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Tax Reform and Automatic Stabilization

By Thomas J. Kniesner and James P. Ziliak*

*An income tax provides implicit insurance by dampening the variability of dispos-
able income and consumption. Using an empirical framework derived from the
consumption insurance literature and data from the Panel Study of Income Dynam-
ics we examine the effect of federal income tax reforms of the 1980's on automatic
stabilization of consumption. Overall, ERTA and TRA86 reduced consumption
stability by about 50 percent. Recently increased EITC generosity restored or
enhanced consumption insurance. The welfare cost of moving to the post-TRA86
system is sizable for relatively risk-averse households facing large income risk but
is much more modest for the typical household. (JEL H21)*

One of the most important economic events of the 1980's was the comprehensive overhaul of the United States federal income tax system. The Economic Recovery Tax Act of 1981 (ERTA) reduced marginal tax rates an average of 23 percent within each bracket. The Tax Reform Act of 1986 (TRA86) broadened the tax base and reduced the number of tax brackets from 16 to four. The marginal tax rate on high-est income earners dropped from 70 percent in 1981 to 50 percent in 1982 and dropped further to 28 percent in 1988. In 1980 over 75 percent of taxpayers faced statutory tax rates above 15 percent; by 1995 fewer than 25 percent faced rates above 15 percent (Leonard E. Burman et al., 1998). Overall, the tax reforms in the 1980's reduced the average tax burden by 25 percent. Many economists have examined how tax re-form influenced incentives to work (Barry Bosworth and Gary Burtless, 1992; Nada Eissa,

1996; Richard Blundell et al., 1998; Kniesner and Ziliak, 1998; Ziliak and Kniesner, 1999), to save (Bosworth and Burtless, 1992; Eric M. Engen and Gale, 1996; B. Douglas Bernheim, 1999), and to invest (Alan J. Auerbach, 1996; Auerbach and Joel Slemrod, 1997). Conspicu-ously absent is research on how the tax reforms of the 1980's offset a beneficial dimension of progressive taxation—automatic stabilization of expenditures. We examine empirically how the reforms to the federal income tax in the United States during the 1980's reduced the automatic smoothing of household consumption after a shock to income.

The paucity of empirical research on auto-matic stabilization is somewhat surprising in light of the parallel literature on the consump-tion-smoothing benefits of social insurance pro-grams (Daniel S. Hamermesh, 1982; Jonathan Gruber, 1996, 1997; Susan Dynarski and Gruber, 1997) and because a key aspect of a progressive income tax is providing collective insurance against idiosyncratic shocks to income, in turn smoothing consumption and dampening the business cycle. For example, consumption falls by less than a negative shock to taxable income because the household's tax burden is reduced, possibly because it falls into a lower marginal tax bracket. ERTA and TRA86 lowered tax rates and established fewer and wider marginal tax brackets, which diminishes the likelihood of falling into a lower tax bracket after a negative shock to income and limits households' abil-ity to maintain consumption compared to a more progressive tax. Contrary to the welfare-

enhancing effects of the flattening of the income tax during the 1980's operating through the labor-supply substitution effect (Jerry Hausman, 1981; Kniesner and Ziliak, 1998), a weakened automatic stabilizer is welfare-reducing because households have greater variability of disposable incomes (Hal Varian, 1980).

There is substantial empirical research on how actions within families (Fumio Hayashi et al., 1996) and between families (Sumru Altug and Robert A. Miller, 1990; John H. Cochrane, 1991; Barbara J. Mace, 1991; Julie A. Nelson, 1994; Robert M. Townsend, 1994; Orazio Attanasio and Steven J. Davis, 1996; Hayashi et al., 1996; James Banks et al., 1997; Angus Deaton, 1997; John Ham and Kris Jacobs, 2000; Paul Gertler and Gruber, 2002) can stabilize consumption. Recent research on implicit consumption insurance uses a theoretical framework in which a hypothetical central planner allocates resources across households to equate the growth rates of the marginal utilities of consumption. The strong testable implication of complete consumption insurance is that after accounting for changes in aggregate resources the growth of an individual household's consumption should not depend on changes in the household's own economic resources. With few exceptions (Altug and Miller, 1990; Mace, 1991), empirical research rejects complete implicit consumption insurance.

An income tax produces partial implicit consumption insurance for households when income changes, whether the income change is anticipated or unanticipated. There is little research on partial implicit consumption insurance; most of it focuses on developing countries (Deaton, 1997; Gertler and Gruber, 2002); little of it considers recent United States tax reforms (Auerbach and Daniel Feenberg, 2000; Darrel Cohen and Glenn Follette, 2000).

We specify a model of the evolution of consumption where the focus is on identifying the degree to which partial consumption insurance has changed because of ERTA and TRA86. To track time variation in partial risk sharing we use panel data and the Michael P. Keane and David E. Runkle (1992) forward-filter estimators of Euler equations with latent heterogeneity. Our data are from the Panel Study of Income Dynamics (PSID) for interview years 1980–1991, which encompasses the periods before ERTA and after TRA86. Food consumption is the measure examined most

often by researchers using the PSID to test complete consumption insurance (Altug and Miller, 1990; Cochrane, 1991; Hayashi et al., 1996; Ham and Jacobs, 2000). Because the Food Stamp Program will stabilize food consumption, it is plausible that the tax reforms of the 1980's did little to food consumption. We therefore focus primarily on total consumption constructed as a residual of income net of taxes and saving (Ziliak, 1998).

We find that across the 1980's the progressive income tax stabilized household consumption by 15 percent in response to a given reduction in gross income. On balance, though, the tax reforms of the 1980's cut in half the consumption stabilizing effect of the United States income tax. Welfare simulations indicate that the average household would have to be compensated annually with an additional 2.5 percent of baseline consumption to move from a pre-ERTA tax system to an equal-yield annual lump-sum tax, compared to compensation of 1.4 percent to move from a post-TRA86 system to an equal-yield annual lump-sum tax. Moreover, the cost of moving to the post-TRA86 system is upward of 6 percent for relatively risk-averse households facing large income risk, but is much more modest for the typical household. Our results highlight an underappreciated benefit of a progressive tax system and how that benefit was reduced by the 1980's tax reforms. There are some exceptions. Changes in Social Security taxes and the Earned Income Tax Credit during the 1980's and 1990's increasingly stabilized consumption for low-income couples and single mothers in the upper half of the income distribution.

I. Conceptual Framework

The theory of complete consumption insurance begins with a social planner who, given household-specific social weights, μ^h, allocates resources under uncertainty across households and over time to equalize the growth rates of the marginal utilities of consumption. The planner's problem is to maximize the weighted sum of households' utilities

$$(1) \quad \text{Max} \sum_{h=1}^{H} \mu^h \sum_{t=1}^{T} \sum_{s=1}^{S} (\rho^h)^t \pi_{st} U(c_{st}^h, \delta_{st}^h)$$

where h indexes households, t indexes time, s indexes economic state, ρ^h is the household's rate of time preference, π_{st} is the probability of state s happening at time t, c_{st}^h is the household's consumption in state s and time t, and δ_{st}^h indexes shocks to preferences across households and over time. The adding-up constraint in the maximization problem posed is

$$(2) \qquad \sum_{h=1}^{H} c_{st}^h = C_{st}$$

such that the sum of households' consumption expenditures is aggregate consumption in state s at time t.

The choice variable is household consumption, c_{st}^h, and the first-order conditions for maximizing (1) subject to (2) given the realization of state s are

$$(3) \qquad (\rho^h)^t \mu^h \pi_t U_c(c_t^h, \delta_t^h) = \lambda_t$$

where λ_t is the Lagrange multiplier associated with the aggregate resources constraint, and U_c is the marginal utility of consumption.

Taking the natural log of (3), first-differencing to eliminate the fixed household social weight μ^h, and rearranging yields the Euler equation

$$(4) \qquad \Delta \ln U_c(c_t^h, \delta_t^h)$$
$$= \Delta \ln \lambda_t - \Delta \ln \pi_t - \ln \rho^h.$$

The right-hand side of equation (4) describes the main implication of complete consumption insurance. After adjusting for the household-specific discount factor, the growth in the marginal utility of consumption is the same across households because marginal utility of consumption depends only on aggregate resources and state of the economy.

To operationalize (4) we need to specify a functional form for within-period utility. We use the isoelastic utility function suggested by Deaton (1997):

$$(5) \quad U(c_t^h, \delta_t^h) \equiv U(c_t^h, \theta_t^h, \sigma)$$
$$= (1 - \sigma)^{-1} \theta_t^h n_t^h (c_t^h/n_t^h)^{(1-\sigma)}$$

where θ_t^h is a multiplicative taste shifter capturing time variation in the household's preferences, σ is the coefficient of relative risk aversion, n_t^h is the size of household h at time t, and c_t^h/n_t^h is per capita consumption.[1] Given isoelastic preferences and defining $\Delta \ln \lambda_t^* \equiv \Delta \ln \lambda_t - \Delta \ln \pi_t$, equation (4) becomes

$$(6) \quad \Delta \ln(c_t^h/n_t^h)$$
$$= -\sigma^{-1}(\Delta \ln \lambda_t^* - \Delta \ln \theta_t^h - \ln \rho^h)$$
$$= -\sigma^{-1}(\Delta \ln \lambda_t^* - \Delta \varepsilon_t^h).$$

With preference shocks that are mean-zero stochastic disturbances, the right-hand side of (6) highlights how the discounted growth of per capita consumption will be the same for all households.

