Taxation and Inequality: Active and Passive Channels

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Abstract

This paper identifies and estimates two mechanisms by which the federal income tax system has affected consumption inequality between 1968 and 2010. In particular, we refer to changes in the tax system due to changes in the tax code as *active* and changes due to changes in income distribution as *passive*. To do this, we use data from 1968--2010, combine a structural macro-labor model of income and consumption processes with micro-simulations of taxation and decompose changes in the transmission of income shocks to consumption over this period. We find that (i) though the transmission of income shocks to consumption was partial and did not change much over the whole period, there were large changes in this transmission depending on periods, (ii) though the role of the federal income tax to smooth income shocks did not change much over the whole period, further decomposing the tax system reveals that active and passive tax policy changes counteract each other with a net tax effect that often obfuscates large changes in the role of tax policy, (iii) the overall transmission of income shocks is heterogeneous, falling relatively more on lower income groups and (iv) active and passive tax changes have heterogeneous impacts across income quartiles and education groups.

JEL: D12, D31, D91, H24, E21
Keywords: inequality, personal income taxation, income risk, consumption

Acknowledgements: We thank Nick Bloom, Wojciech Kopczuk, Byron Lutz, Ramen Molley, Austin Nichols, Fabrizio Perri, Andreas Piechl, and Luis Rayo for the very valuable comments. We are grateful to Daniel Feenberg of the National Bureau of Economic Research for his help compiling certain CEX years, Alexey Khazanov for excellent research assistance, as well as seminar participants at the Federal Reserve Board, ZEW Public Finance Conference in Mannheim, CESIFO conference on Marcoeconomics and survey data, the New Economic School in Moscow, and Drexel University in Philadelphia for their helpful comments.

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I Introduction

Rising income inequality and ways to combat it are at the forefront of the policy debate in the United States. Recent policy proposals to address the rise in inequality focus on taxation, including those by Presidential candidates.[1] The income tax is a natural policy instrument to combat inequality because it is a direct mechanism for redistribution and because it insulates people from income shocks. In practice, this insulation results in a smaller variance of after-tax income than pre-tax income. People, however, may respond to taxes and transfers in ways that undo these policy goals. In fact, Domar and Musgrave (1944) showed that although the income tax provides insurance to individuals they may respond by taking on additional risk in ways that increase the variance of after-tax income.

Despite the large and growing evidence of rising income inequality and of the tax system as a potential insurance mechanism, the effectiveness of tax policy in reducing income and consumption inequality remains an open question. One reason is because of the complexity of the problem. For example, previous studies have shown that the transmission of income shocks to consumption and the implications on income inequality depend on the type of income shock---permanent or transitory.[2] Blundell, Pistaferri and Preston (2008) find that individuals' consumption is almost perfectly insulated from transitory income shocks but that a substantial portion of permanent income shocks are transmitted to consumption. We go one step further to show that the insulation from income shocks also depends on the tax code and we identify different types of tax policy changes that differently affect this insulation.

To investigate whether income tax policy is an effective tool for combating income inequality, we consider how income taxes have affected the transmission of income shocks to consumption. In

[1] In particular, these proposals aim to increase how progressive the tax system is by increasing the top marginal income tax rate, instituting a wealth tax, increasing taxes on capital income, and increasing corporate taxes. For example see, ''How Poverty and Inequality are Motivating Democrats on Tax Policy.'' Lisa Desjardins. PBS News Hour. February 19. https://www.pbs.org/newshour/show/how-poverty-and-inequality-are-motivating-democrats-on-tax-policy and ''Alexandria Ocasio-Cortez's Tax Hike Idea Is Not About Soaking the Rich. It's About Curtailing Inequality and Saving Democracy.'' Emmanuel Saez and Gabriel Zucman. New York Times. January 22, 2019.

[2] A large literature exists that measures the permanent and transitory components of income shocks (Heathcote and Violante, 2010; Moffitt and Gottschalk, 2012).

particular, we decompose changes in the transmission of income shocks to consumption into the components due to changes in active tax policy changes, passive tax policy changes, and behavioral changes--that include changes to other government programs and self-insurance.

A simple thought experiment helps clarify the specific roles active and passive tax policy changes can have in the transmission of income shocks to consumption. Consider two households with pre-tax incomes of $10,000 and $60,000. We can measure pre-tax income inequality by the coefficient of variation of 101; the mean is 35,000 and the standard deviation is 35,355, and the coefficient of variation is the ratio of the standard deviation and the mean. Suppose the tax system consists of two brackets with a cut-off at $30,000, such that the lowest bracket is taxed at 15 percent and the second bracket is taxed at 25 percent. After-tax income inequality, measured as the coefficient of variation, decreases to 98.9; after-tax incomes are $8,500 and $48,000, with a mean of $28,250 and standard deviation $27,930. This calculation demonstrates the role income taxation can have in decreasing after-tax income inequality. Now consider how a change in the tax code can contribute to changing after-tax inequality with an *active* tax policy policy change that increases the top marginal income tax rate from 25 to 29 percent. In this scenario, the coefficient of variation decreases to 97.9; the mean and standard deviation of after-tax income is $27,650 and $27,082, respectively. Finally consider a *passive* tax policy change where income tax rates remain at 15 and 25 but incomes increase by 20 percent to $12,000 and $72,000, respectively for the two income groups. After-tax income inequality decreases to 98.5. In this scenario, even though the tax system did not change, its non-linearity contributed to a decrease in after-tax inequality.

We find that active and passive tax policy changes contributed to large changes in the transmission of permanent income shocks to consumption from 1968 to 2010. In particular, the transmission of permanent income shocks increased by 31 percent from 1968 to 1991 and decreased by 29 percent from 1992 to 2010. From 1968 to 2010, active tax policy changes increased the transmission of income shocks to consumption by 55 percent, while passive tax policy changes decreased the transmission by 105 percent. Additional changes, including changes to other government programs and self-insurance, increased the transmission of income shocks to consumption by 52 percent.

