# Price Elasticity Estimates for Tobacco and Other Addictive Goods in India*

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Working Paper Series No. WP-2005-003
August 2005

**Abstract**

*The tax base of tobacco in India is found to be heavily depended on about fifteen per cent of the tobacco users who represent cigarettes smokers. Non-cigarette tobacco products used by the majority of tobacco users are largely out of the tax net. Analysis of the price elasticity of various tobacco products would bring out the potential of tax as an instrument to control tobacco use of any kind. In this context, this paper examines how the demand for a variety of tobacco products and addictive goods such as pan and alcohol respond to changes in prices. The spatial variations of prices that are obtained from a cross section of 120,000 households spread across the country have been used for this purpose. Estimates of price elasticities showed that the own price elasticity estimates of various addictive goods in India ranged between* $-0.5$ *to* $-1.0$ *with bidis, leaf tobacco and alcohol having elasticities close to unity, cigarettes being the least price elastic of all. As against the general notions regarding the complementarity between cigarettes and alcohol, our study finds that these are substitutes at least in urban India. We also observed that, over a five year period, the addictive goods such as bidis and leaf tobacco in India have become slightly more price responsive while elasticity of cigarettes and pan have stabilized. With some assumptions, it is shown that taxes on cigarettes can be raised nearly 2.5 times the current level while that of bidis can be raised tenfold without any fall in revenue.*

**Keywords:** *Tobacco, Bidi, Cigarette, Alcohol, Consumption, Elasticity, India.*
**JEL Code:** C31, D12, H21, I18, R22

*This paper is a part of my ongoing Ph.D. thesis that I am presently pursuing at the Indira Gandhi Institute of Development Research, Mumbai. I am indebted to my thesis supervisors Dr. A. Ganesh Kumar, Prof. Kirit Parikh and my thesis committee member Dr. Joy de Beyer for their valuable comments and suggestions. I thank the participants of $67^{th}$ 'Health Economists Study Group Meeting', held at University of Newcastle upon Tyne, UK (29 June 2005), for their useful comments on an earlier draft of this paper. I have also benefited from the discussions with Cecily S. Ray. However all errors remain my own.

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# 1 Introduction

Tobacco has become the predominant cause of preventable deaths in the world (Reddy and Gupta, 2004). There is overwhelming evidence in the literature to prove the hazardous nature of tobacco use and a variety of diseases and disability associated with it. In India an estimated sixty five per cent of all men and thirty three per cent of all women consume some form of tobacco and India is home to nearly seventeen per cent of the smokers in the world (Shimkhada and Peabody, 2003). Estimates of household expenditure shares from the National Sample Survey (NSS) in India shows that expenditure on consumption of addictive goods account for 4.4 per cent of total budget of a household who choose to consume any of the addictive goods, in both rural and urban India. High prevalence of tobacco use coupled with a sizeable proportion of the family budget spent on its consumption will have far reaching implications on welfare of the public, in general, and the tobacco using households in particular.

The opportunity costs of spending on tobacco is very high especially for poor households. Busch *et al.* (2004) find that compared to non-smokers, smokers spent less on housing and apparels. Moreover tobacco use also imposes burden, especially on users, in the form of numerous tobacco related diseases such as cancer, tuberculosis, heart diseases and various acute respiratory diseases. Probability of various respiratory, vascular and neoplastic diseases and mortality rates are found to be higher among tobacco users compared to non-users (Gajalakshmi *et al.*, 2003). Hence, for a household, in addition to the dire health consequences ranging from disease to death and the consequent loss of an income earning member, it has also to bear other costs like consumption forgone for children in the form of milk and milk products and investment forgone in the form of education, which have a long term consequence in terms of adverse implications for human development and income earning opportunities. Considering the fact that prevalence of all kinds of tobacco consumption is higher among poor income groups in India[1], it is argued that tobacco

[1]See Rani *et al.* (2003); Subramanian *et al.* (2004) for information on prevalence of smoke and

use has the potential to trap the poor in a vicious circle of poverty and ill health (John, 2005).

Regulating the use of all tobacco products is necessary to reduce the potential burden of disease, while leaving more disposable income in the hands of tobacco consuming households, which would have alternative uses. Ever since the huge morbidity and mortality associated with tobacco became evident, nations all over the world have been trying to regulate its use by various price and non-price instruments. Taxation is an important price instrument for regulating tobacco use. Like many other countries, cigarettes consumption has been under heavy taxation in India too. But unlike other countries, tobacco consumption in India is characterized by heavy use of non-cigarette tobacco in the form of bidis[2], leaf tobacco etc. Roughly eighty five per cent of the tobacco consumption in India is non-cigarette type. However, taxation of tobacco products in India is highly skewed towards cigarettes as shown in table 1. As high as eighty six per cent of the excise revenue collected from tobacco products is contributed by cigarettes whereas bidis, which is the predominant form of tobacco consumption, contribute only five per cent to the tobacco tax. Chewing tobacco also attracts only very small tax. Taxes on cigarettes in India are levied on the basis of its length, and it ranged from Rs.135 to Rs.450 per thousand units for non-filtered cigarettes and Rs.670 to Rs.1450 for filtered cigarettes in the year 2002-03, as given in table 2. Whereas tax on thousand units of bidis is only a meager Rs.7. Chewing tobacco attracts an *ad valorem* tax in India.

On the one hand cigarettes users constitute only fifteen per cent of the total tobacco consumers whereas eighty six per cent of the tobacco tax is been paid by them, while on the other, eighty five per cent of the tobacco consumers who use non-cigarette tobacco contributes only a tiny amount as tax. Thus the tax base

smokeless tobacco among various socio-economic groups based on the National family health survey data and John (2004) for a detailed analysis of the use of different kinds of tobacco products among various socio-economic and religious groups based on the NSS data from the year 1999-2000.

[2]Bidi is an indigenous tobacco preparation in India made by rolling a dried piece of *Temburini* leaf (*Diospyros melanoxylon*) with 0.15 to 0.25g of sun-dried, flaked tobacco into a conical shape and securing the roll with a thread (Gupta *et al.*, 1992).

of tobacco is heavily depended on about fifteen per cent of the tobacco users who represent cigarettes smokers. The issue here becomes more serious when we consider the fact that bidis, which are consumed by the majority of tobacco users in India, is more harmful than cigarettes. Bidis contain only a small amount of tobacco compared to cigarettes. However, it delivers as much as 45mg - 50mg of Tar and 1.74mg - 2.05mg of Nicotine compared to 18mg - 28mg and 1.55mg - 1.92mg of Tar and Nicotine respectively in Indian cigarettes (Gupta *et al.*, 1992). If the tobacco products are sufficiently price responsive, an increase in the tax rate of addictive goods will have the effect of reducing the consumption substantially, while in fact raising the revenue. We do have overwhelming evidence from countries elsewhere (Chaloupka and Warner, 2000) and from India (Reddy and Gupta, 2004) showing the effect of taxation on reducing tobacco consumption. A study sponsored by Tobacco Institute of India (Sen *et al.*, 1998) found that frequent hikes in excise duties help in slowing down the consumption to an extent such that comparable increases in excise revenue are not forthcoming.

