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ABSTRACT

In this paper we construct measures of tax incidence over the life-cycle and compare these measures to traditional measures based on annual data. We show that annual measures of the incidence of taxes on consumption goods may differ from life-cycle measures for three reasons. First, annual measures of income reflect transitory components which should have smaller effects on consumption than permanent changes in income. Second, income measured in a single period differs from lifetime income due to age-related differences in earnings. Third, consumption of certain items follows life-cycle patterns independent of changes in income. Surprisingly, we find that these effects cause almost no change in the assessment of the incidence of taxes applying to the consumption of cigarettes. For alcohol, however, we find that a tax on its consumption is slightly less regressive when measured with respect to lifetime income than when measured with respect to annual income.

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I. Introduction

The 1990 budget act included significant increases in the Federal excise taxes on alcohol, cigarettes, and gasoline. Taxes from the consumption of these items are expected to increase by $40 billion over the next five years. In part to balance the perceived distributional effects of the budget package, a new luxury tax was introduced on high priced furs, jewelry, automobiles, boats, and aircraft.

Most traditional analyses of tax incidence would concur that excise taxes on alcohol, cigarettes, and gasoline are regressive. These studies compute tax incidence on the basis of current expenditure on these items relative to current income. In this study, we seek to increase our understanding of the incidence of these taxes by examining tax incidence in a life-cycle framework.

Using the Panel Survey of Income Dynamics, a panel survey containing income and other demographic information on households from 1968-1987, we construct measures of the incidence of taxes on alcohol and cigarettes. We first estimate the determinants of household income and the demand for alcohol and cigarettes. We then use these estimates to simulate the life-cycle behavior of a sample of 1,054 PSID households in order to compare tax incidence measures based on annual income and annual consumption with incidence measures based on longer time periods. Our results suggest that it may be very difficult to draw general conclusions on this issue. We find, perhaps surprisingly, that there is relatively little change in the measured regressivity of a tax on cigarettes by including time periods longer than one year. In contrast, we find that a tax on alcohol is closer to a proportional tax over the life-cycle though clearly regressive in the analysis of a single year's data.

The next section of this paper describes the reasons why we may suspect that lifetime tax incidence would differ from annual measures of tax incidence. In Section III, our data and empirical methodology for estimating lifetime income and consumption is presented. In Section IV, these estimates are used to construct alternate measures of tax incidence. The final section provides a brief summary and directions for further research.

II. Why Life-Cycle Tax Incidence May Differ from Annual Tax Incidence

Most examinations of tax incidence in the economic literature, and those used almost exclusively by government (although see below for exceptions), use a single year's estimated tax payments and income. These annual incidence studies, however, may incorrectly describe the distributional effects of a tax over the lifetime of an individual. As a result, while annual incidence studies correctly describe the current distributional effects of a tax, they may not be helpful in assessing lifetime distributional effects.

Life-cycle effects may be particularly pronounced when examining the distributional effects of taxes based on consumption. There are three primary reasons for this discrepancy. First, as noted by Friedman (1957) in his discussion of the permanent income hypothesis, it is likely that consumption of individuals is less affected by changes in transitory income -- for example random events such as sickness or temporary unemployment -- than changes in permanent income, described by Friedman as representing the predictable component of one's income. As a result, annual incidence studies will show that among individuals with equal permanent incomes, those with high transitory income consume a smaller share of their total income than individuals with low transitory income. However, if these transitory fluctuations in income average out over one's lifetime, consumption will be proportional to permanent income.

Second, consumption at any point in time may be a function of lifetime income, rather than strictly the predictable component of current income (Modigliani and Brumberg [1954]). Over any short period of time, there is no necessary correspondence between one's income and one's consumption when one is able to save, dissave, or borrow. Where the individual's subjective rate of time preference is equal to the market interest rate, the individual would move consumption across periods to equate the marginal utility of consumption. It is quite reasonable therefore to expect that the young and the elderly consume more than their current income. Annual incidence studies of consumption taxes would show very high tax burdens on these individuals, whereas, in the absence of bequests, a consumption tax would be borne proportionately with respect to lifetime income.

Third, where consumption taxes are not uniform over all goods, life-cycle consumption patterns may cause a further distortion in annual incidence studies. Consider a simple case where individuals consume only out of current income, but young consumers spend a larger share of their consumption on highly taxed consumption goods than do older consumers. If young consumers have lower current earnings than older consumers, annual incidence studies would show these consumption taxes to be regressive. A lifetime incidence analysis, however, would correctly show the tax burden to be proportional to lifetime earnings.

Previous analyses have noted the potential discrepancies between annual tax incidence and lifetime tax incidence. Pechman (1985), using annual incidence measures, finds the total tax burden in the United States to be roughly proportional to annual income, although it is slightly regressive over the lowest income ranges. He noted (1985, pp. 50-51):

> The regressivity of total tax burdens found in the lower income levels under all incidence variants results from the regressivity of the sales and excise taxes and of

property taxes. Whether the regressivity of these taxes with respect to income would remain for accounting periods longer than one year is not known. It seems clear, however, that the regressivity shown in the lowest income levels on the basis of annual figures would be moderated, if not completely eliminated, over the longer period.

Simulation analysis by Davies, St-Hilaire, and Whalley (1984) on the lifetime incidence of Canadian taxes finds that the incidence of sales and excise taxes is very sensitive to the distinction between lifetime and annual earnings. Using estimates of earnings mobility over time, Davies et al. convert a cross-sectional survey of households into a simulated longitudinal profile. They then calculate the incidence of various taxes based on both lifetime and annual income. They find the annual incidence of sales and excise taxes in Canada range from 27.2 percent of annual income in the lowest income decile to 8.5 percent in the highest income decile. Using lifetime income, however, the sales and excise taxes are roughly proportional -- ranging from 15.0 percent of lifetime income in the lowest income decile to 12.4 percent in the highest income decile. This simulation suggests that life-cycle effects can be important in assessing the tax burdens of taxes linked to consumption.

