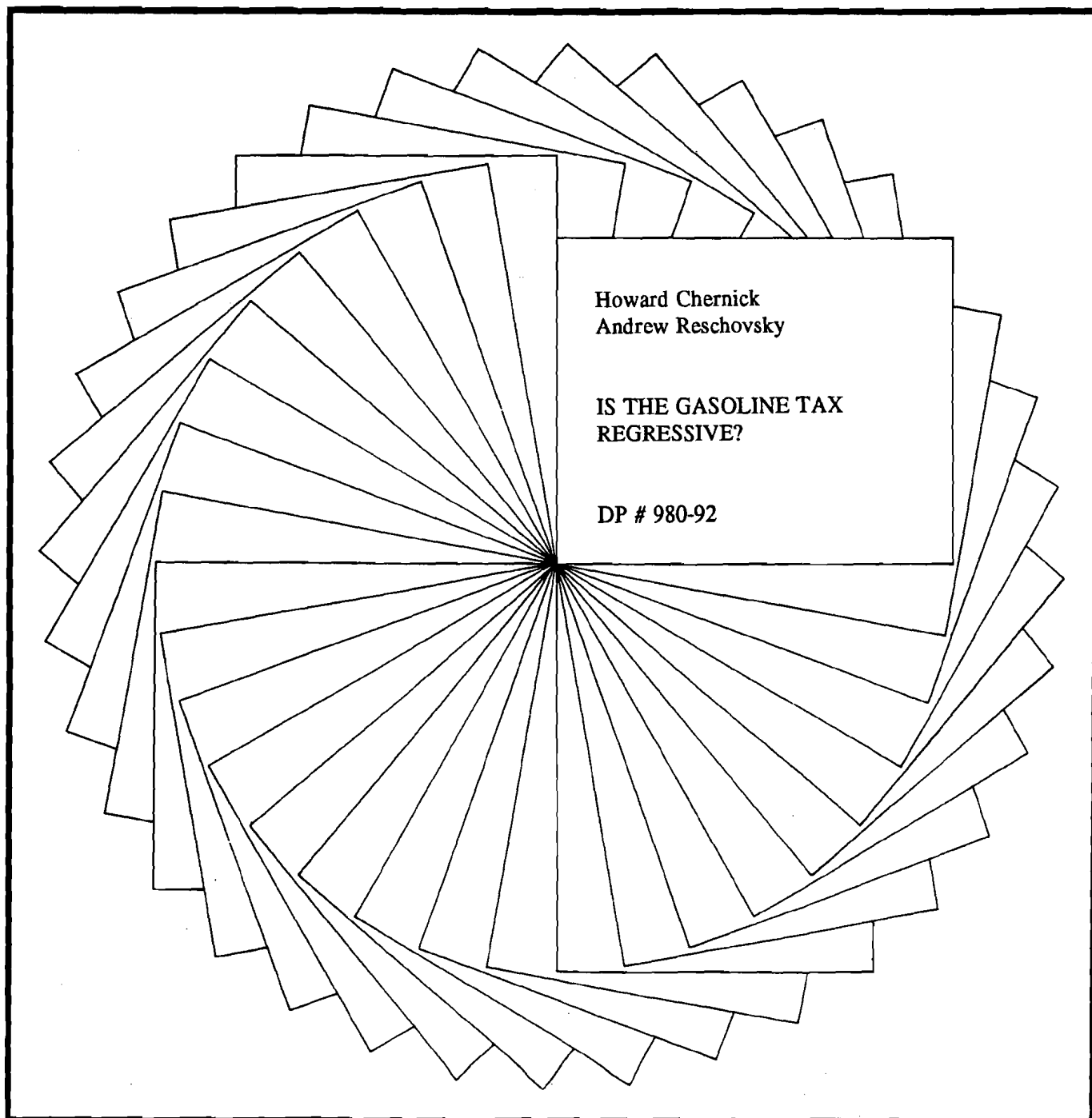


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Discussion Papers



Is the Gasoline Tax Regressive?

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Abstract

Many consider the gasoline excise tax to be regressive, forcing the poor to pay a greater percentage of their income on it than the rich. This position has been challenged, most notably by James Poterba, on the grounds that calculations of gas tax burdens based on measures of annual income lead to an overestimate of the regressivity of the tax. By contrast, Poterba's recent calculation based on annual expenditures, as a proxy for permanent income, shows that the gas tax burden is actually progressive over the bottom four income deciles. The authors argue that long-run income is preferred to annual income or annual expenditures as a measure of ability to pay. Using the Panel Study of Income Dynamics, they demonstrate that, measured against eleven-year average income, the gasoline tax is almost as regressive as it is when measured against annual income. They attribute this finding to the lack of income mobility over time. This long-run regressivity of the gasoline tax need not preclude an increase in gas taxes to meet revenue needs and reduce carbon emissions. Rather, the authors conclude that it reinforces the need to accompany any gas tax increase with compensation to poor households who would be unduly burdened.

Is the Gasoline Tax Regressive?

I. INTRODUCTION

Gasoline excise taxes are considered by many to be the solution to revenue shortfalls at all levels of government. This is particularly true in light of the current ideological and economic resistance to higher levels of income taxation. Gasoline excise taxes are seen as the answer to a number of environmental problems as well. Several have argued that higher gas taxes will force motorists to reduce the amount of gas they consume, thereby reducing carbon emissions, which contribute to pollution and global warming. In fact, state and federal governments relied heavily on gasoline taxes in the 1980s. Together, the state and federal gasoline excise tax rate rose by 92 percent between 1980 and 1990, from 13 to 25 cents per gallon (Advisory Commission on Intergovernmental Relations, 1991). Still, the U.S. gasoline excise tax rates remain very low when compared to rates in Western Europe and Japan. In 1988 the average gas tax rate in the countries of the European Economic Community was the equivalent of \$1.96 per gallon and the rate in Japan the equivalent of \$1.63 per gallon (Congressional Budget Office, 1990).

The major obstacle to further increases in the gas tax has been the widely held perception that the tax is unfair because it is regressive, imposing a greater economic burden on the poor than on higher-income families, and horizontally inequitable, unduly penalizing some regions of the country over others.

Recently, the regressivity of the gas tax has been challenged by a number of economists, most notably James Poterba (1989, 1991a).¹ The evidence for the regressivity of excise taxes comes primarily from cross-section surveys which show that low-income families spend a larger proportion of their annual income on gasoline than do high-income families. Poterba's basic argument is a familiar one, based on Friedman's permanent income theory of consumption (Friedman, 1957) and

the companion life-cycle model of saving (Ando and Modigliani, 1963). Poterba suggests that studies relying on annual income overestimate the regressivity of excise taxes over the bottom portion of the income distribution. His argument is that if most people with low incomes are only temporarily poor, and if gasoline consumption decisions tend to be made on the basis of lifetime incomes, then calculating tax burdens based on data from a single year will yield tax burdens for low-income people that are substantially higher than burdens calculated on the basis of lifetime or permanent income.

Poterba's primary contribution is to suggest an alternative way to measure the incidence of consumption taxes. He argues that as long as consumption is a constant fraction of permanent income, annual consumption expenditures provide a proxy for permanent income. As annual income includes a transitory component which is uncorrelated with consumption, the use of data on annual expenditures provides a better measure of ability to pay, and a better approximation of lifetime income, than annual income. Thus the use of annual expenditures as a basis for calculating tax burdens will counteract the bias toward regressivity created by using annual income data.²

On the basis of this argument, Poterba (1991a) demonstrates that gasoline expenditures as a proportion of total expenditures actually rise over the bottom four deciles of people ranked by their total annual expenditures, implying that the gasoline excise tax is actually progressive over that portion of the income distribution.

