The Demand for Cigarettes in China

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Abstract: In the early-Seventies per-capita cigarette consumption began to rise in poorer nations, while in richer ones it has fallen in recent decades. There is an extensive literature using micro-level data to examine demand for cigarettes in wealthy societies, but relatively few studies extend such analysis to developing nations. It has been suggested theoretically, and generally confirmed with aggregate-level data, that smoking is more sensitive to price in poorer countries. However, aggregate data is plagued by well-known econometric problems and precludes exploration of smoking within population subgroups. This paper studies cigarette demand in China, using a unique and rich longitudinal micro-level household and community survey that permits more detailed and econometrically rigorous analysis. It focuses on smoking by males, because female smoking rates in China are comparatively negligible and any campaign to lower aggregate smoking rates must, as a result, be aimed primarily at men. The panel nature of the data permits control for community-level unobservables which might bias estimates of price effects. Such controls are still rare in the wealthy country literature and unprecedented in the body of work concerning smoking in poorer ones. Price elasticity estimates vary somewhat across specifications, but all are substantially lower than those suggested by earlier work. The policy implications are obvious. Raising prices in poorer countries would not be expected to reduce smoking to the degree previously suggested. Perhaps health education improvements would increase the willingness of Chinese to reduce smoking as smoking prices increase.

Section I. Introduction

Traditionally, cigarette smoking has been more pervasive in wealthier societies. However, in the Seventies per-capita consumption began to rise dramatically in poorer nations, while on balance it fell in recent decades in richer ones. As consumption patterns have shifted, so too have the anticipated future health burdens from smoking. By 2020, seventy percent of smoking-related deaths will occur in the developing world (Chaloupka and Jha 1999). In Western nations, cigarette taxes have often been an important instrument for discouraging smoking. It is unclear whether they will prove effective in lower- and middle-income countries, but it would seem that there is a fairly widely held belief that they should (eg Economist 2002). In this paper, we estimate the sensitivity of consumers in China to cigarette prices and therefore provide some insight into the likely implications of Western-style cigarette excise taxes in poorer nations.

Surprisingly, cigarette smoking behavior in poorer nations has received little attention from economists. Most demand analyses rely on data drawn from wealthy societies. Nonetheless, it is apparently widely accepted that smoking behavior in developing nations is significantly more sensitive to prices (Warner 1990 and others). Several factors appear to drive this belief. Warner 1990 emphasizes the importance of low initial smoking and income levels in poorer societies. It has also been argued (see Chaloupka et al. 2000 and others) within the framework of rational addiction models that lower educational levels heighten price sensitivity. The sparse demand analysis involving poorer societies has generally sustained this belief.

However, there is clear scope for further work. The theoretical prediction of greater price sensitivity has not been convincingly sustained. Nearly all elasticity estimates from poorer nations rely on aggregate data involving rather short time series. To our knowledge only one study utilizes micro-level data. In some cases, the aggregate studies are forced to rely on questionable data. There are no studies which confine estimation to demographic subgroups within a developing nation. This could be important, since modest overall smoking rates in poorer societies often mask high incidence for certain subgroups (such as men in Indonesia, Russia China, etc.) among whom consumption is highly concentrated. Another drawback to aggregate data is the failure to observe variation within the unit of aggregation, which can be considerable in developing nations (due, for instance, to more limited infrastructure, information, and, in some instances, market contestability). Finally, despite heroic efforts, aggregate studies are still subject to caution owing to certain serious econometric problems (eg high degrees of simultaneity and multicollinearity) to which micro-level data is generally less susceptible (Chaloupka and Warner 1999).

This paper examines the demand for cigarettes in China with a unique longitudinal micro-level survey of individuals, households and the communities within which they reside. This is one of the richest datasets ever applied to the study of cigarette smoking in developing nations (see Lance et al. 2002 for an application involving a similarly rich Russian survey). It allows us to correct for the

presence of community-level unobservables which might contaminate our estimates of the role of cigarette prices in the conditional distribution of demand (the main focus of this paper). It also permits extensive examination of possible differences in price sensitivity among subgroups of the population.

China is an ideal subject for cigarette demand analysis. China is classified by the World Bank as a lower middle income country and is ranked 106th out of 174 countries in the 1998 United Nations Human Development Index (HDI) ranking (UNDP 1998). It is a large and diverse nation which exhibits nearly all of the economic circumstances present in the contemporary developing world. Among developing nations, it is the largest market by volume for cigarettes. Foreign (particularly British American Tobacco (BAT)) and domestic firms have aggressively pursued the Chinese cigarette market since the late 19th century. For decades, it has been nearly totally dominated by the state-owned China National Tobacco Corporation (CNTC), which sells over a thousand brands. A fact sheet from the World Health Organization (WHO 1997a) presents astonishing statistics:

- On a per capita basis, cigarette consumption in China rose 260 percent from the early-Seventies to the early-Nineties.
- China has approximately 300 million smokers.
- Roughly one in three cigarettes smoked in the world are smoked in China.
- By 2020, roughly 20 million will die annually as a result of cigarette smoking.
- Of the current population cohort aged 20 and under, 200 million will take up smoking, and at least 50 million will eventually lose their lives as a result.

The growth in cigarette consumption has been so substantial that China alone is responsible for a significant portion of the global shift in smoking prevalence toward developing countries. Female smoking rates are negligible compared with those of men, whose cigarette consumption is driving such incredible statistics.

The plan of the paper is as follows. Section II provides an overview of previous work in this area. Section III introduces the demand model and then presents and discusses results. Section IV concludes.

Section II. Previous Literature

The large body of work examining demand for cigarettes in wealthy societies can be reasonably grouped into two distinct branches (Chaloupka and Warner 2000): studies that utilize aggregate data and those that employ micro-level surveys. The former dominated early research and continue to represent a substantial portion of new work. Unfortunately, several related econometric challenges plague aggregate studies. In particular, explanatory variables are often highly collinear (undermining the stability of estimates), and there can be (possibly substantial) simultaneity. Numerous studies attempt to address these problems explicitly (see Chaloupka and Warner 2000), with most reporting elasticity estimates in the vicinity of -.4 (Chaloupka and Warner 2000).