Taken together, the combined change in the transmission of income shocks to consumption over the 42-year period is small, consistent with the illustrative evidence by Blundell, Pistaferri and Preston (2008) and Debacker and Vidangos (2013). This small overall effect, however, obscures substantial effects from passive and active tax policy changes. In this way, we reconcile the small overall effect found by Blundell, Pistaferri and Preston (2008) and the large changes due to active tax policy changes found by Bargain, Dolls, Immervoll, Neumann, Peichl, Pestel and Siegloch (2015).

To further investigate the mechanisms by which active and passive tax policy changes have affected the transmission of income shocks, we allow the transmission of income shocks to consumption to vary by income and education groups. We find that although active tax policy changes increased the transmission of income shocks to consumption in aggregate, they decreased the transmission of income shocks for the lowest income group and least educated group. We also find that the changes in active and passive tax policy effects are also large for the lower- and upper-middle-income groups and the middle education group. This non-monotonicity may be due to higher-income individuals being able to self-insure, therefore experiencing less transmission of income shocks to consumption, while bottom income individuals benefit from other government programs. The finding that active and passive tax policy changes counteract each other remains consistent across income and education groups.

Our methodology to identify and decompose active and passive tax policy changes makes several important advances. First, we extend the sample period typically studied (1980--1992) to the 42 years (1968--2010). To do this, we combine data from the Panel Study of Income Dynamics (PSID) and the Consumer Expenditure Survey (CEX). This extension allows us to estimate time-varying measures of the transmission of income shocks to consumption (or insurance). We find large changes in the transmission of income shocks to consumption between the periods that are not observable in the smaller period typically studied.

Second, we use micro-simulations to decompose tax policy changes into active and passive tax policy changes using the National Bureau of Economic Research's TaxSim software. Active tax policy changes are calculated by simulating the changes in the transmission of pre-tax to after-tax income a household would have received if its income had not changed (in real terms) while the tax system had changed as observed. Passive tax policy changes are calculated by simulating the changes in the transmission of pre-tax to after-tax incomes a household would have received if the tax code had *not* changed (in real terms) while its income had changed as observed (and deflated to dollars in a base year). We find large and opposite changes in active and passive tax policy from 1968 to 2010 that obfuscate the impact of tax policy in studies that do not separate these components.

Third, we decompose and quantify the impact of active and passive tax policy changes in the transmission of income shocks to consumption. We start from a standard micro-economic model of the joint distribution of income and consumption. We then add taxes to the model to derive a structural relationship between changes in active and passive tax changes and the transmission of income shocks to consumption. This structural relationship allows us to decompose the total change in the transmission of income shocks to consumption into the changes due to active and passive tax policy changes, and behavioral changes captured by the residual. Behavioral changes include other government programs, changes in household's propensity to consume tax refunds, and changes in credit availability. To the best of our knowledge, such a decomposition of the transmission of income shocks to consumption has not been done.

Our main contribution is to combine the insights of Domar and Musgrave (1944) with the state of the art techniques of Blundell, Pistaferri and Preston (2008) and Bargain, Dolls, Immervoll, Neumann, Peichl, Pestel and Siegloch (2015) to understand the impact of tax policy on inequality when we allow individuals to respond to tax policy. Our findings reveal that without the decomposition of tax policy changes, by types and periods, within the structural model, researchers may have erroneously found that tax policy had little impact on the transmission of income shocks to consumption. The findings suggest at least two important considerations for future tax policy. First, tax policy changes can substantially influence the transmission of income shocks to consumption. Second, the nonlinear structure of the income tax damps inequality and acts as an automatic counter to rising before-tax income inequality.

This paper is structured as follows. Section II provides an overview of methods in the literature and how we combine and extend these methods. Section III provides a detailed description of the theory and empirical approaches. Section IV describes the data and the imputation strategy. Section V presents the results, and section VI concludes.

II Background

We investigate the next open questions in a large literature that has shown that income and consumption inequality has increased. Specifically, we consider the extent to which income taxation can be a policy tool to damp consumption inequality and the mechanisms by which tax policy changes the impact of the transmission of income shocks to consumption. To answer these open questions, we build on the insights of the previous literature in several ways.

The macro-labor literature finds that the income process that most closely fits individual income data allows for both permanent and transitory shocks (MaCurdy, 1982; Abowd and Card, 1989; Autor and Kearney, 2008; Meghir and Pistaferri, 2004).[3] These models estimate the evolution of income shocks in either levels or growth rates. Both types of models show that the sharp increase in income inequality over the past 40 years was driven by both permanent and transitory shocks, with permanent income shocks generally driving the long-term trend and transitory income shocks showing a large and increasing contribution in the late 1980s and early 1990s (Blundell et al., 2008; Primiceri and Rens, 2009; Moffitt and Gottschalk, 2011, 2012; Heathcote and Violante, 2010; Debacker and Vidangos, 2013).

Most of these studies use a model-based approach, making assumptions about the income process and the nature of liquidity constraints (MaCurdy, 1982; Abowd and Card, 1989; Autor and Kearney, 2008; Meghir and Pistaferri, 2004). A notable exception is Kopczuk and Song (2010), who use a non-parametric method. Using US Social Security income data, Kopczuk and Song

[3]More flexible models allow some consumers to be liquidity constrained, other economic and policy changes (such as skill-biased technological change, labor unions, or minimum wages), and other types of shocks (such as unemployment, which is more likely to affect less educated groups). These models also imply that consumers experience large responses to permanent income shocks and that permanent increases or decreases in taxes should result in proportional consumption responses (Carroll, 2009; Violante, 2002).

(2010) decompose income shocks into a permanent component, obtained from a five-year moving average of residual income, and a transitory component, obtained from the difference of the true residual income and permanent income. They find that permanent income shocks are an important part of the increase in inequality since at least the 1970s. Debacker and Vidangos (2013) compare the Kopczuk and Song (2010) method and the model-based method, widely adopted by the literature and used in this paper. They find that both methods attribute a large portion of the increase in income inequality to permanent income shocks, but that the model-based approach attributes more weight to transitory shocks.