In assessing Poterba's approach to measuring gasoline excise tax burdens it is useful to highlight three critical assumptions implicit in his analysis.

1. Most individuals with low incomes in any given year will have low incomes for only short periods of time. In other words, income mobility is quite high.
2. Gasoline consumption decisions are made on the basis of lifetime or permanent income.
3. Total annual consumption is a constant fraction of permanent income, and thus annual expenditures provide a good measure of permanent income.

In this paper we shall question the validity of each of these assumptions and suggest an alternative measure of gasoline tax incidence that we believe is based on a more appropriate measure of taxpayer ability-to-pay. Specifically, we use longitudinal data on income and miles driven from the Panel Study of Income Dynamics to examine directly the long-run burden of the gasoline tax. Using an eleven-year average of real income, we find, as does Poterba, that moving from annual income to a longer-run measure of income does reduce the regressivity of the gas excise tax; nonetheless, in contrast to Poterba, we find that with the exception of the bottom average income decile, the gas tax remains regressive.

The use of longitudinal data allows us to address empirically several of the issues raised by Poterba's work. First, by exploring the joint distribution of annual and eleven-year average real incomes, we conclude that income mobility is rather limited. A large proportion of individuals with relatively low incomes in a given year are in the midst of an extended period of low incomes. Second, by examining which demographic groups face the highest gas tax burdens, we find that gasoline consumption decisions are much more sensitive to current income than to permanent income. True, the regressivity of the gasoline tax would be substantially overstated by relying on annual incomes if gasoline consumption decisions tended to be made on the basis of permanent incomes; we would see high annual burdens among individuals whose current incomes are low relative to their lifetime incomes. Thus, we would find a concentration of both young adults and the elderly among those with high burdens, since in any given year they are likely to have low incomes relative to their permanent incomes. However, we fail to find any concentration by age group among those individuals with high burdens. Therefore we conclude that gasoline consumption decisions are much more sensitive to current income than to lifetime income.

Third, while most economists agree that annual income provides a biased measure of individuals' ability to pay taxes, it is not apparent to us why total consumption expenditures in any

given year should provide a good basis for assessing taxpaying capacity, as Poterba argues. The existence of transitory consumption and the concentration of savings for bequests among high-income taxpayers both suggest that annual consumption expenditures may be a very poor measure of permanent income. Furthermore, given the absence of perfect capital markets, we argue that lifetime income is an inappropriate measure of the ability of individuals to pay the gasoline tax.

The next section of the paper describes the data. The third section compares our approach to measuring the incidence of the gasoline excise tax to Poterba's. The fourth section briefly addresses the issue of compensating low-income families if gasoline taxation were increased. A final section summarizes and concludes.

II. DATA

We use a sample from the Panel Study of Income Dynamics (PSID) to compare the long-run burden of the gasoline tax with annual burdens. The PSID is a large longitudinal survey that has followed the members of over five thousand families since 1968. Our sample consists of all individuals who were in the PSID in 1982. We follow the 1982 sample backward to 1976 and forward to 1986. The sample is restricted to this eleven-year period because data on property tax payments (needed for a different portion of our research) were first available in 1976, and data on the annual number of miles driven were no longer available on the PSID after 1986. We shall argue, however, that using average real income calculated over an intermediate time period, such as eleven years, provides an appropriate measure of the ability to pay gasoline excise taxes.³ Our sample consists of 18,734 individuals.

Our sampling strategy seems the most natural way to make our results comparable to annual incidence studies based on cross-section data sets such as the Current Population Survey. It duplicates the annual approach by choosing a sample at a point in time, and then addresses long-term incidence by following the sample backward and forward over time. It also avoids sample selection problems

inherent in a choice of sample based on headship, as in Lyon and Schwab (1990).⁴ Since changes in family composition are major determinants of changes in income (Bane and Ellwood, 1986), it is important that inclusion or exclusion from the sample not be conditional on such changes.⁵

The basic unit of analysis for long-term incidence is the individual. We assume that income and expenditures are pooled among all members of the family unit. Therefore, at any point in time the resources available to an individual equal the total resources of the family unit in which the individual resides, and consumption tax burdens depend on family expenditures relative to family income. Our measure of long-run income is the average income of the family (or families) in which an individual lives over the eleven-year period covered by our sample. If the individual stays in the same family unit over the sample period, then family and individual incidence are the same. If the individual passes through different family units, long-run incidence is the average of family incidence at each point in time.

It was not possible to calculate average incomes and tax burdens over the full eleven-year period for every individual in the 1982 sample. Some people were not yet born when the sample started in 1976, while others died or left the sample at some point between 1982 and the end of the sample period in 1986.⁶ However, the full eleven years of data are available for 82.6 percent of the sample, and data are available for nine or more years for fully 90 percent of the sample.

Although the PSID provides considerable data on sources of income, it provides only limited information on consumption expenditures of individuals in the sample. In order to develop an estimate of expenditures on gasoline, we rely on data available on the PSID on the annual number of miles driven by the members of each family.⁷ Gasoline expenditures are then imputed to the sample by first dividing the miles driven by the average miles per gallon (which varies by year but not by location), and then multiplying gallons consumed by the price per gallon. The data on gasoline prices are gross of federal excise taxes and state excise and sales taxes. The gas price data, which were

provided by the Bureau of Labor Statistics, are disaggregated by region and in addition were available for a sample of major metropolitan areas. Individuals living outside the sampled metropolitan areas were assigned the average price for the region of the country and the size of the jurisdiction in which they lived.

We believe that the PSID is the best available data set for examining long-term tax burdens. The repeated reinterviewing of families and individuals has resulted in higher quality income data than are collected in other large surveys. Duncan and Hill (1989) report that total income reported by the PSID accounts for about 95 percent of income as measured by aggregate national statistics. Estimated income from the PSID also exceeds total income estimates from the Current Population Survey (CPS). Clayton-Matthews and Kazarosian (1988) report that income measured by the Consumer Expenditure Survey (CES), the data set used by Poterba, is even lower than income as reported on the CPS. Furthermore, even after accounting for differences in definition, they find total consumption expenditures as reported on the CES are considerably lower than aggregate estimates of consumption from the National Income and Product Accounts. In previous work, we have found that estimates of sales and excise tax revenue made using consumption data from the CES are generally substantially below actual tax collections (Chernick and Reschovsky, 1990).

III. INCIDENCE RESULTS

Gasoline Expenditures as a Percentage of Income

In order to make our results comparable to Poterba's, we focus first on gasoline expenditures as a fraction of income. However, we will also present results of our calculations of gasoline excise tax burdens. Paralleling the approach adopted by Poterba, we start by ordering our sample by deciles of annual income.

Columns 1 and 2 in Table 1 allow us to compare annual gasoline expenditure burdens calculated from two alternative data sources. Column 1, which is taken from Table 1 of Poterba (1991a), is based on 1985 gasoline and motor oil expenditures and income data from the CES. The gasoline expenditure burdens in column 2 are based on 1982 data from the PSID. Data from both sources indicate that annual gasoline expenditure burdens are regressive, although data from the PSID result in slightly higher burdens. The similarity of the two series suggests that the method we used to impute gasoline expenditures to the PSID has not introduced systematic errors, at least in comparison to the CES.