Micro-level analysis has the advantage that many problems associated with aggregate data, such as simultaneity and multicollinearity, are *less* serious (Chaloupka and Warner 2000). Micro-level data permits more extensive

examination of variation in price sensitivity across demographic subgroups. For the most part these studies provide total elasticity estimates comparable to those obtained with aggregate data (Chaloupka and Warner 2000) although, as with the aggregate literature, the range of estimates is quite wide.

Considerably less attention has been paid to smoking in developing societies. Nearly all studies conducted in developing countries rely on aggregate data (eg Chapman and Richardson (Papua New Guinea) 1990; van der Merwe (South Africa) 1998; Maranvanyika (Zimbabwe) 1998; Tansel (Turkey) 1993; Costa e Silva (Brazil) 1998). In general (Tansel 1993 being one notable exception), they report price elasticity estimates significantly larger than those recovered by studies using data from wealthier countries. However, the range of elasticity estimates from poorer countries is really quite wide (Chaloupka et al. 2000). Of course, these estimates are subject to all of the limitations and empirical concerns normally associated with aggregate data. Compounding these problems is the fact that many of the aggregate studies utilize extremely short time series (studies with 10 to 15 observations are not unusual, whereas many aggregate studies in the US use state-level aggregates, so that even a five year sample period yields 250 observations) and may be affected by bias stemming from measurement error and related data problems.

Several papers examine demand for cigarettes in China. Mao et al. 1997 use annual time series data for Sichuan province from 1981 to 1993. Mao and Xiang 1997, the only demand study from a developing country (of which we are aware) using micro-level data, employs a cross-sectional sample of 2431 adults from the same province. Finally, Xu et al. 1998 estimate demand with annual national data from 1978 through 1992. Aggregate data studies generally produce overall elasticity estimates centered on -.75. Mao and Xiang 1997 report participation and conditional consumption elasticities of -.89 and -.18, respectively.

Aside from demand analyses, there are non-economic studies of smoking in China. Most are essentially descriptive works that provide a useful overview of smoking patterns. In particular, a number of papers utilize National Prevalence Surveys of Smoking Patterns in China, conducted in 1984 and 1996. Yang et al. 1999 report smoking statistics based upon the 1996 National Prevalence Survey, providing comparisons with findings from the 1984 wave. The overall smoking rate from the 1996 survey was 34.1 percent, up 3.4 percentage points from 1984. Smoking rates were far higher for men (63 percent) than women (3.8 percent). The smoking rate for men 15 to 19 years of age was 18 percent, and rose to 55 percent for the next five year age cohort. Among men, smoking prevalence appeared to decline with education. Smoking rates were slightly higher among rural men and older urban women. It appears that the age of initiation has been falling (consistent with the observations of others, such as Zhu et al. 1988; Li et al. 1996; etc.), and the average number of cigarettes smoked per day rising, indicating a shift toward “the increasingly high-risk smoking profile seen in Western countries” (Yang et al. 1999).

Section III. Econometric Model and Results

The dominant econometric concept considered in studies which employ micro-level data is the two-part model. This approach involves separating demand into two parts: the decision to smoke (participation) and the number of cigarettes smoked conditional upon smoking (intensity). Then, demand *Y* is

$$E(Y) = Pr(Y>0)*E(Y|Y>0)$$

The elasticity of unconditional demand γ_Y is thus

$$\gamma_Y = \gamma_{Pr(Y>0)} + \gamma_{E(Y|Y>0)}$$

The participation decision is generally considered with a simple binary model while the number of cigarettes smoked is usually treated as a continuous variable and addressed with ordinary least squares.

We estimate two basic models:

Model 1 (Base Model): Participation and intensity depend only upon cigarette price and a panel dummy.

Model 2 (Full Model): We add to model 1 controls for age, wealth, education and household size. We also include terms interacting cigarette price with age and wealth.

It has usually been the practice, even in work involving surveys from wealthier countries, to apply models such as these to purely cross-sectional or pooled cross-sectional estimations. However, results which identify price effects solely from cross sectional variation must be viewed with caution, due to the possible confounding effect of community-level unobservables which, in equilibrium, influence demand *and* prices. Deaton 1997 has suggested in the developing country context that demand analyses involving village or cluster level prices are generally subject to such endogeneity bias. Unfortunately, we cannot statistically address this with an instrumental variables approach for lack of statistically powerful (Bound et al. 1995) and theoretically reasonable identifying instruments. However, if smoking behavior in a community could be observed at two reasonably close points in time, then with certain assumptions we could control for confounding unobserved community-level factors with a fixed effects (FE) estimation strategy. Fortunately, the longitudinal nature of our surveys allows implementation of FE estimators. Therefore, for each of these two basic models we offer three specifications, each providing successively more exact FE controls for community-level unobservables. These are:

Pooled Cross Sectional Specification

This is the most straightforward specification and includes only the baseline covariates for that particular model. This can be thought of as a “heterogeneity free” specification similar to Mao and Xiang’s 1997 analysis and, for that matter, most of the micro-level work conducted in rich country settings.

Provincial Specification

In this specification we add controls for the interaction of province with urbanicity. One drawback to FE estimators is their tendency to exacerbate bias associated with measurement error, particularly if genuine “within” variation is comparatively modest (Deaton 1997; Angeles et al. 1998; etc.). Inclusion of controls for province*urbanicity allows us to address endogeneity bias to a certain degree by controlling for unobservables that tend to move at those levels. It could be argued

that in many instances community-level unobservables (such as cultural preferences or attitudes toward smoking) are, to a significant extent, likely shared within a region. Since we generally have more variation within each province than each community, a given signal-to-noise ratio for prices if less problematic with regional or provincial controls than with strict community-level FE estimation. Therefore, this specification represents something of a compromise between the strong exogeneity assumption of a purely cross sectional "heterogeneity-free" approach and the community-level FE estimator.

Community-level Fixed Effects Specification

In the final specification we correct for community-level unobservables by introducing dummy variables for each community (the strategy of Angeles et al. 1998). This specification allows for the most exact controls for community-level unobserved heterogeneity.