The Congressional Budget Office (1990) in a study of the incidence of taxes on alcohol, tobacco, and motor fuels also presents calculations of tax incidence on a basis other than annual incidence. Lacking sufficient information to calculate lifetime incomes of consumers, the CBO presents calculations of the shares of expenditure on these three consumption items by household as a fraction of all consumption by the household. The CBO suggests that total consumption may more closely correspond to the lifetime and/or permanent income of households than annual income. Poterba (1989, 1991) presents similar comparisons based on total household consumption. This approach was used earlier by Davies (1960) who studied the incidence of a state sales tax. Davies found the state sales tax to be regressive relative to annual income, but progressive relative to total consumption since certain consumption items (notably food consumed at home) were exempt from the sales tax.

The CBO study finds that taxes on alcohol, tobacco, and motor fuels appear to be regressive relative to annual income. Relative to the alternative base -- total consumption of all goods by the household -- taxes on alcohol are found to be slightly progressive. Taxes on motor fuels appear to be roughly proportional to total consumption, and taxes on tobacco are much less regressive using this measure. This evidence suggests that taxes on these items are less regressive in a life-cycle context than shown in annual incidence studies. However, in the absence of data on lifetime income and lifetime consumption these findings are only suggestive. Taxes on these goods may be more or less progressive than shown in the CBO study depending on whether consumption of these items varies more or less than total consumption over the life-cycle.

Unfortunately, very limited work has been conducted with actual households over their lifetimes to assess lifetime tax incidence.[1] Longitudinal household data allow one to observe both lifetime income and lifetime consumption. No inferences need to be made on how consumption of these items may vary relative to total consumption or whether households base consumption decisions exclusively on lifetime incomes or if they are in fact largely dependent on current income.[2]

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[1]Exceptions to the limited work on lifetime tax incidence include Fitzgerald and Maloney (1990), Fullerton and Rogers (1991), and Sacher (1990). These studies also make use of the PSID.

[2]Hall and Mishkin (1982) present evidence on the extent to which consumption decisions appear to be based on lifetime income. They find that about 80 percent of consumption appears to be determined by lifetime income and the remainder by current income.

In the next section we describe our use of the twenty-year Panel Survey of Income Dynamics (PSID) to analyze the tax incidence of an excise tax on alcohol and cigarettes. The PSID data allow us to calculate and compare measures of annual and lifetime tax incidence on these consumption items. Econometric estimates based on the available PSID data allow us to extrapolate beyond the twenty-year study period to measure lifetime tax incidence.

III. Data and Methodology

The perfect data set for this study would follow a sample of families over their lifetime. Ideally, it would include a history of each family's income and its expenditures on alcohol and cigarettes. Given these data, we could then calculate directly the distribution of the burden of a hypothetical tax in a single year and compare it to the burden of that tax over each family's lifetime. Thus if such a data set were available, our job would be straightforward.

As is often the case, however, the ideal data set does not exist and we therefore have to fall back on a less direct approach. We have drawn on the Panel Study of Income Dynamics (PSID) in this paper. PSID began in 1968 by interviewing nearly 5,000 families, and has reinterviewed those families (as well as any new families formed by individuals in the original sample who moved to different households) each succeeding year; currently, data from the first twenty waves (1968-1987) are available. PSID has included questions on family income and other demographic information each year. During the first five years of the study, respondents were also asked information used to estimate each family's expenditures on alcohol and cigarettes. Our strategy is as follows. We use the full twenty years of data to estimate the time path of income over the life of a household. Similarly, we use the data on alcohol and cigarette expenditures from the first five waves of PSID to estimate the demands for alcohol and cigarettes as a function of income and other variables. We then use these three sets of parameter estimates and the known values of exogenous variables to simulate income and expenditures for 1,054 PSID households. We calculate the incidence of a hypothetical tax, and compare incidence in a single year to lifetime incidence.

Sample Selection

The notion of the "life-cycle of a household" is more complicated than most economists acknowledge. Most life-cycle models implicitly assume that people marry on the first day of their adult lives and then live together until the day they both die.[3] Life, of course, is not so simple. Divorce and widowhood are common; in PSID, for example, as of 1980 (the twelfth year of the study) only two in five families had failed to experience a change in head.[4] Thus in this study we have had to be quite careful in defining the life-cycle of a household.

We have chosen a strategy of following a sample of people who were continually heads of households throughout the twenty years of PSID.[5] This rule has some important implications for the nature of the households in our sample. If a head (as identified by PSID) and spouse divorce and both remarry, we follow the head. If the spouse dies but the head does not,

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[3]For example, this assumption is used in the simulation model of Davies, et al. (1984).

[4]Life is very complicated for some PSID families; several couples in the study divorced and then subsequently remarried each other.

[5]One concern is that this selection procedure may result in a nonrepresentative sample. Becketti et al. (1988) present evidence that attrition in the PSID between 1968 and 1981 does not appear to result in any bias in labor income determination.

then the household continues; if on the other hand the head dies and the spouse survives, the household would not have survived under our definition and would thus not be included in our sample. Since PSID almost always considers the male as the head of a married household and thus there are very few women who headed a household for the full twenty years, we include only male heads in our study. We acknowledge that to some extent these decisions are arbitrary. It is difficult, however, to think of a sampling rule which would avoid all such problems.

We excluded those households that were not part of the original PSID random sample (roughly 40 percent of the PSID sample were part of a sample designed to oversample low-income families), and those households where key variables were not available. The remaining sample included 1,054 households. All of the results reported in this paper are unweighted.

Econometric Specification

We estimate current household income using a fixed effect model that can be described as follows. The value of the dependent variable ln y_{it} (log of labor plus transfer income) for household i in year t depends on a vector of exogenous variables x_{it} that differs across households in a given year and across time for a given household, a set of factors summarized by a scalar α_i that is specific to household i and that stays constant over time, and an error term u_{it} which represents factors that cannot be observed. Under these assumptions, this model can then be written

(1) $$\ln y_{it} = \alpha_i + x_{it}\beta + u_{it}.$$

We assume that u_{it} is an independently identically distributed random variable with mean zero and variance σ_u^2.

