Karnataka, involving the auction of the monopoly right to sell.

3.2. Cross-section

The advantage of the cross-section data is that they allow examination of the effect of household characteristics. Accordingly we concentrate on household characteristics and income in the determination of demand. A major issue in the analysis of cross-section data is the treatment of zero expenditures. As we have noted, about 90% of households report no consumption of alcohol in the preceding month. In an attempt to identify those characteristics which determine whether a household will report positive consumption we estimated probit models. In the probit model we do not include the amount that is spent and simply define a variable which is 1 for households reporting consumption and 0 otherwise. Note that we cannot separately identify the effects of variables influencing the propensity to consume and those influencing the propensity to report. As we suggested above, whilst the reported consumption figures are likely to be unreliable it seems highly probable that those who report some consumption are in fact drinkers. Thus we concentrate our analysis on the discrete (0, 1) variable rather than the actual quantity. As a model of who actually drinks some bias would remain since some of those reporting zero consumption will, in fact, be drinkers. Thus the appropriate interpretation is a model of who actually admits to drinking.

We investigate the model where the probability of a household i reporting the consumption of (e.g.) arrack is given by

$$P_i = F(\beta \cdot X^i) = F(z^i), \tag{3}$$

where F is the normal distribution function, β is a vector of coefficients and X^i a vector of characteristics of household i (including a constant). Once the model has been estimated one can compute z for different households and thus evaluate the estimated probability (for a household) of reporting consumption of arrack from the normal distribution.

The probit estimates concern only the question of what characteristics are likely to influence whether a household reports consumption of arrack or not. They do not indicate consumption levels of those who do report. We have presented results on a cross-section estimation of the determination of consumption in an earlier version of this paper [Musgrave and Stern (1985)]; it was not possible to provide very satisfactory explanations of reported quantities. There are, however, some interesting questions of modelling [see our earlier paper and Atkinson, Gomulka and Stern (1984)].

Results using the SHAZAM package are shown in table 5 (separately for arrack and toddy) for the probit models and several interesting features are immediately apparent. The explanatory variables are household per capita expenditure, which we use as a proxy for per capita income, land operated, the number of males, the number of females, the number of children, a dummy variable taking the value 1 for urban areas and 0 for rural areas, a dummy variable which is 1 if the household comes from scheduled castes or scheduled tribes and a dummy variable which is 1 if a manual occupation provides the majority of household income and 0 otherwise. The variables were chosen on the basis of explanatory factors which commonly appear in general discussion [and see Thimmaiah and Sharma (1978)]. Religion is another explanatory variable discussed in Thimmaiah and Sharma (1978) who argued that Christians drink much more and Muslims a little less than Hindus. However, the number of Christians in the NSS sample was small and only two of them drank arrack in 1973/74 and we did not therefore include religion as a variable. Also the Thimmaiah/Sharma analysis was not multivariate in that it looked only at simple averages by category.

For arrack the coefficient on per capita expenditure is positive and significant. Given that different groups are likely to behave in different ways this effect is quite difficult to interpret. Thus within certain groups of potential drinkers income (proxied by per capita expenditure) may be positively related to drinking. However, higher status groups may not report drinking arrack at all (being teetotallers, embarrassed or consumers of IML). Further, relative income may be of importance and it must be remembered that the quantity consumed is not being examined here. For all these reasons

Table 5

Estimated coefficients for the probit models of alcohol consumption.[a]

	Arrack		Toddy	
	1973/74	1977/78	1973/74	1977/78
Constant	−3.49 (−8.90)	−2.59 (15.16)	−2.23 (5.19)	−2.21 (12.53)
Percapex (Rs./month)	0.0053 (3.56)	0.0021 (3.81)	−0.00038 (0.18)	0.000095 (0.13)
Land operated (acres)	−0.026 (1.61)	−0.011 (1.51)	−0.032 (1.71)	−0.050 (4.16)
No. of males	0.11 (1.46)	0.040 (1.05)	−0.039 (0.44)	0.056 (1.46)
No. of females	−0.028 (0.33)	0.0020 (0.06)	−0.12 (1.10)	−0.016 (0.48)
No. of children	0.15 (3.54)	0.046 (2.69)	−0.0054 (0.12)	0.042 (2.20)
Sector dummy	−0.079 (0.44)	−0.13 (1.29)	−0.31 (1.59)	−0.44 (4.48)
SC/ST dummy	0.76 (4.45)	0.42 (4.18)	0.39 (2.28)	0.48 (5.36)
Occupation dummy	0.87 (2.81)	0.53 (3.73)	0.93 (2.48)	0.65 (4.34)
Likelihood ratio test that slope parameters are zero				
[$\chi^2_{0.95}$ with 8 d.o.f. = 15.51]	53.50	57.77	31.70	129.07
No. obs. at one	45	126	42	173
No. obs. at zero	945	3158	948	3111

[a]Sector dummy – urban 1, rural 0. SC/ST dummy – members of scheduled caste or tribe 1, otherwise 0. Occupation dummy – if the occupation providing the largest share of household income is manual 1, otherwise 0. Percapex – household per capita expenditure in rupees per month. 't' ratios are in parentheses.

and because tastes may be changing over time it is not straightforward to link this result to any movement of general incomes over time as in the time-series data. In any event quantitatively the effect is small – see below. On the other hand the negative coefficient on land operated might suggest that those not operating a holding (i.e., landless labourers) have a higher propensity to consume, although it is not significant.

It might have been thought that more men in the household, for a given per capita expenditure, would increase the probability of finding a drinker but this view does not receive strong support from our results. There is a positive and significant coefficient on the number of children in the case of arrack which may indicate that their role as consumption units may be

exaggerated. In other words larger numbers of children may conceal, if per capita expenditure is used, the actual disposable income available to the consumers in the household who may wish to drink alcohol. Alternatively children may drive some people to drink.

The sector dummy is insignificant. The scheduled castes/scheduled tribes dummy indicates that households belonging to these groups have a higher proportion of (reporting) arrack consumers. The occupation dummy indicates that it is rather manual workers who tend to report consumption than non-manual ones. The relative importance of the different factors is discussed below.

The toddy results also reveal some interesting features. Per capita expenditure has an insignificant coefficient, suggesting that income level plays no part in determining whether a household reports consumption of toddy. The only rider to this is the positive and significant coefficient on the number of children in the 32nd round which, for reasons pointed out above, may indicate that there is a positive effect of income on the decision to consume toddy. The negative coefficient on land operated may indicate that it is the non-farmers and landless who are more likely to drink toddy.

The coefficients on males and females, as in the case of arrack, suggest no strong conclusions. The sector dummy reflects the greater proportion of drinkers in rural areas. The scheduled castes/scheduled tribes dummy is again very significant as is the occupation dummy in both periods. Where they are both significant the coefficients in the two periods are quite similar suggesting that the propensity to consume toddy may have changed little over the period.

The likelihood ratio test reported at the bottom of the table indicates that all the equations are highly significant, $\chi^2_{0.95}$ is 15.51 and $\chi^2_{0.99}$ is 20.99 with eight degrees of freedom.

The probabilities that a certain type of household will consume arrack and toddy are shown in table 6. These give an indication of the magnitude of the coefficients in table 5. We also show the mean per capita expenditure, land possessed and number of children for each group. These mean values were used together with the classifications of different types of household: urban versus rural, manual versus non-manual, and SC/ST versus others to evaluate z for each group [see eq. (3)] and hence the probability. One feature of the table is the very low propensity to consume alcohol among non-manual groups, especially in the urban areas. These are groups who may have a higher propensity to consume beer and IML but nevertheless, traditionally do not drink much alcohol. As was to be expected from table 5 it is the manual workers and especially those in scheduled castes and tribes who show the highest probability of drinking but even the highest probability, 15.6% for consumption of toddy by rural manual scheduled castes and tribes, is low by the standards of most countries, even allowing for some under-

Table 6

Probability of arrack and toddy consumption for different household groups.[a]