Permanent income theory predicts that, because measured annual income contains a transitory component which is uncorrelated with consumption, the elasticity of consumption with respect to annual income should be smaller than the elasticity with respect to permanent income. Moreover, the transitory component is positively correlated with the level of measured annual income, so that measures of low annual incomes are more likely to have negative transitory components, while measures of high annual incomes are more likely to have a positive transitory component. Since the fraction of measured income which is transitory should decline as the time period is lengthened, the implication is that expenditures on any given item, in this case gasoline, should be less regressive relative to permanent than relative to annual income.

This hypothesis is supported by the results in column 3 of Table 1, which report 1982 gasoline expenditures as a proportion of long-run income, measured here as average yearly income (in 1982 dollars) over the eleven-year period from 1976 to 1986. The data in column 3 show gasoline expenditures to be approximately proportional to long-run income for deciles 2 through 6, and regressive thereafter. By contrast, annual burdens (shown in column 2) are regressive for all but the first decile.⁸

TABLE 1

Expenditures on Gasoline as a Percentage of Income, by 1982 Family Income Deciles

1982 Family Income Decile	Gasoline Expenditures as a Percentage of Annual Income		Family Gasoline Expenditures in 1982 as a Percentage of Average Family Income during Each Year of the 1976-1986 Period (3)	Average Family Gasoline Expenditures during Each Year of the 1976-1986 Period as a Percentage of Average Family Income during Each Year of the 1976-1986 Period (4)
	1985 Data from CES ^a (1)	1982 Data from PSID (2)		
1 (lowest)	6.7 ^b	6.9 ^c	4.1	4.2
2	6.5	7.9	5.9	5.1
3	6.4	6.3	5.6	5.1
4	6.1	6.5	6.0	5.2
5	5.0	5.9	5.7	4.8
6	4.7	5.8	5.7	4.5
7	4.4	5.2	5.3	4.3
8	3.8	4.9	5.2	4.2
9	3.6	4.3	4.7	3.7
10 (highest)	2.4	3.6	4.3	3.1

Source: In column 1, Poterba's (1991a) tabulations based on the Consumer Expenditure Survey; in columns 2 through 4, authors' tabulations based on the Panel Study of Income Dynamics.

^aIn this column, deciles are based on income in 1985.

^bExcludes the lowest 5 percent of the income distribution.

^cExcludes the lowest 1 percent of the income distribution.

As a simple summary measure of the bias created in estimated expenditure burdens using annual income instead of long-run income, we compute the ratio of the average burden in the lowest five deciles to the average burden in the highest five deciles. The higher the ratio, the greater the regressivity of the gasoline excise tax. This ratio is 1.4 for expenditure burdens based on annual income (column 2), but only 1.1 for expenditure burdens based on long-run average income (column 3). Thus the decline in regressivity is substantial.

If there are life-cycle trends in gasoline consumption, then basing calculations of gas tax burdens on data from a single year of gasoline consumption may give a misleading picture of the long-run burden of the gas tax. If the adjustment of gasoline expenditures to changes in permanent income is not instantaneous, or if gasoline consumption is correlated with other variables that vary over time (e.g., age), then annual consumption will be an imperfect indicator of long-run consumption. Under the permanent income hypothesis, consumption as well as income has a permanent and a transitory component. Assuming that the ratio of transitory to permanent consumption declines as the measurement period increases, average gasoline expenditures over eleven years will provide a better approximation of permanent expenditure patterns. For these reasons, a better measure of the long-run burden of gasoline taxes is given by comparing the average amount of money spent on gasoline during each year of the 1976-1986 period with the average amount of real income earned during each year of that same period.

Using this average burden measure (displayed in column 4 of Table 1), the distribution of expenditure burdens is less regressive than the distribution of annual burdens shown in column 2, but somewhat more regressive than the long-run expenditure burdens calculated using a single year of gasoline consumption data (column 3). The simple regressivity ratio calculated from the data in column 4 is 1.25, about midway between the regressivity ratios calculated from the other two expenditure burden measures.⁹

If, as we have argued, a long-run measure of income provides a better measure of taxpayer ability-to-pay than does annual income, it makes sense to rank individuals by long-run income rather than annual income, and use this ranking as a basis for assessing the distributional equity of the gasoline excise tax. It is precisely this argument that leads Poterba (1991a) to rank taxpayers by total expenditures, his preferred measure of long-run income.

In the left-hand panel of Table 2 individuals in the PSID sample are ordered by their average yearly incomes over the 1976-1986 period. Thus individuals in the lowest several deciles can be characterized as persistently poor and near-poor, where persistence is defined to mean low average incomes. The data in column 1 show 1982 gasoline expenditures as a proportion of average income. The resulting pattern is proportional between the second and fourth deciles and regressive over the rest of the income distribution. In column 2 gasoline expenditure burdens are measured as eleven-year average gasoline expenditures as a proportion of eleven-year average income. The burdens decline monotonically from 5.6 percent for the second decile to 2.8 percent for the highest decile. Thus an ad valorem tax on gasoline would impose an economic burden on the long-run or persistently poor that is nearly twice as high as the burden placed on the persistently rich.

The incidence pattern for long-run gasoline expenditure burdens closely parallels the pattern found for annual expenditure burdens (Table 1, column 2). To verify that this result was not merely an accident of the eleven-year accounting period we chose, we have calculated both average gasoline expenditures and average income for the five-year period from 1980 to 1984. Figure 1 plots one-year, five-year, and eleven-year gasoline expenditure burdens by decile of income. For comparability, individuals are ranked according to their income position over the relevant accounting period. Thus, for eleven-year burdens, individuals are ranked by eleven-year average income position, while for the five-year period they are ranked by five-year income deciles. Figure 1 shows

TABLE 2

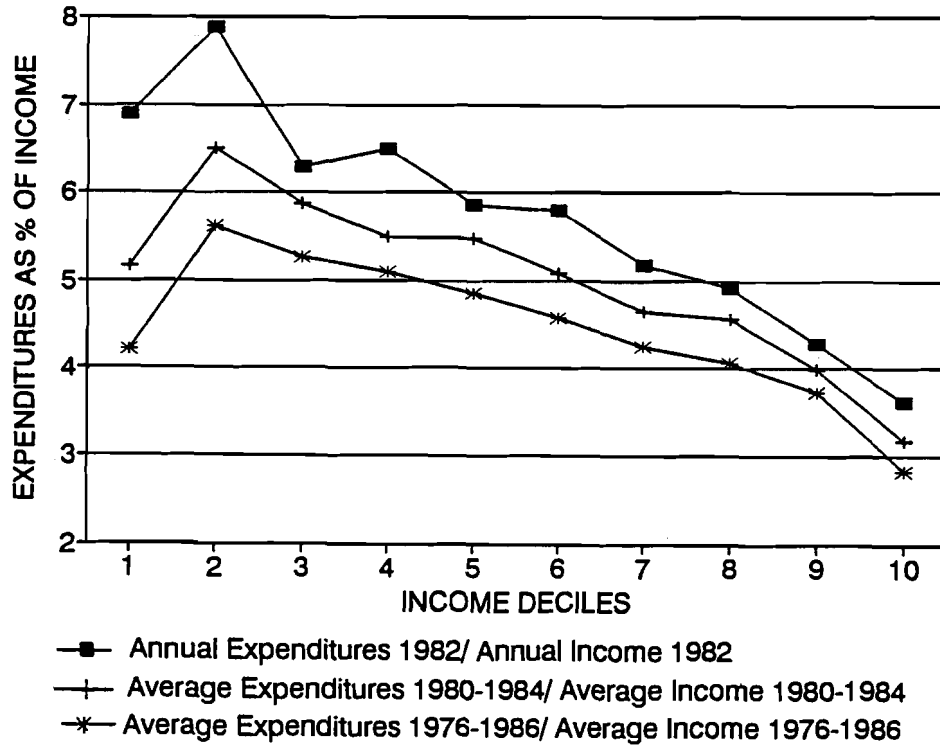
Family Gasoline Expenditures as a Percentage of Family Income, by Average Family Income Deciles, and Gasoline and Motor Oil Expenditures as a Percentage of Total Expenditures, by Total Household Expenditure Deciles