The fixed effect model correctly captures the notion that unobservable characteristics may permanently affect household income. Additionally, where the exogenous variables are correlated with the individual-specific effects (e.g., if people with a great deal of unobservable ability also have more education), fixed effect estimates are unbiased. Random effects models yield biased estimates in such cases.

We explored several alternative models of cigarette and alcohol consumption. We initially attempted to exploit the panel nature of PSID by estimating a set of fixed effects and random effects models where we treated consumption as a continuous variable. Since for both alcohol and cigarettes roughly 46 percent of the observations involve zero consumption, we also estimated a set of tobit random effects models. It became clear, however, that none of these models were able to accurately capture the appropriate life-cycle pattern of consumption. The fixed effects models, for example, rely exclusively on intrahousehold variation in consumption over the five years for which we have consumption data. The estimated fixed effects from those models showed a very strong negative relation between age at the start of PSID and consumption. This suggests that these models missed an important part of the relationship between age and consumption that was evident in the cross-sections; the only other explanation would emphasize an implausibly large cohort effect.

Because we were unable to estimate accurately these household-specific effects, we chose to treat the consumption data as a cross-sectional survey. While this is a slight disappointment, it is unlikely to lead to substantial error in our estimates of the regressivity of alcohol and cigarette taxes. To see this, suppose that the correct model of consumption were some sort of random effects model but we adopt an approach that ignores the household-specific component of the error term. We would then be unable to simulate any particular household's consumption over time very well. We would expect, however, that these errors will be uncorrelated with income so that when we aggregate households within an income group our estimate of total expenditures will be unbiased.[6]

The results we present in this paper are based on a sample selection model similar to the models in Lee and Trost (1978) and Heckman (1976). We postulate that the quantity of alcohol or cigarettes consumed by a household is determined in a two-step decision process. In one step the household determines whether it will consume a positive quantity. If so, in the next step the quantity is determined. Unlike the tobit model, this model allows for the possibility that the determinants of positive consumption are different from the determinants of the expenditure level of those who consume. For example, education may influence the decision to smoke, but have no effect on the quantity consumed by those who do smoke.[7]

The model may be written as follows. Let I_i be the observable decision by household i to either abstain ($I_i=0$) or consume the good in positive quantity ($I_i=1$). I_i^* is an unobservable index variable which is negative when the household abstains or positive when the household consumes positive quantities. This unobservable variable is determined by a set of exogenous factors Z_i and an error term ϵ_i:

(2) $$I_i^* = Z_i\gamma - \epsilon_i$$

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[6]In contrast, ignoring household-specific effects in the income equation could lead to seriously biased estimates of regressivity, since an important difference between life-cycle and one year estimates of regressivity is the extent to which household income changes over time. Ignoring household-specific effects in consumption does, however, prohibit us from saying anything about horizontal equity.

[7]Atkinson, Gomulka, and Stern (1990) make a similar criticism of the tobit model.

If I_i^* is nonnegative, then expenditures C_i on the good for household i are determined by a set of exogenous factors X_i and an error term $\epsilon_{1,i}$:

(3) $$C_i = X_i\beta + \epsilon_{1,i}$$

Alternatively, if I_i^* is negative, then $C_i = 0$.

The error terms in equations (2) and (3) have a bivariate normal distribution, where only contemporaneous correlation between the disturbances is permitted. Such correlation allows for the possibility, for example, that those with a high unexpected probability of smoking also have an above average level of expenditures conditional on the exogenous variables. Because of this correlation, estimation of equation (3) by least squares is biased and inconsistent.

Lee and Trost (1978) show that consistent estimates of equation (3) can be derived in a two-step procedure, where equation (2) is first estimated using probit. The estimated $\hat{\gamma}$ are used to form the inverse of the Mills ratio

(4) $$\lambda = -f(Z_i\gamma)/F(Z_i\gamma),$$

where $f(\cdot)$ and $F(\cdot)$ are the standard normal density function and distribution function, respectively. The variable λ is then added as an additional regressor on the right-hand side of equation (3) and the coefficients of X_i can now be estimated consistently using OLS. The estimated coefficient of λ equals the estimated covariance between ϵ_i and $\epsilon_{1,i}$; given the way the model is written in (2), (3), and (4), we would expect the coefficient to be negative (those with an unusually high propensity to smoke given their observables will smoke a great deal if they decide to smoke at all).[8]

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[8]Lee and Trost note that this two-step procedure, while consistent, is inefficient. They propose computing the joint likelihood function of equations (2) and (3) and estimating all parameters of the model simultaneously by maximum likelihood. Because we are not interested in

Summary Statistics

The definitions, means, and standard deviations of the variables we have used in our econometric work are summarized in Table 1. The dependent variable in our income equation is the log of labor plus transfer income in constant 1990 dollars.[9] Our independent variables include a range of social and economic factors that are likely to be important determinants of income, and for the most part are self-explanatory. (Variables that do not change over time cannot be included in a fixed effects model.)

The dependent variables in the two expenditure equations are the annual level of expenditures on alcohol and cigarettes in constant 1990 dollars.[10]

Lifetime income in the alcohol and cigarette equations is defined as the annuity value of the stream of expected family labor and transfer income that will be received over the expected remaining life of the household. We use the estimates of the coefficients (including the individual intercepts) from the income equation, age- and race-specific

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undertaking any hypothesis tests associated with consumption equations, we have continued to use the computationally easier two-step procedure.

[9]We used the personal consumption deflator from the National Income and Product Accounts to convert current dollar amounts to constant 1990 dollars.