	Mean percapex	Mean land operated (acres)	Mean no. males	Mean no. females	Mean no. children	Arrack		Toddy	
						Est. prob	Actual proportion	Est. prob.	Actual proportion
73/74 URBAN manual									
Non SC/ST	56.43	0.70	1.62	1.57	2.33	3.8	4.7	2.9	3.5
SC/ST	51.30	0.10	1.76	1.45	2.31	15.4	24.1	3.1	6.9
Non-manual									
Non SC/ST	81.66	1.02	1.56	1.51	1.87	0.5	0.6	0.2	0.0
SC/ST	64.14	0.02	2.29	2.14	3.29	5.1	0.0	0.2	0.0
RURAL manual									
Non SC/ST	54.34	6.29	1.70	1.64	2.55	2.4	3.5	3.8	4.4
SC/ST	39.87	3.39	1.50	1.44	2.49	10.6	10.6	5.1	11.5
Non-manual									
Non SC/ST	64.37	0.73	1.18	1.05	1.39	0.2	2.3	0.7	2.3
SC/ST	69.75	0.47	0.60	0.60	0.60	1.3	0.0	0.9	0.0
77/78 URBAN manual									
Non SC/ST	71.77	1.80	1.76	1.69	2.22	3.1	2.9	2.7	2.7
SC/ST	65.86	0.31	1.52	1.68	2.30	7.4	11.7	8.5	11.7
Non-manual									
Non SC/ST	100.69	1.27	1.63	1.54	1.89	0.9	1.5	0.5	0.4
SC/ST	77.57	0.01	1.05	1.26	1.54	2.2	2.6	2.0	0.0
RURAL manual									
Non SC/ST	67.26	6.20	1.72	1.64	2.51	3.7	4.2	4.6	6.0
SC/ST	47.74	1.85	1.63	1.52	2.22	8.4	7.6	15.6	15.2
Non-manual									
Non SC/ST	81.16	1.86	1.36	1.43	2.14	1.4	1.9	1.5	1.9
SC/ST	50.10	2.02	1.25	1.30	2.00	2.7	0.0	4.6	5.0

[a]In 73/74 non-manual SC/ST consists of just 7 and 5 households in the urban and rural sectors, respectively, and the numbers in some of the other cells are not large. For definitions of variables, see table 5.

reporting. The goodness-of-fit can be examined by comparing our estimated probabilities with those proportions in each group actually reported in the data.

The marginal effect of changing a single variable j on the probability, $\partial p/\partial X_j$, is given from (3), in (4a),

$$\frac{\partial p}{\partial X_j} = \beta_j F'(z) = \beta_j \phi(z) = \beta_j \phi(\beta \cdot X), \tag{4a}$$

where F is the standard normal distribution function and ϕ the density function. Thus,

$$\frac{\partial p}{\partial X_j} = \beta_j \frac{1}{\sqrt{2\pi}} \exp\left\{\frac{-(\beta \cdot X)^2}{2}\right\}. \tag{4b}$$

For a probability of drinking of 0.09, z (or $\beta \cdot X$) would be -1.28 and $\exp(-\beta \cdot X^2/2)$ would be 0.44; $(1/\sqrt{2\pi})$ is 0.40 hence the marginal impact of change in a variable may be considered as approximately 0.40×0.44 or 0.18 times a coefficient. For example, a shift from 0 to 1 in the SC/ST dummy (i.e., changing a household to SC/ST holding other things equal) would imply, around the mean of the sample, an increase in the probability of drinking arrack of roughly 8% using the coefficient for 1977/78 in table 5 ($0.42 \times 0.18 = 0.076$).

From this point of view it is clear from (4a) and (4b) and table 5 that the most important variables are the SC/ST and occupation dummies with each representing for arrack for 1977/78 increases in the probability of drinking of around 8% and almost double this for 1973/74. For given per capita expenditure the effect of another child is only one-tenth as big for 1977/78. The effect of a 10% increase in income from the mean (say, an extra 8 rupees per capita per month in 1977/78) being an increase in the probability of drinking of only 1/5th of 1%.

4. Taxation

The demand function for alcohol is an important ingredient of tax policy. In this section we shall use the estimates derived in the preceding section to comment on the taxation of alcohol in Karnataka. Before we can do this, however, we shall have to examine briefly some theoretical questions. These questions arise because the form of taxation in Karnataka is different from the standard specific or ad valorem taxes. In particular the auctioning of the right to sell arrack and toddy provides the major source of revenue. In section 4.1 we shall analyse these theoretical issues. In section 4.2 we provide a brief description of the system and use the theory and estimates to discuss policy.

4.1. Theory

We shall concentrate here on a system where the government can both auction the right to sell a commodity and levy an excise or specific tax. The focus will be on three questions. What is the effect of an excise tax on price and profit? Second, what is the optimum combination of auction and excise taxes from the point of view of revenue and of social welfare? Third, how will price, demand and government revenue change in response to changes in variables, such as growth in income, or changes in parameters? The answers to these questions will depend critically on the post-licence market structure which will in turn depend on the details of the operation of the system, and the system itself will be the subject of policy choice. One has to consider in particular the market relations between licence holders and illegal sellers and amongst licence holders in different areas.

The questions that arise have not been studied in detail in public finance which has tended to concentrate on the case of specific or ad valorem taxes and perfect competition. At the same time the theory of oligopoly has seen major advances in recent years. The scope for productive research on public finance in imperfect markets is therefore substantial and the issues which arise from the operation of the system in practice in Karnataka pose some interesting questions for that research. This is not the place for an extensive analysis [see Stern (1987) for some examples] and we shall concentrate on some simple cases. Nevertheless the results provide some important lessons.

We begin with the question of the appropriate design of licences and the appropriate combination of auction revenue and specific taxation of commodities. It is assumed that agents do not collude in the auction. The Gulati Report (p. 141) argued that competition in the auctions was 'stiff' and it was not easy for licence holders to maintain their contract from year to year (the auction for each district takes place in April or May). The Government can enter its own bid which acts as a floor on the auction price. The intensity of the auctions is also described in Bhaktavatsala (1981a, b, 1983). We shall suppose that there is no evasion of the excise tax by licence holders. We consider first the case where the illegal sector can be ignored. We go on to consider competition from that sector below.

Where the aim is the maximisation of government revenue the optimum policy is straightforward. The government should issue a single licence, establishing a monopoly, and levy no excise taxes whatsoever. The reason is that the auction plus excise tax revenue will be equal to pre-tax pure profits if the auction is fair. This is clear in the absence of excise taxes. With excise taxes the government receives an auction revenue of post-tax pure profit plus excise tax revenue, the sum being pre-tax pure profit. This pre-tax profit is at least as great with a single firm as with many firms if we suppose that any output and cost available to several firms could be replicated by the single firm. Thus there should not be more than one licence. Further, any tax

which changes output from the level associated with unconstrained profit maximisation cannot increase pre-tax pure profits.

The above argument is rigorous but it may be helpful if it is expressed formally. In the case of a single firm let $\Pi(x)$ be the pre-tax pure profit associated with output x. In the absence of excise taxes let the chosen output be x^* and with excise taxes of t per unit let the chosen output [maximising $\Pi(x)-tx$] be x'. Then from the maximisation,

$$\Pi(x^*) \geqq \Pi(x') \tag{5a}$$

and

$$\Pi(x')-tx' \geqq \Pi(x^*)-tx^*. \tag{5b}$$

The government tax revenue with excise taxation when the output level is x is $\Pi(x)-tx$, post-tax profits (from the auction of the licence), plus tx, the excise tax revenue, i.e., $\Pi(x)$. Thus (5a) tells us that it is revenue maximising to have no commodity taxes. Also $\Pi(x^*) \geqq (\Pi(x')-tx')+tx'$ from (5a) so that any linear tax t which allows positive post-tax profit must raise less revenue than $\Pi(x^*)$. Hence we cannot, for example, directly compare the competitive (taxed) solution with the monopoly auctions since the former cannot achieve as much revenue.

Eqs. (5a) and (5b) together show that if $t>0$,

$$x^* \geqq x'. \tag{6}$$

This is the familiar result (and the standard proof) that commodity taxation reduces the output of the monopolist and thus raises the price to the consumer (similarly a subsidy increases the output and reduces the consumer price). This points us to the appropriate policies for criteria other than the maximisation of auction plus tax revenue.

The government may be interested in the welfare of consumers as well as in government revenue. Notice that the government takes all pure profit so the traditional criterion of consumer surplus plus producer surplus plus government revenue reduces to consumer surplus plus government revenue. If the government is interested in maximising this latter sum then the optimum policy is the auction granting a monopoly together with a subsidy to the producer so that the consumer price is equal to marginal cost. If the marginal cost is c then the standard pricing rule for the profit-maximising monopolist yields eq. (7),

$$p=\frac{c+t}{1-1/\varepsilon}, \tag{7}$$

where ε is the elasticity of demand at the profit-maximising output. As usual we need $\varepsilon>1$, a point to which we shall return.