Average Family Income Decile, 1976-1986	Family Gasoline Expenditures in 1982 as a Percentage of Average Family Income during Each Year of the 1976-1986 Period (1)	Average Family Gasoline Expenditures during Each Year of the 1976-1986 Period as a Percentage of Average Family Income during Each Year of the 1976-1986 Period (2)	1985 Total Household Expenditure Decile	Gasoline and Motor Oil Expenditures in 1985 as a Percentage of Total Household Expenditures in 1985
1 (lowest)	4.8	4.2	1 (lowest)	3.7
2	6.5	5.6	2	5.3
3	5.9	5.3	3	5.5
4	6.3	5.1	4	5.7
5	5.7	4.9	5	5.2
6	5.4	4.6	6	5.2
7	5.4	4.2	7	4.9
8	4.9	4.1	8	4.4
9	4.8	3.7	9	4.5
10 (highest)	3.7	2.8	10 (highest)	3.2

Source: For the left-hand-side panel, authors' tabulations based on the Panel Study of Income Dynamics; for the right-hand-side panel, Poterba's (1991a) tabulations based on the 1985 Consumer Expenditure Survey.

Figure 1

Three Measures of Gasoline Expenditures as a Percentage of Income
Single Year, Five-Year Averages, and Eleven-Year Averages



that although the average burden falls as the accounting period is lengthened, the overall regressive pattern is approximately the same regardless of time period.

These results suggest a long-run income elasticity of demand for gasoline well below 1.0 and cast doubt on the argument that the long-run incidence of the gas tax is substantially less regressive than the short-run incidence. While it is true that long-run incidence is less regressive than short-run incidence for people whose incomes are low in a given year, the gas tax imposes an economic burden that is substantially higher on those who are persistently poor or near-poor than on those who are persistently rich. Our results parallel those of Lyon and Schwab (1990), who find that the patterns of tax incidence for alcohol and cigarette taxation are not necessarily less regressive when consumption is measured relative to permanent rather than annual income.

These results contrast sharply with those presented by Poterba. To see this most clearly, compare the data in column 2 and in the right-hand panel of Table 2. The latter, copied from column 3 of Table 2 in Poterba (1991a), shows gasoline expenditures as a share of total expenditures for families ranked by 1985 annual expenditure deciles. The data show that expenditure burdens are progressive through the bottom four deciles, rising from 3.7 percent in the lowest decile to 5.7 percent in the fourth decile, and then declining to 3.2 percent in the top decile. This pattern is very different from our results based on average gasoline consumption to income burdens, which show a continually regressive pattern above the bottom decile. The difference between the two approaches is also clearly seen by comparing the simple regressivity ratios of the average burden in the lowest five deciles to the average burden in the highest five deciles. This ratio equals 1.29 when burdens are measured as average gasoline expenditures divided by average income (column 2), but only 1.14 when burdens are measured as gasoline consumption as a share of total consumption (right-hand panel).

Gasoline Tax Burdens

It is reasonable to ask whether the distribution of gasoline expenditure burdens presented in the previous tables accurately reflects the incidence of the gasoline excise tax. Gasoline excise taxes are levied on a per-gallon basis, and on average about two-thirds of the excise tax rate faced by consumers is composed of state excise taxes. State taxes range from 8 to 22 cents per gallon. Hence it is possible that the incidence of the gasoline tax will differ from the incidence of gasoline expenditures. Table 3 provides results of an annual and a long-run calculation of gasoline excise tax burdens.¹⁰ Both calculations were made under the assumption that gasoline taxes are fully forward shifted to consumers. Tax burdens based on both miles driven and state and federal excise tax rates in 1982 are displayed in the left-hand panel, ranked by 1982 annual income deciles. The tax burdens in the right-hand panel are calculated by dividing eleven-year average gas tax liabilities by average income. They are ranked by average income deciles. The results show that the incidence of the tax burdens is very similar to the incidence of gasoline expenditure burdens displayed in Tables 1 and 2. In fact, the ratios of the average burden in the lowest five deciles to the average burden in the highest five deciles are the same for gasoline expenditure burdens and gasoline tax burdens. The distributional pattern of annual tax burdens is almost identical to the pattern of long-run burdens. In both cases, above the bottom decile, the gas tax is regressive.

Previous studies of gasoline excise tax burdens have either focused entirely on expenditure burdens or have restricted their analysis to the federal excise tax (Congressional Budget Office, 1990). In order to determine whether differences in state gasoline excise tax rates have an impact on the pattern of regressivity, we have compared the actual distribution of tax burdens in 1982 with the excise tax burdens that would result from a revenue-neutral uniform national tax rate. We conclude from this exercise that a uniform rate would slightly increase the regressivity of the gasoline excise

TABLE 3

**Annual and Long-Run Gasoline Tax Burdens, by Annual and
Average Family Income Deciles: 1982 and 1976-1986**

1982 Family Income Decile	1982 State and Federal Gasoline Excise Taxes as a Percentage of 1982 Family Income	Average Family Income Decile, 1976-1986	Average State and Federal Gasoline Excise Taxes during Each Year of the 1976-1986 Period as a Percentage of Average Family Income during Each Year of the 1976-1986 Period
1 (lowest)	0.76	1 (lowest)	0.70
2	0.84	2	0.94
3	0.71	3	0.88
4	0.71	4	0.86
5	0.66	5	0.81
6	0.66	6	0.78
7	0.59	7	0.71
8	0.56	8	0.68
9	0.48	9	0.62
10 (highest)	0.43	10 (highest)	0.48

Source: Authors' tabulations based on the Panel Study of Income Dynamics.

tax.¹¹ This implies that states with a concentration of residents with relatively low long-run incomes tend to have below-average excise tax rates.

Interpretation of the Results

Two obvious questions emerge from the results presented in Tables 1 and 2. First, why is the distribution of gasoline expenditure burdens so different when we measure taxpaying capacity as average income than when we measure it as total annual consumption expenditures? Second, why is the long-run incidence of the gas tax only slightly less regressive than the short-run incidence? To shed some light on the first question, it is useful to review the reasons why total annual expenditures might provide a better measure of long-run taxpaying ability than annual income. If annual gasoline consumption decisions are made on the basis of long-term income, then annual variations in income can lead to overestimates of consumption burdens for those with low annual incomes and underestimates for those with high annual incomes. Annual incomes will differ from long-term income because of temporary phenomena such as unemployment, illness, or the receipt of bonuses or prizes, and for life-cycle reasons. Young adults who are expecting to enter lucrative careers might well have high expenditures but low current incomes. On the other hand, through dissavings the elderly might also be consuming in excess of their current income.¹² To the extent that life-cycle considerations are important determinants of consumption decisions, annual expenditures are likely to be an appropriate way to measure the ability to pay taxes.