[10]The PSID data on annual alcohol expenditures are based directly on a question about expenditures in the week preceding the interview. The annual cigarette expenditure data are transformed slightly from that provided by PSID. Cigarette expenditures were calculated by PSID by multiplying the quantity of cigarettes reported by the family by an assumed price. PSID's measure of price is somewhat crude. For example, in 1972, cigarettes were assumed by PSID to cost $.30, $.40, or $.50 per pack, depending on the state cigarette tax. We have chosen instead to construct an alternative price per pack of cigarettes for each state based on state cigarette tax data provided by the U.S. Advisory Commission on Intergovernmental Relations for the period 1968-1972.

estimates of life expectancy, and a real interest rate of four percent to construct lifetime income.[11]

Data on financial wealth in PSID are very poor. Only for a single year were detailed estimates available for net household assets (and expenditure data are not available in that year). Annual data on different categories of investment income are available for most years. For the expenditure equations, we impute financial wealth by grossing up investment and business income before losses by the interest rate prevailing on 10-year Treasury bonds. These data are problematic in that investment and business income are frequently available only in grouped ranges and are top coded; additionally, negative income amounts are variously recorded by PSID as small positive income, netted from other investment income, or recorded as negative amounts. Due to the difficulty of precisely estimating financial wealth as a function of various determinants, simulations presented later in the paper assign individuals the mean wealth for individuals of their age as found in our sample.

We use the Suits (1977) index to provide a measure of progressivity against which to compare current versus lifetime tax incidence. The Suits index is constructed by comparing at each point on the income distribution the cumulative distribution of the tax burden relative to the distribution of income. The Suits index is bounded between -1 and 1, with -1 indicating a tax borne exclusively by the poorest household and 1 indicating a tax borne solely by the richest household. A Suits index of zero indicates a strictly proportional tax.

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[11]We have implicitly ignored the impact of smoking and drinking on life expectancy.

Further Considerations

Five further points deserve mention before we present our results. First, this paper only examines the distribution of the portion of the burden of a tax on alcohol and cigarettes that falls on consumers; our work does not offer any evidence as to how the overall burden of the tax is distributed between producers and consumers.

Second, we assume that the distribution of the tax burden is proportional to expenditure. Cigarette taxes are nearly always unit taxes, but since the price per package does not vary much, they are roughly equivalent to ad valorem taxes. State and federal taxes on alcohol vary widely among beer, wine, and spirits. Within a given type of alcoholic beverage the tax is commonly a function of alcohol content and rarely a direct function of price. As a result, two alcoholic beverages may be taxed equal amounts yet differ substantially in price. Our decision to model the alcohol tax as proportional to expenditures may understate the regressivity of the actual system of alcohol taxes. Suppose, for example, that high income families spend the same proportion of income on alcoholic beverages as low income families, but purchase more expensive brands. A study that focused only on alcohol expenditures in this case would conclude incorrectly that the tax is proportional to income. We know of no data set that would allow us to address this question, but it is an important issue that deserves further attention.

Third, our results assume all individuals are subject to the taxes throughout their lifetimes. If alternatively an alcohol or cigarette tax were imposed at a particular point in time, tax incidence would depend on the consumption of individuals over their remaining lifetime. For instance, if cigarette expenditures fell over the life-cycle, the transition to a cigarette tax would benefit the current elderly at the expense of younger generations.

Fourth, it is believed that survey respondents often under report actual alcohol and tobacco use [see Cook (1990) and Wasserman et al. (1991)]. This may be less of a problem in surveys like the PSID which are not directly concerned with monitoring health behavior. Alternatively, if consumption were underreported by a constant percentage, our incidence analysis is unlikely to be affected.

Finally, we do not explore efficiency aspects of these taxes. A key issue in the debate over sin taxes is the extent to which smoking and drinking generate harmful externalities. Also, as these goods are believed to have relatively inelastic demands, taxes on these goods may result in smaller efficiency losses than other possible taxes. We ignore these aspects to focus only on distributional consequences of the taxes.

IV. Tax Incidence Estimates

It is helpful to begin by first looking at some descriptive measures that are available directly from the data. We arrange the families in our sample into five groups based on 1968 family income. We then calculate the cumulative percent distribution of income and expenditures on alcohol and cigarettes as we move from the lowest to highest income group. These calculations are therefore equivalent to the "snapshot" estimates of annual tax incidence that appear in the literature.

Table 2 summarizes our estimates of the incidence of these taxes relative to current income. If a tax on alcohol or cigarettes were borne in proportion to expenditures, then those taxes would be regressive relative to current income. In our sample, families in the lowest quintile of the income distribution received 7.7 percent of all income, but accounted for 9.2 percent of aggregate expenditures on alcohol and 16.6 percent of aggregate expenditures on cigarettes. Current alcohol expenditures as a fraction of current income fall from .86 percent for the lowest income group to .59 percent for the highest; the pattern for cigarette consumption is even more pronounced. The Suits index for a tax proportional to alcohol expenditures is -.10; a tax proportional to cigarette expenditures would have a Suits index of -.23.[12]

None of this should be surprising. A number of studies, including Congressional Budget Office (1990), that have looked at the incidence of "sin taxes" at a point in time have concluded that they are likely to be regressive. Similar results emerge in our PSID sample as well.

Next we examine the incidence of these taxes when actual income and actual consumption are measured over a five-year period. We argued above that single-year incidence might differ from lifetime tax incidence in part because of transitory income. That is, if consumption does not respond to changes in transitory income, then among families with equal permanent income, those with high transitory income would consume a smaller share of their current income than families with low transitory income. We might reasonably expect that over a five-year period transitory fluctuations in income would average out. If this is correct, then we should expect to find taxes to be less regressive if we were to repeat the analysis in Table 2 using five years of data.

Table 3 shows that this is not the case. The tax incidence measures in that table are based on the comparison of the present value of actual 1968-1972 expenditures relative to the present value of actual 1968-1972 family income. These measures suggest that our view of the regressivity of sin taxes would not change very much if we think of expenditures over a five-year rather than a one-year period. Tables 2 and

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[12]We have also calculated the Suits index when we place households in twenty, rather than five, income groups. The results are very similar to those shown in the paper.