To explore the potential of curbing tobacco use by raising taxes on non-cigarette tobacco along with cigarette tobacco it is imperative that we know the price responsiveness of various tobacco products. To the best of our knowledge there is no study that provide some information on the price responsiveness of tobacco and tobacco products in India. Against this backdrop, this paper examines how the demand for a variety of tobacco products and other addictive goods such as pan and alcohol respond to changes in prices. The spatial variations of prices that are obtained from a cross section of more than hundred thousand households spread across the country have been used for this purpose. This exercise would be highly helpful in finding out the factors determining tobacco use, the responsiveness of tobacco consumers to price changes, their preferences between different tobacco products and other addictive goods, regional variations in consumption of different tobacco products and its implications for tobacco control, potential demand side policies to curb tobacco use etc. Major focus of this study is to analyze the behavior responses with respect

to changes in prices of tobacco products. Earlier studies have, however, found association between consumption of tobacco products and pan and alcohol products in India.[3] Hence we explicitly introduce alcohol and pan consumption also into the analysis.

Our study finds that cigarettes, unlike other tobacco products, are luxury goods in both rural and urban India with income elasticity close to two. The study also showed that household size has a very significant effect of increasing the budget share devoted to consuming bidis and leaf tobacco. Price elasticity of tobacco products, pan and alcohol found to be lying in the range of $-0.5$ and $-1.0$ in India, with bidis, leaf tobacco and alcohol having elasticities close to unity, cigarette being the least price elastic. A comparison of similar estimates based on data from earlier years showed that the price responsiveness of bidis and leaf tobacco have slightly increased over a five year period while that of cigarettes and pan have stabilized. We also find that, as a percentage of retail prices, current cigarettes taxes are not much below the revenue maximizing level, whereas the current tax on bidis is found to be far less than the revenue maximizing level.

In the next section we briefly review various studies on demand for tobacco and alcohol products followed by a discussion of consumption of addictive goods in India in section three. Section four discusses the methodology of elasticity estimation that we have used. In section five the spatial variation in prices of addictive goods is used to estimate own and cross price elasticities of tobacco, pan and alcohol products. The last section concludes the discussion.

## 2 Studies on demand for tobacco and alcohol

Unlike most other consumer goods, demand for tobacco and alcohol is often presumed to be addictive in the sense that the consumption decision on these products at any given time is not independent of the past choices of the same good. Con-

[3]Studies by Rahman (2003) and John (2004) bring out such associations.

sumption of a good can be considered to be addictive if an increase in the past consumption of that good leads to an increase in current consumption. Different models of addiction have been developed in economic theory to model addictive behaviors.[4] However, these models are questioned within and outside the realm of economics due to its applicability and various restrictive assumptions they require. Moreover, recent literature clearly indicates that the demand for tobacco products do respond to changes in prices and other factors in spite of its addictive nature. Most estimates of the price-elasticity of demand for tobacco products from developed countries range from $-0.25$ to $-0.50$, whereas those from the low-income and middle-income countries suggest that price elasticity of demand varies between $-0.50$ to $-1.00$ (Chaloupka and Warner, 2000). Similar estimates for alcohol products show that own price elasticities range between $-0.35$ and $-0.98$ in developed countries (Clements *et al.*, 1997). Analysis from various South East Asian countries have found that short-run price elasticity estimates for tobacco products range from $-0.17$ to $-0.78$, while long-run estimates range between $-0.4$ and $-1.21$ (Guindon *et al.*, 2003).

Estimates of price elasticities for various tobacco products are hardly available in India. National Council of Applied Economic Research (NCAER) has estimated the price elasticity of cigarettes consumption to be $-0.67$ for the sample period 1981-82 to 1992-93 (Sarma, 2000). However cigarettes smokers alone constitute only fifteen per cent of the tobacco users in India. Comparable and more recent estimates for other tobacco products are essential to formulate any comprehensive price control measures. There are no national level studies in India that estimates the price responsiveness and cross price elasticities of various tobacco products, to the best of our knowledge.

Price elasticity estimates are however available for alcohol consumption in India. Using NSS data Musgrave and Stern (1988) have estimated the arrack (country liquor) price elasticities in the range of $-0.47$ and $-0.62$ in a south Indian state

[4] Chaloupka *et al.* (2000) gives a good review of such studies relating to the demand for tobacco products.

of Karnataka. A recent study by Mahal (2000) showed that own price elasticity of demand for alcohol participation is $-0.50$ for people aged twenty five years and above and $-1.00$ among those aged between 15 and 25 years. This study used data collected by NCAER, in a survey in the year 1994 among the rural households of fifteen major Indian states.

The main reason for the dearth of estimates of price elasticities for India is the lack of sufficient data on prices and quantity consumed for various tobacco products. While the surveys of the National Sample Survey Organization (NSSO) provide cross-sectional information on household's expenditure and quantity consumed of various tobacco products, they don't provide information on prices. In this paper we use a methodology developed by Deaton (1988, 1997) that makes use of the spatial variation in the unit values, implicit in the NSS data, to derive the own and cross price elasticities for various tobacco products along with pan and alcohol.

# 3 Data on consumption of addictive goods

National Sample Survey Organization (NSSO) conducts nationwide sample surveys on the consumption habits of households in India during its quinquennial surveys.[5] The last such survey that was carried out during July 1999 to June 2000 collected information on consumption from 120,309 households spread over 10140 villages in India. The goods of consumption on which it collected the information included a wide variety of addictive goods such as tobacco, pan and alcohol products along with 500 food and non-food items. Various household characteristics were also surveyed along with it. The quantity purchased as well as the expenditure incurred for consumption of various products over the last thirty days prior to the date of interview were recorded.[6] Addictive goods that are surveyed included eight tobacco

[5]Quinquennial surveys are large sample surveys carried out in every five years.