If, at the optimum, p is to be equal to c then we have the optimum tax t^* given by (8),

$$t^* = -c/e, \tag{8}$$

i.e., a subsidy equal to marginal cost divided by the elasticity of demand. All this is the very familiar rule of price equal to marginal cost for the public enterprise – in this case we merely have a slightly unusual way of achieving it through the auction which grants a monopoly, then a subsidy. Typically, if there are fixed costs, net government revenue will be negative, i.e., the cost of the government subsidy will exceed the auction revenue.

The example of alcohol may, however, not be one where the government wishes to weight consumer surplus equally to government revenue, indeed it may not wish to give consumer surplus from alcohol any weight at all. Alcohol may be the opposite of a 'merit good', i.e., the government may desire to actively discourage it. If this is the case and consumer surplus from alcohol enters negatively into the criterion, then in addition to the auction there should be a tax which will, as we have seen, reduce sales. The tax implies lower total revenue to the government than the pure auction but has the advantage, under these assumptions, of reducing consumption. As we have seen, if the consumer surplus is merely omitted from the criterion, then there should be neither a tax not a subsidy.

We turn now to competition between the legal and illegal sectors. The government's judgement of the appropriate price and tax policy will now be influenced by the effect of these variables on evasion and adulteration. The higher the price the greater the incentive to illicit production and evasion and the associated dangers may influence the government to lower prices from the monopoly level even it it has no desire to weight consumer surplus positively. The government may be unable to subsidise sales for political, legal or administrative reasons (e.g., if there were a subsidy evidence might be produced to make non-existent transactions appear as sales in order to gain the subsidy). Where the government cannot subsidise any concern to lower price from the monopoly level might have to be met by other means. One possibility would be to regulate the price and insist that demand be satisfied at that price. Granting a licence for longer periods may improve quality, at least in the early part of the period, if the seller wishes to establish a reputation. However, the problem of the high monopoly price encouraging the illegal sector would remain and an alternative would be to grant more than one licence.

4.1.1. Competition

The presence of the illegal sector and the possibility of more than one licence leads us to consider alternative market structures. We shall consider

first non-spatial oligopoly and then spatial oligopoly. The prime motivation for the first is the existence of competition between legal and illegal sectors in any given area. The reason for considering the second is that the licence grants the right to sell alcohol for a particular area. The area of a licence for arrack (1981) is a taluk (a sub-division of a district) and for toddy is a district (there are 175 taluks and 19 districts). The average population of a taluk is in excess of 200,000 people and for a district around 2 million. There are several shops in any given taluk. A given bidder can buy the licence for more than one taluk although it seems rare for the area controlled by any individual or group to spread across districts. In principle it would be possible for someone to secure the monopoly for the entire state by outbidding those who might try for smaller areas and who might have to suffer spatial competition. This state level monopoly does not arise, however. There presumably exist local knowledge and networks which allow local bidders a cost advantage. Also, an attempt to establish very large areas might lead to adverse publicity and thus be pre-empted by administrative or political intervention. The size of the area (between a taluk and a district) is therefore substantial and there is a considerable element of local monopoly. One does, however, have to consider the possibility of some form of competition at the boundaries of areas.

4.1.2. Non-spatial competition

We think in particular of the competition between the licence holder and the illegal sector, although some versions of the model could describe the competition between many licence holders in the same area, should more than one licence be given. The prices and quantities which emerge will depend on the conduct of the game between the sellers. If there is a single licence holder in competition with the illegal sector then the outcome will depend on whether the licence holder correctly perceives the behaviour of the illegal sector. If he does predict correctly then the previous analysis of monopoly goes through with the demand interpreted as the residual demand facing the licence holder after allowing for sales by the illegal sector. Thus for any given price from the licence holder there will be a given level of legal and illegal demand. He correctly perceives the former and acts to maximise profits given that demand curve. From the point of view of maximising tax revenue, therefore, the optimum policy is as before, to auction the licence and have no excise taxation. Tax revenue would be increased by stricter controls on the illegal sector. As we have noted the government may be concerned with limiting the incentive to illegal production and may, therefore, wish to reduce price from the monopoly levels.

The licence holder, however, may only be able to conjecture the response of the illegal sector. To illustrate what might then happen we consider a simple model of conjectural variation. We use one which is now fairly

standard [for a description and discussion, see e.g., Dixit and Stern (1982)]. We suppose that there is a homogenous product and a fixed number of n firms indexed $i=1,2,\ldots,n$. We may wish to think, in particular, of the two-firm case, one legal and the other illegal (we could think of an illegal bottle being worth some fraction of a legal one to preserve the homogenous product assumption). Each firm conjectures that other firms will increase output by $\alpha\%$ if its output increases by 1%. The Cournot–Nash assumption is $\alpha=0$. The marginal cost of firm i is c_i (which includes any specific tax). It is fairly easy to show that the price p will be [see, e.g., Dixit and Stern (1982)] in equilibrium

$$p=\frac{\bar{c}}{1-\gamma/\varepsilon}, \tag{9}$$

where $\gamma=\alpha+(1-\alpha)/n$, $\bar{c}$ is $1/n\ \sum_i c_i$ and ε is the market elasticity of total demand. Note first that increasing the number of firms lowers the price (given $\bar{c}$), and second that equilibrium requires $\varepsilon>\gamma$ but that this can be consistent with $\varepsilon<1$.

We can also ask what happens to pre- and post-tax profits when we introduce an excise tax t per unit. Recall that the government's total revenue under the combined auction and excise tax system is *pre-tax* profits but also note that revenue comes only from those firms involved in the auction and subject to the tax and not from the illegal sector.

We consider first the case where *all* firms have to pay the excise tax. Seade (1985) has shown, using some plausible examples, that it can happen that post-tax profits, both in total and for each firm, increase as a result of increasing tax. Intuitively the tax pushes up price closer to the monopoly level below which it is held by the competition; and this price increase is larger the more the elasticity of demand falls with the price increase. The effects can be large enough to increase post-tax profits. If post-tax profits increase with the introduction of the tax, then total government revenue must increase since this is the sum of post-tax profits (auction revenue) and excise tax revenue. Of course the class of cases where pre-tax profits increase as a result of excise tax is much wider than that for post-tax profits. Indeed in this type of model it would be generally true that total pre-tax profits will rise. The reason is that the tax increases market price, moving it in the direction of the monopoly price. Hence, even though auction revenue or post-tax profits might fall, the excise tax would more than offset the loss of auction revenue.

One can also show that post-tax profits for one firm may increase when an excise tax is imposed *only* on that firm. Similar effects arise in that the overall market price is increased, although in this case the range of parameters for which post-tax profit of the given firm increase with the tax is much narrower. It is also no longer generally true that there will be a rise in

the pre-tax profits of the single firm which is taxed although the parameter range for which this holds is obviously wider than for an increase in post-tax profits.

For the model we have described it is straightforward to illustrate the results just mentioned. If $\hat{\Pi}_i$ is the profit (after excise tax) of the ith firm and X is total market demand one can show, after some manipulation, using the equilibrium condition (9) and the implied output for each firm, that

$$\frac{1}{X}\frac{\partial \hat{\Pi}_i}{\partial c_i}=\frac{1}{n^2(1-1/n\varepsilon)}\left[-2n+\left(2-\frac{1}{n}\right)\left(1+\frac{1}{\varepsilon}\right)\right], \tag{10}$$

where we start from a position where $c_i=c$ for all i and move c_i holding c_j constant for $i\neq j$ (and we have assumed $\alpha=0$, so that $\gamma=1/n$, and that ε is constant). From (9) we require $1-1/n\varepsilon$ to be positive and thus $\partial\hat{\Pi}_i/\partial c_i$ is positive if

$$\left(1+\frac{1}{\varepsilon}\right)\left(2-\frac{1}{n}\right)>2n. \tag{11}$$

If, for example, $n=2$ as in the case of a single licensed firm competing with an illegal firm, we have

$$\tfrac{1}{2}<\varepsilon<\tfrac{3}{5} \tag{12}$$

as the range of ε for which post-tax profits of the single firm increase with the imposition of the tax [the l.h.s. inequality comes from $1-1/n\varepsilon>0$]. See Seade (1985) for an analysis of some more general cases.