In order to explore why gasoline expenditure burdens based on income and on expenditure differ, Poterba (1991a) presents a joint distribution of households assigned to income and expenditure deciles. He finds that for about five-sixths of households, expenditure and income decile rankings are quite similar. To determine the role of life-cycle and transitory phenomena in explaining differences in the two rankings, he looks at the economic and demographic characteristics of those households whose expenditure rankings substantially exceed their income rankings. Within that group, he finds a

concentration of elderly (about 25 percent of the total) and of families with two or more children at home (about 16 percent) and, to a much smaller degree, of the young (about 7 percent of households). At the same time, Poterba finds that very few of the households with income rankings below expenditure rankings suffered from short-term setbacks such as illness and unemployment. Thus he concludes that ". . . life-cycle factors are more important than year-to-year income fluctuations in explaining divergences between income and expenditure rankings."

Using data from the PSID allows for a more direct test of the importance of life-cycle factors in explaining gasoline consumption. In Table 4 individuals are ranked by average gas tax burdens, which are calculated using data on eleven-year average gas tax liabilities. If life-cycle factors are an important determinant of gasoline consumption, we would expect that the young, those with children, and the elderly would tend to be concentrated among those with high average gasoline tax burdens. To the contrary, the data in columns 1 through 4 in Table 4 show that while 1982 annual income declines almost monotonically as average gas tax burdens increase, family size and the percentage of young persons in each burden decile do not vary across burden levels. The data also show that contrary to the predictions of the life-cycle hypothesis, a below-average proportion of elderly are subject to high average tax burdens. We conclude from these findings that the primary determinant of high gas tax burdens are low incomes, and that life-cycle considerations are dominated by other factors affecting the demand for gasoline. In particular, miles driven declines for the elderly, thus reducing their gasoline consumption relative to their income.¹³

Assessing Income Mobility

Even if this conclusion were incorrect, and gasoline consumption decisions are made on the basis of permanent income, the long-run incidence of the gasoline tax will differ from annual incidence only if annual income differs significantly from long-run income for a large number of individuals (i.e., if there is significant income mobility over time). Specifically, we want to

TABLE 4

**Selected 1982 Income and Demographic Data, by 1976-1986
Gasoline Excise Tax Burden Deciles**

Tax Burden ^a Decile, 1976-1986	Family Income (1)	Family Size (2)	% Young (Age 15-24) (3)	% Elderly (Over 65) (4)
1 (lowest)	\$22,000	3.0	18	28
2	40,510	3.2	17	16
3	35,050	3.4	17	10
4	33,790	3.6	19	8
5	32,710	3.4	19	6
6	30,600	3.4	20	6
7	28,700	3.5	23	5
8	24,490	3.4	20	6
9	23,860	3.4	20	7
10 (highest)	17,570	3.5	19	6
Average	28,580	3.4	19	10

Source: Authors' tabulations based on the Panel Study of Income Dynamics.

^aTax burdens are calculated as average gasoline expenditures during each year of the 1976-1986 period relative to average family income during each year of the 1976-1986 period.

determine what proportion of individuals with low (high) incomes in a given year are only temporarily poor (rich) and what proportion have persistently low (high) incomes.

To address this issue, we compute the joint distribution of annual (1982) and eleven-year (1976-1986) income decile ranks for all individuals in our sample. Figure 2 shows the proportion of individuals in each 1982 income decile whose average income position is the same as their annual income position. For comparison purposes, we use Poterba's data to show the proportion of households in each 1985 annual income decile who are in the same total expenditure decile. Thus, for example, for all those in the second decile in terms of 1982 annual income, 49 percent are also in the second decile of average income, while of those households in the second decile of 1985 annual income, 34 percent are in the second decile of households ranked by 1985 total expenditures.

A comparison of the two lines in Figure 2 marked by solid rectangles and plus signs, respectively, shows that an individual's annual income position is a much better predictor of its long-run income position than it is of its annual expenditure position. Across all deciles, the match-up of annual income positions with average income positions is from 10 to 25 percentage points higher than the corresponding match-up of annual income with annual expenditure positions.

The extent of the bias in the calculation of tax burdens created by using data on annual incomes will be relatively small if income mobility remains limited. If most people with low annual incomes in any given year fail to enter the middle class, but rather remain relatively poor over time, then tax burden calculations based on permanent income will be reasonably close to burdens calculated using annual income. In a recent paper Gottschalk, McLanahan, and Sandefur (1992) provide evidence from the PSID to suggest that most of observed year-to-year income mobility involve only small changes in income. They show, for example, that under 4 percent of families with incomes in the lowest quartile in 1986 have incomes in the upper half of the income distribution in 1987.

Figure 2

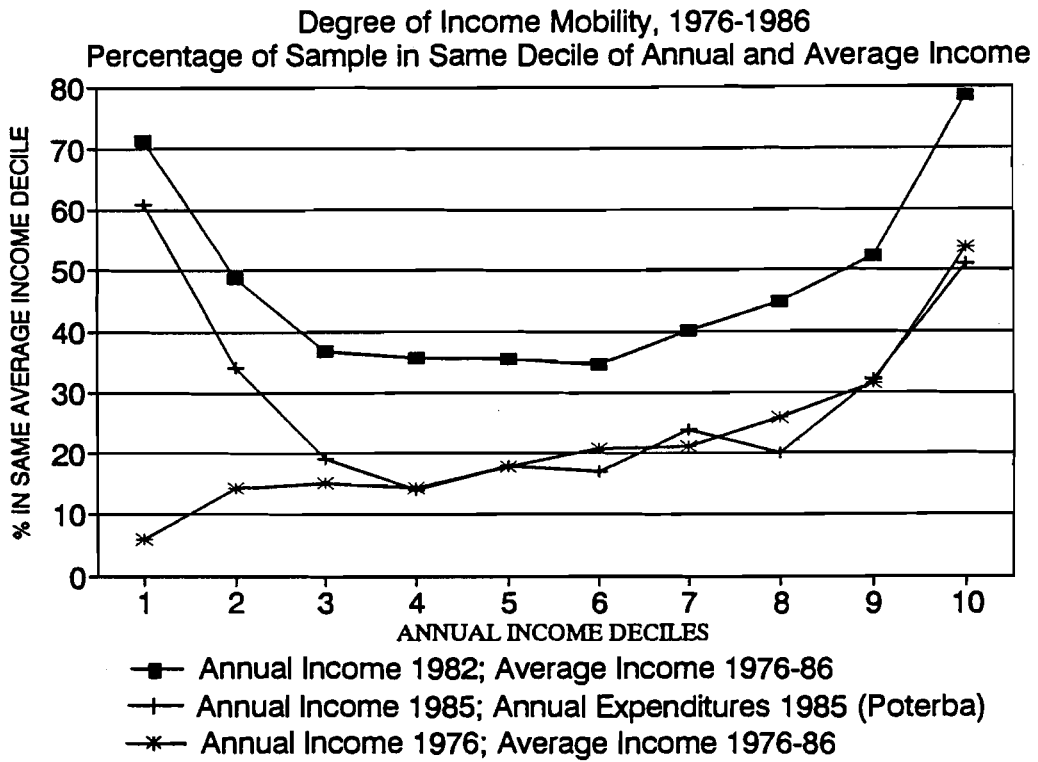
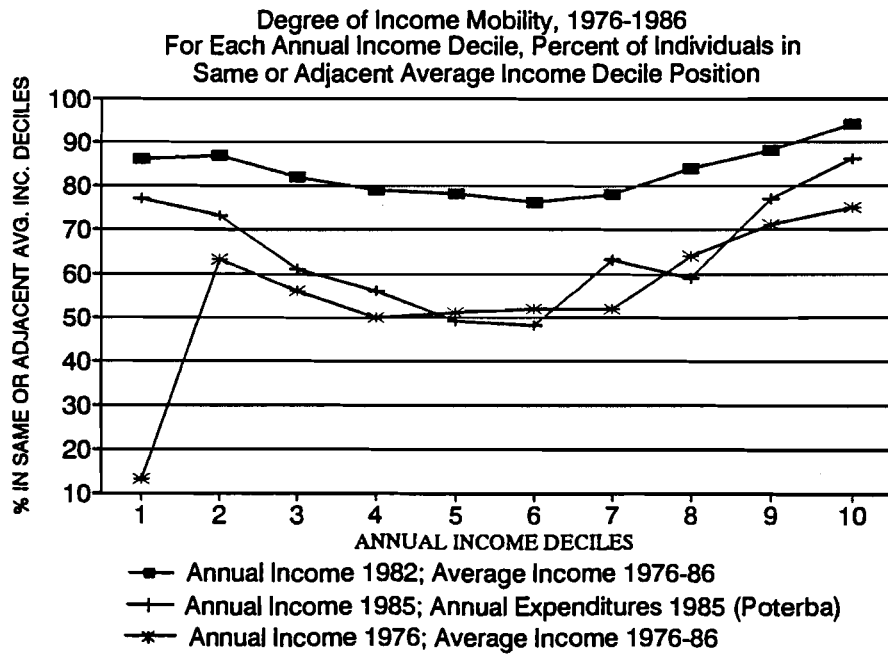