[6]Consumption of tobacco and other addictive goods were reported also for a seven day recall period in this survey and this practice was not there in the previous rounds of NSS. Nevertheless, we did all analysis including the price elasticity estimates, using both 30-day and 7-day recall data and have found that the results are more or less the same. Hence we report only the results from 30-day recall data for the sake of comparison with previous rounds. NSSO Expert Group (2003)

products, six pan products[7] and six alcohol products. Pan and alcohol products are grouped into pan and alcohol respectively in our analysis. Pan includes pan leaf and finished pan. Similarly alcohol, in our exercise, is an aggregate commodity comprising of toddy, country liquor, beer and foreign liquor.[8]

Our data indicates that sixty five per cent of the rural households and forty nine per cent of the urban households report consumption of at least one of these addictive goods in the last thirty days prior to the date of interview. Tobacco users constitute the major chunk of households consuming addictive goods. Approximately ninety five percent of the reporting tobacco users consume either bidis, cigarettes, leaf tobacco or a combination of these. Except cigarettes and foreign liquor, consumption of every other item is higher among rural households than their urban counterparts. Table 3 gives average unit value over those households who bought the good and the average over all households (including those who do not buy) of the share of total expenditure that is devoted to each goods along with the fraction of households consuming each of them. Right hand panel of the table shows the weighted averages using inverse sampling probabilities as weights so that estimates should be representative of the corresponding rural and urban households in India.[9] It can be observed that the unit value of alcohol is substantially higher in urban India than in rural India. This is mainly because beer and foreign liquor users as a proportion of total alcohol users is relatively much higher in urban India than in rural India. Whereas toddy and country liquor constitute the major chunk of alcohol users in rural India. Given that toddy and country liquor are cheaper than beer and foreign liquor it is natural that unit value for alcohol is substantially higher in urban India.

provides an analysis of various issues regarding the use of different recall periods.

[7]Pan consists of betel leaf, areca nut, slaked lime, catechu and tobacco. Tobacco forms only a small portion of pan and the amount of tobacco varies in different pan products.

[8]Foreign liquor refers to items formally produced in large distilleries such as whisky, rum, gin and brandy. Whereas country liquor includes liquor that is generally made from locally available raw materials such as sugarcane, rice, coconuts and so on. Toddy is a drink made from either coconut or palm tree.

[9]Since two sets of numbers are quite close to each other and using weights in more complex analysis poses more econometric problems (Deaton *et al.*, 1994) we will not be using them in further analysis.

Portion of household budget spent on addictive goods, averaged by the number of all households, including those who do not consume any of it, shows that three per cent of the rural and 2.2 per cent of the urban household budget is spent on consuming addictive goods.

# 4 Methodology

Unit values that we get from the survey are different from prices so far as there are measurement errors involved in quantity and variations in quality due to heterogenous nature of the commodity. A theoretical model is developed by Deaton (1988, 1997), wherein consistent estimation of price elasticities is made possible in such cases. We have adapted the same model here to estimate the own and cross price elasticities of various addictive goods. Deaton (1997) provides detailed exposition of the methodology described here and we only describe the basic equations to estimate the model. This is a model of consumer behavior in which households chose both quantity and quality so that expenditure on a good is the product of quantity, quality and price. Commodities are defined as collections of heterogeneous goods and quality is defined as a property of commodity aggregates. Because the unit values are defined to represent quality also, the analysis must take account of price and income elasticities of quality as well. Model requires that the households are geographically clustered within the sample. Spatial variations in prices are used to estimate the demand responses. Once we know that there is sufficient variability in prices we can proceed to the estimation of the demand model.

Village demand patterns as represented by the budget shares are regressed on the average village prices, as represented by unit values. The following two equations link the budget shares and unit values to household expenditures, other household

characteristics, and the underlying prices of commodities.

$$W_{Ghc} = \alpha_G^0 + \beta_G^0 \ln x_{hc} + \gamma_G^0 . Z_{hc} + \sum_{H=1}^{N} \theta_{GH} \ln p_{_{Hc}} + (f_{Gc} + u_{Ghc}^0) \quad (1)$$

$$\ln UV_{Ghc} = \alpha_G^1 + \beta_G^1 \ln x_{hc} + \gamma_G^1 . Z_{hc} + \sum_{H=1}^{N} \psi_{GH} \ln p_{_{Hc}} + u_{Ghc}^1 \quad (2)$$

$W_{Ghc}$ is the budget share of good $G$ in the budget of household $h$ living in village (cluster) $c$. The budget share of the household is taken to be a linear function of the logarithm of total household expenditure, $x$, a vector of household characteristics, $Z$, and the logarithm of $N$ prices.[10] However, coefficients of these equations are not elasticities, which needs to be calculated. The first element of the residual in equation (1), $f_{Gc}$, is a village-level effect that is same for all households within a village. Since both $f_{Gc}$ and price are unobserved it is required to assume that the term $f_{Gc}$ is uncorrelated with price in order to estimate the influence of the later. The term $u_{Ghc}^0$ is the standard error term representing, among other things, measurement errors in the budget share and taste (quality) variations. The price in equation (1) is not observed but is related to unit value (UV) as given in equation (2). Logarithm of unit value is a function of $\ln x$, household characteristics represented by the vector $Z$, and price. Since unit value is price multiplied by quality, $\beta_G^1$ is the expenditure elasticity of quality. Differentiating (1) with respect to $\ln x$ and defining $\epsilon_G$ to be the elasticity of expenditure with respect to quantity, yields $\partial \ln W_G / \partial \ln x = \beta_G^0 / W_G = \epsilon_G + \beta_G^1 - 1$, since the logarithm of share is the sum of logarithms of quantity and quality less logarithm of expenditure. Rearranging it will yield the expenditure elasticity of quantity

$$\epsilon_G = (1 - \beta_G^1) + (\beta_G^0 / W_G) \quad (3)$$

[10]The budget share equation here closely follows the one suggested by Working (1943) with an extra price term and household demographic terms. This has the theoretical advantage of being consistent with a utility function (Deaton, 1997). Though the budget share equation resembles Almost Ideal Demand System it is actually not. Budget shares are taken for all households with both zero and positive consumption. It is thus an unconditional formulation of demand function covering non-consumers as well as consumers. It is important to include all households to analyze the effects of changes in prices or taxes.

so that the total income elasticity of quantity and quality together will be $\epsilon_G + \beta_G^1$.

The non-price parameters such as $\alpha$, $\beta$ and $\gamma$ in both the equations can be consistently estimated by standard OLS with the assumption that market prices do not vary for a given commodity within each village over the relevant reporting period. The unit value equation does not contain village fixed effects because, conditional on prices, unit values depend only on quality effects and measurement errors. The price terms in this equation are introduced by way of dummy variables for each villages following a result from Frisch-Waugh theorem.[11] Introduction of village dummies will control for the village fixed effects in equation (1) and for the prices.