If we are considering pre-tax profits, then the relevant expression is $\partial\hat{\Pi}_i/\partial c_i+x_i$ where x_i is the output of the ith firm since the rate of change of the excise tax revenue with a tax on a single firm (starting from a zero level) is simply x_i. A little manipulation shows that

$$\frac{1}{X}\left(\frac{\partial \hat{\Pi}_i}{\partial c_i}+x_i\right)=\frac{n-1}{n^3(1-1/n\varepsilon)}\left[-n+1+\frac{1}{\varepsilon}\right], \tag{13}$$

under the same assumptions as before. The condition for pre-tax profits to increase is

$$1+1/\varepsilon>n, \tag{14}$$

where again we need $1-1/n\varepsilon>0$ from (9). The conditions for $n=2$ become

$$\tfrac{1}{2}<\varepsilon<1, \tag{15}$$

so that the range, whilst still small, is substantially wider than (12). Thus whilst it is likely that the imposition of an excise tax on the single licensed form will decrease total revenue (auction plus excise) it is not guaranteed. Notice that the upper limit in (15) is close to our estimated elasticity.

4.1.3. Spatial competition

We again keep the models very simple to bring out some central issues. We consider an infinite line (or equivalently a circle) with a density of consumers of D. There is a fixed number of producers a distance $2R^*$ apart. Each producer chooses a price and consumers bear the transport cost which is t per unit quantity per unit distance. We suppose that the demand curve for an individual is linear and the quantity demanded by an individual distance r from a shop charging a price p is $a-b(p+rt)$. If the price charged by a given firm is p and that by the neighbour is $\bar{p}$ then the market radius $\hat{R}$ for the given firm is given by

$$p+\hat{R}t=\bar{p}+(2R^*-\hat{R})t \tag{16}$$

or

$$\hat{R}=R^*+\left(\frac{\bar{p}-p}{2t}\right). \tag{17}$$

In the case where R^* and $\bar{p}$ are sufficiently high that the firm acts like a monopolist we have the radius determined by the distance R^0 where demand becomes zero, i.e.,

$$R^0=\frac{1}{t}\left(\frac{a}{b}-p\right). \tag{18}$$

If $\hat{R}>R^0$ we have monopoly and if $\hat{R}<R^0$ we have the potential for competition between neighbours.

We can now draw the perceived demand curve for a firm which believes that its neighbours will not change their prices. We consider the case where each of the two neighbours charges the same price. Where the market area is radius R, demand for a firm's output when price is p is

$$2D\int_0^R [a-b(p+tr)]\,\mathrm{d}r \tag{19}$$

or

$$2D(a-bp)R-DtbR^2. \tag{20}$$

When R is $R^0(<\hat{R})$, the monopoly case, or case M, demand is, using (18),

$$(a-bp)^2\frac{D}{bt}. \tag{21}$$

If $\hat{R}<R^0$, the competitive case, or case C, demand is, using (17),

$$D\left[R^*+\left(\frac{\bar{p}-p}{2t}\right)\right]\left[2a-btR^*-\frac{b\bar{p}}{2}-\tfrac{3}{2}bp\right]. \tag{22}$$

The borderline case is where $\hat{R}=R^0$, i.e., where the price is $\tilde{p}$,

$$\tilde{p}=\frac{2a}{b}-2tR^*-\bar{p}. \tag{23}$$

We have on differentiating (21) and (22), respectively, that ($1/D$ times) the derivative of demand with respect to p at the borderline is $-4bR^*+(2b/t)(a/b-\bar{p})$ for both case M and case C. On the other hand ($1/D$ times) the second derivative is $2(b/t)$ for case M and $(3/2)(b/t)$ for case C.

At the borderline therefore the perceived marginal revenue curve has a kink as illustrated in fig. 1 although the demand, or average revenue, curve does not.

The borderline price, for given $\bar{p}$ and R^*, is given by (23). For the symmetric case, where the price is equal to the neighbours', $\hat{R}=R^*$ and $\tilde{p}=(a/b-tR^*)$. The demand and marginal revenue curves B for a given firm for prices below the borderline indicate the demand and marginal revenue corresponding to a mutual understanding of non-invasion by neighbours (so that perceived radius is R^*) – it represents the collusive solution for the fixed number of firms.

Salop (1979) produces an example with a kink in the *average* revenue or demand curve so that the marginal revenue curve is discontinuous. He uses a demand behaviour which involves each consumer buying a fixed amount subject to some cut-off price. The cut-off price is given exogenously in the monopoly case or by the neighbours' price (if this is lower than the exogenous cut-off). The market radius R then gives us the demand and it is easy to see that $\partial R/\partial p$ for the monopoly case is $-D/t$ and for the competitive case is $-2D/t$ [see eqs. (18) and (17)]. Thus, there is a kink in the demand curve shown in fig. 2.

If the marginal cost curve (including the excise tax) cuts the marginal revenue curve to the right of the borderline, then we have a competitive solution if firms make the Cournot assumption with respect to prices (on curves C), and the collusive solution (on curves B) if the firms have an

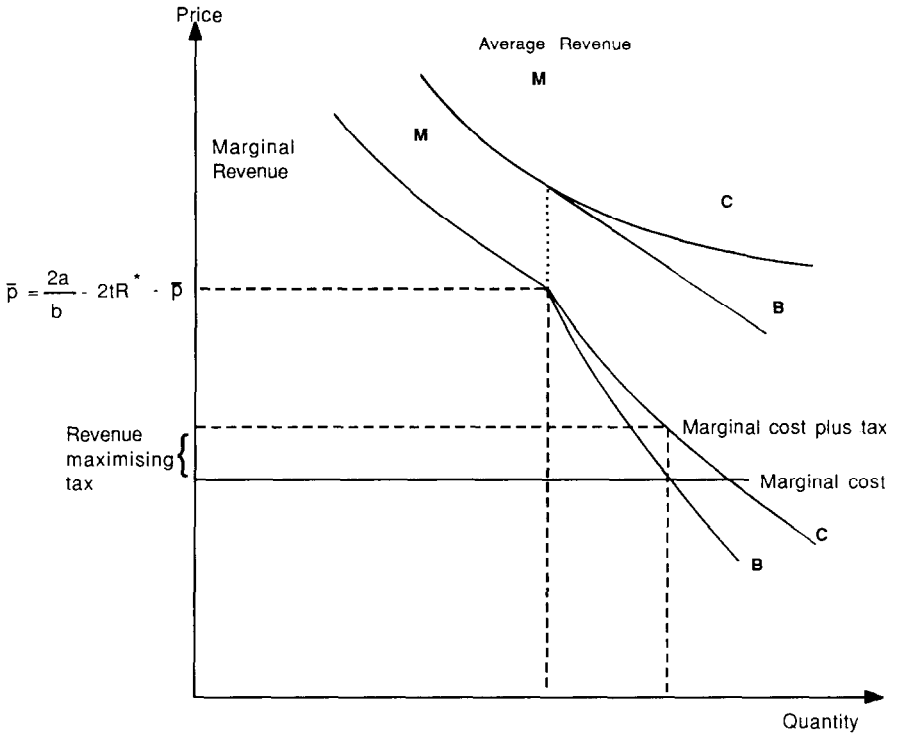

Fig. 1. Perceived demand and marginal revenue curves in the spatial case. *M* denotes the monopoly case where demand is zero for an interval between neighbours so they act like monopolists. *C* denotes the case where there is a competitive borderline at which the delivery price is the same for both firms. Each firm acts as if its neighbour will not change prices. *B* denotes the case where there is a mutual understanding of non-invasion by neighbours, or multi-plant monopoly.

understanding of non-invasion. If the marginal cost curve cuts the marginal revenue curve to the left of the borderline we have the monopoly solution.