Most studies that evaluate the evolution of income shocks over time focus on either male earnings (MaCurdy, 1982; Gottschalk and Moffitt, 2009; Moffitt and Gottschalk, 2002, 2011, 2012; Meghir and Pistaferri, 2004), household incomes (Krueger and Perri, 2006; Blundell et al., 2008), or both (Heathcote and Violante, 2010; Debacker and Vidangos, 2013).[4] This literature generally finds subtle differences in the impact of permanent and transitory shocks on male and household incomes and that transitory income shocks contributed heavily in the late 1980s and early 1990s (Blundell et al., 2008; Primiceri and Rens, 2009; Moffitt and Gottschalk, 2011, 2012; Heathcote and Violante, 2010; Debacker and Vidangos, 2013).[5]

The extent to which the increases in permanent and transitory income shocks have led to consumption inequality depends on how much of these shocks are transmitted to consumption. The fact that the increase in consumption inequality is smoother than that of income suggests that individuals can predict and insure against at least part of income shocks (Cutler and Katz, 1992; Altonji and Siow, 1987; Attanasio and Weber, 1995; Aguiar and Bils, 2015; Attanasio and Pavoni, 2011; Attanasio and Pistaferri, 2014). Moffitt and Gottschalk (2012) and Heathcote and Violante (2010) find that the overall increasing trend in consumption inequality is generally smaller than that

[4] In addition to male earnings, household income includes spousal labor earnings, transfer income (e.g., alimony, pensions, annuities, unemployment compensation, tax refunds, social security benefits, etc.), investment income (e.g., dividends, capital gains, etc.), and business income (i.e., income from sole proprietorships, partnerships, S corporations, etc.). Therefore, household income is likely to more broadly reflect household consumption and welfare.

[5] Debacker and Vidangos (2013) find that about 20 percent of the total increase in income variance from 1980 to 2006 is due to transitory shocks, although this is more likely to be true for household income than for male earnings.

of income inequality because a component of these income shocks is transitory and insurable.[6]

To better understand the transmission of income shocks to consumption, Blundell et al. (2008) directly estimate the size of the transmission of permanent and transitory income shocks to consumption. To do this, they construct a panel of individual consumption and income from the PSID and the CEX from the early 1980s to the early 1990s. They show that the level of the transmission of income shocks to consumption significantly depends on whether income shocks are permanent or transitory. They find little evidence that the level of transmission varied over their sample years, 1980--1992. Instead, they suggest that the increase in consumption smoothing in the late 1980s and early 1990s was due to increases in transitory shocks, which are transmitted to consumption less.

Blundell et al. (2008) provide additional evidence that the tax system is an important determinant of the transmission of permanent income shocks to consumption.[7] Covering a longer period up to the financial crisis, Heathcote and Violante (2010) and Debacker and Vidangos (2013) evaluate the variability of before-tax and after-tax income shocks, attributing the difference to the tax system.[8] They find suggestive evidence that the tax system contributed to insure against permanent income shocks since the 1980s but not enough to contain the large increase in before-tax income inequality. [9]

[6] The macroeconomic literature has extensively studied the transmission of income shocks to consumption, with particular attention to the validity of the permanent income hypothesis (PIH), as opposed to other models of buffer-stock savings, impatient consumers, or models with liquidity constraints (Zeldes, 1989; Carroll and Kimball, 2001). While the PIH implies that forward-looking consumers fully adjust consumption in response to permanent shocks and unconstrained consumers fully insure transitory shocks, impatient or constrained consumers are subject to both permanent and transitory income shocks. Carroll (2009) applies various models of consumers' behavior under constraints to PSID data and finds that, although the marginal propensity to consume out of permanent income shocks is always less than one, the PIH is approximately right: across a wide range of assumptions on the degree of impatience, marginal propensity to consume out of permanent income shocks is between 0.75 and 0.92.

[7] Blundell et al. (2008) also document a significant degree of variation across income groups. In particular, while their overall finding is that there is only partial insurance to permanent income shocks and almost full insurance to transitory shocks, wealthier income groups can better insure against permanent income shocks, while bottom income groups experience partial insurance to both types of income shocks.

[8] Although they use different empirical approaches to estimate income shocks and different underlying data on male earnings and total income, they find that after-tax income is at least 15 percent smoother than before-tax income.

[9] Heathcote and Violante (2010) show that, contrary to household income, male earnings have been more sensitive to income shocks, but because a large part of their variance was transitory until the mid-1990s, they were insurable through increased access to financial markets. They also find that the tax system has insured lower income groups relatively more that other income groups but not enough to reduce the overall increasing trend. Debacker and Vidangos (2013) note that the contribution of the tax system to insure consumption to income shocks has remained stable in spite of large reductions in marginal income tax rates in 2001 and 2003, probably because these tax policy

There is also a public finance literature that provides evidence that the tax system provides insurance against income shocks. This literature uses tax simulation software to simulate tax policy and income shocks to separately identify these effects (Auerbach and Feenberg, 2000; Pechman, 1973; Bargain et al., 2015).

We build on the insights of both the macro-labor and public finance literature by combining the model-based estimation in the macro-labor literature and the simulation methods in the public finance literature. Combining these methods allows us to cleanly identify how tax policy impacts the transmission of income shocks to consumption and, ultimately, consumption inequality.

III Model of Income and Consumption Dynamics

The primary purpose of the model is to decompose the changes in insurance individuals have against income shocks, identified by the transmission of income shocks to consumption, to evaluate the contribution of different types of changes in the federal income tax, either due to changes in the tax code (active tax changes) or to changes in income distribution (passive tax changes). We start from a standard life-cycle consumption-smoothing model that describes the relationship between consumption and income shocks. Next, we model the amount of transmission of income shocks to consumption as a function of active and passive tax policy (or active and passive automatic stabilization effect). Finally, we derive a set of moment conditions implied by the model, adapted to the specific nature of our panel data.

changes were partly offset by increases in earned income credits and child tax credits. Guvenen (2007), Primiceri and Rens (2009), and Storesletten and Yaron (2004b) attribute the fact that consumption inequality is smaller than permanent income inequality to heterogeneity across consumers. Guvenen (2007) finds that the predictability of permanent income shocks increases with education, implying that less educated groups are more sensitive to income shocks. Storesletten and Yaron (2004b) also find that, although predictable, idiosyncratic income risk is counter-cyclical. Storesletten and Yaron (2004a) also attribute the gap between consumption and income inequality growth to increases in *private* risk-sharing (e.g., financial markets), arguing that models of buffer-stock savings fit well the data.