$\psi_{GH}$ is the matrix of own and cross price elasticities of the unit values. In the absence of quality shading the matrix $\Psi$ would be an identity matrix. Elasticities of quality with respect to price are $\psi_{GH} - \delta_{GH}$ for Kronecker delta $\delta_{GH}$. Let $\epsilon_{GH}$ be the standard matrix of own and cross price elasticities of quantities. Differentiating (1) with respect to $\ln p_{_H}$ gives $\partial \ln W_G / \partial \ln p_{_H} = \epsilon_{GH} + \psi_{GH} = \theta_{GH}/W_G$, so that

$$\epsilon_{GH} = -\psi_{GH} + \theta_{GH}/W_G \tag{4}$$

Then price elasticity of quantity and quality together will be $\epsilon_{GH} + \psi_{GH} - \delta_{GH}$. Given that prices are not observed identification of all parameters require further prior information. Given a separability assumption about the basic goods that comprise each heterogenous commodity, Deaton (1988) shows that

$$\psi_{GH} = \delta_{GH} + \beta_G^1 \epsilon_{GH}/\epsilon_G \tag{5}$$

The price of good $H$ effects the quality of good $G$ only to the extend that there is a cross price quantity elasticity $\epsilon_{GH}$. Assuming that (5) holds at the sample means, (3) and (4) can be used to substitute for $\epsilon_{GH}$ and $\epsilon_G$ in (5), and we obtain the

[11] As noted in Deaton (1997, P. 288), Frisch-Waugh (Frisch and Waugh, 1933) theorem states that the regression of deviations from village means gives identical parameter estimates to those that would have been obtained from the regression containing the village dummies.

relationship linking the underlying parameters:

$$\psi_{GH} = \delta_{GH} + \frac{\beta_G^1(\theta_{GH}/W_G - \psi_{GH})}{(1-\beta_G^1) + \beta_G^0/W_G} \tag{6}$$

This analysis also allows for completing the system of demand equations by adding a composite commodity which will then exhaust the total household budget. Symmetry restrictions that add to the precision of parameter estimates can also be imposed.

# 5 Empirical results

We start with the results of spatial variations in prices which are necessary to estimate the demand responses in this model. Table 4 provides the extent and significance of the spatial variation in prices along with the source of variability. Results are given separately for rural and urban India. First column in each panel shows standard deviation of the logarithms of unit values multiplied by 100 so that the figures can be interpreted as percentage variability. Tobacco leaf seems to have maximum variability in both rural and urban areas. $F$ and $R^2$ are the $F$-statistics and $R^2$-statistics from a regression of unit values on dummy variables, one for each village[12] in the survey where there is a purchaser for at least one good. In other words, this is the result of a decomposition of variance of unit values over villages. We observe that more than seventy per cent of the variation in prices are explained by variability between villages for most of the goods. Within village variation is thus relatively small. We also tested for the broad regional effects.[13] Column $F$-reg in each panel shows the $F$-statistics for the regression of log unit values on seventy eight region dummies and it shows strong evidence of regional price variation. The $F$-statistics are significant at one per cent level for all the regressions.

[12]villages are the first stage units (clusters) in the NSSO surveys. For urban areas they are referred to as urban frame survey blocks. There are 6018 villages and 4122 blocks in the data.

[13]NSSO divides the entire geographical region of the survey into seventy eight regions which are called NSSO regions.

The set of household socio-economic characteristics that we have considered for the regression in equations (1) and (2) includes; log of household expenditure, log of household size, ratio of number of adults (fourteen years of age or more) to household size, ratio of total adult males to household size, average education (total education, in years, received by all the members divided by household size) of the household, years of education received by the most educated member in a household, a dummy variable taking the value one if the household resides in major tobacco producing states[14], and dummies for the religion, social groups and occupational groups. Region dummies were also introduced to eliminate broad regional taste differences, if any, that we may not want to attribute to regional price differences. These variables are introduced with the main intention of purging the budget shares and unit values of the household specific effects so as to allow for the quality effects and enable consistent estimation of own and cross price elasticities.

## 5.1 Estimates from unit value and budget share regression

Table 5 shows the estimated coefficients of log household size and log expenditure from both unit value and budget share equations along with income (expenditure) elasticities. The coefficient of $\ln x$ in the unit value equation gives the expenditure elasticity of quality. As we can observe, in all cases it is positive and in most cases significant at one per cent level for both rural and urban India. As expected the most heterogeneous item in the group, alcohol, has the highest quality elasticity in both rural (0.39) and urban (0.5) India. Among the different tobacco product considered, cigarettes have the highest expenditure elasticity of quality with 0.11 in rural and 0.24 in urban India. It implies a doubling of the household total expenditure would raise the average price paid for cigarette by eleven and twenty four per cent in rural and urban India respectively. This is also evidence that lower income households

[14]In India, the three States Andhra Pradesh, Gujarat and Karnataka account for roughly 75 per cent of the area under tobacco crop (Agricultural Statistics at a Glance 2002, Ministry of Agriculture, Government of India).

spent more on lower quality cigarettes, mostly the ones without a filter.[15] This is actually the case with alcohol as well. Quality elasticity of bidis are around five per cent and that of leaf tobacco is insignificant.

Coefficients on the logarithm of household size are similar in size and opposite in sign to the coefficients on the logarithm of total expenditure in the unit value regression. This seem to suggest that increases in household size act like reductions in income. Except in the case of pan in urban India, the estimated coefficients on household size are smaller in absolute size than the coefficients of total expenditure. With total household expenditure and other household characteristics remaining the same, an increase in household size has a significant effect of decreasing the average price paid by the household. It may mean that given the total expenditure, as household size increases, household may increase the consumption resorting to consuming lower quality products which are cheaper.

Budget share equation also shows similarity in magnitudes and opposite signs in case of coefficients of log total expenditure and log household size. Keeping the expenditures and other variables constant, an increase in household size increases the budget shares of bidis and leaf tobacco and it decreases the budget shares of other addictive goods. The pattern is similar in both rural and urban regressions though the extent of the effect varies. Total expenditure elasticity (sum of the expenditure elasticity of quantity and quality) is less than one for both bidis and leaf tobacco in rural and urban India and is more than unity for cigarettes, pan and alcohol. High expenditure elasticities of cigarettes and alcohol show the nature of these commodities as luxury goods. An increase in the total household expenditure more than doubles the consumption of cigarettes among rural households.

Other socio-demographic variables in the regression exerts only occasional and modest effect on the unit values and budget shares. Hence we have not reported them. However few results are worth mentioning. An increase in male ratio would lead to an increase of budget spent on bidis in rural and urban India. Education

[15]There is, however, no conclusive evidence that suggests non-filtered cigarettes are hazardous than the filtered ones.

has mild but significant decreasing effects on budget share devoted to tobacco consumption. Similarly households belonging to the Sikh religious group also exhibited a mild but significant negative effect on budget share of various tobacco products.