For each specification of each model, we employ robust standard errors to allow for clustering at the community level, as well as repeated observations for individuals over time. For the most part we restrict attention to smoking by men. In China, male smoking rates are far higher. Therefore, in order to significantly reduce overall smoking rates, particular attention must be paid to male smoking behavior. Restricting attention to men should not create econometric difficulties. By doing so we are essentially stratifying estimation along the lines of an exogenous variable (see, for instance, Dow 1995 for another example of exogenous stratification in health input demand estimation). If male smoking behavior is systematically different from that of women (and their dramatically higher smoking rates suggest that they might be fundamentally different), then we would certainly want to consider them separately. If it is the same, then there is some efficiency loss associated with stratification, but that is less of a concern in this application, where sample sizes are large either way. In any case, we will nonetheless also provide some discussion of results drawn from the full sample.

Results

For our analysis, the China Health and Nutrition Survey (CHNS) is used. The CHNS is the result of an ongoing collaborative effort involving the Chinese Center for Disease Control and Prevention (formerly the Chinese Academy of Preventive Medicine) and the University of North Carolina Population Center. It is conducted in 8 Chinese provinces (Guangxi, Guizhou, Henan, Hubei, Hunan, Jiangsu, Liaoning (1989-1993 waves), and Heilongjiang (1997 wave)). The survey contains two basic modules. The household module includes an extensive set of health-related instruments that shed light onto the health status, health-affecting behaviors and the health-related constraints of Chinese citizens. It is also a rich source of information on the nutritional and economic status of the survey sample. The community-facility survey provides a detailed picture of the local environment within which CHNS households and individuals make decisions.

The sample is drawn from the 1993 and 1997 panels of the CHNS. After observations with missing values for key variables are eliminated, there are 8,557

Chinese men over age 13 in the analysis sample. The male smoking rate is 55.4%.[1] Means for the key covariates and smoking rates across demographic subgroups are presented in table 1. While over half the sample is in the 25 to 54 age range, there are still substantial samples of younger (age 13 to 24) and older (55+) Chinese men. There is also reasonable representation for nearly every educational cohort. The majority are from rural communities, but the proportions actually represent an oversampling of residents of more urban communities. The sample is more evenly distributed across provinces. Smoking rates peak for males in the 25 to 54 age. The lower rates for the youngest respondents probably reflect gradual smoking uptake. There are two possible explanations for the lower rate among older individuals. First, some smokers decide to quit as they grow older (note that more Chinese men report ever smoking than currently doing so). Second, there is the possibility of a cohort effect, since Chinese smoking rates began to rise dramatically in the early Seventies, when older Chinese had already passed the prime age for smoking uptake. Smoking rates appear generally to fall with wealth and education, though the smoking rates for the least educated conform to the overall average. Smoking rates are highest in suburban neighborhoods, though the variation across types of communities and provinces is comparatively modest.

Tables 2-6 provide results for estimations of our two models (as well as the three specifications within each) over the male subsample. Community-level nominal cigarette prices (the price in yuan of common cigarettes, defined in the interviewers manual as the most commonly smoked variety of cigarettes in a community, from the price module of the CHNS community survey) are utilized and include the deflator variable for the community-time period from which the observation is drawn as a separate regressor (in order to correct for variation in general price levels across time periods and communities). The second specification (the provincial/regional specification) introduces controls for urbanicity interacted with province, since the CHNS contains good urbanicity measures and Chinese provinces are an ideal subnational unit at which to offer some sort of regional controls. Elasticities were computed by simulating demand (a probability in the case of the binary participation model; the (continuous) expected number of cigarettes smoked in the case of the regression) before and after a 1 percent price increase. Each individual's elasticity is then 100 times the difference in their level of demand after and before the price change divided by demand before the price change. The relevant (ie participation or intensity) sample elasticity is the average of these individual elasticities.

Tables 2 and 3 present point estimates and elasticities for the base specification. A few patterns become immediately obvious. Turning first to the participation equation (table 2), we can see that prices are not significant for any of the specifications, though the price term grows more significant as progressively more specific corrections for community-level unobservables are introduced, with the price term in the fixed effects model nearly significant at the 10 percent level (t = -1.45). Introducing fixed effects appears to yield larger elasticity estimates, though the elasticities are extremely small across all specifications. This pattern

corresponds to a rather intuitive explanation of the likely relationship between community-level prices and community-level unobservables (eg cultural preferences toward smoking). Interestingly, the opposite pattern is observed in the intensity equation (table 3): as tighter controls for community-level unobservables are introduced, prices become *less* significant and elasticity estimates become more modest. Once again, however, we see that the intensity elasticities are far smaller than those recovered in earlier work, especially Mao and Xiang 1997. (In terms of their magnitudes, however, the straightforward intensity elasticity for model 1 is much closer to Mao and Xiang's 1997 figures than any of those for the participation equation. The estimated intensity elasticity is 33.9 % (=-.061/-.18) of Mao and Xiang's estimate, while the highest participation elasticity for model 1 is 6.6 % (=-.059/-.89) of theirs.)

A wide variety of variations on the base model were tried. They included models which variously added other control variables, higher order terms in prices, and interactions of the controls with prices. A certain degree of variation in the elasticity estimates was observed, but all estimates were modest and suggested that smoking behavior is not very responsive to prices. One of these variations, the "full" model, is presented in tables 4 and 5. It includes other explanatory variables (wealth, age, education and household size) and interacts prices with a subset of them (wealth and age). The price terms are collectively significant in the participation equation, and evidence for their collective significance generally grows stronger with the introduction of tighter controls for community level unobservables. The magnitude of the estimated elasticities also grow larger with the introduction of fixed-effects controls for heterogeneity. However, they are, once again, quite small. Hence, we see the basic patterns of the base case carry over to a richer model. Interestingly, there is little statistical evidence of wealth effects, after controlling for other individual-level characteristics. The intensity equation also reveals the basic patterns of the base model. Estimated elasticities fall with the introduction of fixed effects as the price terms become less significant. The elasticity estimates are very small. The positive elasticity likely reflects imprecision in the estimation of an extremely small price effect. Finally, wealth is weakly significant at conventional levels.