III.A Dynamic Life-Cycle Model of Consumption

The unit of analysis is the household, defined as stable prime-age married couples with or without children, with before-tax earnings and cash transfers (such as food stamps and welfare payments).[10] Each household i maximizes the present discounted value of its future consumption,

$$(1) \qquad max \quad E_t \sum_{j=0}^{\infty} (1+\delta)^{-j} u(C_{i,t+j}, Z_{i,t+j}),$$

where $C_{i,t+j}$ is the consumption of household i in period $t+j$, $Z_{i,t}$ is a set of deterministic factors including both observable and unobservable taste shifters, and δ is a subjective discount rate. Households are subject to an intertemporal budget constraint and an end-of-life condition for assets, where individuals have income $Y_{i,t}$, assets $A_{i,t}$, and access to a risk-free bond with a real return r_{t+j}

$$(2) \qquad A_{i,t+j+1} = (1+r_{t+j})(A_{i,t+j} + Y_{i,t+j} - C_{i,t+j}), \qquad A_{i,T} = 0.$$

III.A.1 Income Process

The income of household i is a combination of deterministic components, $Z_{i,t}$, and stochastic components, $P_{i,t}$ and $\nu_{i,t}$,. Our baseline measure of income is PSID's total family income, which includes transfers and financial income.[11]

$$(3) \qquad log(Y_{i,t}) = Z'_{i,t}\varphi_t + P_{i,t} + \nu_{i,t}.$$

[10] We recognize that excluding unstable households and single-parent families limits the scope of our analysis, especially insofar as these families are arguably both more likely to experience income shocks and to be targeted by policy insurance programs. However, as in Blundell et al. (2008), we aim to abstract away from income shocks due to changes in family composition such as divorce, widowhood, or separation, to pinpoint economic income shocks. As our main focus is to evaluate the evolution of fiscal policy stabilizers and their contribution to insurance, isolating market shocks is a critical first step. Section IV discusses the limited impact that abstracting away from changes in family composition has on our findings.

[11] As in Blundell et al. (2008), we provide results using alternative measures of income, including males' labor earnings.

The deterministic component of income, $Z_{i,t}$, is known in year t and allowed to shift over time.[12] The stochastic component consists of a permanent, $P_{i,t}$, and transitory, $v_{i,t}$, shock to income, where the permanent component is assumed to be a martingale, and the transitory component is a mean-reverting MA(q) process, described by,

$$P_{i,t} = P_{i,t-1} + \zeta_{i,t}, \tag{4}$$

$$v_{i,t} = \sum_{j=0}^{q} \theta_j \varepsilon_{i,t-j}, \tag{5}$$

where $\zeta_{i,t}$ and $\varepsilon_{i,t}$ are serially uncorrelated, $\theta_0 = 1$, and we determine the order q empirically. For ease of exposition we demonstrate the model using $q = 1$.[13] We estimate the model in two steps: first, we isolate the unexplained component of income growth $y_{i,t} = log(Y_{i,t}) - Z'_{i,t}\varphi_t$, and second, we estimate income growth, represented by

$$\Delta y_{i,t} = \zeta_{i,t} + \Delta v_{i,t}. \tag{6}$$

III.A.2 Consumption Process

The consumption process encompasses transitory and permanent income shocks, *transmission parameters* that determine the transmission of these shocks to consumption (and therefore the amount of insurance), and random innovations in consumption given by,

$$\Delta c_{i,t} = \phi_t \zeta_{i,t} + \psi_t \varepsilon_{i,t} + \xi_{i,t}. \tag{7}$$

This tractable equation is derived from the Taylor expansion of the Euler equation of a CRRA utility function, with the derivation given in Appendix C. This equation allows both permanent

[12]In the empirical approach, deterministic factors include several demographic variables such as education, family size, age, number of kids, region, labor market experience, and ethnicity. We also allow for those characteristics to vary across groups based on education, age, income, and cohorts by including group fixed effects.

[13]Many empirical studies show that this is an accurate representation of the income process (MaCurdy, 1982; Abowd and Card, 1989; Moffitt and Gottschalk, 2011; Meghir and Pistaferri, 2004). Carroll (2009) and Blundell and Pistaferri (2003) show evidence that simulations of equation (3) based on reasonable values accurately reproduce the income process in the PSID.

and transitory shocks to have an impact on consumption and allow these impacts to vary over time t.[14] The parameters ϕ_t and ψ_t capture how much of the permanent and transitory income shocks are transmitted to consumption. In the literature, these parameters are defined as *partial insurance parameters* because consumption insurance is given by one minus these parameters; for example, $1-\psi_t$. While we expect the intermediate case where $\phi_t \in (0,1)$ and $\psi_t \in (0,1)$, this equation also allows us to consider the two polar cases of no insurance ($\phi_t = \psi_t = 1$), as predicted by the permanent income hypothesis (with only self-insurance through savings), or full insurance ($\phi_t = \psi_t = 0$), as predicted by models of complete markets.[15] The lower the partial insurance parameter, the smaller the transmission of income shocks to consumption, and the larger the degree of insurance. To avoid confusion, in the remainder of this paper, we chose to refer to the parameters ϕ_t and ψ_t as the *transmission parameters*.