Figure 3



To get a better sense of how much of the observed mobility implied by the data in Figure 2 reflects only small changes in relative income position, in Figure 3 we have redrawn the graphs to show the proportion of individuals in each annual income decile who remain within one decile of their annual income position. The line in Figure 3 marked by solid rectangles indicates that when 1982 annual income is used as the base, income mobility is extremely limited. On average, nearly 85 percent of individuals remain in the same or adjacent average income deciles. Furthermore, income mobility is most limited at both extremes of the distribution of annual incomes. This finding helps explain why gas tax incidence is quite similar when calculated on the basis of annual income and average income.

While the permanent income hypothesis might seem to suggest that very low and very high income individuals on an annual basis would be the most likely to change income position as we go from the short to the long run, the U-shaped pattern of Figures 2 and 3 suggests the opposite. In part, this result stems from the fact that income change is measured in terms of relative position, rather than absolute value. Thus even if individuals change position according to a random process, individuals who are at the bottom or top of the income distribution in any given year change position only if they move in one direction (up for low-income people, down for high-income people), while people in the middle of the distribution can change positions if income changes in either direction. Nonetheless, a movement down for low-income people or up for high-income people, while leaving relative positions unchanged, only reinforces the long-term income status of the individual. Thus we take it as a significant measure of income stability that more than 80 percent of households whose incomes are very low on an annual basis have very low average incomes.

These results differ from those of Fullerton and Rogers (1991), who present data from the PSID suggesting that annual income provides a poor measure of lifetime income. They measure lifetime income as the average of actual and predicted labor income of each individual, while annual

income is measured by each individual's labor and capital income. They find that only 56.1 percent of individuals are in a lifetime decile within plus-or-minus one of their annual income decile at the end of a period. In contrast to our results, they conclude that annual income is not a good predictor of lifetime income.

Part of the difference between Fullerton-Rogers and us stems from differences in the length of the measurement period and in the definition of income. For example, their long-term measure of income includes only the labor income of the individual, while our income measure includes family income from all sources. However, the major reason for the different results is that they measure mobility retrospectively, while we measure income both backward and forward from a given base year. Our approach allows us to ask the following question: Of those persons at the low or high end of the income distribution in a given year, what fraction are in the midst of an extended spell in that income position? To differentiate from Fullerton-Rogers's measure of income mobility, one might call our approach spell mobility.

We replicated the income mobility results of Fullerton-Rogers by computing mobility prospectively, classifying people by the beginning year of our window (1976) and comparing their annual income decile ranking in that year to their average income position.¹⁴ The results, which are indicated by the lines marked with asterisks (*) in Figures 2 and 3, show the proportion of those in a given annual income decile in 1976 who are in the same (Figure 2) or the same or adjacent (Figure 3) average income position over the eleven-year period from 1976 to 1986. Less than 15 percent of the individuals in the bottom half of the income distribution in 1976 retain the same decile rank in terms of average incomes. When the criteria for income stability includes adjacent deciles, 65 percent or less of those in deciles 2 through 5 in 1976 do not change their relative income position. At the top end of the income distribution, both the prospective and the spell measures indicate relatively little mobility.

Why is prospective mobility so much greater than spell mobility in the bottom half of the income distribution? The difference is related to the distinction between those who were poor at a point in time versus those who were ever poor. Analysis of the distribution of completed spells of poverty reveals that at any point in time the proportion of people who are poor for an extended time period will be higher than the proportion who are only temporarily poor (Bane and Ellwood, 1986). To the extent that long-run spells of poverty are censored because the observation period is of limited duration, poverty will appear to be a relatively transitory phenomenon. In picking an annual year in the interior of the observation window, most of those who are poor in that year and are in the midst of a spell of poverty that began at most six years before and will continue for at most four more years will be classified in the lowest average-income decile(s). By contrast, when we examine the lowest annual income decile(s) in the initial year of the window, an individual who is in the midst of an equally long spell of poverty will be classified as having a higher average income, because the low-income years prior to 1976 are excluded from the sample.

To see this more clearly, consider two low-income people, one of whom is just beginning a spell of poverty in the sample year, the second of whom is in the middle of a ten-year spell of poverty. If the sample year is the beginning of the period, the person who has had low income for the five prior years will have five years of low income, and five years in a higher income position, and will be classified in an intermediate average income decile. The identical person sampled in the middle of the observation window will have ten years of poverty, and will be classified as persistently poor.

To be counted as persistently poor a person who begins a spell of poverty in the beginning of the period must be poor for most of the next eleven years. However, as Bane and Ellwood show, only a small proportion of those beginning a spell of poverty in a given year experience a long period of poverty. Thus, classification by income in the initial year of an observation window, as compared

to classification by income in the interior of the window, systematically censors out many who are in the midst of relatively long spells of poverty. Because at any point in time the group in the midst of a spell of poverty is much larger than the group just beginning a long spell of poverty, this censoring makes income mobility appear to be much greater than it really is.

Which measure of income mobility is most relevant for the analysis of long-term tax burdens? Just as the income dynamics literature stresses the importance of the persistence of poverty in formulating welfare policy, we argue that the persistence of poverty is quite relevant to the analysis of tax incidence. Our long-term incidence findings indicate that a gasoline tax imposes relatively high burdens on those with low incomes in a given year and on those who are persistently poor. The mobility findings indicate that of those with low incomes in a given year, a large majority are in the midst of an extended period of low incomes. Thus our results suggest that the gasoline tax (or tax increase) disproportionately burdens a group who are in the midst of an extended period of economic hardship and who therefore face an extended period of high tax burdens. Though eventually some of the low-income group will raise their economic status, both in the short and the long run the real burden on the poor is significantly higher than the burden on the rich.