## 5.2 Estimates of own and cross price elasticities

Table 6 reports the own and cross price elasticity estimates of various addictive goods without symmetry restrictions and table 7 reports the same with symmetry restrictions. Symmetry constrained estimates guarantee the unique substitution complimentary patterns, ruling out the possibility that good $i$ is a substitute of good $j$ when $j$ is a complement of $i$. The elasticity in row $i$, column $j$ estimates the effect of a change in the price of good $j$ on the quantity demanded of good $i$. Own price elasticities are approximately the same in both the tables. Elasticity coefficients are comparable to other price elasticity estimates available in India for few of these goods as noted in section 2 and falls in the range of elasticity estimates available in the literature from other developing countries. As we can observe, all of the own price elasticities (diagonal elements in table 6) are negative and are statistically significant at one per cent level except cigarettes in urban India. Many of the cross price elasticities are however not significant.

Looking at the own price elasticities we observe that elasticity coefficients for rural and urban households are approximately same, except for cigarettes and alcohol which are more inelastic in urban india than rural India. All goods have own price elasticities greater than 0.5 and some of them such as bidis, leaf tobacco and alcohol have elasticities close to unity. This is a clear evidence to indicate that consumption of addictive goods in India do respond to the changes in prices, though the proportionate increases in price leads to slightly less than proportionate reduction in consumption. Hence prices can be used as an important instrument to curtail tobacco consumption or, for that matter, consumption of any of the addictive goods considered here.

Analysis of cross price elasticities from table 7 indicate that bidis are complement

to all addictive goods in rural India, though this complementarity is not significant in case of alcohol and leaf tobacco. In urban India, on the other hand, bidis are complement only to cigarettes and pan, though the coefficient is not significant for cigarettes. This reiterates the results we obtained from a previous study wherein we found that the relative probability of consuming tobacco products increases relative to not consuming them, if the household has the habit of either alcohol or pan consumption (John, 2004). As against the general notions regarding the complementarity between cigarettes and alcohol, we see that they are substitutes in both rural and urban regressions, although the effect is not significant in the rural regression. Analyses were also carried out using the $50^{th}$ round of NSS data for the period 1993-94 with the objective of checking the robustness of the results from $55^{th}$ round and to examine if there is any change in the elasticities over time. We found that own price elasticities of bidis and leaf tobacco have shown increase over the five year period while that of cigarettes and pan have stabilized. Table 8 gives own price elasticities and income elasticities of various addictive goods for the $50^{th}$ round. It appears that the addictive goods have become more elastic, or more precisely, less inelastic over the period.

## 5.3 Effects of price changes through taxation

Curbing tobacco is critical for health. However, two counteracting objectives of the government with respect to tobacco viz., tax revenue and employment become crucial while formulating policies to regulate tobacco use. In this section we address the tax objective of government while regulating demand for tobacco use. Addressing the employment question is out of the scope of this paper. Using the price elasticity estimates and some appropriate (but non-trivial) assumptions it is possible to calculate the movement of tax revenue and consumption of various tobacco products. Calculations here are done only for cigarettes and bidis and are merely expository in nature. The following assumptions were made:

1. no substitution effects operating due to price change

2. price changes are solely due to changes in taxes

3. elasticity is constant across the entire range of prices.

The annual consumption of manufactured cigarettes in India is 71.5 billion sticks as of year 2000 and the average retail price of pack of 20 domestic cigarettes is roughly Rs.49 (Shafey *et al.*, 2003, p.202). To begin with, the present analysis considers tax component to be 50% of the retail price which translates to Rs.1225 per thousand sticks.[16] This more or less corresponds to the average quantity taxes prevailing for cigarettes in India. Similarly, the annual consumption of manufactured bidis are estimated to be 850 billion sticks as on 1999 (World Health Organization, 2002). Bidis are taxed very low and have a quantity tax of Rs.7 per thousand sticks. Average retail price of a pack of 20 bidis is taken to be Rs.3 and hence the tax component, to begin with, is taken as 4.7% of retail prices. Figure 1 shows the movement of total revenue and consumption due to different rates of changes in retail prices.[17]

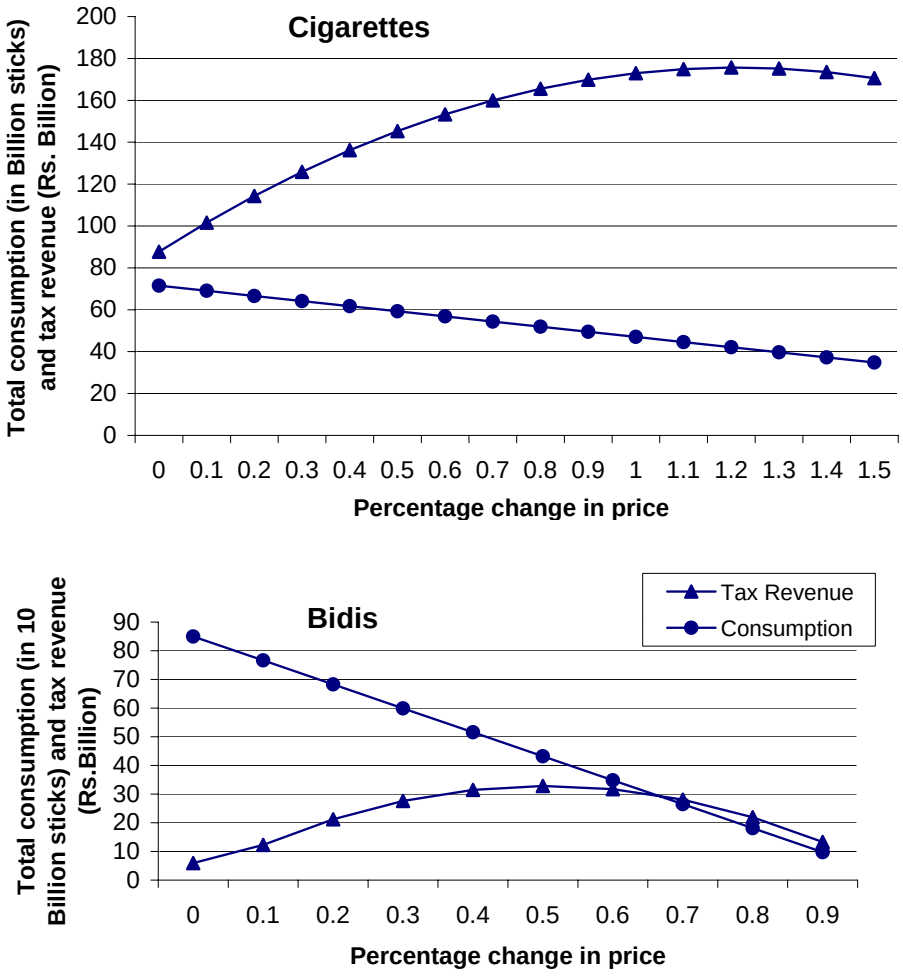
As the diagram shows, revenue from taxation of cigarettes keeps increasing until price increase is up to 122% of the current retail price. Revenue starts falling thereafter. This means, an increase in tax on cigarettes up to Rs.4188 per thousand from the current Rs.1225 can be made without any fall in revenue. In other words, this means tax for cigarettes would constitute roughly 77% of the new retail price after taxes. Similarly for bidis, total tax revenue increases until 51% increase in retail price is achieved from the current level, which would mean that new tax would constitute roughly 34% percent of the new retail price after tax. In other words, tax on bidis can be increased up to Rs.77 per thousand from the current Rs.7 (i.e., a tenfold increase) without fall in revenue. Consumption of both bidis and cigarettes however

[16]Taxes on cigarettes in India are quantity taxes and vary depending on their length and whether filtered or not. Bidis also have a quantity tax (see Table 2). However, for the sake of simplicity we have assumed that taxes are *ad valorem*. The percentages for value taxes have been arbitrarily chosen so as to reflect the actual quantity taxes.