Table 6 reports elasticities by age and wealth levels for the male subsample (we report results only for the full model since the elasticity estimates do not vary in a meaningful and interesting way in the case of the base model). Unsurprisingly, participation elasticities are larger for the poor. Surprisingly, they are also larger for the wealthiest Chinese men. There are a number of possible explanations for this. One is that wealth proxies other individual characteristics, such as expected future earnings. One might expect that those with higher expected future earnings would be more sensitive to considerations of the future health effects of smoking, which could limit their labor market participation. It is therefore possible that, given the intertemporal costs and benefits of smoking, their commitment to smoking is more tenuous and hence the likelihood is greater that price increases will push the latent welfare received from smoking below the key threshold separating smokers and non-smokers. (In some sense, this is a variation on a theoretical possibility first

suggested by Cowell 1998.) Participation elasticities are also larger in magnitude for the youngest and oldest Chinese men. It seems entirely possible that in the former case larger elasticities reflect the impact of prices upon the initiation decision while in the latter case they are indicative of the influence of prices in the decision to quit. Intensity elasticities generally display similar patterns, though the variation across wealth cohorts is more complex.

Finally, despite the assertion that stratification by gender could be important, table 7 summarizes the results estimated over the full sample of 17,318 Chinese men and women over the age of 13 (table 1 provides means and smoking rates for key covariates over the full sample of men and women and 8 provides elasticities by age and wealth). Since Chinese women have far lower smoking rates than men, Warner 1990 would seem to predict that their inclusion in the sample should lead to larger elasticity estimates. However, there is little evidence to support this prediction in the Chinese case. The elasticity estimates are still extremely modest and in the neighborhood of those recovered with the male subsample (note that in many cases moving to the full sample of men and women made no difference whatsoever). These results merit caution. There are few female smokers. Attempts to estimate over the female sample exclusively result in the intensity equations essentially breaking down in many instances where community- or region-level unobserved heterogeneity (for instance, huge portions of an already limited sample are lost due to many cases where the fixed-effect perfectly predicts outcomes in a community) are controlled. Put simply, there are not sufficient numbers of female smokers in many communities over time to estimate a within effect. Nonetheless, tables 7 and 8 present results that are similar to those obtained for the male subsample.

Section IV. Conclusion

This paper presents estimates from two-part models of cigarette demand by Chinese males, using data from extremely rich and detailed micro-level longitudinal surveys from the two countries. Elasticity estimates varied somewhat across different models, specifications of those models, and price measures. However, none were anywhere near the magnitudes theoretically suggested by some or recovered empirically in many other empirical examinations of cigarette demand in developing nations. In particular, our cigarette price elasticity estimates are very modest in comparison with those recovered by Mao and Xiang 1997, the only other study (to our knowledge) to examine price effects in any developing nation with cross-sectional data. Controlling for community-level heterogeneity actually generally lowered our estimated elasticities.

Our research into cigarette demand is not confined to China. In particular, we have also examined demand in Russia and Indonesia. Our results have generally been remarkably similar: estimated price elasticities are far smaller than those recovered by the bulk of the existing literature on smoking in developing nations. We conclude by briefly describing results for our Indonesia work. We use the 1997 wave of the Indonesian Family Life Survey (IFLS2). IFLS2 provides

community-level cigarette prices. However, it is difficult to construct consistent cigarette prices from these. This note instead relies on community-level averages of unit values (uvs) (daily expenditure/number of 20 cigarette packs consumed) reported by IFLS respondents. Deaton [1997] has emphasized that raw uvs could be contaminated by unobserved quality variation: individual smokers report the price of cigarettes that they have *chosen* to smoke. Therefore, the raw uvs were regressed on a set of controls for wealth, age, education, cigarette type smoked (filtered, unfiltered, clove, tobacco), gender, culture and, whenever possible, rich interactions. The original, raw uvs were then purged of the fitted uvs (to a significant extent washing out quality) and averaged among the smokers in a community. After deflating to correct for geographic general price variation, this average is employed as a community-level cigarette price measure.

Summary statistics are reported in table 9 of the appendix. The basic demand model is estimated over the full sample as well as men alone. Price elasticities are never large for men, and generally become smaller with FE estimation. FE yield larger participation and smaller intensity elasticities. Table 11 reports elasticities by age and wealth. Poorer men are clearly more price sensitive, with most of the effect falling on the intensity decision. The introduction of FE does not alter this conclusion, though more of the effect appears to lie with the participation decision. In either case, overall price sensitivity hovers near the elastic threshold for the poorest, but only the poorest, men. Cross-sectional elasticities suggest that the youngest and, to a lesser extent, oldest men are more sensitive to price. Once again, most of the effect is felt through the intensity. FE estimation does not alter this picture, except that the bulk of the price effect for older men now operates through participation. While these results are certainly interesting, they must be viewed with caution since point estimates for interactions of wealth and price and age and price were fairly imprecise. Table 12 reports results for estimation over the full sample. Generally speaking, the full sample appears to be more sensitive to prices. However, these results must as well be viewed with caution since the addition of women actually represents only a small increase in the number of smokers from whom demand effects can be identified.

This will certainly not be the last word on cigarette demand in China or developing countries in general. We cannot be certain that the extraordinarily small elasticities reported herein are not partly the result of some sort of statistical bias. However, Lance et al. 2002 explicitly examines and rejects many obvious possibilities. It is difficult to suggest a remaining source of bias that can convincingly explain even a significant portion of the large gap between these results and those of most earlier papers. Nonetheless, in the future it might be useful to gather sufficient data to estimate cigarette demand exclusively among the young (especially young men). It has been suggested that their (usually more substantial) sensitivity to prices reflects the potential for higher prices to discourage smoking uptake. It is possible that the smoking rate of Chinese males could eventually be reduced with sufficiently high taxes by discouraging young men from taking up the habit. Along similar lines, an analysis of quitting behavior by older men might represent a real contribution to the formation of well-designed smoking

control policies. It might also be interesting to examine the cigarette smoking behavior of young women. Although their overall smoking rates are very low, it might be possible that, in the midst of dramatic social and political upheaval in China, their rates could increase in future years. Careful examination of their smoking behavior might permit governments to craft policies that could quickly reverse any nascent trend toward greater female smoking uptake. Finally, it might be worthwhile to gather more detailed information about the types of cigarettes smoked by Chinese consumers, as well as their prices, in order to see whether taxes might simply induce substitution among cigarette types (longer for shorter lengthwise, higher for lower nicotine, etc.) of the sort suggested by Evans and Farrelly 1998. If this sort of substitution is indeed occurring, it provides a very intuitive explanation for the extremely small intensity elasticities recovered in this paper.