We can now ask what happens to price and pre-tax profits (as before, auction revenue plus excise tax) when we impose an excise tax. For fig. 1 (with a downward sloping individual demand curve) we see that to the right of the borderline, price increases less in the collusive case (*B*) than under the competitive case (the reduction in quantity along marginal revenue curve *C* is greater). Along curve *C*, however, pre-tax profits rise as a result of the price increase since this represents a move towards the higher prices and profits associated with the collusive case. This remains true until the tax reaches the point (see fig. 1) where the price is at the collusive level. For higher taxes pre-tax profits decline. To the left of the borderline, on the other hand, the standard monopoly argument applies and pre-tax profits fall with

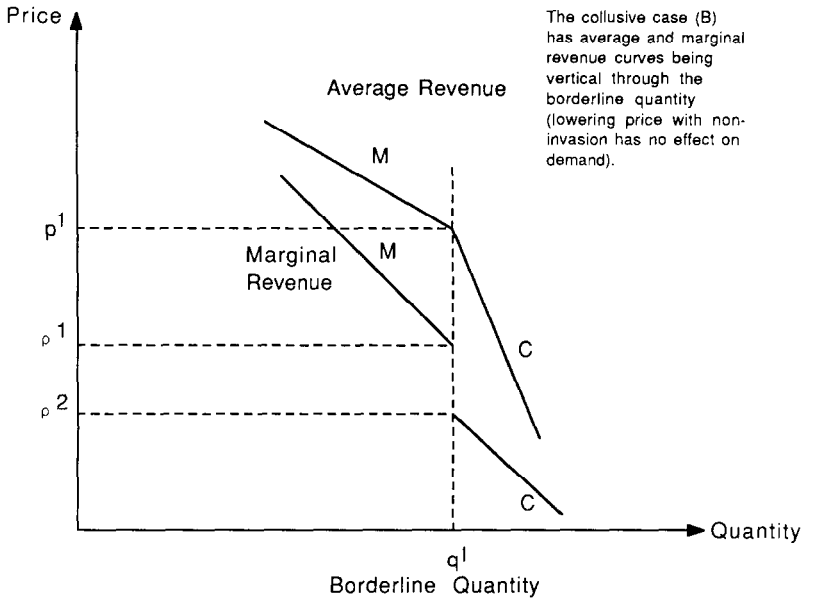

Fig. 2. Perceived demand and marginal revenue curves: Salop example. See the caption of fig. 1.

the imposition of a tax. Plotting pre-tax profits against the tax for a low marginal cost in fig. 3a we have the situation illustrated. Where marginal cost is high we have the situation illustrated in fig. 3b.

In the Salop case the collusive price is p^1 (see fig. 2) for all marginal costs below ρ^1 since the B average and marginal revenue curves are vertical through q^1. If the marginal cost is above ρ^1 then the usual monopoly arguments apply. Hence for spatial competition with the Salop demand curve and marginal cost less than ρ^2, we have pre-tax profits rising with the excise tax until marginal cost plus excise tax is equal to ρ^2 and the situation for low marginal cost is sketched in fig. 4a. For marginal cost above ρ^1 we have the situation sketched in fig. 4b.

4.1.4. Summary of results on pre-tax profits and excise taxation

We can now summarise our results relating pre-tax profits (total government revenue, auction plus excise) to the excise tax.

Monopoly: excise taxation reduces governemnt revenue.

Non-spatial oligopoly with all firms taxed: excise taxation increases government revenue.

Non-spatial oligopoly with one *firm taxed* (*one licence holder plus illegal competition*): correct perception by licensed firm of illegal sector implies

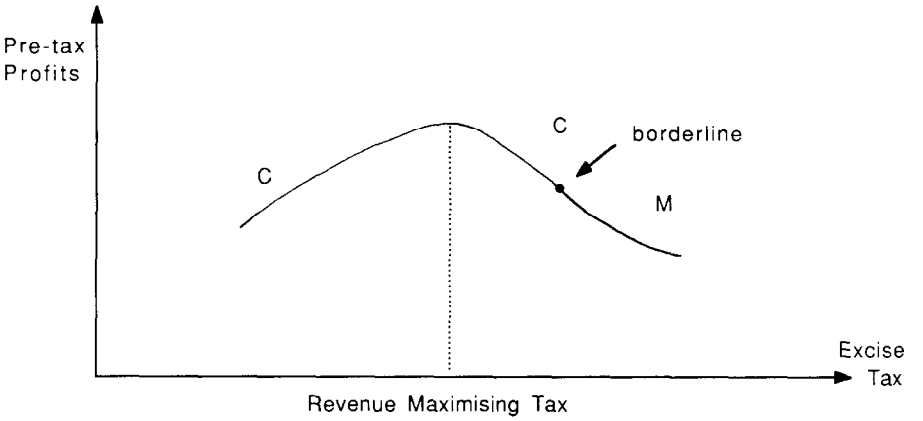

Fig. 3a. Pre-tax profits as a function of excise tax for low marginal cost. See the caption of fig. 1.

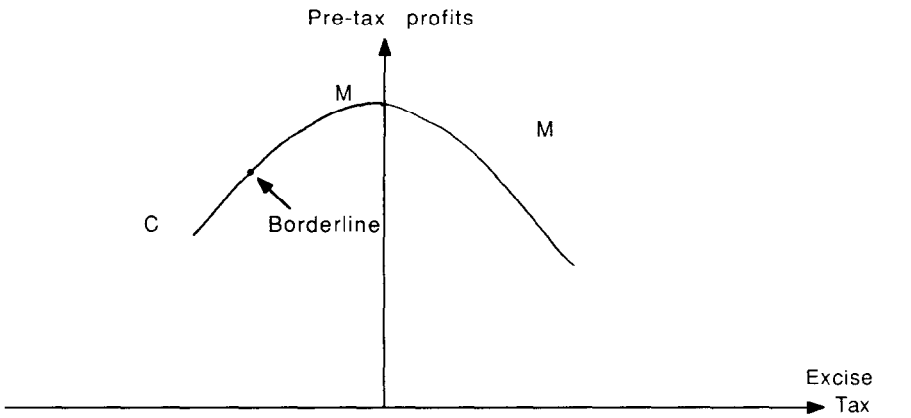

Fig. 3b. Pre-tax profits as a function of excise tax for high marginal cost. See the caption of fig. 1.

excise taxation reduces revenue: in conjectural variation model excise taxation usually (but not always) decreases government revenue.

Spatial oligopoly: for low marginal cost the imposition of an excise tax will increase government revenue up to the point where the price is that which would be chosen by collusive firms.

It is clear therefore that the selection of a policy to maximise government revenue will require careful consideration of market conditions, the size and behaviour of the illegal sector, the shape of market demands, the level of marginal costs and the perceptions of licensed firms concerning the illegal

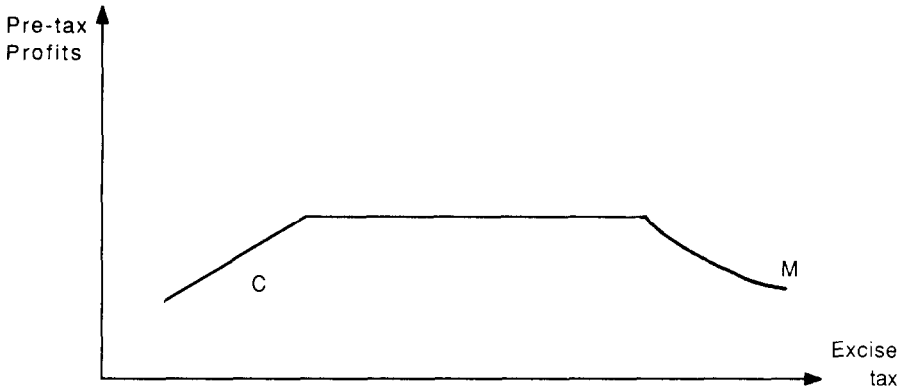

Fig. 4a. Pre-tax profits as a function of excise tax: Salop example, low marginal cost. See the caption of fig. 1.