3 are very similar. The Suits indices for taxes on alcohol and cigarettes based on five-year income are -.11 and -.24. These are very close to our estimates based on current income in Table 2.

It therefore appears that the stochastic elements of income are not an important part of this problem. The possibility remains that income and consumption patterns over the entire life-cycle would generate different estimates of single year and life-cycle tax incidence. We can only address this question through a simulation since, as we noted above, there is no data set available that would allow us to answer this question directly. We present such a simulation below.

Econometric Results

Our simulation model requires us to estimate the determinants of annual labor and transfer income, alcohol expenditures, and cigarette expenditures.

Our estimates of the fixed effects income model are shown in Table 4. The demographic and household-specific determinants of income explain approximately 60 percent of the variation in income in our sample. In general the age-income profile is very similar to that found in other studies. Figure 1 shows the age-income profile generated by our coefficient estimates for each of three different educational levels.[15] Below the age of 25, the incremental return to education is small. As the individual gains experience in the work force, the return to education is shown to increase.

Because demographic characteristics that are constant over time may not be included in the fixed effects regression, we are unable in Table

[15]The figure assumes that individuals marry at age 25 and remain married thereafter. Since education is a fixed effect, the figure uses the mean household effect by educational level.

4 to compare the importance in income determination of unobservable household-specific components relative to known demographic characteristics. To examine this issue, we conducted a least squares regression in which we treated our data as a cross-section. In addition to the variables listed in Table 4, the least squares regression includes additional demographic characteristics that are constant over time, such as education of the head, education of the head's parents, race, and religion. Because the data are treated as cross-sectional, however, unobservable household-specific effects are omitted. The least squares regression explains only about 32 percent of the variation in income. Therefore, the unobservable household-specific effects appear to be nearly as important as the observable characteristics of the family in determining income.[14]

Estimated coefficients of our two equation model of alcohol expenditures are shown in Table 5 and estimates of the cigarette model are shown in Table 6. We do not encourage the independent use of these estimates to make judgements on consumption patterns or tax incidence. For example, both models include current and lifetime income as explanatory variables. However, because other variables, such as age and education, are also correlated with income, it would be incorrect to assess tax incidence by examining only the income coefficients. Only by considering all factors simultaneously can one arrive at the consumption patterns used to assess tax incidence.

Having made this qualification, the coefficients appear sensible. The first two columns of Table 5 show the estimates of the determinants of the decision to drink. Current income positively affects this decision through income levels of up to $175,000. With respect to age and education

[14]These findings are roughly consistent with those found by Lilliard (1977) using a different data set.

of the household head, the propensity to drink reaches a low at age 54 and peaks at two years of college education.

The estimates for the equation evaluating the level of expenditures on alcohol for those who drink are shown in the last two columns of Table 5. The coefficients are all of the same sign as in the decision to drink equation. Current income, lifetime income, and wealth are all important determinants of alcohol consumption.

The first two columns of Table 6 present the estimates of the equation predicting the decision to smoke. This decision is positively influenced by current income up to income levels of $195,000. The smoking decision is negatively related to lifetime income. The propensity to smoke declines with education levels beyond fifth grade. The last two columns of Table 6 show the estimates of the equation estimating cigarette expenditure levels. Current income is an important positive determinant, while lifetime income has a important negative effect. The age coefficients indicate cigarette expenditures peak at age 31.

Simulation Results

We have developed the following simulation model. We consider the 1,054 households that we have used for our econometric models and the tax incidence estimates set forth above. We use the 1968 values for the city size, region, and price variables for each household throughout the simulation. We assume each household head always has the mean financial assets for its age group, enters the work force at age 20, marries at age 25, never divorces, and dies as soon as he reaches age 80. Using our estimated income equation we calculate the deterministic and stochastic components of income. The deterministic component includes the household-specific estimated income effect. The stochastic component is the result of an annual random draw from a distribution with zero mean and the estimated variance from our income equation. This stochastic component will approximately cancel over the life-cycle of each household so it is not expected to significantly affect life-cycle distributions of income. The stochastic component does affect annual income, however, which may in turn affect annual incidence calculations.

After estimating current income and lifetime income (the annuity value of labor plus transfer income over the head's expected remaining life) for each household for a given year, consumption of alcohol and cigarettes can be simulated from our earlier econometric estimates. Resulting estimates of tax incidence are calculated for a simulated single year and over the lifetime of each head.

In comparing lifetime incidence to annual incidence below, we distinguish between those effects due to the stochastic components of current income and those due to deterministic life-cycle factors.

One-Year and Five-Year Simulation Results

Since we have little actual data on life-cycle income and alcohol and cigarette consumption, there is a danger that our life-cycle simulation will yield misleading results on the regressivity of sin taxes but which we might mistakenly accept as sensible. Tables 7 and 8 are a partial (though admittedly imperfect) check of the reliability of our simulation. We can simulate any particular year, such as 1968, by choosing the one year of simulated data for each household that corresponds to that household's actual age in that year. Table 7 presents simulated current income (including the stochastic component of income) and consumption for a single year corresponding to 1968; Table 8 presents similar results for the five years of the simulation that correspond to 1968-1972. If our estimates are sensible, the results in those tables should look very much like those in Tables 2 and 3 since both relate current year expenditures to current year income (though even if our econometric work were perfect they would not be identical because we have not used actual values of wealth and marital status in the simulation).[15]

The one-year simulation results are encouraging, though not quite as close as we would have liked. In particular, the simulated distribution of income is somewhat more concentrated than the actual distribution; in the simulation, the first four income groups receive 56.2 percent of all 1968 income (Table 7) as compared to 62.5 percent of actual 1968 income (Table 2). Simulated alcohol consumption is more concentrated in the lowest income quintile than actual 1968 alcohol expenditures. As a consequence of both effects, the 1968 Suits index for alcohol in the simulation is somewhat larger in absolute value than in the actual data. For cigarettes, the simulated pattern of expenditures closely resembles actual 1968 expenditures.