[17]Changes in consumption and revenue were calculated separately for rural and urban India using the respective rural urban elasticities and shares in consumption taken from NSS survey and later added to arrive at the all India figures.

keeps falling for every increase in price/tax. The required rate of increase in tax is dramatic for bidis simply due to the reason that the current tax base for bidis are at rock bottom level whereas that for cigarettes are not. A larger rate of increase in retail price is required for cigarettes than bidis to arrive at the revenue maximizing level of prices because cigarettes are much more price-inelastic than bidis. While the estimates are subject to the strong assumption of constant price elasticity they nevertheless point to the potential for increasing taxes in order to curb consumption without losing out on revenue.

Figure 1: Projected consumption of and revenue from bidis and cigarettes



The above analysis shows the huge potential of taxation both as a way of generating revenue and curbing consumption. However, as noted earlier taxation of tobacco in India is highly skewed towards cigarettes. As a percentage of retail prices, cigarettes taxes are not much below the revenue maximizing level, whereas the current level of taxes on bidis is far less than the revenue maximizing level. Taxing the non-cigarette tobacco in India has always been a political problem than an economic problem per se (Reddy and Gupta, 2004). Even the latest budget presented on $28^{th}$ February, 2005 in the Indian parliament, proposed a further hike in tax of cigarettes without effecting any change in taxation of bidis. One argument usually given against taxing non-cigarette tobacco is the fact that it is mainly used by the poor, hence increasing bidi taxes would amount to taxing the poor more, given the addictive nature of its consumption. But the price elasticity estimates in our exercise show that increase in prices of bidis (say by taxation) would have the effect of reducing consumption almost by an equally proportionate rate which effectively would mean better health and more disposable income with the poor. Similar is the case of leaf tobacco.

# 6 Conclusion

Taxation of tobacco is recognized as one of the most important price measure to regulate tobacco consumption. However tax base of tobacco in India is heavily depended on about fifteen per cent of the tobacco users who represent cigarettes smokers. Analysis of price responsiveness of various tobacco products would be helpful to explore the potential of curbing tobacco use by raising taxes. With this objective we examine how the demand for a variety of tobacco products and other addictive goods such as pan and alcohol respond to changes in prices. The spatial variations of prices that are obtained from a cross section of more than one lakh households spread across the country have been used for this purpose.

We find that a doubling of household's total expenditure would have the effect

of raising the average price paid for cigarettes by more than ten percent in rural and twenty four percent in urban India. This also pointed out the fact that lower income households spent more on lower quality cigarettes. Our study also shows that, given the total household expenditure and other household characteristics, an increase in household size has a significant effect of decreasing the average price paid by the household on consuming a given tobacco product. But at the same time, it has the effect of increasing the budget share spent on consuming bidis and leaf tobacco. Cigarettes, unlike other tobacco products, and alcohol were found to be luxury goods in both rural and urban India with income elasticity greater than one.

Estimates of own and cross price elasticities showed that own price elasticity estimates of various addictive goods in India ranged between $-0.5$ to $-1.0$ with bidis, leaf tobacco and alcohol having own price elasticities close to unity. Cigarettes, on the other hand, were the least price elastic of all. Analysis of the cross price elasticities revealed that bidis are complement to all addictive goods in rural India, while they were so only with respect to cigarettes and pan in urban India. As against the general notions regarding the complementarity between cigarettes and alcohol, our study find that these are substitute goods at least in urban India. A comparison of similar estimates with data from previous years showed that own price elasticities of bidis and leaf tobacco have become marginally less inelastic over a five year period, while that of cigarettes and pan have stabilized. With certain assumptions, further analysis on taxation showed that taxes on cigarettes can be raised nearly 2.5 times the current tax while that of bidis can be raised tenfold without any fall in revenue. As a percentage of retail prices, current cigarettes taxes are not much below the optimal level, whereas the current level of taxes on bidis are found to be far less than the optimal level.

The analysis clearly brings out the fact that raising taxes do have multiple benefits. It has the potential to increase tax revenue while decreasing the consumption. At the same time there are also arguments against raising taxes beyond a point,

citing mainly the arguments based on *Laffer curve*,[18] but on the other hand there are strong health reasons why consumption should be curbed. What is to be noted is the fact that the current level of taxes on tobacco products in India are much lower than the levels at which revenues start falling. Given that non-cigarette tobacco, especially bidis are taxed at very low rate, there is a huge potential to increase its taxes. Taxation of different tobacco products could be seen as a tool to raise government revenue while simultaneously attaining the objective of curbing tobacco consumption. The objectives of tobacco taxation should be defined in much clearer terms and the emphasis needs to be given on curbing consumption of various tobacco products. Higher rates of increase in taxes may result in smuggling and the government machinery needs to be equipped to handle this. A large scale regulation of tobacco consumption also will have implications on tobacco farming and manufacturing of various tobacco products. Hence a detailed analysis of the economics of tobacco farming and manufacture of various tobacco products would be highly useful to analyze the net effects of various regulatory measures.

[18]It says raising the taxes above an optimal level will not result in an increase of revenue, rather it causes revenue to fall.

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Table 1: Share of different tobacco products in total Union excise duty (basic and additional) collected from tobaco.

| Year | Cigarettes | Bidi | Chewing | Others | Total Revenue (Rs.Billion) |
|---|---|---|---|---|---|
| 1994-95 | 86.71 | 6.90 | 4.69 | 1.62 | 31.577 |
| 1995-96 | 85.86 | 4.54 | 5.29 | 4.21 | 39.877 |
| 1996-97 | 85.60 | 5.18 | 5.59 | 3.57 | 46.529 |
| 1997-98 | 86.30 | 5.66 | 5.37 | 2.61 | 51.376 |
| 1998-99 | 86.29 | 5.70 | 5.99 | 1.98 | 55.954 |
| 1999-00 | 86.06 | 5.77 | 6.25 | 1.87 | 55.660 |
| 2000-01 | 85.10 | 5.40 | 7.14 | 2.33 | 60.389 |

*Source:* Calculated from P.240, Reddy and Gupta (2004).