Equation (6) is the mode specification in the empirical literature on consumption insurance. The substantial amount of research emerging over the past decade tests the complete insurance hypothesis with data from both developing countries (Townsend, 1994; Jonathan Morduch, 1995; Deaton, 1997; Gertler and Gruber, 2002) and developed countries (Altug and Miller, 1990; Cochrane, 1991; Mace, 1991; Nelson, 1994; Attanasio and Davis, 1996; Hayashi et al., 1996; Banks et al., 1997). The predominant finding is that complete implicit consumption insurance is not typical either between or within families.

Rejection of complete insurance is probably not surprising given the moral hazard problems inherent in devising comprehensive intra- and interhousehold insurance schemes. At the same token, the weakness of high-frequency co-movements in the relative wage and consumption distributions strongly rejects the extreme alternative of no consumption smoothing (Attanasio and Davis, 1996). Both public and private institutions clearly exist that offset consumption loss because of income loss. A more general

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[1] Our empirical model will parameterize intertemporal preferences as $\theta_t^h = \exp\{\sigma(\mathbf{d}_t^h \gamma + \ln v_t^h)\}$, where $\mathbf{d}_t^h$ is a $1 \times k$ vector of observed time-varying demographics, γ is a coefficient vector to be estimated, and $\ln v_t^h$ is a mean-zero random shock.

approach to examining consumption insurance empirically admits partial consumption insurance, whose effectiveness may vary over time.

A. How the Income Tax Creates Partial Consumption Insurance

Consider the United States federal income tax system and the attendant reforms in the 1980's. If the only trade-off facing policy makers were between the equity effects of changing the income distribution and the efficiency effects of behavioral incentives, then the optimal income tax literature yields either a declining or zero marginal income tax on the highest income earner (Joseph E. Stiglitz, 1987; Momi Dahan and Michel Strawczynski, 2000) or in some cases a U-shaped marginal tax rate structure (Peter A. Diamond, 1998). However, if policy makers are also concerned about the variability of after-tax income and consumption, and some of the observed differences in income are due to exogenous differences in luck, then the marginal tax rate on the highest income earner might be quite large (Varian, 1980; Strawczynski, 1998). If redistribution and partial insurance are important policy objectives then a steeply progressive income tax system might, on balance, be welfare improving.

In Table 1 we present the United States federal income tax rates for a married couple filing jointly for the years immediately before and after ERTA (1980 and 1982) and the years immediately before and after TRA86 (1985 and 1987). The pre-ERTA United States federal income tax system is targeted towards redistribution and partial insurance. In 1980 there were 16 marginal tax rates, which increased by about 4 percentage points for each successive bracket above the zero bracket amount. At low levels of the taxable income distribution the tax brackets were quite narrow, creating a high probability of a tax-rate reduction in the event of an idiosyncratic income loss. As evidenced by the rate schedules for 1982 and 1985, ERTA did little to the number and width of tax brackets. However, ERTA indexed the brackets for inflation by 1985 and reduced the marginal tax rates at all levels, especially for upper-income Americans. TRA86 slashed the number of statutory brack-

TABLE 1—TAX-RATE SCHEDULES FOR MARRIED TAXPAYERS IN SELECTED TAX YEARS

Taxable income (thousands of dollars)	Marginal tax rate (percent)	Taxable income (thousands of dollars)	Marginal tax rate (percent)
1980		1982	
3.4 or less	0	3.4 or less	0
3.4–5.5	14	3.4–5.5	12
5.5–7.6	16	5.5–7.6	14
7.6–11.9	18	7.6–11.9	16
11.9–16.0	21	11.9–16.0	19
16.0–20.2	24	16.0–20.2	22
20.2–24.6	28	20.2–24.6	25
24.6–29.9	32	24.6–29.9	29
29.9–35.2	37	29.9–35.2	33
35.2–45.8	43	35.2–45.8	39
45.8–60.0	49	45.8–60.0	44
60.0–85.6	54	60.0–85.6	49
85.6–109.4	59	85.6–109.4	50
109.4–162.4	64	109.4–162.4	50
162.4–215.4	68	162.4–215.4	50
215.4+	70	215.4+	50
1985		1987	
3.54 or less	0	3.0 or less	11
3.54–5.72	11	3.0–28.0	15
5.72–7.91	12	28.0–45.0	28
7.91–12.39	14	45.0–90.0	35
12.39–16.65	16	90.0+	38.5
16.65–21.02	18		
21.02–25.6	22		
25.6–31.12	25		
31.12–36.63	28		
36.63–47.67	33		
47.67–62.45	38		
62.45–89.09	42		
89.09–113.86	45		
113.86–169.02	49		
169.02+	50		

Notes: Taxable income for tax years prior to 1987 is typically defined as adjusted gross income less exemptions and excess itemized deductions (the excess of itemized deductions over the zero bracket amount). For 1987 and beyond taxable income is defined as adjusted gross income less exemptions and the larger of itemized deductions or the standard deduction.

ets to five in 1987 and to four in 1988 (the 33-percent rate created a so-called bubble for some higher-income taxpayers before declining back to 28 percent). Under TRA86 the brackets widened substantially, which reduces the probability of a marginal tax-rate reduction in the presence of income loss, although average tax burdens still decline. Changes to the United States federal income tax code in the 1980's
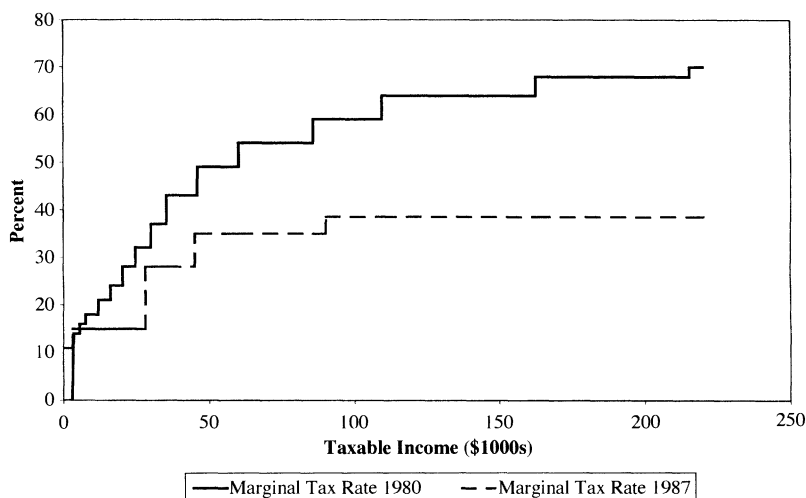
FIGURE 1. STATUTORY FEDERAL MARGINAL TAX RATES FOR MARRIED COUPLES FILING JOINTLY

suggest a reduced concern about the automatic stabilizing component of the system relative to the deadweight loss of reduced incentives. Indeed, the 1982 and 1987 issues of the *Economic Report of the President* contain extensive discussion of the efficiency costs of high income tax rates but no mention of the possible efficiency benefits via consumption smoothing.[2]

An intuitive way to think about the partial-insurance capability of the federal income tax is through the curvature of the tax function. In Figure 1 we graph the statutory rates for 1980 and 1987. It appears that 1980's pre-ERTA system is more globally concave than 1987's post-TRA86 rate structure; the rate of change in marginal tax rates is greater overall before ERTA than after TRA86. However, the 1987 structure appears more locally concave in certain regions, particularly in the 15- and 28-percent marginal tax brackets. If the bulk of taxpayers are located just above the 28 percent tax kink, then it is possible that automatic stabilization actually increased with TRA86. In

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[2] Also important is the impact of tax reforms on the taxable income base. TRA86 had several base-broadening measures, which likely enhanced stabilization relative to the pre-TRA86 system. We attempt to isolate the effects of changes in tax rates versus tax base in some of our welfare simulations below.

1995 about 60 percent of taxpayers were in the 15-percent bracket, and about 17 percent were in the 28-percent bracket (Burman et al., 1998). Provided that the incomes of upper-income Americans are relatively rigid downward, the likely outcome was a decrease in automatic stabilization with TRA86.

Concurrent with reforms to the federal income tax were reforms to the Social Security payroll tax (FICA) in the early 1980's and to the Earned Income Tax Credit (EITC) with TRA86. Because of concerns over the solvency of the Social Security program, Congress legislated an aggressive program to increase both the FICA tax base and tax rates. During 1980–1987 the FICA tax base increased by 70 percent from $25,900 to $43,800, and the payroll tax rate increased by 17 percent from 6.13 to 7.15 percent. To counter the regressivity of the payroll tax and to stimulate work among low-income households, Congress also expanded the EITC in 1986. The phase-in subsidy rate of the EITC increased from 10 percent in 1980 to 14 percent in 1987 and the phase-out rate decreased from 12.5 percent to 10 percent. The declining phase-out tax rate resulted in a 54-percent increase in the cut-off income level for credit eligibility from $10,000 to $15,432. Overall, reforms to Social Security and the EITC offset to some extent the declines in federal marginal tax rates

for low- and moderate-income earners and restored the implicit automatic stabilization in the tax system.