III.B The Role of the Federal Income Tax on the Transmission of Income Shocks

The share of income shocks transferred to consumption depends on the transmission parameters ϕ_t and ψ_t, given by equation (7). These parameters partly depend on the amount of insurance provided by the federal individual income tax, also known as automatic stabilizers. For example, if $Y_{i,t}$ denotes pre-tax income and $Y^D_{i,t}$ denotes post-tax, or disposable income, then the amount of insurance to income shocks that results from tax policy (or automatic stabilization effect) can be written as

$$S_{i,t} = 1 - \frac{\Delta Y^D_{i,t}}{\Delta Y_{i,t}} = \frac{\Delta T_{i,t}}{\Delta Y_{i,t}}, \tag{8}$$

[14]For identification reasons discussed below, we estimate ten sets of transmission parameters for the years 1968--1970, 1971--1973, 1974--1976, 1977--1979, 1980--1982, 1983--1985, 1986--1991, 1992--1996, 1998--2002, 2004--2010. We often report our estimates using the periods 1967--1979, 1980--1992, and 1993--2010 for expositional ease. These years correspond to the years before, during, and after most studies and they roughly correspond to three different tax regimes. Our findings are not sensitive to the grouping of years.

[15]Traditional life-cycle models with forward-looking consumers imply that the marginal propensity to consume out of permanent income shocks should be equal to one. However, extensive macroeconomic and micro-economic empirical literature has shown evidence of ‘‘excess-smoothness’’ or excess sensitivity in consumption response to predicted income shocks. See, among others, Hall (1978), Deaton (1991), and Hall and Mishkin (1982).

where $\Delta T_{i,t}$ is the change in household i's tax liability that results from an income shock in year t. At one extreme, if policy stabilizers completely absorb shocks to pre-tax income such that $\Delta Y^D_{i,t} = 0$, then $S_{i,t} = 1$. At the other extreme, in the absence of insurance (such as in a system with no taxation), changes in disposable income are equal to changes in pre-tax income and $S_{i,t} = 0$. If instead the tax system consisted of a flat marginal tax rate, τ_t, then the tax structure would insure τ_t percent of disposable income against income shocks in year t; that is $S_{i,t} = \tau_t$.

We posit that the amount of insurance received from the federal income tax can be driven by two forces. The first is *active* changes in tax policy--that is changes in the distribution of after-tax income that result only from changes in the tax system, *ceteris paribus*. The second is *passive* changes in tax policy--that is changes in the distribution of after-tax income that result only from changes in the income distribution, everything else fixed including the nonlinear income tax. In the remainder of this paper, we denote *active changes* as the amount of transmission that results from active tax policy, and *passive changes* as the amount of transmission that results from passive tax policy.

III.B.1 Micro-Simulations of Active and Passive Tax Policy Changes

For purposes of evaluating federal tax payments, we use the PSID's taxable income of husbands and wives, and allow families to take all deductions for which they are eligible.[16] The *active* and *passive* changes in tax policy stabilizers-or insurance-are expressed in changes in net tax liability. We use NBER's TaxSim 27 software to simulate a household's tax liability, $T(y_{i,t}, \tau_t)$, given an income level, $y_{i,t}$, and a nonlinear tax schedule, τ_t.[17] We propose that, *ceteris paribus* a change in a household's tax liability in real terms stems from either a change in tax policy (*active* tax policy change) or a change in family income (*passive* tax policy change). *Active* changes in insurance are

[16] As our focus is federal tax liabilities, and because of limited state information from the PSID, we do not account for the deduction of state taxes, as in Blundell et al. (2008).

[17] Butrica and Burkhauser (1997) provide a methodology for calculating tax liability based on TaxSim and PSID data. Auerbach and Feenberg (2000) and Pechman (1973) pioneered the use of TaxSim to isolate the effects of controlled income and policy shocks in the United States. Dolls and Peichl (2012) use Euromod, a similar tax simulation software, and TaxSim to isolate the effect of income and unemployment shocks on disposable income and compare the stabilization effect of fiscal policy in the United States and Europe over time.

isolated by holding an individual's income fixed to a base year and adjusted for inflation to match the policy year's dollars.[18] *Passive* changes in insurance are isolated by holding the tax schedule fixed to a base year and deflating individual's income to match the base year's dollars. We calculate *active* and *passive* changes in insurance for each individual i in each year t.

To calculate the active changes in insurance, we simulate each individual's tax liability in every year using two levels of income: the household's income in the base year (1980), $y_{i,1980}$, and 1.1 times the household's income in the base year, $y^c_{i,1980}$, which simulates a 10 percent income shock.[19] The difference in federal income tax liability using the household's actual income, $T(y_{i,1980}, \tau_t)$, and using its counterfactual income after a 10 percent shock, $T_i(y^c_{1980}, \tau_t)$, is the change in after-tax income a household would experience if its (fixed) real value of pre-tax income increased by 10 percent. We define the *active* changes in insurance as the difference in simulated tax liabilities divided by the size of the simulated income shock,

(9)
$$S^A_{i,t} = \frac{T(y_{i,1980}, \tau_t) - T(1.1 \times y_{i,1980}, \tau_t)}{0.1 \times y_{i,1980}}.$$

To calculate the *passive* changes in insurance, we simulate each individual's tax liability in every year using the household's actual income that year, $y_{i,t}$, and its actual income in the previous year, $y_{i,t-1}$, holding the tax code fixed to a base year. The resulting change in simulated federal income tax liability across years is entirely due to changes in household income. We define *passive* changes in insurance as the difference in simulated tax liabilities due to observed income shocks

[18]To account for tax bracket indexation, we inflate the base year's income in each year. Tax bracket indexation was introduced as part of the Economic Recovery Tax Act (ERTA) of 1981 to end bracket creep and went into effect in 1985. The results are robust to not indexing income. For more information on indexing in the federal income tax system, see Gillingham and Greenlees (1990).