Is Total Consumption a Good Measure of Permanent Income?

How can we reconcile Poterba's finding that gasoline consumption burdens measured relative to total consumption are progressive over the bottom portion of the permanent income distribution, given that burdens measured relative to average incomes are regressive? The most likely explanation is that because total consumption is more equally distributed than annual income, any component of consumption, such as expenditures on gasoline, will also be more equally distributed (Slesnick, 1991). The difference in the distribution of consumption and income is a result of two factors. First, annual consumption includes a transitory component (Friedman, 1957). A number of recent papers have emphasized the importance of this component, finding evidence for "excess sensitivity" of

consumption changes to changes in current income, where excess sensitivity is defined relative to that predicted by the permanent income hypothesis (Hall and Mishkin, 1982; Wilcox, 1989). Zeldes (1989) shows that constraints on borrowing may be particularly important for those with low asset levels, constraining the ability to smooth consumption. Hence the ratio of gasoline expenditures to "permanent" total consumption (something on which we have no data) may differ from the annual ratio. However, it is hard to see what direction such a bias would take. More important is the probable role of bequests and inter vivos transfers. Greenwood and Wolff (1992) demonstrate the dominant role of these two forms of intergenerational transfers in explaining observed changes in wealth for cohorts under age forty. If bequests are concentrated among those with high lifetime incomes, as observed by Menchik and David (1982), the permanent income elasticity of total consumption is likely to be well below 1.0. It is certainly possible that the elasticity with respect to an intermediate period of income (e.g., the eleven years in our sample) could be lower than lifetime elasticities. Although direct longitudinal evidence on this elasticity is sparse, we conjecture that a major part of the explanation for the long-run regressivity of the gasoline tax is that the ratio of consumption to permanent income declines with permanent income.

Indexing and the Burden of Gasoline Taxes

Browning and Johnson (1979) argue that, given the importance of transfer payments in the income of the poor, the regressivity of forward-shifted consumption taxes is substantially mitigated by the indexing of transfer income. Under the assumption that higher gas taxes lead to higher consumer prices, individuals who receive indexed transfer payments are partially protected from the price increases by the receipt of higher transfer payments. While the incidence model underlying Browning and Johnson's analysis has been critiqued by a number of economists (Smeeding, 1979; Due, 1986), an examination of the role of indexing in potentially offsetting the regressivity of the gasoline tax is still useful. Column 1 of Table 5 shows the average share of average real income coming from

TABLE 5

Impact on Gasoline Expenditure Burdens of Indexed Income

Decile	Average Share of Income Indexed		Unindexed Average Gasoline Expenditure Burdens, by Average Income Deciles (1976-1986) (3)
	PSID Data, by Average Family Income Deciles (1976-1986) (1)	CES Data, by Expenditure Deciles (1985) (2)	
1 (lowest)	37.0%	64.9%	2.6%
2	18.6	45.7	4.8
3	10.8	29.4	4.8
4	6.1	20.0	4.8
5	4.1	16.5	4.7
6	3.0	11.6	4.5
7	1.9	6.4	4.1
8	1.7	4.1	4.0
9	1.1	3.1	3.7
10 (highest)	0.8	3.0	2.8

Source: For columns 1 and 3, authors' calculations based on the Panel Study of Income Dynamics; for column 2, Poterba's (1991a) tabulations based on the Consumer Expenditure Survey.

Notes: Data in column 1 are the average share of eleven-year average income from Social Security benefits and Food Stamps. Data in column 2 are Poterba's (1991a) tabulations of the average percentage of income received by households in each expenditure decile that is indexed. The data in column 3 are eleven-year average gasoline expenditure burdens after netting out the effect of indexed income. This is accomplished by subtracting the fraction of income that is indexed times 4.45. This number is the average percentage share of income spent on gasoline during the 1976-1986 period.

Social Security and Food Stamps, the two major indexed transfer programs. For comparison, column 2 (taken from Table 6 of Poterba, 1991a) shows the average share of income that is indexed, where the ranking is by expenditure deciles. The PSID data indicate that only about 18 percent of the income of those in the lowest four average income deciles was indexed. This contrasts with Poterba's finding that 40 percent of income of households in the four lowest expenditure deciles was indexed.¹⁵ Thus, we conclude that even for those with persistently low incomes, income indexation is not significant enough to offset the burden of gasoline taxation.

Using his data on indexed income, Poterba adjusts gasoline expenditure burdens for the impact of indexed income.¹⁶ The resulting unindexed gasoline expenditure burdens are quite steeply progressive over the bottom five expenditure deciles, with the burden equal to 0.7 percent in the first decile, 2.8 percent in the second decile, and 5.0 percent in the fifth decile. The last column of Table 5 replicates Poterba's calculations of unindexed burdens using the PSID data on income from indexed sources. The resulting burdens are ranked by average income decile. Accounting for indexed income reduces the regressivity of expenditure burdens over the bottom half of the income distribution, resulting in a pattern that is approximately proportional between the second and the sixth average income decile. However, except for the first decile of income, gasoline expenditure burdens are still substantially lower in the upper half of the income distribution than in the lower half.

IV. COMPENSATION FOR EXCISE TAX INCREASES

Any significant increase in gas taxes, for example as part of a generalized carbon tax, might be coupled with offsetting changes in the tax structure to neutralize the equity effects. To minimize the cost of a compensation scheme, it would be desirable to target compensation primarily to those facing significant long-run burdens from an increase in gasoline taxation. Our results show that the

primary correlate of high tax burdens is low income. Ideally, a compensation scheme should be targeted to the persistently poor, rather than to families with temporarily low incomes.

Actual compensation schemes would probably be based on a relatively easily observable characteristic, such as annual income. In this case the degree of misplayment in any year would depend on how many of those who are poor in any given year are persistently poor, and how many of the persistently poor happen to be above the cut-off line for eligibility for compensation in a particular year.

To illustrate this issue, consider a \$100 per ton carbon tax analyzed by Poterba (1991b). Based on projected retail energy prices in the United States, Poterba estimates that a fully forward shifted tax of this level would cause a 25 percent increase in the retail price of gasoline. Assume that the following simple compensation scheme is adopted:

1. Compensation is restricted to those in the lowest three deciles of the annual income distribution;
2. the amount of compensation is set so that after compensation, the average eligible person's increase in gasoline tax burden is limited to one-half of 1 percent of income.

We find that about 18 percent of those in the lowest three annual income deciles (based on their 1982 income) would be ineligible for compensation if compensation were based on average income. Conversely, about 6 percent of those ineligible for compensation because their 1982 income places them above the third income decile would be eligible if compensation were based on average income. Under the assumption of a long-run gasoline price elasticity of -0.5, we have calculated that Poterba's \$100 per ton carbon tax would have raised \$9.8 billion in 1982.¹⁷ The implementation of the compensation scheme outlined above would have cost \$692 million, which equals 7 percent of the tax revenue raised. Furthermore, we estimate that significantly less than 18 percent of total compensation would have been paid "incorrectly" to persons who were above the third average income decile.¹⁸

V. CONCLUSION

Attention has focused on the gasoline tax as an efficient way of simultaneously addressing a number of major economic problems: the threat of global warming, our deteriorating infrastructure, and the large federal budget deficit. Aside from the political viability of any tax increase, the major objection to increasing the gas tax has been its alleged regressivity—the view, based on annual studies of tax incidence, that the tax imposes a much higher burden on the poor than on the affluent. However, this view has been forcefully challenged by a number of economists, most notably James Poterba, who argue that in the long run the gas tax will be much less regressive than on an annual basis. Using annual consumption expenditures as a proxy for long-run income, Poterba demonstrates that the gasoline excise tax is actually progressive over the bottom half of the income distribution.