B. Econometric Framework Admitting Partial Insurance

To estimate how the partial consumption insurance implicit in the United States income tax system evolved during the 1980's, we amend the Euler equation for household consumption [equation (6)] to become

$$(7) \quad \Delta \ln(c_t^h/n_t^h)$$

$$= \alpha\Delta \ln(C_t) + \beta\Delta \ln(y_{dt}^h) + \Delta\varepsilon_t^h$$

where aggregate consumption, C_t, represents aggregate resource constraints at time t, and y_{dt}^h is the household's disposable income, $y_{dt}^h \equiv y_t^h - T(y_t^h - E_t^h - D_t^h) + \underline{C}_t^h(y_t^h)$. Total tax payments, $T(\cdot)$, are a function of taxable income defined as gross income less exemptions and deductions. Tax credits, $\underline{C}(\cdot)$, are a function of gross income. With complete consumption insurance, the effect of any variable that is cross-sectionally uncorrelated with preference shocks should be zero given controls for aggregate resources, which means $\beta = 0$. Under partial insurance, changes in consumption will be a function of both aggregate and idiosyncratic resources ($\beta \neq 0$). With partial insurance the elasticity of per capita consumption with respect to gross income is $[\partial \ln(c_t^h/n_t^h)/\partial y_t^h] y_t^h = \beta(1 - \tau_t^h)(y_t^h/y_{dt}^h)$, where $\tau_t^h = \partial T/\partial y_t^h - \partial \underline{C}_t^h/\partial y_t^h$ is the household's total marginal tax rate from total tax payments $T(\cdot)$ net of credits $\underline{C}(\cdot)$.[3] Stabilization emanates through marginal

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[3] Note that when gross income changes there is both a direct effect on per capita consumption via β and an indirect effect via the tax system:

$$\beta\left(1 - \frac{\partial T}{\partial y_t^h} + \frac{\partial \underline{C}_t^h}{\partial y_t^h}\right) * \left(\frac{1}{y_{dt}^h}\right).$$

Because equation (7) is in double-log form, the partial derivative with respect to gross income is

$$\partial \ln(c_t^h/n_t^h)/\partial y_t^h = \frac{\partial(c_t^h/n_t^h)}{c_t^h/n_t^h} \Big/ \partial y_t^h.$$

To keep the formula in terms of an elasticity it is necessary to multiply both sides by gross income, y_t^h.

tax rates, τ_t^h, and through average tax rates via changes in disposable income, y_{dt}^h.

II. Data

Our data come from the Panel Study of Income Dynamics (PSID) for interview years 1980–1991. The survey has followed a core set of households since 1968 plus newly formed households as members of the original core have split off into new families. The PSID contains detailed information on income and household composition. Our sample spans the two major recent income tax reforms in the United States, which occurred in 1981 (ERTA) and 1986 (TRA86), and our data are the best available to study how a less graduated income tax affected the automatic stabilization of consumption inherent in the United States progressive income tax.[4]

Our sample is an unbalanced panel treating missing observations as exogenous events. By eliminating only a missing person-year of data, the time series for each household can be of different length within 1980–1991. To be included in the sample the household head must (1) be at least 25 years old in 1980 and no more than 64 years old in 1991; (2) be finished with school by 1980; (3) not be permanently disabled or institutionalized; and (4) have the same marital status for 1980–1991 (so as to keep the same tax table, which facilitates understanding how taxpayers who income split with a spouse for tax purposes may be differentially affected by the tax reforms of the 1980's). To reduce further the influence of household composition changes and possible outliers, we follow the existing literature and delete person-years with more than a 300-percent increase or more than a 75-percent decrease in consumption. We also require per capita consumption and disposable income to be no less than $1,000 in any year. Our selection criteria produce a sample of 1,298 households with 12,341 person-years of consumption.

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[4] A practical reason for our sample dates is that in 1980 the PSID converted from hand-calculated income tax information to computer-generated data, reducing measurement error considerably. In 1992 the PSID ceased collecting tax data, making 1991 the last year tax information is available.

A. *Consumption*

The advantage of the PSID relative to repeated cross-section surveys such as the Consumer Expenditure Survey (CEX) is that the PSID follows the same households longitudinally, which makes it unnecessary to construct a time series on artificial households based on membership in demographic cohorts (Attanasio and Davis, 1996). The disadvantage of the PSID is that it presents less ideal measures of consumption than the CEX. Previous studies using the PSID to test for complete consumption insurance examine Euler equations for food consumption expenditures (Altug and Miller, 1990; Cochrane, 1991; Hayashi et al., 1996). For comparability we too estimate Euler equations for food expenditures. Because tests of the permanent income hypothesis are known to be sensitive to the consumption measure, we focus on a broader measure of consumption defined as the residual of income net of the change in predicted wealth and taxes paid (Ziliak, 1998).

To elaborate on the more comprehensive consumption measure we use, the PSID allows one to estimate household wealth $(\hat{A}_t^h)$, and, given wealth, construct personal saving as the year-to-year change in wealth, $\hat{S}_t^h = \hat{A}_{t+1}^h - \hat{A}_t^h$. Total consumption then follows by subtracting saving from disposable personal income, $\hat{c}_t^h = y_{dt}^h - \hat{S}_t^h$. The precision of total consumption as disposable income net of changes in wealth accumulation rests on how well we predict wealth $(\hat{A}_t^h)$.

Using the PSID one can construct wealth alternatively as liquid assets (the capitalized value of rent, interest, and dividend income) or the sum of liquid assets and home equity (the difference between house value and mortgage principal). However, liquid assets and home equity miss changes in wealth holdings in the 1980's via Individual Retirement Accounts (IRAs). An alternative is to exploit information in the PSID's wealth supplements.

In 1984 and 1989 the PSID conducted detailed wealth surveys for each household head, including questions on the amount of cash in checking and savings accounts, stock and bond holdings, vehicle equity, farm and nonfarm business equity, equity in primary and secondary homes/real estate, and IRA contributions. Our strategy for predicting wealth is to estimate

fixed-effect wealth regressions with either liquid assets or liquid assets and home equity as regressors. Specifically, we pool the 1984 and 1989 wealth supplements for the 1,298 household heads and run a regression permitting a household-specific intercept along with a common coefficient each for liquid assets and home equity.

Appendix Table A.1 displays the wealth regressions (with the person-specific intercepts suppressed). We examine both net worth and net nonhousing nonbusiness wealth as dependent variables. The accuracy of the wealth predictions as determined by the adjusted R^2 improves markedly using net worth versus the narrower wealth measure, but there is only a trivial increase in fit from 0.92 to 0.93 when including home equity as an additional covariate in the net worth prediction equations.

Although Ziliak (1998) focuses on the broader wealth measure, most of the flow in saving emanates from liquid sources. It may also be tenuous to define consumption as involving unrealized capital gains in the housing stock.[5] In addition, because we trim extreme changes in consumption there are an additional 2,000 person-years of data lost when constructing consumption using net worth predicted from liquid assets and home equity. Hence, most of our tests rely on the narrower definition of consumption based on net worth predicted from liquid assets.[6]

Our total consumption measure is advantageous compared to food expenditures because

food is stabilized by the Food Stamp Program. The PSID also did not collect food consumption for the 1988 and 1989 interview years, which are two critical years after TRA86 needed to identify automatic stabilization effects. Our total consumption measure also improves on predicted consumption for the PSID proposed by Jonathan Skinner (1987) because the PSID stopped collecting many of the components used in Skinner's measure prior to TRA86, and Skinner's measure may be more susceptible to changes in the relative prices of goods compared to our measure (Attanasio and Guglielmo Weber, 1995).

A potential disadvantage of our consumption measure is that it implicitly includes durable goods, which introduces the difficulty of distinguishing between expenditures and service flows of consumption (Hayashi, 1985). Hayashi includes durable consumption by modeling total consumption as a distributed lag of current and previous expenditures. Although we do not take the distributed lag approach for the evolution of consumption, we attempt to control for implied autocorrelation in our total consumption measure via our econometric estimator as described below. We also have reason to be concerned about potential measurement error in total consumption, which will lead us to adopt an instrumental variables estimator.

B. Income and Taxes

The final data issue we need note concerns key independent variables in our estimating equation (7): gross family income and tax payments. Information is available to construct family income from labor and interest earnings and transfers received. Because transfer income such as unemployment insurance, food stamps, and AFDC is an important source of consumption insurance (Hamermesh, 1982; Gruber, 1996, 1997; Dynarski and Gruber, 1997) we include government transfers as part of income when identifying the automatic stabilization properties of income taxes.

With each wave until 1992 the PSID has used household income and estimates of deductions and exemptions to construct a household's marginal tax rate and taxes paid. For exemptions, the PSID has recorded the number of dependents used for tax purposes. For deductions,

they have used the Internal Revenue Service's *Statistics of Income* to generate a typical value of itemized deductions for the household's adjusted gross income. Taxable income is then computed by subtracting positive values of excess itemized deductions (itemized deductions less the standard deduction) from gross income for tax years prior to 1987, or by subtracting the larger of itemized deductions and the standard deduction from gross income for tax years 1987 and later. Given taxable income, they then compute tax payments based on the statutory rates for each year. The PSID also computes an estimated value of the EITC for qualifying families so that tax payments can be negative. However, they omit both Social Security tax payments as well as state income tax payments. As in Ziliak and Kniesner (1999) we obtain an estimate of total taxes by adding to federal income taxes the estimated payroll tax payment for the head (and spouse when present) and the state income tax payment using the average income tax rate for the household's state.[7]

A possible concern is the quality of the tax data available in the PSID relative to the population tax-return information collected by the Internal Revenue Service (IRS). Although a comprehensive comparison of the PSID tax data with the IRS tax data is beyond our scope, we can compare the IRS's published 1980 average tax rates (*Statistical Abstract of the United States*, 1983) to average tax rates for 1980 from the PSID. Because the IRS data are from households of all types, we select a fresh cross-section sample of heads of households in the 1980 PSID to make the PSID data maximally comparable to the IRS data. We report the average tax rates for adjusted gross income classes in Figure 2. The PSID tax data compare favorably to the IRS data at all income levels, with the possible exception of the very rich.