[19]We impute income in 1980 for households that do not report income that year. Although we chose 1980, which falls in the middle of the periods covered in our data, we also try 1995 as the base year for income distribution and find that it does not affect the implications of our results. The sensitivity of active and passive tax policy stabilizers to the choice of the base year is analyzed in Appendix A. The Economic Recovery Tax Act of 1981 marks the first year when federal income tax schedules started to be indexed for inflation. Our methodology controls for the effect of inflation on a tax system's parameters.

divided by the size of the observed household income shock between two successive years,

$$S_{i,t}^{P} = \frac{T(y_{i,t}, \tau_{1980}) - T(y_{i,t-1}, \tau_{1980})}{\Delta y_{i,t}}. \tag{10}$$

Figure 1 shows active and passive changes in insurance from 1967 to 2010. As expected for a progressive tax system, the level of insurance the federal income tax provides is highest for high-income taxpayers. Insurance from active tax policy changes decreases for all income groups from 1970 to 2010, with the largest decrease occurring in 1987. This pattern implies that observed changes in the tax code have reduced the amount of insurance provided by the federal income tax system. Overall, insurance from passive tax policy changes has slightly increased for all income groups from 1967 to 2010, implying that observed changes in income distribution have led the progressive federal income tax system to provide slightly more insurance.

III.B.2 Decomposing the Transmission of Income Shocks to Consumption

The amount of insurance households have against permanent and transitory income shocks depends on the nonlinear tax code and the income distribution. We formalize this by allowing the transmission parameters to be a function of active and passive tax policy changes. The coefficients on active and passive tax policy changes capture the feature that individuals may internalize this stabilization more or less and differentiate between active and passive. In particular, the transmission parameter for permanent income shocks can be written as

$$\phi_t = \alpha + \beta_{A,t} S_{i,t}^{A} + \beta_{B,t} S_{i,t}^{P} + \varepsilon_{i,t}. \tag{11}$$

To quantify the contribution of active and passive tax policy changes and all other changes, we use a Oaxaca (1973) and Blinder (1973) decomposition of the change in the transmission parameter

$$\Delta\phi_{1,0} = \phi_1 - \phi_0 = \alpha_1 + \beta_{A,1} S_{i,1}^{A} + \beta_{P,1} S_{i,1}^{P} + \varepsilon_{i,1} - (\alpha_0 + \beta_{A,0} S_{i,0}^{A} + \beta_{P,0} S_{i,0}^{P} + \varepsilon_{i,0}). \tag{12}$$

By adding and subtracting $\beta_{A,1}S^{A}_{i,0} + \beta_{P,1}S^{P}_{i,0}$, this difference can be written as,

$$\begin{aligned} \Delta\phi_{1,0} = {} & \beta_{A,1}(S^{A}_{i,1} - S^{A}_{i,0}) + \beta_{P,1}(S^{P}_{i,1} - S^{P}_{i,0}) \\ & + S^{A}_{i,0}(\beta_{A,1} - \beta_{A,0}) + S^{P}_{i,0}(\beta_{P,1} - \beta_{P,0}) + \alpha_1 - \alpha_0 \\ & + \varepsilon_{i,1} - \varepsilon_{i,0}. \end{aligned} \tag{13}$$

The first two terms on the right side of equation (13) capture changes in active and passive tax policy, respectively. The terms on the second line capture all other *behavioral* factors (e.g., self-insurance, households' propensity to consume tax rebates, changes in policy other than tax). The key identifying assumption is that the difference in the error terms is conditionally equal to zero. Fortin, Lemieux and Firpo (2011) provide a discussion of this identifying assumption and methods to loosen it.

To quantify the effect of active and passive tax policy changes on the transmission of income shocks to consumption, it is necessary to combine micro-simulations and a structural labor model. On the one hand, the micro-simulations provide information on how much active and passive tax policy changes affect the transmission of pre-tax income shocks to post-tax income. These simulations, however, do not provide evidence on how individuals respond to these changes when making consumption decisions. On the other hand, the macro-labor model estimates the transmission of pre-tax income shocks to consumption, which is a function of active and passive tax policy changes. The full contribution of active tax policy changes to the changes in the transmission of pre-tax income to consumption is represented by changes in active tax policy, $(S^{A}_{i,1} - S^{A}_{i,0})$, weighted by the impact active changes have on the transmission of pre-tax income to consumption, β_A. Similarly, the contribution of passive tax policy changes to changes in the transmission of pre-tax income to consumption is the weighted change in passive tax changes $\beta_{P,1}(S^{P}_{i,1} - S^{P}_{i,0})$. The micro-simulations and the structural labor model are both necessary as they could uncover, for instance, that even if a change in active tax policy is larger than a change in passive tax policy, passive tax policy changes could still affect more the transmission of income shocks to consumption than active changes if individuals respond more to passive tax changes.

III.C Moment Conditions

This subsection derives a series of moment conditions used to estimate the variance of the permanent and transitory income shocks, the transmission parameters, and other model parameters such as the serial correlation of the transitory shocks. One complication is that PSID data after 1996 are only reported biannually, which precludes using the moment conditions based on one-year differences. To extend our analysis to years after 1996, we construct moment conditions based on the covariances of two-year differences in income and consumption, which can be derived from the model as,

(14) $$\tilde{\Delta} y_t = \zeta_t + \zeta_{t-1} + \tilde{\Delta} v_t, \text{ and}$$

$$\tilde{\Delta} c_t = \phi_t \zeta_t + \phi_t \zeta_{t-1} + \psi_t \varepsilon_t + \psi_t \varepsilon_{t-1} + \xi_t + \xi_{t-1},$$

where $\tilde{\Delta} x_t$ defines the two-year difference in variable x. We derive the moments based on two-year differences in the text and derive the moment conditions from one-year differences in Appendix D because those follow directly from Blundell et al. (2008). The first set of moment conditions is based on the covariance of the two-year growth in income with different leads,