Table 2: Excise duty rate of different tobacco products in India as on 2003-04.

| Tobacco Products | Duty per 1000 units in Rs. |
|---|---|
| Non Filter Cigarettes | |
| not exceeding 60 mm in length | 135 |
| Between 60 mm and 70 mm | 450 |
| Filter Cigarettes | |
| not exceeding 70 mm in length | 670 |
| between 70 mm and 75 mm | 1090 |
| between 75 mm and 85 mm | 1450 |
| Bidis | 7 |
| Rates of duty (*ad valorem*) | |
| Cigars and cheroots | 16% |
| Other Tobacco products | 60% |
| Pan masala | 55% |
| Pan masala containing Tobacco | 60% |

*Notes:* The *ad valorem* taxes for cigars and cheroots are only from basic excise duty (BED) whereas that of other tobacco products and pan masala containing tobacco comprise of 16% BED, 16% Special duty, 18% Additional duty, and 10% National Calamity Contingency Duty (NCCD). The duty on pan masala comprises of BED and special duty 16% each and NCCD 23%.

*Source:* Central Board of Excise and Customs, Government of India.

Table 3: Unit values and budget shares of different addictive goods

| Rural India | | | | | | |
|---|---|---|---|---|---|---|
| | Unweighted | | | Weighted | | |
| Commodty | % Consuming | Unit value | Share | % consuming | Unit value | Share |
| Bidis | 35.33 | 0.22 | 0.97 | 36.50 | 0.17 | 1.08 |
| Cigarettes | 5.46 | 1.59 | 0.18 | 3.69 | 1.40 | 0.14 |
| Leaf-Tob | 18.68 | 70.00 | 0.23 | 19.42 | 69.86 | 0.24 |
| Pan | 22.54 | 0.70 | 0.36 | 18.47 | 0.65 | 0.30 |
| Alcohol | 15.65 | 48.02 | 0.82 | 16.40 | 47.02 | 0.72 |
| Total | 64.77 | NA | 3.16 | 64.23 | NA | 2.92 |
| Urban India | | | | | | |
| Bidis | 18.93 | 0.21 | 0.50 | 19.84 | 0.21 | 0.54 |
| Cigarettes | 11.32 | 1.47 | 0.43 | 9.61 | 1.32 | 0.39 |
| Leaf-Tob | 7.39 | 74.98 | 0.09 | 7.25 | 74.73 | 0.08 |
| Pan | 18.79 | 1.13 | 0.39 | 15.46 | 1.13 | 0.32 |
| Alcohol | 9.65 | 99.10 | 0.59 | 10.20 | 95.07 | 0.56 |
| Total | 48.95 | NA | 2.27 | 44.16 | NA | 2.14 |

*Notes:* Total includes all the addictive goods including the ones that are not listed here but are there in the NSS data. Unit of measurement for bidi, cigarette and pan is number, leaf tobacco is Kg., and alcohol is litre. Unit values are all in Rupees. Budget shares (averaged for consuming and non-consuming households alike) are in percentages.

*Source:* Author's calculation from NSSO (2000) data.

Table 4: Variability in unit values

| | Rural India | | | | Urban India | | | |
|---|---|---|---|---|---|---|---|---|
| Items | SD | F-stat | R-sq | F-reg | SD | F-stat | R-sq | F-reg |
| Bidi | 59.8 | 12.35 | 0.76 | 71.63 | 56.3 | 4.58 | 0.68 | 23.73 |
| Cigarette | 63 | 4.08 | 0.81 | 7.52 | 55.7 | 2.82 | 0.68 | 9.75 |
| Leaf Tobacco | 206.6 | 7.67 | 0.68 | 39.1 | 227.5 | 5.72 | 0.76 | 11.4 |
| Pan | 123.9 | 16.89 | 0.83 | 304.97 | 120.25 | 8.46 | 0.77 | 127.3 |
| Alcohol | 125.5 | 8.98 | 0.79 | 92.66 | 130.1 | 3.26 | 0.7 | 14.2 |

*Notes:* SD refers to 100 times the standard deviation of log unit values calculated over the households reporting positive consumption. $F$ and $R^2$ are the $F$-statistics and $R^2$-statistics associated with the presence of dummy variables for each village in the survey. $F$-reg is the $F$-statistics of an ANOVA of log unit values on dummies for seventy eight regions. All statistics are significant at 1% level.

Table 5: Income and household size coefficients and income elasticities

| | Rural India | | | | | Urban India | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | log Unit Value | | Budget Share | | | log Unit Value | | Budget Share | | |
| Items | $\ln x$ | $\ln n$ | $\ln x$ | $\ln n$ | $\eta_x$ | $\ln x$ | $\ln n$ | $\ln x$ | $\ln n$ | $\eta_x$ |
| Bidi | 0.05* | -0.03* | -0.19* | 0.19* | 0.76 | 0.04* | -0.02 | -0.16* | 0.12* | 0.63 |
| | (0.00) | (0.00) | (0.00) | (0.00) | | (0.00) | (0.29) | (0.00) | (0.00) | |
| Cigarette | 0.11* | -0.11* | 0.27* | -0.2* | 2.37 | 0.24* | -0.16* | 0.41* | -0.3* | 1.72 |
| | (0.00) | (0.00) | (0.00) | (0.00) | | (0.00) | (0.00) | (0.00) | (0.00) | |
| Leaf Tobacco | 0.005 | -0.005 | -0.09* | 0.04* | 0.6 | 0.1 | -0.3* | -0.03* | -0.005 | 0.58 |
| | (0.92) | (0.91) | (0.00) | (0.00) | | (0.29) | (0.00) | (0.00) | (0.34) | |
| Pan | 0.03 | -0.12* | 0.06* | -0.09* | 1.12 | 0.13* | -0.23* | 0.08* | -0.11* | 1.08 |
| | (0.08) | (0.00) | (0.00) | (0.00) | | (0.00) | (0.00) | (0.00) | (0.00) | |
| Alcohol | 0.39* | -0.32* | 0.72* | -0.46* | 1.48 | 0.5* | -0.32* | 0.62* | -0.38* | 1.54 |
| | (0.00) | (0.00) | (0.00) | (0.00) | | (0.00) | (0.00) | (0.00) | (0.00) | |

*Notes:* Each panel shows the partial results of log unit value and budget share equations separately for rural and urban India. $\ln x$ & $\ln n$ are logarithms of total expenditure and household size respectively. $\eta_x$ is the total expenditure or income elasticity as given by $\epsilon_G + \beta^1$. Coefficients of $\ln x$ & $\ln n$ in the budget share equations are all multiplied by 100 for the convenience in reporting.