III. Estimation Issues

The complete implicit consumption insurance model in (6) can be estimated consistently using ordinary least squares (OLS) (Cochrane,

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[7] The state income tax is best viewed as a proportional tax over and above the federal marginal tax rate and is an additional source of consumption stabilization.
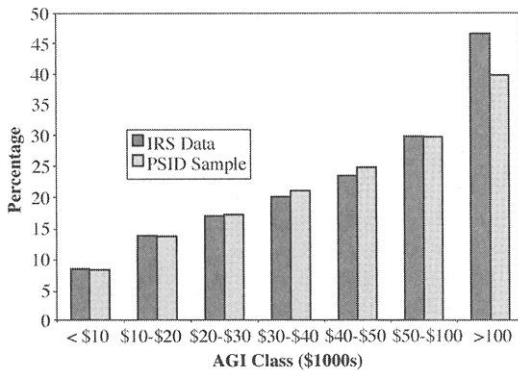
FIGURE 2. AVERAGE TAX RATES FOR 1980 IRS AND PSID TAX RETURNS BY ADJUSTED GROSS INCOME

1991; Mace, 1991; Nelson, 1994; Deaton, 1997; Gertler and Gruber, 2002). Introducing household-specific disposable income to capture partial insurance makes estimating the Euler equation in (7) more complicated econometrically. It is unreasonable to assume that $E(\Delta y_{dt}^h \Delta \varepsilon_t^h) = 0$ because the composite error term contains the household-specific discount factor, $\ln \rho^h$, which is likely to covary with income over the life cycle. Another complexity we must confront in the econometric setup is that if disposable income is measured with error, then it will covary contemporaneously with the error term in consumption.

A. Latent Heterogeneity

Consider first the case where the evolution of gross income is not independent of the discount factor. Because the model in equation (7) is in first differences, unobserved person-specific time-invariant heterogeneity in consumption levels is swept away. Growth-rate heterogeneity may manifest itself in the household's discount factor. One econometric approach that immediately comes to mind is to treat the discount factor as time invariant and sweep it out with either the within or the first-difference transformation. Eliminating discount rate heterogeneity with the first-difference transformation exacerbates measurement-errors-in-variables problems relative to the within transformation and results in the loss of another year of data (Zvi Griliches and Hausman, 1986). Here the within transformation also makes predetermined vari-

ables invalid as instruments (Keane and Runkle, 1992). Neither the simple first-difference estimator nor the simple within estimator is suitable for our purposes.

The econometric approach we take builds on the correlated random-effects estimators of Yair Mundlak (1978), who proposed using the individual's means of the time-varying regressors as proxies for the fixed effect, and Gary Chamberlain (1984), who proposed using the linear projection of the time-varying regressors as proxies for the fixed effect. We use a correlated random-effects approach similar to Mundlak (1978), but instead of using the individual's means of the time-varying regressors we follow more closely the method of Emily C. Lawrance (1991), who estimates discount rates as a function of pre-sample information. The equation for the discount factor we use is

$$(8) \qquad \ln \rho^h = \mathbf{x}^h \varphi + \omega^h$$

where $\mathbf{x}^h$ is a vector of pre-sample variables and ω^h is a mean-zero random error. Pre-sample information includes the household head's education level, race, and five-year birth cohort, the latter of which are intended to capture cohort-specific differences in discount rates. Amended in light of (8), along with the parameterization of intertemporal preferences described in footnote 1, our estimating equation becomes

$$(9) \quad \Delta \ln(c_t^h/n_t^h) = \alpha \Delta \ln(C_t) + \beta \Delta \ln(y_{dt}^h)$$
$$+ \Delta \mathbf{d}_t^h \gamma + \mathbf{x}^h \varphi + \Delta \zeta_t^h$$

where $\Delta \zeta_t^h = \omega^h + \Delta \ln \nu_t^h$.

B. Measurement Error

Estimation of equation (9) is further complicated by possible measurement error in changes in disposable income. In the case of income changes there are two, possibly offsetting, sources of measurement error. First, there is classical attenuation bias in the coefficient toward zero due to incorrect measurement of the various income components and tax payments. Second, there may be a positive bias arising because the household's income is used to construct the dependent variable, total consump-

tion. It is impossible to determine a priori whether stochastic components of income make the regression coefficient of disposable income likely to be biased upward or downward, if at all.

To estimate the parameters of equation (9) consistently we specify a vector of moment conditions, $E(\mathbf{z}_t^h \Delta \zeta_s^h) = 0 \ \forall s \geq t$, using an available set of predetermined instruments, $\mathbf{z}_t^h$, that are maintained to be orthogonal to the contemporaneous error term.[8] One possible approach to estimating the moment conditions is two-stage least squares (2SLS). Because the error term $\Delta \zeta_t^h$ contains both random time-invariant heterogeneity, ω^h, and an MA(1) component, $\Delta \ln v_t^h$, serial correlation is likely and problematic. As discussed previously, total consumption implicitly contains durable goods, which may also generate autocorrelation. Consequently, 2SLS will not be efficient. A tractable approach admitting general forms of serial correlation, due both to unobserved heterogeneity and to the moving average process in $\Delta \zeta_t^h$, is Keane and Runkle's (1992) forward-filter estimator.

The forward-filter estimator, which still maintains orthogonality with the original set of predetermined instruments, has several steps. First, we estimate equation (9) by 2SLS and save the $(T - 2)$ vector of estimated residuals for each household, $\Delta \hat{\zeta}^h$. We then compute a $(T - 2) \times (T - 2)$ matrix, $\hat{\mathbf{C}} = [(1/H) \times \Sigma \Delta \hat{\zeta}^h \Delta \hat{\zeta}^{h\prime}]^{-1}$, and filter it with an upper-triangular Cholesky decomposition. Last, we premultiply (9) by $\hat{\mathbf{Q}} = (\mathbf{I}_H \otimes \hat{\mathbf{C}})$ and estimate the transformed forward-filtered equation with the original set of instruments. Although Lars Peter Hansen's (1982) Generalized Method of Moments (GMM) estimator is efficient, recent bootstrap Monte Carlo evidence is that the estimator we use has good finite-sample properties relative to 2SLS and GMM (Ziliak, 1997).

IV. Empirical Results

We begin estimating (9) by specifying a base-case model where total household consumption

is disposable income net of the change in net worth predicted by liquid assets. As time-varying demographics we include changes in the number of children in the household and changes in the age of the youngest child. Controlling for children implicitly introduces household economies to scale given that consumption is measured per capita. In addition to a constant and the time-varying contemporaneous covariates the instrument set has values at time $(t - 1)$ of the head's annual hours of work, age, number of children, real hourly wage, the state unemployment rate, and dummies for marital status, health status, spouse's education, geographic region, industry, occupation, union status, home ownership, and female headship and values at time $(t - 2)$ of real disposable income. As specification checks on instrument sets we test the validity of the overidentifying restrictions with the Sargan test from the first-stage 2SLS regression.[9]

Column 1 of Table 2 reports base-case estimates. The estimated coefficient on the change in log disposable income is highly statistically significant, which is consistent with the existing consumption-smoothing literature's common rejection of the complete consumption insurance hypothesis. The base-case estimate of $\hat{\beta}$ indicates that absent an offset from income taxation a 10-percent decrease in gross family income would make total consumption fall by about 7.8 percent. Evaluated at the overall sample means, the posttax effect of a 10-percent reduction in gross income is a 6.6-percent reduction in consumption $[0.775 \times (1 - 0.316) \times (42,240/34,040)]$. On average, the progressive federal income tax system in place during the 1980's stabilized consumption losses by about 15 percent, which is an underappreciated benefit to households who experience idiosyncratic income losses.[10]

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[8] Following Hayashi et al. (1996), we balance the naturally occurring unbalanced data by setting to zero incalculable changes in consumption across years due to missing person-years. The procedure guarantees positive semidefiniteness of the fourth moments and ensures that the expectation of the moment condition is zero.

[9] Selected summary statistics for regression variables appear in Appendix Table A2. We deflated food consumption by the food component of the CPI and deflated total consumption and income by the personal consumption expenditure deflator (base 1987).