(15) $$cov(\tilde{\Delta} y_t, \tilde{\Delta} y_{t+s}) = \begin{cases} var(\zeta_t) + var(\zeta_{t-1}) + var(\tilde{\Delta} v_t) & \text{if } s = 0 \\ var(\zeta_t) + cov(\tilde{\Delta} v_t, \tilde{\Delta} v_{t+1}) & \text{if } s = 1 \\ cov(\tilde{\Delta} v_t, \tilde{\Delta} v_{t+2}) & \text{if } s = 2 \end{cases},$$

where $cov(.,.)$ and $var(.)$ denote the cross-sectional covariance and variance, respectively. The second set of moment conditions is based on the covariance of the two-year growth in consumption with different leads,

$$(16)\qquad cov(\tilde{\Delta}c_t,\tilde{\Delta}c_{t+s}) = \begin{cases} \phi_t^2 var(\zeta_t) + \phi_t^2 var(\zeta_{t-1}) + \psi_t^2 var(\varepsilon_t) & \\ \qquad + \psi_t^2 var(\varepsilon_{t-1}) + 2var(\xi) & \mathit{if}\ s = 0 \\ \phi_t^2 var(\zeta_t) + \psi_t^2 var(\varepsilon_t) + var(\xi) & \mathit{if}\ s = 1 \\ 0 & \mathit{if}\ s > 1 \end{cases}.$$

Finally, the covariance between the two-year growth in income and consumption at various lags provides the third set of moments,

$$(17)\qquad cov(\tilde{\Delta}y_{t+s},\tilde{\Delta}c_t) = \begin{cases} \phi_t var(\zeta_t) + \phi_t var(\zeta_{t-1}) & \\ \qquad + \psi_t cov(\varepsilon_t,\tilde{\Delta}v_t) + \psi_t cov(\varepsilon_{t-1},\tilde{\Delta}v_t) & \mathit{if}\ s = 0 \\ \phi_t var(\zeta_t) + \psi_t cov(\varepsilon_t,\tilde{\Delta}v_{t+1}) + \psi_t cov(\varepsilon_{t-1},\tilde{\Delta}v_{t+1}) & \mathit{if}\ s = 1 \\ \psi_t cov(\varepsilon_t,\tilde{\Delta}v_{t+2}) + \psi_t cov(\varepsilon_{t-1},\tilde{\Delta}v_{t+2}) & \mathit{if}\ s = 2 \end{cases}.$$

These 312 moment conditions are used to estimate the 122 parameters from the model. The parameters of interest are the partial insurance parameters ϕ_t and ψ_t. The transmission parameters require three years of data for identification (see Meghir and Pistaferri (2004) for a discussion). We, therefore, estimate one transition parameter for each of the following periods; 1968--1970, 1971--1973, 1974--1976, 1977--1979, 1980--1982, 1983--1985, 1986--1991, 1992--1996, 1998--2002, 2004--2010, noting that the later years only have data every other year from the PSID, and there are some missing years due to data limitations in the late 1980s. We also estimate the model using more years for each transmission parameter, and the results are qualitatively similar. Appendix D provides more details on deriving each of the moment conditions and calculating the standard errors following Chamberlain's 1984 method.[20]

[20]The computation of the standard errors requires the variance-covariance matrix of the moments conditions, the Jacobian matrix evaluated at the estimated parameters, and the weights used in the estimation. The weights are given by the diagonal matrix of the inverse of the variance-covariance matrix.

III.C.1 The Autocovariance of Income and Consumption Growth

The panels in Figure 2 report the data we use in the moment conditions derived in equations (15)-(17). We first remove the deterministic characteristics, Z_{it}, from income and consumption using regressions of these variables on year dummies and a set of dummies for socio-demographic characteristics as described in section III. Panel A reports the variance of income growth, which the model shows is associated with changes in the variance of permanent and transitory income shocks. This panel reports the variance using both one- and two-year differences because after 1996 only two-year differences are possible due to changes in the PSID. The variances using one- and two-year differences follow a similar pattern. The variance of income increases over time with large jumps in the middle of the 1970s, late 1980s, and early 1990s.

Panels B and C report the covariance of current income growth and lagged income growth, which is used to quantify the permanent and transitory components of the increase in the variance of income. Specifically, increases in the covariance of current and lagged income growth indicate an increase in the variance of permanent income shocks. From 1970 to the early 1990s the covariance is steady or slightly decreases, which suggests no change in the variance of permanent income shocks during this period. In the late 1990s, the covariance of current income growth and its 2-year lagged value sharply increases, which suggests an increase in the variance of permanent income shocks in the late 1990s.

Panels D, E, and F depict the covariance of consumption (current and lagged) and income and the variance of consumption. These covariances provide preliminary evidence on the changes in the transmission of income shocks to consumption.[21] From 1970 to 2010, the variance of consumption increases steadily with large increases in the late 1990s. These increases are potentially due to increases in the variance of income, depicted earlier, and changes in the transmission of income shocks to consumption. We are particularly interested in changes in the transmission of income shocks to consumption, and the potential role tax policy has in that change. The covariance of

[21] The variance of consumption growth also captures the heterogeneity in household's responses to income shocks and the measurement error from the imputation. The minimum distance estimation takes into account this measurement error by separately estimating a variance of consumption shocks.

income and consumption provides additional insights into the transmission of income shocks to consumption. In particular, the covariance of income and consumption experiences large increases in the 1980s, which is consistent with the transmission of income shocks increasing during this period. The following section describes the underlying data for this figure and our estimates generally.

IV Data

To understand how income tax changes have impacted the transmission of income shocks to consumption, we need a panel that includes income and consumption covering several tax regimes. We construct this panel using the consumer expenditure survey (CEX) and combine it with the panel data from the Panel Study of Income Dynamics (PSID) using the imputation approach developed by Skinner (1987) and used extensively since then (Blundell, Pistaferri and Preston, 2004; Blundell et al., 2008).[22]

One innovation of our paper is that we expand the sample years to include the years 1967 through 2010. This allows us to compare the imputed values of non-durable consumption produced through this method with data on non-durable consumption collected in the PSID from 1999 to 2010. Additional data collection information is given in Appendix A.