Footnotes

1. The female smoking rate is 4.0%, leading to an overall rate of 29.4%. The male smoking rate is about 7 percentage points lower than that reported in the National Prevalence Survey. Most likely this discrepancy is due to the different sampling schemes employed in the two surveys. The National Prevalence Survey was fully nationally representative, with a probability sample that included all of China's provinces, whereas the CHNS focuses on 8 of them. Those in the CHNS tend to be inland eastern or coastal provinces, with no large southwest provinces (such as Sichuan). However, an important finding from the 1996 Prevalence Survey is that smoking rates for men are highest in Southwestern provinces (Yang et al. 1999).

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Table 1. Variable definitions

		Full sample		Male subsample	
Variable	**Definition**	**Mean**	**Rate[a]**	**Mean**	**Rate[a]**
eversmoke	Equals 1 if the individual ever smoked as of interview, 0 otherwise.	0.325	-	0.611	-
smoke	Equals 1 if currently smoke.	0.294	1.000	0.554	1.000
cigs	Equals number of cigarettes smoked	15.80b	**-**	16.13[c]	-
price	Price of pack common cigarettes in yuan. At the CHNS community level, deflated to common year-community terms.	1.855	-	1.859	-
age<20	Equals 1 if the individual is less than 19 years of age.	0.128	0.070	0.137	0.129
age21-24	Equals 1 if the individual is between 20 and 24 years of age.	0.107	0.264	0.112	0.498
age25-54	Equals 1 if the individual is between 25 and 54 years of age.	0.563	0.350	0.560	0.678
age55+	Equals 1 if the individual is over 54 years of age.	0.202	0.296	0.192	0.530
wealth1[d]	Equals 1 if the individual is from a household in lowest wealth quartile.	0.259	0.299	0.261	0.560
wealth2[d]	Equals 1 if the individual is from a household in second lowest wealth quartile.	0.255	0.302	0.258	0.565
wealth3[d]	Equals 1 if the individual is from a household in the second highest wealth quartile.	0.246	0.295	0.243	0.554

wealth4[d]	Equals 1 if the individual is from a household in the highest wealth quartile.	0.240	0.279	0.238	0.537
educ0	Equals 1 if the individual has no education.	0.172	0.185	0.082	0.552
educ1-5	Equals 1 if the individual has some primary education.	0.198	0.328	0.195	0.622
educ6	Equals 1 if the individual completed primary school.	0.092	0.338	0.097	0.605
educ7-9	Equals 1 if the individual has at least some lower middle school education.	0.356	0.316	0.412	0.538
educ10-12	Equals 1 if the individual has at least some upper middle school education.	0.118	0.316	0.139	0.535
educ>12	Equals 1 if the individual's educational experience extends beyond upper middle school (to university/college, technical/vocational school).	0.064	0.259	0.075	0.442
city	Equals 1 if reside in city neighborhood, 0 otherwise.	0.129	0.285	0.126	0.537
suburb	Equals 1 if reside in suburban village, 0 otherwise.	0.174	0.306	0.174	0.573
town	Equals 1 if reside in town neighborhood, 0 otherwise.	0.162	0.281	0.159	0.541
rural	Equals 1 if reside in rural village, 0 otherwise.	0.535	0.296	0.541	0.557
Liaoning	Equals 1 if reside in Liaoning province, 0 otherwise.	0.038	0.320	0.036	0.600
Jiangsu	Equals 1 if reside in Jiangsu province, 0 otherwise.	0.093	0.283	0.095	0.527
Shandong	Equals 1 if reside in Shandong province, 0 otherwise.	0.103	0.271	0.098	0.506

Henan	Equals 1 if reside in Henan province, 0 otherwise.	0.133	0.290	0.133	0.569
Hubei	Equals 1 if reside in Hubei province, 0 otherwise.	0.137	0.289	0.138	0.544
Hunan	Equals 1 if reside in Hunan province, 0 otherwise.	0.109	0.287	0.110	0.546
Guangxi	Equals 1 if reside in Guangxi province, 0 otherwise.	0.162	0.268	0.163	0.516
Guizhou	Equals 1 if reside in Guizhou province, 0 otherwise.	0.167	0.331	0.169	0.633
Heilong	Equals 1 if reside in Heilongjiang province, 0 otherwise.	0.057	0.337	0.058	0.535
year	Equals 1 if the observation is drawn from the 1997 panel of the CHNS.	0.566	0.286	0.574	0.532
deflate[e]	A price deflator.	1.104	-	1.107	-
gender	Equals 1 if the observation is a woman.	0.506	-	0.000	-
	N	17318		8557	

a. Rate refers to the mean of smoke, and hence the smoking rate, within the indicated cohort.
b. Average among the 4965 smokers with available data for smoking intensity.
c. Average among the 4624 male smokers with available data for smoking intensity.
d. The wealth quartiles are based on a household wealth index. The household wealth index is the 1st principal component of several household asset ownership indicators (ownership of bicycle (number of bikes owned), tricycle, motorbike, automobile, radio, vcr, black and white TV, color TV, washing machine, refrigerator, air conditioner, sewing machine, electric fan, camera) and dwelling characteristics (whether household has in-house tap water, tap outside the dwelling, in house flush toilet, in house non-flushing toilet, access to public flush toilet, electric light; type of cooking fuel (coal, natural gas, wood or other), number of rooms, material from which walls constructed). Principal components analysis results available upon request.
e. The deflator was constructed by computing the value of a basket of goods in the community, in a baseline community used to calculate the deflator for all CHNS communities, and then dividing the former by the latter (hence the deflator value for the baseline community is 1). The basket is composed of a series of goods for which price data is available in the community-facility module of the CHNS. The goods, as well as their weight in the basket, were determined by the 1989 consumer basket provided in Ren et al. 1989 (the same basket employed by the CHNS survey team to build the province-level urban-rural price deflators available with the public release CHNS). The goods included in the basket are millet, unbleached flour, common rice, pork, beef, live chicken, fish, vegetables, milk, eggs, sugar, tea, local liquor, cotton fabric, and gasoline. Where a price is missing for any given community, the basket value in the baseline community is re-computed with the subset of goods for which there is available price data for that community.