[10] In addition to the Sargan test, a specification check on the results in column 1 is the pseudo-likelihood ratio test of Martin S. Eichenbaum et al. (1988), which can be used to examine the exogeneity of instruments: the household head's hours of work at time $t - 1$ and the household's disposable income at time $t - 2$ in particular. Disposable

TABLE 2—FORWARD-FILTER ESTIMATES OF THE IMPACT OF DISPOSABLE INCOME ON $\Delta\ln$(CONSUMPTION PER CAPITA)

	Base case[a]	Alternative consumption measures[b]		
	C_0	C_1	C_2	C_3
$\Delta\ln$(Sample consumption)	0.4165	0.3502	0.4348	0.4988
	(0.0764)	(0.0819)	(0.1418)	(0.1496)
$\Delta\ln$(Disposable income)	0.7752	0.9253	0.6773	0.0869
	(0.0963)	(0.0909)	(0.1423)	(0.0768)
Sargan test[c]	33.4146	27.8353	49.3175	42.0248
	[35, 0.545]	[35, 0.800]	[35, 0.055]	[35, 0.193]
Number of observations	10,360	10,894	8,308	9,874

Notes: Heteroscedasticity and autocorrelation-consistent standard errors are in parentheses. Each specification controls for changes in the number of children, changes in the age of the youngest child, and dummy variables for race, education, and five-year birth cohort. The instrument set includes a constant, $(t - 1)$ values of head's annual hours of work, age of head, the number of children, the head's real hourly wage, state unemployment rate, dummies for marital status, health status, spouse's education, geographic region, industry, occupation, union status, female head, and home ownership, along with $(t - 2)$ values of real disposable income.

[a] Base total consumption is defined as disposable income less saving, where saving is the first difference of net worth predicted by liquid assets.

[b] Total consumption denoted as C_1 is defined as disposable income less saving, where saving is the first difference of net nonhousing nonbusiness wealth predicted by liquid assets. Total consumption denoted as C_2 is defined as disposable income less saving, where saving is the first difference of net worth predicted by liquid assets and home equity. Total consumption denoted as C_3 is defined as food expenditures at home and away from home.

[c] The Sargan test is for the validity of the overidentifying restrictions in the first-stage IV model. The degrees of freedom and p values are given in square brackets.

Our base-case estimate of the impact of disposable income changes on total consumption changes of 0.78 is quite similar to the instrumental variables estimate of 0.80 found in Attanasio and Davis's (1996) test of complete insurance in which they regressed nondurable consumption from the CEX on the husband's wage, and is also in line with Jonathan A. Parker's (1999) estimate of the impact of predictable changes in Social Security taxes on nondurable consumption in the CEX of 0.6.

As another check on our base-case estimate we consider three alternative measures of per capita consumption in Table 2: total consumption defined as income net of changes in net

income at $t - 2$ may fail exogeneity if there is sluggish adjustment of consumption changes to past income. Hours of work may fail exogeneity if consumption and leisure are not separable in utility, although by including gross income we are implicitly allowing nonseparability between consumption and leisure. The data do not reject the null of instrument exogeneity. As a final check of our base specification's instrument quality we estimated the first-stage model of the change in disposable income with our instrument set, which yields a first-stage F test of instrument relevance of 7.03 with a p value less than 0.0000, indicating that our instruments are of reasonable statistical relevance.

nonhousing nonbusiness wealth predicted by liquid assets, total consumption defined as income net of changes in net worth predicted by liquid assets and home equity, and food consumption. The estimated coefficients on disposable income move in the expected directions.

By netting out a narrower definition of saving in column 2 we expect consumption to more closely track income, and the estimate of 0.92 is consistent with our prior.[11] Likewise, by netting out a broader definition of saving we expect a weaker link between consumption changes and income changes, which is confirmed by the point estimate of 0.68. Third, we expect the link between income changes and food consumption changes to be weaker still because food, once accounting for household scale economies, is likely to be a relatively fixed share of the budget. Food is also stabilized by the Food Stamp

[11] We have also constructed total consumption using wealth computed by capitalizing rent, interest, and dividend income. The resulting point estimate for β was 0.91. We also constructed saving by permitting asset revaluations between years, with the interest rate a weighted average of equity and bond yields. There was little difference in the point estimates for β.

Program. In food consumption regressions that do not control for children and age of youngest child, the coefficient of income change is about 0.27; once we control for household-size economies the estimate of β falls to 0.09 and becomes statistically insignificant. Parker (1999) likewise finds the impact of Social Security tax changes on food consumption to be insignificant (0.133 with a standard error of 0.2).

A. Automatic Stabilization After ERTA and TRA86

To gauge how the automatically stabilizing component of the income tax has changed because of ERTA and TRA86 we calculate the effect of gross income changes on consumption changes that can be attributed to income tax offsets, $\hat{\beta}(1 - \tau_t^h)(y_t^h/y_{dt}^h)$. Using the benchmark no-tax impact of 0.775 from column 2 of Table 2 we infer at different points in the income distribution the percent reduction in total consumption per capita in response to gross income cuts of 10 and 30 percent under each of the tax regimes in effect during the 1980's. We also evaluate the additional contribution to the automatic stabilization of consumption due to FICA and the EITC.

Our reference households are a married couple filing jointly with two children and a female head of household with two children. To compare households situated similarly in the income distribution, we consider married and female-headed households with the median, 50 percent of the median, and 150 percent of the median United States gross incomes based on income distribution estimates from the Current Population Survey. We also examine a typical married couple located in the top 5 percent of the income distribution to gauge how the tax system has stabilized consumption of the wealthy.

Income Taxes in Isolation.—Because the income distribution is likely an endogenous function of the tax system, it is most informative to calculate consumption stabilization based on constant dollars rather than current dollars (Richard A. Kasten et al., 1994). Table 3 presents our calculations for a 10- or 30-percent cut in gross income evaluated at constant 1985 dollars. The general pattern in Table 3 is an increase in the effect of gross income changes on

consumption changes, and thus a substantial decline in automatic stabilization of consumption associated with the 1980's tax reforms.

For a married couple with the median income in 1980, a 10-percent cut in gross income led to a 6.6-percent cut in consumption, or a reduction of 15 percent from the no-tax case of about a 7.75-percent cut in consumption. As of 1987 a 10 percent gross income loss results in a 7.3-percent reduction in consumption, which is a 60-percent reduction in the stabilization present in 1980.[12] Although married couples at 50 percent of the median had little change in stabilization between the 1980 and 1987 federal income tax regimes, married couples at 150 percent of the median and in the top 5 percent of the income distribution experienced reductions in stabilization of 35 and 28 percent. A similar pattern of larger post-tax effects of income changes on married couples' consumption changes (less stabilization) is also evident for 30-percent income cuts.

For female-headed households at half the median income for their group, the tax system provides no consumption-smoothing benefits for income losses because they are outside the federal income tax system altogether. Alternatively, median income female-headed households experiencing 30-percent declines in income faced a 100-percent decline in consumption stabilization from 1980 to 1987. In 1980 a 30 percent gross income cut led to a 20.5-percent cut in consumption; by 1987 the same taxable income cut lowered their marginal tax rate from 14 percent to zero producing in turn a 23.25-percent consumption loss. Although low-income single mothers have access to the transfer system for consumption stabilization, reductions in both the generosity of real transfer payments and in access to programs after passage of the Personal Responsibility and Work Opportunity Reconciliation Act of 1996 makes consumption stabilization less in evidence.

FICA and the EITC.—The bolded figures in parentheses in Table 3 expand the definition of

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[12] In 1980 the household moved from the 28- to the 24-percent marginal tax bracket. In 1987 the household remained in the 15-percent bracket after the income cut.

TABLE 3—PERCENT REDUCTION IN TOTAL CONSUMPTION PER CAPITA IN RESPONSE TO GROSS INCOME CUTS
OF 10 AND 30 PERCENT FOR ALTERNATIVE TAX YEARS AND FILING STATUS
(INCLUSIVE OF FICA AND THE EARNED INCOME TAX CREDIT)

	Married couple with two children				Female head with two children		
Year	50 Percent of median	Median	150 Percent of median	Top 5 percent	50 Percent of median	Median	150 Percent of median
10-Percent Cut in Gross Income (1985 dollars):							
1980	6.89	6.62	5.72	5.62	7.75	6.84	6.67
	(6.83)	**(7.09)**	**(6.00)**	**(5.84)**	**(7.75)**	**(5.66)**	**(6.59)**
1982	6.93	6.69	5.82	5.87	7.75	7.00	6.79
	(6.87)	**(6.61)**	**(6.25)**	**(6.18)**	**(7.75)**	**(5.71)**	**(6.72)**
1985	7.09	6.87	6.28	6.28	7.75	7.14	6.98
	(7.03)	**(6.79)**	**(6.80)**	**(6.65)**	**(7.75)**	**(5.85)**	**(6.92)**
1987	6.82	7.26	6.42	6.22	7.75	7.00	6.98
	(5.88)	**(7.21)**	**(6.97)**	**(6.60)**	**(7.75)**	**(5.71)**	**(5.98)**
30-Percent Cut in Gross Income (1985 dollars):							
1980	20.55	20.22	19.29	17.55	23.25	20.46	20.88
	(20.37)	**(19.98)**	**(18.63)**	**(18.39)**	**(23.25)**	**(16.32)**	**(20.70)**
1982	20.70	20.22	18.36	18.03	23.25	20.97	20.82
	(20.52)	**(19.98)**	**(17.94)**	**(19.23)**	**(23.25)**	**(16.44)**	**(17.28)**
1985	21.27	21.09	20.25	19.35	23.25	21.21	21.21
	(21.12)	**(20.91)**	**(19.98)**	**(20.76)**	**(23.25)**	**(16.65)**	**(17.67)**
1987	20.85	21.36	21.96	19.68	23.25	23.25	20.37
	(17.61)	**(21.21)**	**(21.87)**	**(21.15)**	**(23.25)**	**(18.57)**	**(16.83)**