The five-year simulation results in Table 8 appear to be very good. In the simulation, the lowest income group earned 8.2 percent of total income; in the actual data, that group earned 8.7 percent of income. Alcohol and cigarette expenditures as a proportion of income in the simulation fall from 1.22 and 1.70 percent for the lowest income to .55 and .49 percent for the highest; in the actual data, households in the lowest income group spent 1.18 percent of their income on alcohol and 1.95 percent of their income on cigarettes as compared to .62 and .52 percent for the highest income group. In the simulation, taxes on alcohol and cigarettes would have a Suits index of -.13 and -.23 as compared to actual Suits indices of -.11 and -.24.

It thus appears that the simulation generates results which are quite plausible. Moreover, it appears that the simulation yields better

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[15]Current year income here is defined to include asset income to make this comparison comparable with other single-year incidence analyses.

results for longer periods (five-years) when the stochastic component of income is relatively unimportant than short periods (one-year) when the stochastic element is quite important. We would argue that these results suggest that the simulation results presented below may accurately characterize life-cycle behavior.

Life-Cycle Simulation Results

Lifetime tax incidence results are presented in Table 9. These lifetime estimates are based only on the deterministic component of income. Simulation results that include the stochastic component of income throughout the lifetime are virtually identical to those shown in the table. This is expected since the transitory shocks roughly cancel over the lifetime. In the table, families are classified by the discounted present value of simulated lifetime labor income; consumption represents the discounted present value of simulated expenditures on alcohol and cigarettes.

Life-cycle patterns in earnings result in greater income equality over the lifetime than observed in a single year. The lowest lifetime income quintile has 10 percent of all lifetime income, whereas the lowest annual income quintile has only 7.7 percent of actual 1968 annual income (Table 2). Similarly, lifetime income is less concentrated in the highest income quintile than is annual income. The top lifetime income quintile has 32.7 percent of lifetime income compared to 37.5 percent actual of annual income for the top annual income quintile.

Lifetime consumption of alcohol is more concentrated in the highest income quintile and less concentrated in the lowest income quintile than when current consumption is classified by current income. Together, both the change in income distribution and the change in the distribution of alcohol consumption reduce the regressivity of the tax on alcohol relative to its annual incidence. The Suits index is -0.06 over the lifetime, relative to a single year index of -0.10 in the actual 1968 data.

For cigarettes, lifetime consumption is more concentrated within the lowest income quintile than when current consumption is classified by current income. Here the changes in the distribution of income and consumption offset each other and the Suits index of -0.23 is virtually identical to that in the actual single year data.[16]

We can get some sense of the importance of transitory income shocks in this problem relative to life-cycle effects by comparing the results from the life-cycle simulation to either the actual or simulated five-year results. No general result emerges. For cigarettes, controlling only for transitory components of income appears to adequately characterize the lifetime tax incidence. For alcohol, there is a significant additional effect of life-cycle factors. This suggests that in general lifetime tax incidence will not be correctly estimated merely by controlling for stochastic components of income.

We can also offer insights on the question of whether deterministic life-cycle components of income or life-cycle components of consumption are most responsible for differences between lifetime and annual incidence. We conducted a simulation where tax incidence is computed based on lifetime income, but for consumption we used only each family's reported actual consumption in 1968. The results of this analysis were very similar to the incidence results based on lifetime consumption presented in Table 9. The Suits indices are -0.07 for alcohol and -0.23

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[16]One possible objection to this analysis is that we have used different definitions of income in Tables 2 and 9. Table 2 uses household income, which is the sum of labor, transfer, and asset income, to be comparable to the definition of income used in most annual incidence studies. Table 9 uses only labor plus transfer income as required by the life-cycle model (ignoring inheritance). We have also calculated lifetime incidence including initial asset wealth and generated results very similar to those in Table 9.

for cigarettes. While age is a significant determinant of alcohol consumption (in addition to other time varying explanatory variables) and these affect lifetime consumption, these effects should be uncorrelated across lifetime income quintiles.[17] Unless time varying effects are correlated with lifetime income, lifetime tax incidence may be appropriately proxied for by using a single year's consumption data and lifetime income. For incidence analysis, this observation points to the importance of conducting surveys, such as the PSID, that are long panel surveys of income, but which only periodically examine consumption behavior.

V. Conclusions

Our research points to some interesting results. We find that it would be incorrect to believe the simple notion that life-cycle effects reduce the regressivity of all taxes. Particularly, we find that the stochastic portion of income has little impact on our view of tax incidence. This conclusion was based on our examination of the actual data which showed that the annual incidence of cigarette and alcohol taxes is not significantly different from that measured on the basis of five-year consumption and income. Our simulations present evidence on deterministic life-cycle effects. Incorporating consumption and income patterns over the entire life-cycle is a further improvement in capturing the burden of a tax over one's lifetime, but these adjustments do not necessarily cause significant changes in tax incidence measures. For cigarettes, we find virtually no difference between incidence measures calculated on the basis of current consumption and current income and those calculated on the basis

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[17] We thank Dan Feenberg for bringing this to our attention.

of lifetime consumption and income. On the other hand, for alcohol these life-cycle income effects do appear to be important. Taking into account both the reduction in transitory effects over the lifetime and the deterministic life-cycle effects to income, the tax on alcohol expenditures appears to be less regressive than in the actual one-year data.

Our findings reconfirm that, in general, panel studies of income are required to characterize accurately life-cycle tax incidence. Unobservable household-specific effects are important determinants of income. These effects cannot be measured with cross-sectional data. Omission of these factors results in a misclassification of households by lifetime income. This is an unfortunate result given the much wider availability of cross-sectional surveys. On the other hand, the omission of household-specific determinants of consumption should not affect tax incidence calculations. Panel surveys of income that may only infrequently survey consumption behavior might therefore still provide the data necessary to undertake life-cycle tax calculations.