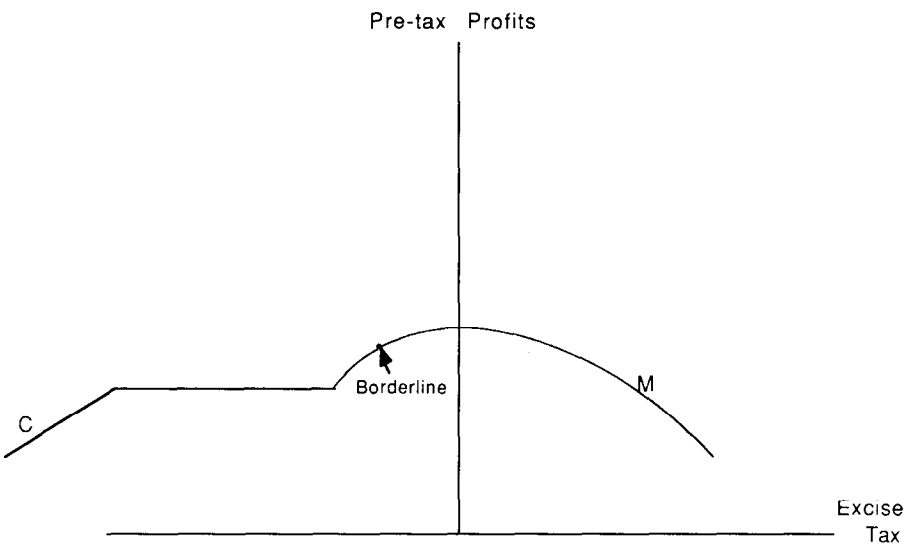

Fig. 4b. Pre-tax profits as a function of excise tax: Salop example, high marginal cost. See the caption of fig. 1.

sector and their neighbours. In our judgement the situation in Karnataka is probably best modelled by a non-spatial oligopoly with one legal and an illegal sector with moderate, but probably not critical, spatial competition. It is probably also likely that the licensed firm acts as a price leader with a fairly accurate anticipation of the response of the illegal sector. Hence we would argue that the lessons from the simple monopoly model concerning revenue

maximisation and social welfare may not be misleading for Karnataka. Thus revenue maximisation would lead to total reliance on auctions whereas a concern for quality and social welfare would lead to some price control and lower auction revenue. The direction of taxation and revenue in the 1970s with its switch towards the auction and the rapid increase in revenue (see section 4.2 below) would appear to indicate that the Karnataka authorities may have moved towards the revenue maximising solution. Bhaktavatsala (1981a, b, 1983) has argued in the Indian press that this move has had very serious consequences in terms of illegal sales and adulteration. These have sometimes been fatal.

Before leaving our discussion it is important to note that the outcome from auctioning monopoly licences could be achieved directly by the government itself acting as a monopolist. This has the possible advantage of greater quality control. Further, as we saw in section 3 it is possible that the separate tax and price effects on measured demand under the current system lead to a perceived price elasticity by the private monopolist to be less than that which would be seen by the government. Both the government and the monopolist would face the problem of illicit sales but the monopolist may perceive and consider only the price effect on demand in choosing his price. For the government the perception would be in terms of the overall price and there would be no separate elements. This difference in perception might lead to lower prices under the government monopoly, to higher revenue, and to less evasion and illicit production.

4.1.5. Effect of income on tax revenue

The last set of issues in this section concern the measurement of the response of tax revenue to parameter and variable changes. The particular example we have in mind is the effect of income changes on tax revenue. The familiar competitive model where we have a single good, a specific tax t, fixed producer prices, market demand $x(p, M)$ where p is the (exogenous) price and M income, and R is revenue (tx), yields

$$\frac{\partial R}{\partial M} = t\frac{\partial x}{\partial M} \tag{24}$$

or

$$\frac{M}{R}\frac{\partial R}{\partial M} = \frac{M}{x}\frac{\partial x}{\partial M}, \tag{25}$$

which is simply the income elasticity of demand. Hence estimates of the latter give us directly the revenue elasticity with respect to income. Notice that a constant supply price fixes p, for given t, thus justifying the assumption that p is independent of M. Where licences are auctioned the above derivation

does not apply since the price set by the licence holder will itself depend on M and government revenue includes that from the auction as well as tx.

As an example we consider the case where a single licence is sold granting a monopoly and there is no commodity taxation. Let the profits of the monopolist (i.e., the government revenue from auctioning the licence) be $\Pi(p, M)$ when price is p and income is M. The elasticity of tax revenue with respect to income is now $(M/\Pi)/(\mathrm{d}\Pi/\mathrm{d}M)$, where we now have to recognise that the price is endogenous. The total derivative $\mathrm{d}\Pi/\mathrm{d}M$ is

$$\frac{\mathrm{d}\Pi}{\mathrm{d}M}=\frac{\partial\Pi}{\partial p}\frac{\mathrm{d}p}{\mathrm{d}M}+\frac{\partial\Pi}{\partial M}, \tag{26}$$

which is equal to $\partial\Pi/\partial M$ (the familiar envelope theorem) since profit maximisation yields $\partial\Pi/\partial p=0$. If there are fixed costs K and constant marginal costs c, then

$$\Pi(p, M)=px(p, M)-cx(p, M)-K \tag{27}$$

and

$$\frac{\partial\Pi}{\partial M}=(p-c)\frac{\partial x}{\partial M}=\frac{p-c}{p}\frac{\partial(px)}{\partial M}=\frac{1}{\varepsilon}\frac{\partial(px)}{\partial M}. \tag{28}$$

Thus the rate of change of profit with income is the expenditure share divided by the price elasticity. Hence,

$$\frac{M}{\Pi}\frac{\partial\Pi}{\partial M}=\frac{M}{x}\frac{\partial x}{\partial M}\cdot\frac{(p-c)x}{\Pi}. \tag{29}$$

This will exceed (in absolute magnitude) the income elasticity $(M/x)(\partial x/\partial M)$ provided $K>0$ since the factor $(p-c)x/\Pi$ is 'variable' profit divided by total profit and is greater than one.

A similar analysis can be constructed of the variation with M of tax as a proportion of price, i.e., (Π/px). At constant producer prices in the competitive model we would have t/p independent of M but here the relationship will be quite complicated since it will involve second derivatives of the demand curve. If these are ignored then both $\mathrm{d}p/\mathrm{d}M$ and $\mathrm{d}/\mathrm{d}M$ (Π/px) have the same sign as $\partial x/\partial M$.

Given that Karnataka moved from specific taxes to auctions over the 1970s it is interesting to ask how tax as a proportion of the price differs between the two schemes. If a specific tax t is chosen to maximise revenue tx then the first-order condition for maximisation can be written

$$\frac{t}{p}=\frac{-x}{p(\mathrm{d}x/\mathrm{d}t)}. \tag{30}$$

Where we have perfect competition and fixed producer prices the r.h.s. is simply $(1/\varepsilon)$ where ε is the elasticity of demand. Where x is chosen by a profit-maximising monopolist then, differentiating the first order condition for profit maximisation, we have

$$\frac{dx}{dt} = \frac{1}{2p' + xp''}, \tag{31}$$

where p', p'' are the first and second derivatives of the inverse demand curve.

We wish to ask whether t/p given by (30) and (31) is greater or less than tax as a proportion of price under the auction system, i.e., (Π/px) where Π is the maximum monopolist profit. Thus we ask whether

$$\frac{-x^T}{p(x^T)}(2p'(x^T) + x^T p''(x^T)) \gtrless \frac{p(x^*) - c}{p(x^*)} - \frac{K}{p(x^*)x^*}$$

$$= \frac{1}{\varepsilon} - \frac{K}{p^*(x^*)x}, \tag{32}$$

where the l.h.s. is evaluated for the output x^T associated with the specified tax system and the r.h.s. for the output x^* for the standard monopoly solution.

For certain special cases this answer is straightforward. An example is the isoelastic demand curve: the l.h.s. becomes $1/\varepsilon(1 - 1/\varepsilon)$. Hence in this case the tax as a proportion of price is higher for the revenue maximising system with specific taxes than it is for the auction if $\varepsilon^2 > p(x^*)x^*/K$. We have already seen that tax revenue and output are higher in the latter system. Notice that x^* and ε are independent of K; hence it will be possible to choose positive K such that the condition goes either way. The share of tax in price will be greater for the specific tax case than for the auction if ε and K are both high.