Notes: Based on the estimate of $\hat{\beta}$ from column 2, Table 2, the numbers in the table reflect the impact of gross income changes on total consumption changes after a 10- (30-) percent income loss, $\hat{\beta}(1 - \tau_t)(y_t/y_{dt})$. In the absence of income taxes the consumption effect is $\hat{\beta} \times 100$ percent and $\hat{\beta} \times 300$ percent, or 7.75 percent and 23.25 percent. Each representative filing unit is assumed to take the standard deduction and personal exemptions in calculating taxable income.

tax liability to include FICA taxes and the EITC. There are a few noticeable changes. For married couples at one-half the median income, the impact of gross income losses on total consumption per capita falls by the late 1980's from 6.8 percent to 5.9 percent for 10-percent income cuts, and from 20.4 percent to 17.6 percent for 30-percent income cuts. EITC expansions as part of TRA86, coupled with the rising FICA base and rate, enhanced low-income households' ability to mitigate drops in consumption. For small income shocks the extent of stabilization for median-income households was little changed during the 1980's after inclusion of FICA and the EITC. A substantial proportion of the 60-percent reduction in stabilization from federal income tax reform was offset by FICA and the EITC changes, especially FICA because the EITC was insufficiently generous to impact median-income households. The pattern of reduced consumption stabilization for high-income married couples is unchanged by recent adjustments to FICA and the EITC. Importantly, female heads of households at 150 percent of the median, like low-income married households, experienced a reduced effect of income on consumption (greater stabilization) because of EITC and FICA expansions.

Tax Reforms of the 1990's.—How much did the automatic stabilization of consumption change as a result of the Omnibus Budget Reconciliation Acts of 1990 and 1993 and the Taxpayer Relief Act of 1997? The tax reforms of the 1990's partially reversed the move toward fewer brackets begun with TRA86 in favor of a rate structure more like 1987's. Instead of the four tax brackets that existed in 1988, by 1998 there were five marginal tax rates: 15, 28, 31, 36, and 39.6 percent. Significant expansions of the payroll tax base and rates continued during the 1990's; by 1998 the applicable base was

$68,400 with a rate of 7.65 percent. More significant for low-income households was the substantial increase in the generosity of the EITC. From 1987 to 1998 the phase-in rate increased from 14 to 40 percent, the maximum tax credit increased from $851 to $3,756, and the phase-out rate increased from 10 to 21 percent. The greater number of tax rates, the broader payroll tax base, and the higher EITC subsidy and phase-out rates should make automatic stabilization at the end of the 1990's greater than at the end of the 1980's.

To examine the possibility of increased stabilization of consumption by changes in income-related taxes during the 1990's we conduct an exercise analogous to the calculations in Table 3 by using our estimated consumption Euler equation with tax system data for 1998. When factoring in the combined impact of federal income taxes, FICA, and the EITC, there are several instances of greatly increased automatic-consumption stabilization. A 30-percent income loss reduced consumption for a married couple with the median income by 21.2 percent in 1987; by 1998 the corresponding consumption loss was 14.01 percent, or a nearly fourfold increase in stabilization. The reason for the substantial increase in consumption insurance is that the median-income married couple now falls into the phase-out range of the EITC and faces a substantially higher marginal tax rate than ten years earlier. Similarly enlarged consumption stabilization during the 1990's appears for married couples at 50 percent of the median income and single mothers at 150 percent of the median income. Relatively high-income married couples got increased consumption insurance against large income losses during the 1990's too because of the expanded FICA base. Overall, there has been a restoration or expansion of collective consumption insurance in the federal income-related tax system during the 1990's driven largely by the increased generosity of the EITC.

B. Sensitivity Checks

The final econometric activity is to examine whether our central conclusion that the progressive federal income tax system provides collective insurance benefits to households depends on any obvious econometric detail. Table 4 presents the results of six sensitivity checks.

Aggregate Resources.—Equation (9), which we use to examine the impacts of income tax reforms on consumption stabilization, is similar econometrically to what researchers use to test the permanent income hypothesis (Robert E. Hall and Fredric S. Mishkin, 1982; Stephen P. Zeldes, 1989; David E. Runkle, 1991; Annamaria Lusardi, 1996; Ziliak, 1998).[13] If we replace aggregate consumption by the after-tax interest rate, and if the after-tax interest rate captures aggregate business-cycle conditions, then a nonzero coefficient on income changes indicates so-called excess sensitivity.

Chamberlain (1984) notes that tests of the permanent income hypothesis are valid to the extent that the after-tax interest rate captures aggregate resources. Tests of partial insurance using equation (9) are likewise valid to the extent that C_t adequately tracks aggregate resources. As a check on the assumption that aggregate consumption tracks aggregate resources well we replace average consumption with time dummies in the second column of Table 4. The estimated effect of disposable income changes is 0.766, which is nearly identical to our base-case estimate of 0.775.

Smooth Tax Function.—Our next robustness check is to replace the tax payments constructed by the PSID staff that we use in calculating disposable income with tax payments estimated from a tax function that is approximated by a smooth cubic polynomial in taxable income. A smooth tax function is an econometrically attractive alternative to the piecewise linear approach to estimating tax effects on labor supply. By smoothing the tax kinks one lessens concerns over measurement error problems if households switch tax brackets when hours change (Thomas MaCurdy et al., 1990; Ziliak and Kniesner, 1999). In the smooth income tax approach the payroll and average state income tax rates still apply, but the federal rate is a continuously differentiable function. When we

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[13] It is possible to have complete consumption insurance and yet violate the permanent income hypothesis, or vice versa, however (Cochrane, 1991).

TABLE 4—SENSITIVITY OF THE EFFECT OF DISPOSABLE INCOME CHANGES
ON LOG PER CAPITA TOTAL CONSUMPTION CHANGES

	Δ ln(Disposable income)	Sargan test[g]
Time dummies[a]	0.7663	32.6673
	(0.0985)	[35, 0.58]
Smooth MTR[b]	0.8005	32.5554
	(0.0964)	[35, 0.59]
First difference[c]	0.6884	20.0116
	(0.1499)	[35, 0.98]
Asymmetric responses[d]		
Δ ln(y)	0.7906	
	(0.0306)	
		33.8156
Δ ln(y) * $I(\Delta$ ln $y < 0)$	−0.0168	[35, 0.53]
	(0.0473)	
Permanent/transitory[e]		
Δ ln(y^P)	0.8273	
	(0.1046)	
		35.4120
Δ ln(y^T)	0.7246	[35, 0.45]
	(0.0461)	
Heterogeneous responses[f]		
Δ ln(y) * $I(\bar{y}_i < 0.5$ Med)	0.8124	
	(0.1689)	
Δ ln(y) * $I(0.5 < \bar{y}_i < 1.5$ Med)	0.7030	
	(0.1079)	
		108.3599
		[136, 0.96]
Δ ln(y) * $I(1.5 < \bar{y}_i <$ Top 5)	0.6080	
	(0.1709)	
Δ ln(y) * $I(\bar{y}_i \geq$ Top 5)	0.6765	
	(0.1688)	

Notes: Heteroscedasticity and autocorrelation-consistent standard errors are given in parentheses. Base-case estimate is 0.7752 (0.0963). See Notes to Table 2 for additional details.

[a] Time dummies are used as covariates in place of the sample average of consumption, $NT = 10,360$.

[b] The marginal tax rate is approximated by smooth, cubic polynomial in taxable income, $NT = 10,351$.

[c] Model in equation (7) is estimated in first differences. $NT = 8,570$.

[d] Model permits differences in income coefficients for positive versus negative changes. $NT = 10,360$.

[e] Model permits differences in income coefficients for permanent versus transitory income changes, where permanent income is predicted income from a fixed-effect Mincer equation and transitory income is the current period deviation from predicted income. $NT = 10,360$.

[f] Model permits differences in income coefficients for 12-year mean income less than 50 percent of the median, 50 percent to 150 percent of the median, between 150 percent of the median and the top 5 percent of the distribution, and those in the top 5 percent of the distribution. $NT = 10,360$.

[g] The Sargan test is for the validity of the overidentifying restrictions in first-stage IV. The degrees of freedom and p values are given in square brackets.

use the smooth tax rate function in estimating the Euler equation for consumption the estimated amount of automatic stabilization is virtually unchanged. That the estimates based on a smooth tax function are in accord with estimates based on the PSID's tax rates lends further support that the taxes computed by the PSID are comparatively well measured.

Additional Latent Heterogeneity.—If our correlated random-effects specification for the discount rate inadequately captures unobserved

growth-rate heterogeneity, then there may be additional latent heterogeneity in the Euler equation for consumption growth equation (9). For completeness we estimate the baseline specification in first-difference form (difference in consumption differences), which appears in column 4 of Table 4. Allowing for additional person-specific heterogeneity lowers the estimated marginal effect of disposable income on consumption by about 11 percent, such that $\hat{\beta}$ falls from about 0.775 to about 0.688. Estimating the baseline correlated random-effects model on the restricted first-difference sample of 8,570 person-years yields a disposable income coefficient of 0.66, which suggests the lower coefficient from first-differencing is not due to additional heterogeneity but from changes in the sample. We infer that our baseline correlated random-effects specification captures time-invariant heterogeneity in the evolution of consumption reasonably well.