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Table 1
Variable Definitions and Summary Statistics

	Definition[1]	1968 Mean	1968 Std Dev
ALCOHOL	Alcohol expenditures	277.60	489.60
CIGARETTE	Cigarette expenditures	393.23	457.93
CURRENT INCOME	Annual family labor plus transfer income (family income)	36596.01	21624.54
LIFETIME INCOME	Annuity value of expected future family income	42202.05	22540.12
FINANCIAL ASSETS	Annuity value of assets	2784.77	9796.05
CIGARETTE PRICE	Tax plus average retail price of cigarettes (cents)	119.25	11.02
ALCOHOL TAX	State tax per case of beer (cents)	116.46	106.86
EDUCATION	Number of years of education, head	12.29	3.40
NONWHITE	= 1 if head is nonwhite	0.0626	0.24
AGE	Age of head	39.61	12.22
OVER 65	= 1 if head is over 65	0.0275	0.1637
YEARS OVER 65	= number of years above 65 if head is over 65 = 0 otherwise	0.0683	0.5453
UNDER 25	= 1 if head is under 25	0.1214	0.3268
YEARS UNDER 25	= number of years below 25 if head is under 25 = 0 otherwise	0.2381	0.8480
MARRIED	= 1 if head is currently married	0.9383	0.2407
LARGE SMSA	= 1 if head lives in large metropolitan area	0.2704	0.4444
MEDIUM SMSA	= 1 if head lives in medium metropolitan area	0.2163	0.4119
SMALL SMSA	= 1 if head lives in small metropolitan area	0.1290	0.3354
MIDWEST	= 1 if head lives in midwest	0.3330	0.4715
SOUTH	= 1 if head lives in south	0.2970	0.4571
EAST	= 1 if head lives in east	0.2087	0.4066

[1] All dollar amounts in constant 1990 dollars.

Table 2
Actual 1968 Cigarette and Alcohol Consumption
Classified by Actual 1968 Income

Income Group	Cumulative Distribution Income	Cumulative Distribution Alcohol	Cumulative Distribution Cigarette	Consumption / Income Alcohol	Consumption / Income Cigarette
1	7.7	9.2	16.6	0.86	2.19
2	21.3	27.0	36.6	0.93	1.49
3	39.3	48.0	56.9	0.83	1.13
4	62.5	68.9	77.1	0.65	0.89
5	100.0	100.0	100.0	0.59	0.62
Mean				0.71	1.01
Suits Index		-0.096	-0.229		

Table 3
Actual 1968-1972 Cigarette and Alcohol Consumption
Classified by Actual 1968-1972 Income

Income Group	Cumulative Distribution Income	Cumulative Distribution Alcohol	Cumulative Distribution Cigarette	Consumption / Income Alcohol	Consumption / Income Cigarette
1	8.7	13.9	19.0	1.18	1.95
2	22.8	29.9	39.0	0.84	1.28
3	40.7	50.9	59.5	0.87	1.03
4	63.6	69.4	78.7	0.60	0.75
5	100.0	100.0	100.0	0.62	0.52
Mean				0.74	0.90
Suits Index		-0.111	-0.242		

Table 4
Estimated Family Income Equation
(Dependent variable = log of labor plus transfer income)

Fixed Effects Model

	Coefficient	t-statistic
AGE	0.060521	3.290
AGE^2	-0.000972	2.847
AGE^3	0.000002928	1.275
AGE * EDUCATION	0.004492	5.530
AGE^2 * EDUCATION	-0.000036615	4.651
MARRIED	0.063828	0.888
MARRIED * EDUCATION	0.018239	3.324
LARGE SMSA	0.093408	5.258
MEDIUM SMSA	0.059707	3.585
SMALL SMSA	0.065605	3.392
MIDWEST	-0.194876	4.960
SOUTH	-0.216581	5.319
EAST	-0.050323	0.987
UNDER 25 * EDUCATION	-0.000107	0.036
YEARS UNDER 25	-0.120660	6.375
OVER 65	-0.007889	0.134
YEARS OVER 65	0.019346	3.342
Over 65 * EDUCATION	-0.016837	3.416
ADJ R^2	.607	

Table 5
Estimated Alcohol Expenditure Model

	Probit Estimate of Decision Function		Estimated Expenditure Equation	
	Coefficient	t-stat	Coefficient	t-stat
INTERCEPT	0.1788	0.514	-1545.0157	3.897
ALCOHOL TAX	-0.0003	1.495	-0.8144	4.242
CURRENT INCOME	0.0001E-1	6.660	0.0188	5.524
$INCOME^2$	-3.9410E-11	3.929	-4.7178E-8	4.487
LIFETIME INCOME	1.7443E-6	1.285	0.0052	5.938
FINANCIAL ASSETS	2.0811E-6	1.216	0.0038	3.690
EDUCATION	0.1206	3.903	240.4206	6.259
$EDUCATION^2$	-0.0044	3.562	-9.2536	6.409
NONWHITE	0.2341	2.918	583.7072	7.407
CATHOLIC	0.1967	2.153	165.2863	2.399
BAPTIST	-0.5600	6.201	-969.4217	6.672
JEWISH	-0.7953	6.342	-1519.1523	7.494
PROTESTANT	-0.2376	2.834	-448.4963	6.442
OTHER RELIGION	-0.5789	4.896	-1153.4481	7.071
AGE	-0.0301	2.404	-33.9135	3.084
AGE^2	0.0002	2.052	0.3422	3.002
MARRIED	-0.3682	4.556	-782.6516	8.141
LARGE SMSA	0.1601	3.032	270.7354	4.988
MEDIUM SMSA	0.3369	6.635	493.8783	5.663
SMALL SMSA	0.1958	3.256	327.2419	4.957
MIDWEST	-0.1699	2.976	-179.6373	3.554
SOUTH	-0.3765	5.305	-403.9018	4.034
EAST	-0.1881	2.987	-218.9129	3.816
UNDER 25	-0.0746	0.811	-250.0378	3.867
λ	--	--	-2418.9583	6.00