Table 2. Smoking participation, base specification (dependent variable smoke)[a,b]

	Pooled		Province* urbanicity fixed effects		Community-level fixed effects	
Variable	**∃**	**s.e.**	**∃**	**s.e.**	**∃**	**s.e.**
constant	0.563***	0.110	0.756***	0.126	0.937***	0.219
price	-0.027	0.032	-0.034	0.033	-0.066	0.046
deflate	-0.232*	0.118	-0.217*	0.122	-0.110	0.211
Year (1997=1)	-0.058	0.073	-0.069	0.076	-0.123	0.124
N	8557		8557		6551	
elasticity	-0.025		-0.031		-0.059	
Test[c]	$\Pi^2(1)=0.72;Pr>\Pi^2=0.397$		$\Pi^2(1)=1.05;Pr>\Pi^2=0.305$		$\Pi^2(1)=2.10;Pr>\Pi^2=0.147$	

*: significant at the 10% level.
**: significant at the 5% level.
***: significant at the 1% level.
a. Estimation across male subsample.
b. Logit model employed for each specification.
c. Test of the significance of all of the price terms. In models with only 1 price term, this is equivalent to a t-test.

Table 3. Smoking intensity, base specification (dependent variable: cigs)[a,b]

	Pooled		Province* urbanicity fixed effects		Community-level fixed effects	
Variable	**∃**	**s.e.**	**∃**	**s.e.**	**∃**	**s.e.**
constant	15.10***	0.838	13.71*	0.761	10.55***	1.118
price	-0.487**	0.206	-0.346*	0.194	-0.037	0.236
deflate	1.440	1.087	1.013	0.931	2.332***	0.890
year (1997=1)	0.770	0.628	0.845	0.606	-0.180	0.690
N	4624		4624		3515	
elasticity	-.061		-.044		-.004	
Test[c]	F(1,200)=5.61 Pr>F=0.019		F(1,200)=3.20 Prob>F=0.075		F(1,119)=0.02 Prob>F=0.8760	
R^2	0.009		0.061		0.130	

*: significant at the 10% level.
**: significant at the 5% level.
*** significant at the 1% level.
a. Estimation across male subsample.
b. Ordinary least squares used for each specification.
c. Test of the significance of all of the price terms. In models with only 1 price term, this is equivalent to a t-test.

Table 4. Smoking participation, full model (dependent variable: smoke)[a,b]

	Pooled		Province* urbanicity fixed effects		Community-level fixed effects	
Variable	**∃**	**s.e.**	**∃**	**s.e.**	**∃**	**s.e.**
constant	-1.594***	0.347	-1.612***	0.364	-2.116***	0.476
price	-0.123	0.150	-0.123	0.165	-0.004	0.215
price*wealth2	0.121*	0.072	0.099	0.073	0.032	0.076
price*wealth3	0.091	0.081	0.064	0.084	-0.001	0.110
price*wealth4	0.024	0.086	-0.018	0.084	-0.137	0.113
price* age21-24	0.141	0.122	0.141	0.128	0.070	0.142
price* age25-54	0.093	0.118	0.092	0.124	0.030	0.146
price*age55+	-0.044	0.114	-0.061	0.122	-0.130	0.140
wealth2	-0.219	0.152	-0.143	0.151	-0.003	0.170
wealth3	-0.221	0.171	-0.102	0.171	0.064	0.227
wealth4	-0.137	0.199	0.166	0.199	0.543**	0.276
age21-24	1.682***	0.246	1.709***	0.253	1.883***	0.267
age25-54	2.537***	0.246	2.630***	0.252	2.810***	0.288
age55+	2.218***	0.252	2.346***	0.261	2.623***	0.294
educ1-5	0.291**	0.118	0.309***	0.120	0.387***	0.139
educ6	0.198	0.135	0.224*	0.136	0.339**	0.161
educ7-9	0.207*	0.118	0.249**	0.122	0.341**	0.143
educ10-12	0.084	0.136	0.133	0.139	0.225	0.163
educ>12	-0.401**	0.159	-0.413**	0.168	-0.255	0.225
hhsize	0.016	0.022	0.002	0.021	0.014	0.026
deflate	-0.212	0.151	-0.204	0.150	0.032	0.242

year (1997=1)	-0.144	0.091	-0.137	0.093	-0.313**	0.144
N	8557		8557		6551	
elasticity	-.019		-.045		-.034	
Test 1[c]	$\Pi^2(7)=15.73;Pr>\Pi^2=0.028$		$\Pi^2(7)=19.03;Pr>\Pi^2=0.008$		$\Pi^2(7)=18.50;Pr>\Pi^2=0.010$	
Test 2[d]	$\Pi^2(6)=7.19;Pr>\Pi^2=0.303$		$\Pi^2(6)=5.92;Pr>\Pi^2=0.432$		$\Pi^2(6)=7.86;Pr>\Pi^2=0.248$	

*: significant at the 10% level.
**: significant at the 5% level.
*** significant at the 1% level.
a. Estimation across male subsample.
b. Logit model employed for each specification.
c. Test of the significance of all of the price terms. In models with only 1 price term, this is equivalent to a t-test.
d. Test of the significance of all of the wealth terms.