Asymmetric Responses.—We do multiple specification checks relaxing the assumption of a common coefficient on disposable income.[14] The first allows consumption to respond proportionately differently to a given proportionate positive versus negative income shock. To examine the asymmetric response hypothesis we construct a variable indicating if the income change is negative and interact it with the proportionate income change variable. We also append to our instrument set the interaction of income and the negative shock indicator at $(t - 2)$. Columns 5 and 6 of Table 4 contain consumption Euler equation estimates that permit an asymmetric response. Based on the coefficient of the interacted regressor, -0.0168 (which has a standard error of 0.0473), we find no evidence that consumption responds proportionately asymmetrically to a given positive versus negative disposable income shock.

Permanent/Transitory Income.—The permanent income hypothesis is that consumption responds to permanent changes in income but not to transitory changes so that the Euler equation error over time is expected to be zero. The consumption insurance hypothesis makes no explicit distinction between permanent and transitory income changes and only implies that Euler-equation errors are expected to be equal across households and not necessarily equal to zero. The tax code does not distinguish between permanent and transitory income shocks— regardless of source, the tax code automatically stabilizes income shocks.

To test the neutrality of income changes proposition, we decompose income fluctuations into permanent and transitory shocks. Following Peter Gottschalk and Robert Moffitt (1994) we estimate a fixed-effect Mincer equation for income where the human-capital regressors include a quadratic in the head's age, education, marital status, industry, and occupation. We then create permanent income as the fitted value of the estimated Mincer equation, and transitory income is the deviation of observed current income from permanent income. We report forward-filter estimates of the impact of permanent and transitory income changes on changes in total consumption per capita in columns 7 and 8 of Table 4. Although the coefficient on transitory income is less than the coefficient on permanent income, which is consistent with the permanent income hypothesis, a Wald test does not reject the null hypothesis that the two income change coefficients are equal at the 0.37 level.[15]

Income Heterogeneity.—In all specifications considered we have assumed that the impact of disposable income on consumption is homogeneous across the income distribution. It is conceivable that there is reduced access to formal and informal channels of insurance as one moves down the income distribution. A consequence would be that the consumption of

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[14] In an additional check not tabulated we consider the Lucas Critique, which suggests that the impact of disposable income may itself vary with the tax regime. We tested the possibility of policy-induced parameter change by permitting the estimated disposable income coefficient to differ pre- and post-TRA86. The income coefficient is slightly more positive (consumption slightly less smooth) but never significantly so post-TRA86.

[15] Note that it is possible to estimate the model by OLS if we assume that permanent and transitory income are correctly measured. OLS yields coefficients of 0.840 (0.068) and 0.783 (0.015) for permanent and transitory income. The Wald test again does not reject the null of equality at the 0.39 level.

low-income households may be more respon-
sive to disposable income changes than the con-
sumption of high-income households.

In Table 4 we interact the change in dispos-
able income with a four-part spline function
based on average household income. Specifi-
cally, we compute average income by calcu-
lating the household-specific time-mean of
income,

$$\frac{1}{T^h} \sum_{t=1}^{T^h} y_{dt}^h$$

and order average income from lowest to high-
est. We then split the distribution into four parts
similar to Table 3 to create four dummy vari-
ables: income is (1) less than or equal to 50
percent of the median income (I_1); (2) between
50 and 150 percent of the median (I_2); (3)
between 150 percent of the median and the top
5 percent of the income distribution (I_3); and
(4) in the top 5 percent of the distribution (I_4).
We also interact the income category spline
function with the set of excluded instruments,
substantially increasing the number of overi-
dentifying restrictions. The results for a con-
sumption Euler equation that incorporates
income distribution effects appear in the last
four columns of Table 4. Although there is a
qualitative difference in the responsiveness of
consumption to income changes across the in-
come distribution, a Wald test does not reject
the null hypothesis of equal responsiveness (p
value = 0.89), which lends further support
for our base-case specification in column 2 of
Table 2.

C. Welfare Costs of Reduced Stabilization

Finally we address the broader issue of the
welfare costs of reduced consumption stabiliza-
tion due to tax reform. Parameter estimates in
Tables 2 and 3 indicate that for the median
household the federal tax reforms of the 1980's
reduced automatic stabilization of consumption
by about 50 percent. Adding in expansions in the
EITC and the payroll tax, the median household
had little change in stabilization, low-income
households had an increase in stabilization, and
high-income households had a decrease in sta-
bilization during the 1980's. The heterogeneity

of results across the income distribution sug-
gests that there were welfare gains and losses
from the 1980's reforms. Using both the base-
case parameters from Table 2 and the hetero-
geneous income parameters from Table 4 we
document the net effect of changes on house-
hold welfare.

We calculate the income/consumption desta-
bilizing welfare cost of tax reform as the pro-
portional increase in consumption necessary to
leave the household equally well off when mov-
ing from a more progressive tax regime to a less
progressive tax regime (from a system offering
more consumption insurance to one offering
less consumption insurance). Based on the so-
cial welfare function in equation (1), the
isoelastic preferences in equation (5), and the
corresponding estimated parameters in Tables 2
or 4 for the consumption equation (9), we solve

(10)

$$\kappa \sum_{h=1}^{H} \mu^h \sum_{t=1}^{T} (\hat{\rho}^h)^t (1 - \sigma) \hat{\theta}_t^h n_t^h (\hat{c}_{0t}^h / n_t^h)^{1-\sigma}$$

$$= \sum_{h=1}^{H} \mu^h \sum_{t=1}^{T} (\hat{\rho}^h)^t (1 - \sigma) \hat{\theta}_t^h n_t^h (\hat{c}_{1t}^h / n_t^h)^{1-\sigma}$$

for κ given estimated pre-reform per capita con-
sumption $(\hat{c}_{0t}^h / n_t^h)$, post-reform per capita con-
sumption $(\hat{c}_{1t}^h / n_t^h)$, alternative values of risk
aversion (σ), and household-specific weights
(μ^h).[16] For simplicity we assume that only one
state is realized at time t, and we assume a
utilitarian social welfare function giving equal
weight to each household.[17] Equation (9) is in
terms of consumption growth, and we need con-
sumption levels to construct utility in (10). We
therefore calculate household-specific con-
sumption intercepts using the estimated con-
sumption parameters and time-means of the
variables as $\hat{\psi}^h = \overline{(c^h/n^h)} - \hat{\alpha}\bar{C} - \hat{\beta}\bar{y}_d^h -$

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[16] The calculation is similar to how Attanasio and Davis
(1996) examine the welfare cost of complete insurance.

[17] The standard model of consumption insurance postu-
lates that the household weight is a positive function of the
consumption endowment. In results not reported we used
estimated household fixed effects as the weight with little
change in the results.

$\overline{\mathbf{d}}^h \hat{\gamma} - \overline{\mathbf{x}}^h \hat{\varphi}$, and then add back $\hat{\psi}^h$ to obtain predicted per capita consumption. Predicted consumption per capita varies across the tax reforms here because disposable income, $\hat{y}^h_{dt}$, changes with tax regimes, ceteris paribus.

To focus on mean-preserving increases in risk, all the reforms we consider are revenue neutral. Reforms also incorporate FICA and EITC tax payments and credits. The reforms we evaluate include moving from the 1980 tax structure for all years to (1) an equal-yield annual lump-sum tax, (2) an equal-yield proportional tax, (3) an equal-yield 1987 tax regime, and (4) an equal-yield 1987 tax rate but 1980 tax base regime. Because a proportional tax also provides consumption stabilization, the comparison between the 1980 regime and the proportional tax reveals the additional stabilization from progressivity. Likewise, distinguishing changes in the base from the rates in 1987 sheds light on the combined effects of base-broadening and indexation from TRA86. Lastly, for comparative purposes, we also calculate a fifth reform that moves the household from the 1987 tax regime to an equal-yield annual lump-sum tax and a sixth reform that moves the household from a tax regime that has the 1987 rates but the 1980 tax base to an equal-yield annual lump-sum tax. We calculate two broad sets of results in Tables 5 and 6, one based on actual data and the other based on simulated data.

For the actual data we take the 12-year time series of income, deductions, demographics, and family structure for each household in the sample and construct disposable income under the various tax regimes. Given disposable income it is possible to construct predicted consumption per capita, which we then use to solve for κ in equation (10) at various levels of risk aversion.

The simulated data differ from the actual data in the construction of gross and net income. For each household we compute the 12-year time mean of income and then construct current income as a multiplicative shock of permanent (average) income. In each period the household realizes one state of nature and faces shocks from two sources, a common macroeconomic shock and an idiosyncratic shock. The macro shock is parameterized to the growth in actual aggregate income in the sample for each period, and the idiosyncratic shock is a random normal

variable that is distributed with mean one and standard deviation of either 10 or 30 percent. To reduce the noise from any one simulated outcome we report the mean value of κ across 100 iterations.

Table 5 presents estimated welfare costs for alternative tax reforms based on the estimated consumption parameters in column 2 of Table 2, and Table 6 presents estimated welfare costs for alternative tax reforms based on the estimated consumption parameters from the last four columns of Table 4. Although the Wald test could not reject the null of a common income coefficient across the income distribution, we believe that the qualitative differences are significant enough to warrant separate welfare calculations. Because our estimated coefficient of relative risk aversion is near 2 (1/0.42), we focus our discussion on the center columns of Tables 5 and 6.