4.2. Policy in Karnataka

The sources of revenue are set out in table 7 which is taken from the Gulati Report (pp. 152–153). It can be seen that the most important items in recent years were the 'shop rents' for arrack and toddy. These are 'the collections made from lessees who are given the exclusive right to vend toddy or arrack in any particular area. Every year in the month of April or May the exclusive right to vend toddy/arrack in the several taluks of the State is sold by public auction' [Gulati Report (p. 139)]. Actually toddy licences are given by district and arrack by taluk (a sub-division of the district). The shop rents have increased considerably in importance in revenue in recent years and in 1980/81 accounted for Rs. 57.76 crore in a total of Rs. 92.61 crore, i.e.,

Table 7

Revenue receipts under state excise (rupees in crores).[a]

	68–69	69–70	70–71	71–72	72–73	73–74	74–75	75–76	76–77	77–78	78–79	79–80	80–81
Country spirits (arrack)													
Duty	2.91	2.93	2.29	1.77	1.68	1.82	6.91	8.77	7.89	10.37	8.10	7.92	9.27
Shop rent	2.42	3.70	4.74	7.41	11.90	15.35	17.49	19.18	21.33	19.70	25.94	33.78	43.04
Sale of arrack	1.86	3.31	3.73	5.22	6.01	7.96	7.78	7.47	6.28	7.45	6.53	6.60	8.24
Licence fees	0.35	0.46	0.77	0.42			0.20	0.02	0.13	0.29	0.03		0.01
Deduct refunds					0.01		0.03	0.01					
Total – I	7.54	10.40	11.53	14.82	19.58	25.13	32.35	35.43	35.63	37.81	40.60	48.30	60.56
Country fermented liquor (toddy)													
Shop rent	1.86	3.48	3.71	3.99	5.53	6.35	6.67	8.64	7.81	10.02	10.82	11.65	14.72
Tree tax	0.50	0.58	0.68	0.94	0.35	0.38	0.34	0.30	0.50	0.48	0.37	0.16	0.49
Tree rent	0.10	0.18	0.20	0.20	0.01	0.04	0.04	0.04	0.20	0.07	0.06	0.01	0.02
Deduct refunds													
Total – II	2.46	4.24	4.59	5.14	5.89	6.77	8.05	9.02	8.51	10.57	11.25	11.82	15.23
Malt liquors (beer)													
Beer duty	0.19	0.19	0.31	0.81	0.59	1.22	1.41	1.12	1.25	0.87	1.86	2.41	1.99
Licence fee	0.14	0.29	0.29	0.38		0.05	0.08	0.09	0.38	0.36	0.05	0.02	0.06
Beer tavern rentals					0.06	0.04	0.24	0.15	0.12	0.07	0.03		
Total – III	0.33	0.48	0.60	1.19	0.65	1.31	1.73	1.36	1.75	1.30	1.94	2.43	2.05
Foreign liquors spirits. Licence fees from:													
Distilleries licence & other fees	0.01	0.02	0.02	0.01	0.04	0.02	0.03	0.01	0.05	0.23	0.07	0.11	0.12
Licence & other fees of foreign liquor	0.35	0.18	0.18	0.20	0.62	0.70	0.74	1.25	1.45	2.26	1.81	2.33	3.52
Wine tavern rentals								0.01	0.01				
Duty in IML	1.04	1.10	1.56	1.63	2.47	2.84	4.03	4.50	3.63	2.75	5.62	7.52	11.13
Deduct refunds							0.01	0.07	0.02				
Total – IV	1.40	1.30	1.76	1.84	3.13	3.56	4.89	5.70	5.17	5.24	7.50	9.96	14.77
Total state excise	13.2	17.98	19.73	23.56	29.68	37.64	47.54	52.01	52.27	56.24	62.60	74.00	94.13

[a]*Source*: Gulati Report (Part 1). Total includes commercial spirits, medicinal preparations and drugs.

62.4%. Apart from arrack and toddy the main source of revenue is IML, the receipts from which come largely from duty (once a licence to sell IML is granted it is usually continued and is subject to a specific fee). Revenue from the sale of arrack arises from production by the State at plants usually attached to sugar factories. The State also licenses private production under controlled conditions. There is also state sales tax on alcohol but it is largely avoided and revenue is negligible [see Gulati Report (pp. 72–77)].

The Excise Department estimates [Gulati Report (p. 144)] that roughly Rs. 10–12 crores of excise revenue might be evaded through in part, we presume, avoidance of duty and purchase price and falsifying of records in the licensed production and distribution, on units public and private. As a proportion of total revenue this may appear fairly small and it is clear that a greater reliance on the auction system diminishes the need for enforcement of tax collection. Indeed if there was a complete reliance of the system then there would be no tax collection although the liquor could still be stolen from government establishments. Possibilities for avoiding shop rents may be more limited since the auctions are public (but there is still scope for falsifying records).

Illicit production is a different problem and it would not be straightforward to estimate its extent, although it must be large, and is facilitated by the extensive local production in rural areas of local raw sugar, gur and khandsari. Illicit sales of liquor from controlled plants through informal outlets have the effect, one presumes, of lowering auction revenue since they diminish the market and increase elasticity of demand for sales from licensed shops. Uncontrolled production and adulterated liquor through whichever outlet can be fatal since the substances produced or introduced can be highly toxic. Adulteration and evasion may go hand in hand where substances are added to alcohol produced in licensed plants.

In the light of the pattern and growth of revenue described in table 7 and the problems of evasion and illicit production we shall, in this sub-section, consider three issues: first, the intertemporal relation between revenue and income, the traditional concept of buoyancy; second, the connections between our demand estimation of section 3 and the theory of section 4.1; and third, policy in Karnataka in relation to the theory, estimates and experience.

The rapid growth in state excise revenue at current prices at a time of rapidly growing money income might be taken to suggest that state excise responds, in revenue terms, very favourably to rising incomes. And the Gulati Report, using simple regressions of the logarithm of revenue at current prices against the logarithm of state domestic product (SDP) at current prices, showed that of all the state taxes the state excise had the highest coefficient on the logarithm of SDP ('buoyancy' at 1.88 with that for arrack being 2.30 [Gulati Report (pp. 23–25)]). However, as we shall see, a closer look at the relationship indicates a small responsiveness of real

revenue to real income and a strong time trend. This is more consistent with our earlier analysis (section 3) of demand relationships and the changing policy towards alcohol taxation (see below) with a switch towards auctions as the primary revenue source.

We show in eqs. (33) to (35) the effects of using constant prices and allowing for serial correlation and a time trend for all excise revenue from 1960/61 to 1979/80. First we present simple regressions of revenue at current prices against SDP (a standard 'buoyancy' treatment), we then use constant as opposed to current prices and allow for serial correlation using the Beach–MacKinnon method and finally introduce a time trend. It can be seen that a simple buoyancy treatment is very misleading and one suspects that this is true of many standard buoyancy analyses.

The data sources were described in section 2 and for these estimations we are able to use 20 annual observations (whereas for data reasons we are limited to 10 in the demand analysis). The price index is the implicit deflator for SDP from the Bureau of Economics and Statistics (for comparison with the Gulati Report).

The variables are:

R – total excise revenue (constant prices),
RP – total excise revenue (current prices),
M – total SDP (constant prices),
MP – total SDP (current prices),
ρ – coefficient of serial correlation.

The standard 'buoyancy' treatment is

$$\ln RP = \underset{(19.56)}{-17.05} + \underset{(18.15)}{2.01} \ln MP,$$

$$R^2 = 0.95, \quad DW = 0.69. \tag{33}$$

Number of observations = 20 (1960/61 to 1979/80).

When we adjust for serial correlation and use constant prices we obtain

$$\ln R = \underset{(1.69)}{-9.89} + \underset{(2.16)}{1.29} \ln M,$$

$$\underset{(10.11)}{\rho = 0.94}, \quad \text{log likelihood} = 3.64. \tag{34}$$

Number of observations = 20.

Introducing a time trend we have

$$\ln R = \underset{(0.62)}{-4.02} + \underset{(0.85)}{0.58} \ln M + \underset{(3.12)}{0.096} \text{ time},$$

$$\underset{(5.97)}{\rho = 0.78}, \quad \text{log likelihood} = 7.06. \tag{35}$$

Number of observations = 20.

Our estimate in (33) is close to that of the Gulati Report; we obtain a coefficient on $\ln MP$ of 2.01 as opposed to 1.88. The Durbin–Watson clearly indicates positive serial correlation. This is reinforced by the value of ρ which is highly significant in both (34) and (35), demonstrating the danger of ignoring serial correlation. The use of constant as opposed to current prices does make a significant difference to (33) but not to (34) and (35). However, we are interested in real changes and so present the results using constant prices. The null hypothesis that a time trend should be omitted is rejected in the comparison of (34) and (35) and the difference between twice the log likelihoods is 6.30 as compared with a 5% Chi-square significance level with one degree of freedom of 5.02. The time trend seems to be accounting for most of the revenue increase and this we would suggest is associated with the policy change of switching from specific duties to auction revenues. Notice that the income term is insignificant, implying that one cannot assume from these results that an increase in real income will increase tax revenue. This is a radically different impression from that associated with eq. (33) and illustrates the dangers of simple buoyancy regressions. The adjustment for serial correlation and particularly for a time trend produces very big changes in results.