Table 5. Smoking intensity, full model (dependent variable: cigs)[a,b]

	Pooled		Province* urbanicity fixed effects		Community-level fixed effects	
Variable	**∃**	**s.e.**	**∃**	**s.e.**	**∃**	**s.e.**
constant	10.09***	1.496	8.349***	1.485	2.093	1.868
price	-0.935**	0.431	-0.713	0.438	0.805	0.544
price*wealth2	0.697	0.429	0.389	0.421	0.293	0.422
price*wealth3	-0.262	0.449	-0.565	0.429	-0.674	0.488
price*wealth4	0.293	0.520	0.204	0.482	-0.472	0.407
price* age21-24	0.564	0.554	0.571	0.559	-0.041	0.553
price* age25-54	0.389	0.479	0.404	0.503	-0.578	0.511
price*age55+	0.180	0.519	0.187	0.550	-0.573	0.579
wealth2	-0.850	0.869	-0.250	0.834	-0.021	0.834
wealth3	1.086	0.956	1.829**	0.862	2.198**	0.982
wealth4	-0.580	1.067	0.092	1.002	2.064**	1.044
age21-24	2.105*	1.240	2.095*	1.248	3.625***	1.143
age25-54	5.593***	1.177	5.562***	1.207	7.802***	1.208
age55+	4.413***	1.357	4.413***	1.422	6.086***	1.477
educ1-5	0.610	0.578	0.589	0.564	0.776	0.591
educ6	0.940	0.751	0.965	0.727	1.318*	0.783
educ7-9	0.279	0.684	0.355	0.679	0.538	0.730
educ10-12	-0.155	0.774	-0.090	0.742	0.265	0.868
educ>12	-1.491*	0.863	-0.812	0.839	0.183	0.973
hhsize	0.013	0.111	-0.043	0.010	-0.053	0.114
deflate	1.333	1.061	0.808	0.893	2.295***	0.807

year (1997=1)	0.568	0.648	0.763	0.595	-0.506	0.660
N	4624		4624		3515	
elasticity	-.063		-.056		.027	
Test 1[c]	F(7,200)=3.10 Pr>F=0.004		F(7,200)=2.69 Prob>F=0.011		F(7,119)=1.53 Prob>F=0.164	
Test 2[d]	F(6,200)=1.85 Pr>F=0.092		F(6,200)=1.94 Prob>F=0.076		F(6,119)=1.88 Prob>F=0.089	
R^2	0.046		0.095		0.168	

*: significant at the 10% level.
**: significant at the 5% level.
*** significant at the 1% level.
a. Estimation across male subsample.
b. Ordinary least squares used for each specification.
c. Test of the significance of all of the price terms. In models with only 1 price term, this is a t-test.
d. Test of the significance of all of the wealth terms.

Table 6. Summary of elasticities, full model[a]

	Pooled			Community-level fixed effects		
	P	**I**	**T**	**P**	**I**	**T**
Overall	-.019	-.063	-.082	-.034	.027	-.007
Wealth1	-.065	-.077	-.142	-.011	.051	.040
Wealth2	.035	.007	.043	.018	.085	.103
Wealth3	.013	-.128	-.115	-.011	-.035	-.046
Wealth4	-.059	-.057	-.115	-.169	-.014	-.183
Age<20	-.109	-.148	-.257	-.041	.118	.077
Age21-24	.080	-.027	.053	.043	.078	.122
Age25-54	.017	-.042	-.025	-.005	.001	-.004
Age55+	-.117	-.082	-.199	-.154	.005	-.149

a. Estimates for male subsample.

Table 7. Results for the full sample[a,b]

Model	Participation		Intensity		
	Test[d]	Elasticity	Test[d]	Elasticity	Total elasticity
pooled estimations, ***base model***					
	$\Pi^2(1)=0.09;Pr>\Pi^2=0.764$	-.010	F(1,200)=5.09; Pr>F=0.025	-.055	-.065
province*urbanicity estimations, ***base model***					
	$\Pi^2(1)=0.35;Pr>\Pi^2=0.555$	-.018	F(1,200)=2.75; Pr>F=0.099	-.038	-.056
community-level fixed effects estimation, ***base model***					
	$\Pi^2(1)=2.11;Pr>\Pi^2=0.146$	-.062	F(1,119)=0.00; Pr>F=0.994	-.000	-.062
pooled estimations, ***full model*** [c]					
	$\Pi^2(7)=13.52;Pr>\Pi^2=0.060$	-.012	F(7,200)=2.74; Pr>F=0.010	-.072	-.083
province*urbanicity estimations, ***full model*** [c]					
	$\Pi^2(7)=17.71;Pr>\Pi^2=0.013$	-.050	F(7,200)=2.41; Pr>F=0.022	-.063	-.113
community-level fixed effects estimation, ***full model*** [c]					
	$\Pi^2(7)=18.27;Pr>\Pi^2=0.011$	-.045	F(7,119)=1.61; Pr>F=0.138	.022	-.023

a. Estimation across full sample.
b. Nominal cigarette prices with the deflator as separate explanatory variable.
c. Gender added as explanatory variable.
d. Test of the joint significance of the price terms.

Table 8. Summary of elasticities, full model[a]

	Pooled			Community-level fixed effects		
	P	**I**	**T**	**P**	**I**	**T**
Overall	-.012	-.072	-.084	-.045	.022	-.023
Wealth1	-.086	-.094	-.180	-.003	.056	.052
Wealth2	.046	.014	.060	.012	.060	.072
Wealth3	.049	-.145	-.096	-.041	-.033	-.073
Wealth4	-.055	-.064	-.119	-.192	-.016	-.208
Age<20	-.157	-.229	-.387	-.076	.027	.049
Age21-24	.119	-.038	.081	.059	.086	.145
Age25-54	.041	-.040	.001	.015	.008	.023
Age55+	-.136	-.078	-.214	-.234	.019	-.216

a. Estimates for full sample.