In this paper, we have argued that annual consumption expenditures are not appropriate as a measure of ability to pay. We propose as an alternative a long-run (eleven-year) measure of family income, which we believe provides a more appropriate gauge of the ability of individuals to pay taxes. In a world where people could accurately predict their stream of future incomes and borrow against their future income, true lifetime income would be the appropriate way to measure taxpaying ability at any point during a lifetime. However, in the real world, not only is there a great deal of uncertainty about future incomes, but capital market imperfections usually make it extremely difficult to borrow against these future uncertain prospects.¹⁹ For example, for a person who has low income during his thirties, the fact that his income may be substantially higher during his forties does nothing to relieve the high tax burdens he faces during the earlier decade as long as he has no way to tap income that will accrue in the second decade. Furthermore, as taxes usually must be paid out of current income, high taxes may reduce the current income an individual has available for education or training, thereby reducing the prospects for higher income in the future.

Using longitudinal data from the Panel Study of Income Dynamics, we show that, when people are grouped into eleven-year average income deciles, long-run average gas tax burdens are only slightly less regressive than annual burdens. Burdens decline monotonically between the second and tenth deciles, from 0.94 percent to 0.48 percent of income. The main reason for the similarity of short- and long-run burdens is the limited degree of income mobility over an eleven-year period. We find that most persons who were poor (or rich) in 1982 were in a similar relative income position over the period from 1976 to 1986. This lack of income mobility means that for most people, annual spending patterns are replicated over a longer time period.

Our results suggest that in assessing the advantages and disadvantages of increased reliance on gasoline taxation, one should not dismiss concerns about the burdens placed on those with low incomes. Persons in the bottom half of the income distribution face eleven-year average gas tax burdens that average 0.85 percent of income. For people with low incomes, burdens of this magnitude and duration can create substantial economic hardships. Nevertheless, we believe that the magnitude of the tax burdens (especially when compared to other taxes) and the degree of regressivity are moderate enough so that, when combined with a reasonably simple compensation scheme, gas tax increases could be implemented that would provide the efficiency benefits arising from higher gasoline prices, yet protect the poor from undue hardship.

Notes

¹Other studies challenging the regressivity of the gasoline excise tax include Congressional Budget Office (1990) and Charles River Associates (1991).

²Paralleling the expenditure share approach to tax incidence is the lifetime perspective (Fullerton and Rogers, 1991). If a person's economic circumstances or their consumption patterns change substantially over their lifetime, an annual accounting period may convey a misleading impression of the long-run incidence of the tax system. Because individuals' income and consumption-to-income ratios vary over the life-cycle, a lifetime perspective will result in different, and in some cases more appropriate, patterns of source and use-side tax incidence than an annual perspective.

³Slemrod (1992), using a panel of tax return data, refers to average real income over a seven-year period as "time-exposure" income.

⁴Their sample consists of only those individuals who were continually heads of households throughout the twenty years of the PSID.

⁵Considerable uncertainty exists with respect to the reported household income when the head of the household changes. A family member leaving a household to become head of a new family unit may, for example, report zero income for the previous year that was spent mainly as part of the original family unit. The original family's income may be a more accurate measure of the individual's financial situation. Since it is not clear how to assign the "correct" income measure, in calculating average incomes, we excluded reported income for each year in which a change in the head of the family unit occurred. This is equivalent to assuming that the income in the year a family change occurred was equal to the average income over the rest of the eleven-year period. For the reference year 1982, average income from the remaining years is used to replace the self-reported income.

⁶We have included the PSID "non-response" files in our analysis. This allows us to include all available data for those people who are now "non-respondents."

⁷A number of automobile owners on the PSID respond to the question asking for the number of miles driven by answering "do not know" for at least one of the eleven years. Since the number of miles driven is a crucial variable in the analysis, we have used an ordinary least squares regression to impute miles for individuals with missing data. Included in the regression as explanatory variables for miles driven are family income, number of adults in the family unit, number of children, number of cars, average miles driven over the previous three years (or the previous two years for 1976 since miles were not reported in 1973), distance to the city center, and state dummies. The sample for the regression includes only the heads of family units.

⁸The expenditure burdens reported in the bottom decile of columns 2 and 3 are very sensitive to the exclusion of individuals with negative or very low reported incomes. Although we have excluded as few individuals as possible, any exclusion rule is by definition arbitrary. A close look at the pattern of income over time of the excluded individuals shows very large year-to-year income swings, suggesting that many excluded individuals are self-employed and comfortably middle class, yet suffer occasional business losses. Similar conclusions are reached by Slemrod (1992), who, drawing on a panel of tax return data, reports that those with negative Adjusted Gross Incomes in a given year have relatively high seven-year average incomes. The numbers reported in the tables for the lowest decile also reflect the fact that a substantial portion of the individuals in the lowest decile do not have access to a car, and hence have a zero burden. If we exclude nondrivers from our calculations, the distribution of burdens is regressive starting with the lowest decile.

⁹The reason the gasoline expenditure burdens based on average gasoline consumption are (with the exception of the lowest decile) lower than the burdens calculated using 1982 gasoline consumption

is that the real price of gasoline was higher in 1982 than in any other year in the eleven-year period between 1976 and 1986.

¹⁰The tax burdens reported in this table include state sales taxation of gasoline in the nine states that included gasoline consumption in their sales tax base during some or all of the eleven-year period between 1976 and 1986.

¹¹We calculated 1982 gas tax liabilities relative to long-term income and compared the resulting distribution of burdens to 1982 tax burdens, calculated under the assumption that there exists a uniform gas tax rate across the country. Our index of tax regressivity equals 1.22 for burdens calculated with a uniform rate and 1.18 for burdens calculated with actual rates.

¹²There is an extensive debate on the extent to which savings and consumption behavior of the elderly conforms to the life-cycle hypothesis. See Modigliani (1988) for a recent summary.

¹³Data from the PSID indicate that in 1982 persons between the ages of twenty-five and sixty-four drove an average of eighteen thousand miles. This number was nearly twice the miles driven by persons between the ages of sixty-five and sixty-nine and 2 1/2 times the number of miles driven by persons over the age of seventy.

¹⁴The results are similar if we compute mobility retrospectively, that is, use the last year of our observation window for the annual classification.

¹⁵It is likely that one reason for this difference is that Poterba's numbers reflect a single year of data, while we calculated the average share of income subject to indexation over an eleven-year period.

¹⁶Poterba defines a household's "unindexed exposure" to gasoline tax changes as (gasoline expenditures/income) - indexed share of income* β , where β is the population average ratio of gasoline expenditures to income.

¹⁷Our choice of gas price elasticity reflects an average of estimated price elasticities in studies of gasoline demand surveyed in Dahl (1986).

¹⁸The amount of "incorrectly" paid compensation is relatively small because most of the families with long-run incomes above the third average income decile, but annual incomes in the lowest three deciles, are close to the annual income cutoff point for our compensation scheme. That is to say, most such families are in the third annual income decile, and would therefore receive lower compensation than those in the first two annual income deciles.

¹⁹Zeldes (1989) presents evidence that liquidity constraints are binding for people with low levels of assets.

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