Table 6: Own- and Cross-price elasticities

| Items | Bidi | Cig | Tleaf | Pan | Alcohol | Composite |
|---|---|---|---|---|---|---|
| **Rural India** | | | | | | |
| Bidi | **-0.997*** | -0.100** | -0.010 | -0.026 | 0.023 | 0.306* |
| | (0.032) | (0.045) | (0.010) | (0.026) | (0.016) | (0.046) |
| Cigarette | -0.187** | **-0.626*** | -0.018 | 0.010 | 0.150** | -1.810* |
| | (0.095) | (0.190) | (0.030) | (0.068) | (0.071) | (0.180) |
| Leaf Tobacco | -0.093 | 0.212** | **-0.848*** | -0.129* | -0.030 | 0.286* |
| | (0.064) | (0.104) | (0.021) | (0.043) | (0.028) | (0.092) |
| Pan | -0.075 | -0.021 | -0.010 | **-0.600*** | -0.023 | -0.426* |
| | (0.053) | (0.077) | (0.017) | (0.052) | (0.024) | (0.079) |
| Alcohol | -0.258** | 0.114 | -0.022 | 0.084 | **-1.032*** | -0.758* |
| | (0.088) | (0.102) | (0.024) | (0.053) | (0.040) | (0.119) |
| Composite | -0.001* | 0.000 | 0.000 | 0.000 | 0.000 | **-0.264*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| **Urban India** | | | | | | |
| Bidi | **-0.944*** | 0.059 | 0.007 | -0.178* | 0.053 | 0.332* |
| | (0.069) | (0.205) | (0.020) | (0.048) | (0.041) | (0.176) |
| Cigarette | -0.135 | **-0.171** | -0.006 | 0.062 | 0.129 | -1.837* |
| | (0.134) | (0.482) | (0.029) | (0.077) | (0.086) | (0.415) |
| Leaf Tobacco | 0.436*** | -0.171 | **-0.794*** | -0.175*** | -0.232*** | 0.255 |
| | (0.231) | (0.837) | (0.062) | (0.105) | (0.139) | (0.706) |
| Pan | -0.248* | 0.405 | 0.015 | **-0.610*** | 0.045 | -0.817* |
| | (0.102) | (0.359) | (0.027) | (0.055) | (0.050) | (0.309) |
| Alcohol | -0.091 | 0.135 | -0.028 | 0.058 | **-0.867*** | -1.256* |
| | (0.132) | (0.385) | (0.041) | (0.082) | (0.075) | (0.350) |
| Composite | 0.000 | 0.002*** | 0.000 | 0.000 | 0.000 | **-0.264*** |
| | (0.000) | (0.001) | (0.000) | (0.000) | (0.000) | (0.001) |

*Notes:* The elasticity in row $i$, column $j$ estimates the effect of a change in the price of good $j$ on the quantity demanded of good $i$. Values in parentheses are the bootstrapped standard errors calculated by making 1000 draws from the second stage data, and is defined as half the length of the interval around the bootstrapped mean, and contains 68.3% of the bootstrapped estimates. Assuming the estimates follow a normal distribution the coefficients with *, **, *** implies a levels of significance at 1%, 5% and 10% respectively.

Table 7: Own- and Cross-price elasticities (With symmetry restrictions)

| Items | Bidi | Cig | Tleaf | Pan | Alcohol | Composite |
|---|---|---|---|---|---|---|
| **Rural India** | | | | | | |
| Bidi | **-1.005*** | -0.070* | -0.009 | -0.029*** | -0.017 | 0.325* |
| | (0.029) | (0.027) | (0.010) | (0.018) | (0.018) | (0.042) |
| Cigarette | -0.381* | **-0.562*** | 0.001 | -0.015 | 0.161 | -1.685* |
| | (0.140) | (0.188) | (0.032) | (0.070) | (0.110) | (0.224) |
| Leaf Tobaco | -0.035 | 0.004 | **-0.851*** | -0.027 | -0.038 | 0.346* |
| | (0.041) | (0.025) | (0.020) | (0.024) | (0.057) | (0.081) |
| Pan | -0.077*** | -0.005 | -0.019 | **-0.601*** | 0.037 | -0.490* |
| | (0.047) | (0.035) | (0.015) | (0.053) | (0.038) | (0.079) |
| Alcohol | -0.034 | 0.044 | -0.016 | 0.018 | **-1.033*** | -0.850* |
| | (0.025) | (0.029) | (0.020) | (0.020) | (0.039) | (0.064) |
| Composite | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | **-0.264*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| **Urban India** | | | | | | |
| Bidi | **-0.923*** | -0.058 | 0.008 | -0.165* | 0.022 | 0.444* |
| | (0.062) | (0.101) | (0.017) | (0.037) | (0.041) | (0.108) |
| Cigarette | -0.078 | **-0.215** | -0.007 | 0.103** | 0.126** | -1.887* |
| | (0.125) | (0.478) | (0.029) | (0.076) | (0.092) | (0.447) |
| Leaf Tobaco | 0.053 | -0.032 | **-0.801*** | 0.021 | -0.172 | 0.250 |
| | (0.110) | (0.146) | (0.052) | (0.101) | (0.189) | (0.295) |
| Pan | -0.220* | 0.113 | 0.004 | **-0.597*** | 0.057 | -0.569* |
| | (0.049) | (0.081) | (0.021) | (0.050) | (0.050) | (0.113) |
| Alcohol | 0.016 | 0.106 | -0.030 | 0.042 | **-0.866*** | -1.318* |
| | (0.043) | (0.077) | (0.031) | (0.040) | (0.069) | (0.127) |
| Composite | 0.000 | 0.001* | 0.000 | 0.000 | 0.000 | **-0.264*** |
| | (0.000) | (0.001) | (0.000) | (0.000) | (0.000) | (0.001) |

*Notes:* The elasticity in row $i$, column $j$ estimates the effect of a change in the price of good $j$ on the quantity demanded of good $i$. Values in parentheses are the bootstrapped standard errors. (See footnote to table 4 for description on standard errors.) Coefficients with *, **, *** implies a levels of significance at 1%, 5% and 10% respectively.

Table 8: Own price and Expenditure elasticities for $50^{th}$ round

| | Rural India | | Urban India | |
|---|---|---|---|---|
| Items | own elsty | $\eta_x$ | own elsty | $\eta_x$ |
| Bidi | -0.769 | 0.65 | -0.707 | 0.589 |
| Cigarette | 0.601 | 2.24 | 0.251 | 1.527 |
| Leaf Tobacco | -0.003 | 0.44 | -0.141 | 0.669 |
| Pan | -0.665 | 1.03 | -0.592 | 1.042 |
| Alcohol | -1.162 | 1.34 | -1.050 | 1.690 |