Table 9. Variable definitions, Indonesia

		Full sample		Men	
Variable	**Definition**	**Mean**	**Rate[e]**	**Mean**	**Rate[e]**
smoke	1 if currently smoke.	.30	-	.62	-
cigs	number of cigarettes smoked	11.42[a]	-	11.61[b]	-
price	Price of cigarette pack in rupiah. At the IFLS community level, deflated to Java terms.	2946	-	2945	-
age1	1 if less than 18 years of age.	.11	.12	.11	.24
age2	1 if between 18 and 22 years old.	.12	.26	.13	.56
age3	1 if between 23 and 30 years old.	.17	.30	.15	.69
age4	1 if between 31 and 55 years old.	.43	.34	.43	.71
age5	1 if over 55 years of age.	.17	.33	.17	.63
wealth1[c]	1 if in lowest wealth quartile.	.21	.35	.21	.72
wealth2[c]	1 if in 2nd lowest wealth quartile.	.24	.32	.24	.67
wealth3[c]	1 if in 2nd highest wealth quartile.	.26	.29	.26	.59
wealth4[c]	1 if in the highest wealth quartile.	.28	.25	.28	.52
educ0	1 if no education.	.15	.22	.10	.68
educ1	1 if at least some grammar school.	.44	.35	.44	.71
educ2	1 if at least some primary school.	.36	.27	.40	.52

educ3	1 if at least some lower middle school.	.05	.29	.06	.50
islam	1 if Muslim.	.87	.31	.87	.64
hindu	1 if Hindu.	.05	.22	.05	.45
lit	1 if literate in Bahasa Indonesian	.78	.31	.85	.60
langi	1 if speak Bahasa Indonesian at home.	.23	.27	.24	.56
langj	1 if speak Javanese at home.	.42	.30	.42	.62
langs	1 if speak Sundanese at home.	.11	.37	.11	.72
rural	1 if reside in rural community.	.52	.32	.53	.67
northsum	1 if reside in North Sumatra.	.07	.25	.07	.52
westsum	1 if reside in West Sumatra.	.05	.32	.05	.70
southsum	1 if reside in South Sumatra.	.04	.32	.04	.65
lampung	1 if reside in Lampung.	.04	.39	.04	.74
jakarta	1 if reside in Jakarta.	.09	.27	.09	.56
westjava	1 if reside in West Java.	.16	.36	.16	.70
centjava	1 if reside in Central Java.	.14	.31	.13	.68
yogya	1 if reside in Yogyakarta.	.07	.25	.07	.53
eastjava	1 if reside in East Java.	.14	.28	.14	.61
bali	1 if reside in Bali.	.05	.21	.06	.44
wnusa	1 if reside in West Nusa Tenggara.	.06	.31	.06	.70
southkali	1 if reside in S. Kalimantan.	.04	.30	.04	.56
southsula	1 if reside in South Sulawesi.	.04	.25	.04	.54
deflate[d]	A price deflator.	.77	-	.77	-

gender	1 if female.	.54	-	-	-
	Observations		17,536		8,051

a. Average among the 5180 smokers with available data for smoking intensity.
b. Average among the 4934 male smokers with available data for smoking intensity.
c. Wealth quartiles are based on a household wealth index. This index is the 1st principal component of a variety of household and asset ownership characteristics (whether home possesses adequate ventilation; size of yard; floor size; whether kitchen is within home; number of rooms; floor material (ceramic/stone, tile, cement/brick, lumber, bamboo, other); whether household has electricity; main source of drinking and cooking water (piped water, pumped water, well, spring, other); ownership of a refrigerator; type of stove (electric, gas, kerosene, wood/charcoal, other); ownership of television). Principal components results available upon request. Averages for quartiles differ from .25 because they are calculated for the full sample, not the remaining sample after dropping observations with missing information relevant to cigarette demand estimation.
d. The deflator was generously provided by Christine Peterson of RAND. Java normalized to 1.
e. Rate refers to the mean of smoke, and hence the smoking rate, within the indicated cohort.

Table 10. Results for the men, Indonesia

Model	Participation[a]		Intensity		
	Test[b]	Elas.	Test[b]	Elas.	Total
cross-sectional estimation, ***base model***					
	$\Pi^2(1)=.15;Pr>\Pi^2=.694$	.03	F(1,4932)=31.42;Pr>F=.000	-.43	-.40
regional estimation, ***base model***					
	$\Pi^2(1)=3.14;Pr>\Pi^2=.076$	-.14	F(1,4909)=.47;Pr>F=.495	.06	-.08
cross-sectional estimation, ***full model***					
	$\Pi^2(8)=4.11;Pr>\Pi^2=.847$	.09	F(8,4906)=4.95;Pr>F=.000	-.52	-.43
regional Estimation, ***Full model***					
	$\Pi^2(8)=5.74;Pr>\Pi^2=.677$	-.06	F(8,4883)=.82;Pr>F=.585	-.14	-.20

a. Participation modeled by logit.
b. Tests the joint significance of the price terms.

Table 11. Summary of elasticities for men, full model, Indonesia

	cross-sectional			region fixed effects		
	P	**I**	**T**	**P**	**I**	**T**
Overall	.09	-.52	-.43	-.06	-.14	-.20
Wealth1	-.06	-1.11	-1.17	-.28	-.51	-.80
Wealth2	.10	-.42	-.32	-.13	.06	-.07
Wealth3	.12	-.30	-.17	.01	-.06	-.05
Wealth4	.17	-.36	-.19	.11	-.10	.01
Age<18	.25	-1.26	-1.01	-.06	-.83	-.88
Age18-22	.13	-.28	-.15	-.01	.15	.14
Age23-30	.15	-.30	-.15	.06	.01	.07
Age31-55	.09	-.46	-.37	-.04	-.10	-.14
Age55+	-.09	-.55	-.64	-.25	-.11	-.36

Table 12. Results for the full sample, Indonesia

Model	Participation[a]		Intensity		
	Test[b]	Elas.	Test[b]	Elas.	Total
cross-sectional estimation, ***base model***					
	$\Pi 2$(1)=0.30;Pr>Π^2=.585	-.05	F(1,5178)=34.26;Pr>F=.000	-.44	-.49
regional estimation, ***base model***					
	Π^2(1)=4.44;Pr>Π^2=.0351	-.23	F(1,5155)=.63;Pr>F=.4287	.07	.16
cross-sectional estimation, ***full model***					
	Π^2(8)=6.17;Pr>Π^2=.628	.01	F(8,5151)=5.77;Pr>F=.000	-.95	-.94
regional estimation, ***full model***					
	Π^2(8)=10.86;Pr>Π^2=.210	-.23	F(8,5128)=.83;Pr>F=.579	-.44	-.66

a. Participation modeled by logit.
b. Tests the joint significance of the price terms.