In Table 5 the actual data indicate households would have to be compensated with about 2.5 percent of their baseline per capita consumption to accept a move from the 1980 progressive tax regime to an equivalent annual lump-sum tax that does less to stabilize disposable income and consumption. Given total consumption per capita of $11,500, the implied compensation (welfare loss) is about $288 per capita annually. The comparable estimate for a risk-aversion parameter of 3 is 7.2 percent, or about $828 of baseline per capita consumption. As anticipated *ex ante,* households also value the extra consumption insurance offered by a progressive tax system over a proportional tax system; they would have to be compensated by about 1.5 percent of consumption to accept the proportional tax instead of the 1980 progressive tax regime, with compensation increasing rapidly in risk aversion. Interestingly, in the actual data there appears to be very little welfare loss from TRA86, either for changes in the rates and base or changes in the base alone.[18] The scant welfare impact of TRA86 based on insurance considerations appears to be due largely to the offsetting

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[18] As a check on the insurance implicitly provided by bracket creep we computed welfare under the 1987 base and rate regime ($\sigma = 2$) versus an equal-yield annual lump-sum tax leaving the brackets unindexed for inflation. The welfare cost rises from the 1.43 percent annually in Table 5 to 1.80 percent annually.

TABLE 5—WELFARE COSTS OF ALTERNATIVE TAX REGIMES—COMMON INCOME COEFFICIENT MODEL
(AS PERCENTAGES)

		Actual data			Common and 10-percent idiosyncratic income shock			Common and 30-percent idiosyncratic income shock		
		Coefficient of relative risk aversion equal to:			Coefficient of relative risk aversion equal to:			Coefficient of relative risk aversion equal to:		
Percentage increase in consumption to compensate for move		1	2[a]	3	1	2[a]	3	1	2[a]	3
From:	To:									
1980 Regime	equal-yield lump sum	0.30	**2.46**	7.19	0.04	**0.14**	0.01	0.29	**7.10**	27.79
1980 Regime	equal-yield proportional tax	0.02	**1.49**	5.89	0.06	**0.05**	0.00	0.01	**0.94**	0.82
1980 Equal-yield proportional tax	equal-yield lump sum	0.28	**1.00**	0.21	0.02	**0.18**	0.01	0.28	**6.43**	26.33
1987 Regime	equal-yield lump sum	0.24	**1.43**	0.30	0.04	**0.10**	0.00	0.23	**5.72**	21.34
1987 Rate regime	equal-yield lump sum	0.21	**1.84**	1.20	0.01	**0.13**	0.01	0.22	**5.79**	25.89
1980 Regime	equal-yield 1987 regime	0.03	**0.21**	0.01	0.00	**0.01**	0.00	0.02	**0.82**	5.91
1980 Regime	equal-yield 1987 rate regime	0.05	**0.16**	0.01	0.02	**0.01**	0.00	0.03	**0.73**	8.79

Note: The estimated income coefficients for the consumption function come from column 2 of Table 2.
   [a] A coefficient of relative risk aversion of 2 is most consistent with the implied estimate from the data.

welfare gains and losses brought about from coincident reforms to FICA and the EITC.[19] Although the magnitudes are slightly lower in the heterogeneous income coefficient case in Table 6, the welfare loss pattern from actual data is quite similar to the constant income coefficient case displayed in Table 5.

When the idiosyncratic income shock is small (10 percent) in the simulated data the welfare losses are inconsequential across all the tax reforms. Similar to the case of log utility ($\sigma = 1$) with the actual data, the household is behaving like a risk-neutral agent with small shocks to income. When the shock is sizable, on the order of 30 percent, the welfare losses get quite large, especially with a high degree of risk aversion. To accept an equivalent annual lump-sum tax versus the 1980 progressive tax regime the household's baseline consumption would have to be increased by upwards of 28 percent. An interesting result, which is consistent with Joseph Pechman (1985) who found the pre-ERTA tax system (federal + FICA + state) to

be nearly proportional, is the small (1-percent) welfare loss by moving from the 1980 system for all years to an equal-yield proportional tax. The near equivalency of the 1980 system and a flat tax is attributable to the fact that in the simulated data there is no distinction between taxable and nontaxable income; all simulated income data are taken as labor income and subject to FICA whereas households can have income that is not subject to FICA. Lastly, we find that the income/consumption destabilizing welfare cost of changing the tax system from ERTA to TRA86 is upwards of 6 percent for relatively risk-averse households facing large income risk, but the welfare costs of consumption destabilization associated with the 1980's tax reforms are much more modest for the typical household.

V. Conclusion

We specify a model of partial implicit consumption insurance with disposable income as the focal regressor. Our data are from the Panel Study of Income Dynamics for interview years 1980–1991, and our measure of consumption is income net of taxes and liquid saving. The econometric model treats person-specific dis-

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[19] The welfare loss is increased by about a third (to 0.27 percent from the 0.21 percent in Table 5) when we separate out the effect of the changes in the federal income tax rates pre-ERTA to post-TRA86.

TABLE 6—WELFARE COSTS OF ALTERNATIVE TAX REGIMES—HETEROGENEOUS INCOME COEFFICIENT MODEL
(AS PERCENTAGES)

		Actual data			Simulated data					
					Common and 10-percent idiosyncratic income shock			Common and 30-percent idiosyncratic income shock		
Percent increase in consumption to compensate for move		Coefficient of relative risk aversion equal to:			Coefficient of relative risk aversion equal to:			Coefficient of relative risk aversion equal to:		
From:	To:	1	2[a]	3	1	2[a]	3	1	2[a]	3
1980 Regime	equal-yield lump sum	0.26	**1.89**	1.53	0.03	**0.10**	0.00	0.27	**5.67**	22.76
1980 Regime	equal-yield proportional tax	0.01	**1.21**	3.16	0.04	**0.05**	0.00	0.02	**0.76**	0.34
1980 Equal-yield proportional tax	equal-yield lump sum	0.25	**0.70**	0.38	0.02	**0.15**	0.00	0.26	**5.11**	21.61
1987 Regime	equal-yield lump sum	0.20	**1.19**	0.19	0.02	**0.07**	0.00	0.23	**4.23**	12.80
1987 Rate regime	equal-yield lump sum	0.18	**1.49**	0.60	0.01	**0.10**	0.00	0.21	**4.50**	16.88
1980 Regime	equal-yield 1987 regime	0.02	**0.17**	0.01	0.00	**0.01**	0.00	0.02	**0.64**	3.09
1980 Regime	equal-yield 1987 rate regime	0.04	**0.14**	0.00	0.02	**0.01**	0.00	0.03	**0.47**	5.12

Note: The estimated income coefficients for the consumption function come from rows 8–11 of Table 4.

[a] Coefficient of relative risk aversion of 2 is most consistent with the implied estimate from the data.

count rates as correlated random effects. To control for possible endogenous explanatory variables and serial correlation we use a forward-filter estimator. The goal of our research is to identify the degree to which the automatic stabilization of consumption has changed because of ERTA and TRA86.

On average, the progressive income tax system in place in the United States during the 1980's stabilized consumption by about 15 percent in the face of idiosyncratic shocks to income. In some cases, tax reforms of the 1980's actually increased the automatic stabilization inherent in a progressive income tax, but the typical outcome is that ERTA and TRA86 reduced total consumption stability by about 50 percent. More recent tax reforms, most notably expanded FICA coverage and increased EITC generosity, have restored or enhanced consumption insurance for single mothers and low-income married couples.

Our results highlight an underappreciated benefit to households implicit in a progressive income tax. Undoubtedly the deadweight loss from reduced incentives declined for many taxpayers with the 1980's tax reforms. However, our simulations indicate that there was also a welfare loss from the reduction in collective insurance. An important topic for future research is to evaluate the offsetting welfare gains and losses from the static versus dynamic efficiency effects caused by changes in the structure of personal income-based taxes in order to produce a more comprehensive understanding of an optimal income tax.

APPENDIX

TABLE A1—FIXED-EFFECT WEALTH PREDICTION EQUATIONS BASED ON 1984 AND 1989 PSID WEALTH SUPPLEMENTS

	Net nonhousing nonbusiness wealth	Net worth	Net worth
Liquid assets	1.1379	1.6788	1.6037
	(0.0260)	(0.0302)	(0.0286)
Home equity			1.4777
			(0.1048)
Adjusted R^2	0.8472	0.9263	0.9361
Number of observations	2,596	2,596	2,596

TABLE A2—SELECTED SUMMARY STATISTICS

Variable	Sample mean	Standard deviation
Δ ln(base total consumption per capita)	0.004	0.380
Δ ln(food consumption per capita)	0.007	0.340
Δ ln(disposable income)	0.012	0.246
Marginal tax rate	0.316	0.099
Gross income ($10,000s)	4.224	3.293
Disposable income ($10,000s)	3.404	2.459
Number of children	1.359	1.259
Age of youngest child	5.365	5.550
White	0.677	0.468
Less than high school	0.224	0.417
High school	0.369	0.483
More than high school	0.406	0.491
Birth cohort 1	0.282	0.450
Birth cohort 2	0.273	0.446
Birth cohort 3	0.163	0.370
Birth cohort 4	0.133	0.339
Birth cohort 5	0.149	0.356

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