We turn now to the relation between the theory of section 4.1 and the estimates of section 3. The result in section 3.1 that the price elasticity of demand is around unity together with the significant elasticity, also around unity, for the tax as a proportion of price, has important implications for our view of the appropriate model. Ignoring the tax elasticity for the moment, the price elasticity of just above one is close to the borderline of the necessary condition for the maximisation of monopoly profits. However, as we noted in section 3.1, the determination of price through monopoly (and similarly oligopoly) is likely to imply that we have underestimated the elasticity. Hence, even though licences are sold annually for a monopoly of outlets in a taluk, some form of competition would have to be present. This could be of at least three kinds: (i) competition with outlets in nearby taluks, (ii) competition from potential bidders next year (if profits are seen to be too great the bids for licences next year might be higher), (iii) competition from the illicit sector.

The separate significance of the tax elasticity is a strong indication that the last explanation may be of importance. Competition from the illicit sector could not be ruled out, even if demand depends only on price and not on the tax, since a high price in the monopoly outlet would imply a strong demand from cheaper sources. However, high taxes increase the cost advantage of the illicit sector and may also imply that the licence holders themselves participate in the illegal production and sale. Their position as licensed sellers could clearly provide a cover for illegal activities.

We can now draw some tentative conclusions from our analysis concerning possible ways of raising extra revenue. First, the auction system for a single licence is in theory a more effective way of raising revenue than any combination of duties and licences. This seems to have been recognised by the authorities. The excise revenue (table 7) rose from Rs. 7.54 crore in 1968/69 to Rs. 60.56 crore in 1980/81 whilst prices rose from an index of 57.2 to 134.3 (using the consumer price index). This was accompanied by a substantial switch in source from duty to shop rent (or auction of licences): shop rent was only 32% of arrack revenue in 1968/69 but 71% in 1980/81. It is reasonable, therefore, to attribute the rapid increase in arrack revenue, to a large extent, to the switch from duties to the more efficient auctions. Given that the duty is still non-negligible (15.3% of revenue) it would appear that the State Government could go further and increase revenue by abolishing the duty altogether. Notice that the increase in revenue and the switch from duties to auctions were not accompanied by any increase in the proportion of tax in price (see table 3) and this is quite consistent with the theory which we examined in section 4.1.

Second, the revenue could be increased by reducing competition from illicit distillers. The resources for raising the level of surveillance might be available from the abolition of duty. And the monitoring of duty is in some respects more complex than identifying illicit production in that in the latter case one tries to trace its existence but in the former one actually has to measure. The identification of illicit production does have its own severe difficulties and one does not wish to make light of them but there would appear to be a case for switching resources from enforcement of duty to tracing illicit production. The former actually *reduces* total revenue (in the long run through loss of auction revenue) whereas the latter increases it.

Third, the government might consider licences giving monopolies for wider areas and longer periods. Again, these might increase auction revenue through a reduction in competition. One must be particularly cautious about this suggestion, however, because it might make the auction process itself more prone to corruption. It does, however, raise a question over the Gulati recommendation that toddy licences should be given for taluks (sub-divisions of a district) rather than whole districts. There may be a trade-off between the competitiveness in the auction (smaller areas may allow smaller and,

therefore more operators to participate) and the monopoly profits after the auction which point in the direction of larger areas to increase bids. A longer period for a licence would provide an incentive, at least at the beginning, to maintain quality.

Finally, we consider the effect of policy on illicit production and evasion. We have seen that a monopoly licence raises more revenue than a combination of duties and licences. Given that it results in lower prices than the duty-cum-licence system and that taxes are more easily evaded than the auctioned 'shop rents' it would appear likely to lead to less evasion and illicit production than would excise production. The problem is that there is an incentive for the revenue-maximising government to promise lax controls on licence holders in order to increase bids [see Bhaktavatsala (1981a, b, 1983)]. This may lead to cheating of the consumer by the sale of adulterated liquor in licensed shops. Further, the only relevance of illicit production to the monopolist is through his profits. Thus there may be a strong argument for *government* monopoly. In this case the government would obtain the revenue directly but would have a tighter control on price and quality and could set price with some concern for the size of the illicit sector. And as we have seen it is possible that the price set by the licence holder may be higher than would be chosen by the profit-maximising government since in the short run the licence holder would not consider, when fixing the price, the effect on demand of the tax element in the price – he would look only at the effect of price on demand. Thus the elasticity as perceived by the government may be higher than the licence holder's and lead to the government setting lower prices, and if it is correct, raising more revenue.

Hence when illicit production and evasion are taken into account it looks as though the best policy may be government-controlled outlets rather than the auction of licences. This could result in lower prices, more revenue and less illicit consumption. It is interesting that this is the proposal made by Bhaktavatsala (1981a, b, 1983) in his newspaper articles in the national press in 1981 after the liquor tragedy when hundreds were killed in Bangalore after drinking adulterated liquor and in 1983 when a report on the tragedy was submitted.

The problems of control of public production and sales and of illicit production would remain under this alternative system. But the direct involvement of the government would make control easier than under the auction of monopoly licences, the different perception of demand elasticities may tend to lower prices, and the concern for public health would be directly embodied in the responsibility of the seller.

5. Concluding comments

We have had three main objectives in this paper. The first was the investigation of the determinants of recorded demand for alcohol, and

particularly arrack, in terms of price and income elasticities, of the role of taxation and of household characteristics. Second, we wished to develop an analysis of some simple theoretical aspects of the revenue system in Karnataka, involving the auction of the monopoly right to sell in a district, and apply this framework using the econometric analysis of demand. And third, we combined these different elements to comment on policy in Karnataka. In pursuing these three objectives we hope to have demonstrated some techniques and provided insights which could be productively used for a range of important problems in developing countries.

The analysis of demand was based on an annual time series for the 1970s and two cross-sections of households, one for 1973/74 and one for 1977/78. In the time-series analysis the significant estimates were a price elasticity of demand, a little above unity, the tax proportion in the price, with an elasticity a little below unity, and a time trend. Income was not significant. It is striking that the tax proportion in the price was significant *separately* from the market price itself. This indicates the importance of the illicit sector and that the effect of a tax increase on demand may be strong since it would include both the tax and the price effect. The most important variables in the cross-section analysis were those distinguishing manual from non-manual and scheduled caste and scheduled tribes from others. In each case being a member of the former category seems to add at least eight percentage points to the probability of the household containing a drinker of arrack. The reported expenditure on drink seems difficult to explain in the cross-section and the precise level reported in a household is probably unreliable.

In the theory of the auction of monopoly prices we showed that the revenue-maximising policy was to auction the licence and impose no additional specific taxes. Such additional taxes would decrease revenue. If the government wished to attach positive weight to consumer surplus from alcohol then it would subsidise the price and if it attached negative weight it would levy additional taxes. If it regarded the monopoly price as too high but was unable to subsidise then there might be grounds for several licences. However, if price is not an issue then a single licence is superior in terms of revenue, provided the auctions can be kept competitive. If the main objective is revenue then enforcement resources should be concentrated on controlling the illicit sector, thereby increasing demand, profits and auction revenue from licensed shops, and specific taxes should be abolished. These results are sensitive to the model of monopoly or oligopoly which one uses but we argued that the situation in Karnataka for alcohol was such that these results were likely to be relevant.

A major qualification to this theoretical analysis arises from concern for the size of the illicit sector. From this point of view a government monopoly could provide all the revenue possibilities of the auction system whilst at the same time permitting better quality control, and enabling pricing policy to be

related directly to worries about the illicit sector. Given the role of the tax variable in the demand estimation it is possible that lower prices would result in both greater revenue and a smaller illicit sector. The time-series analysis of revenue suggested that the main cause of increased revenue over the past decade was the movement away from a duty based system to auctions. When time and autocorrelation were allowed for we saw that the role of income in the traditional tax-buoyancy analysis disappeared. It is possible that the treatment of time-series aspects could make crucial differences to the results of many such buoyancy analyses.

It is usually the case that policy recommendations depend on the viewpoint of the policy-maker and this is no exception. Thus it is not our job to make policy recommendations as such but merely to indicate the directions suggested by different considerations. If revenue is the primary consideration and the government does not wish to involve itself in the sale of alcohol them it may consider the following: (i) abolishing duties and relying entirely on auctions, (ii) reducing competition from illicit distillers, e.g., by greater surveillance, (iii) granting licences for wider areas and longer periods (provided auctions can be kept competitive). If the government is also concerned about the health risks from illicit drinking then government controlled outlets, lower prices, and greater surveillance of the illicit sector might provide protection from the physical dangers of adulterated or poisonous liquor.

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