Table 6
Estimated Cigarette Expenditure Model

	Probit Estimate of Decision Function		Estimated Expenditure Equation	
	Coefficient	t-stat	Coefficient	t-stat
INTERCEPT	1.8061	4.699	-391.7139	2.058
CIGARETTE PRICE	-0.0104	6.779	-2.5649	0.904
CURRENT INCOME	3.9743E-6	1.924	0.0054	3.953
INCOME^2	1.0200E-11	1.018	1.9479E-9	0.411
LIFETIME INCOME	-2.8622E-6	2.155	-0.0036	3.786
FINANCIAL ASSETS	-1.5973E-6	0.904	-0.0022	1.983
EDUCATION	0.0489	1.630	43.6628	1.953
EDUCATION^2	-0.0054	4.477	-4.9675	2.807
NONWHITE	0.0508	0.643	-147.1933	4.019
CATHOLIC	0.0777	0.877	149.0178	3.382
BAPTIST	-0.0210	0.237	-5.2944	0.134
JEWISH	0.2206	1.780	54.9256	0.656
PROTESTANT	-0.0419	0.512	-16.1037	0.424
OTHER RELIGION	-0.2836	2.427	-184.4695	1.910
AGE	0.0046	0.373	40.9951	6.552
AGE^2	-0.0003	1.932	-0.6543	6.207
MARRIED	-0.0256	0.327	42.8532	1.134
LARGE SMSA	0.1189	2.280	159.5802	4.068
MEDIUM SMSA	0.0259	0.520	58.4763	2.484
SMALL SMSA	0.5447	0.921	43.0980	1.416
MIDWEST	0.1456	2.669	91.3370	1.926
SOUTH	0.0801	1.381	9.4217	0.275
EAST	0.1826	2.881	151.3001	2.594
UNDER 25	-0.1147	1.261	-58.5935	1.205
λ	--	--	-1309.6765	2.883

Table 7
Simulated 1968 Cigarette and Alcohol Consumption
Classified by Simulated 1968 Income

Income Group	Cumulative Distribution			Consumption / Income	
	Income	Alcohol	Cigarette	Alcohol	Cigarette
1	6.0	15.3	15.6	1.89	2.29
2	17.2	30.8	34.2	1.02	1.45
3	33.2	48.0	54.1	0.79	1.09
4	56.2	69.2	75.1	0.68	0.80
5	100.0	100.0	100.0	0.52	0.50
Mean				0.74	0.88
Suits Index		-0.198	-0.271		

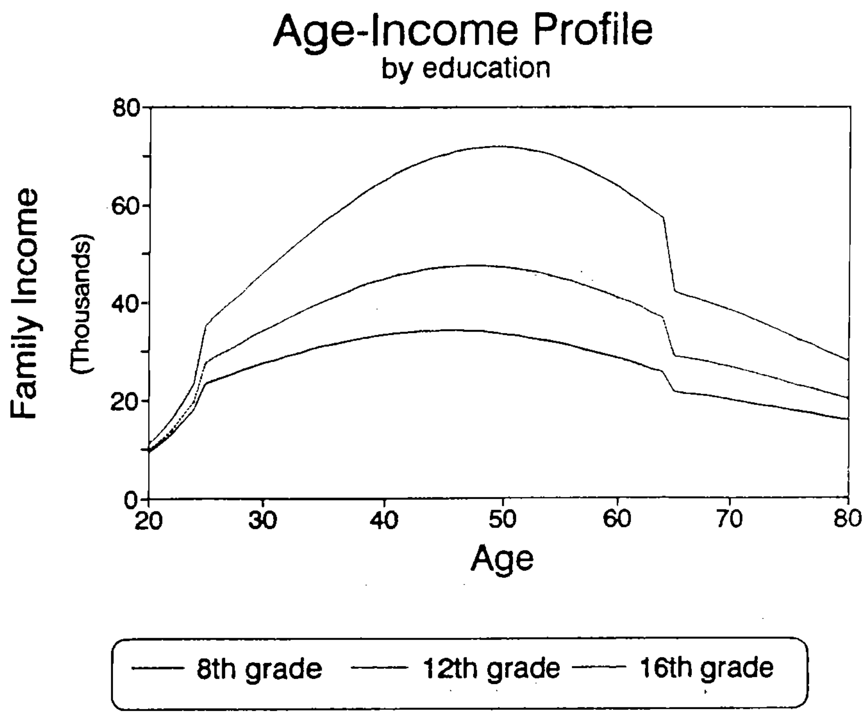
Table 8
Simulated 1968-1972 Cigarette and Alcohol Consumption
Classified by Simulated 1968-1972 Income

Income Group	Cumulative Distribution			Consumption / Income	
	Income	Alcohol	Cigarette	Alcohol	Cigarette
1	8.2	14.2	16.7	1.22	1.70
2	21.2	29.6	35.8	0.84	1.24
3	39.0	48.2	56.4	0.74	0.97
4	62.5	70.9	77.9	0.68	0.77
5	100.0	100.0	100.0	0.55	0.49
Mean				0.71	0.84
Suits Index		-0.128	-0.229		

Table 9
Simulated Lifetime Cigarette and Alcohol Consumption
Classified by Simulated Nonstochastic Lifetime Income

Income Group	Cumulative Distribution			Consumption / Income	
	Income	Alcohol	Cigarette	Alcohol	Cigarette
1	10.0	12.9	20.8	1.04	1.87
2	25.2	29.3	41.5	0.87	1.23
3	44.0	48.4	61.4	0.82	0.95
4	67.3	67.3	80.8	0.77	0.75
5	100.0	100.0	100.0	0.73	0.53
Mean				0.81	0.90
Suits Index		-0.058	-0.232		

Figure 1



Age-Income Profile
by education
Family Income
(Thousands)
80
60
40
20
0
20
30
40
50
60
70
80
Age
8th grade
12th grade
16th grade