IV.A Sample Selection

We start with an unbalanced panel from the PSID using data from 1967 to 2010. To focus on income risk, rather than variation in consumption due to divorce, widowhood, or other household breaking-up factors, we restrict our sample to households in the PSID sample with continuously married couples (excluding 40 percent of households, with or without children) that are headed

[22] Skinner (1987) imputes total consumption in the PSID using the estimated coefficients of a regression of total consumption on a series of consumption items (food, utilities, vehicles, etc.) that are present in both the PSID and the CEX. The regression is estimated with CEX data. Ziliak and Kniesner (2005) and Ziliak (1998) impute consumption on the basis of income and the first difference of wealth (defined as the difference between income and savings obtained from the Federal Reserve Board's Survey of Consumer Finances).

by a male (excluding 34 percent of remaining households).[23] The choice to exclude single-parent families is to ensure that consumption shocks stem from income shocks rather than changes in family composition. Even among low-income households, we do not think that this is an important limitation since, for example, the percentage of single and joint households receiving the EITC are similar.[24]

Within this sample, we exclude households with missing values on important socio-demographic variables, changes in headship, and income outliers defined as households with income growth above 500 percent, below -80 percent, or with a level of income below $100 in a given year (excluding 25.7 percent of the remaining sample).[25] Finally, within this sample, we focus on household heads aged between 30 and 65 and create 12 cohorts, each defined as being born in a given half decade starting in 1920 and ending in 1979 (eliminating 37 percent of the remaining sample).

Overall, starting with 264,810 observations, the final sample is composed of 17,416 observations (7.5 percent). This sample selection is followed in the CEX. Detailed descriptions of the data collection from the PSID and CEX are given in Appendices A.3 and A.4.

An important contribution of our paper is that we allow the effect of fiscal policy to be heterogeneous, allowing different income groups to have differential access to external smoothing mechanisms in addition to self-insurance, through savings or borrowing and family networks. To this end, we use the two available samples of households in the PSID: the representative sample

[23] Additional details are provided in appendix table A.3. These steps exclude families that report changes in headship and family composition or marital status. Also, the PSID public files do not report marital status from 1993-1996. To account for this, individuals are assigned the marital status they had in 1992 and 1997, if these two years have the same values, and dropped otherwise. This restriction also limits the changes due to changes in education and retirement.

[24] This sample selection also makes our paper comparable to previous studies that impute consumption from the PSID (Blundell et al., 2008). We recognize that certain tax and non-tax benefits such as the EITC have largely benefited low-income single households. For instance, in 2003, 76 percent of EITC recipients were single-headed households. Yet, *within* low-income groups, the proportion of single and joint households receiving the EITC are similar. For instance, in 2003, about 0.02 percent of both single-headed and joint households with less than $40,000 of AGI received the EITC (authors' calculations using data from the Joint Committee on Taxation and SOI/IRS tax statistics). We define income groups based on 1980 income distribution, implying that intergenerational mobility likely moved *low-income* families in and out of the EITC over the period.

[25] The PSID public files do not report state for years 1993-1996. To account for this, individuals are assigned the state where they lived in 1992 and 1997 if those are the same, and are dropped otherwise (3.8 percent).

of the US population and the low-income sample (SEO).[26] Table 1 compares the means across the PSID SEO sample, PSID representative sample, and the CEX for the years 1973, 1990, and 2010. In all categories, the demographics look very similar between the representative subsample of the PSID and the CEX. This is important for the imputation to correctly predict consumption for households in the PSID using data from the CEX.

IV.B Imputation

The imputation method relies on measures of food and non-durable consumption. Food consumption is constructed as the sum of food at home and food away from home, reported in both the PSID and CEX. In the CEX, non-durable consumption is constructed as the sum of food, alcohol, tobacco, services, heating fuel, public and private transport (including gasoline), personal care, clothing, and footwear, as proposed by Attanasio and Weber (1995).

Although our baseline measure of consumption is non-durable consumption, we also consider three broader measures that alternatively include semi-durables, services from durable goods, or both, with details provided in Appendix A.3 to test the robustness of the imputation and our findings.[27] The imputation method uses pooled cross-sectional data from the CEX in 1972 and 1973, and from 1980 to 2010, and the following demand equation (following Blundell et al. (2008)'s notation) for food, f, expressed in logs:

$$f_{i,t} = \boldsymbol{W}'_{i,t}\boldsymbol{\mu} + \boldsymbol{p}'_t\boldsymbol{\theta} + \beta(D_{i,t})c_{i,t} + e_{i,t}, \tag{18}$$

for each household i in period t with demographics, W, and relative price, p. Demand shifters, controlling for non-durable expenditure, are given by c, expressed in logs, and the budget elasticity β is allowed to vary with observed household characteristics, D. The budget elasticity is also

[26]The PSID's representative sample of the US population covers 61 percent of the 1967 sample, and the low-income sample (SEO) covers 39 percent of the 1967 sample.

[27]Consumers also use durable goods to smooth non-durable consumption, implying that total consumption including durables is more volatile over the life cycle. Yet, if the imputation method and the model are correct, our estimates of the impact of tax policy on insurance should not be affected by the inclusion of durable goods.

allowed to vary over periods, except in years that do not exist in the PSID. To control for other years we include a quadratic time trend, and allow it to shift the budget elasticity. Finally, we allow for unobserved heterogeneity in the measurement error in food expenditures given by e. Appendix A.3 reports the results of this specification, in which we account for the measurement error in total expenditures with an instrumental variables methodology.

To provide external validity to the imputation method, we take advantage of the fact that, starting in 1999, the PSID provides limited consumption variables.[28] We construct a measure of PSID-non-durable consumption for selected years from 2000 to 2010 and use them as a gauge for the quality of our imputed values of non-durables. Figure 3 shows that over time imputed measures of average non-durable consumption (in logs) are close to our measure of PSID consumption, as well as the CEX and NIPA. Moments of imputed consumption and CEX consumption are also close throughout the period.[29]

V Empirical Evidence

The first goal of this study is to estimate the levels and changes in the insurance of consumption from income shocks, also represented by the transmission parameters, as explained in section III. We estimate transmission parameters separately for permanent and transitory income shocks from 1968-2010. Section V.A reports that the variance of permanent and transitory income shocks and the transmission of income shocks to consumption is reported in section V.B. The second goal and contribution of this study is to better understand the specific roles of active and passive changes in tax policy in the transmission of income shocks. To do this, we further decompose the transmission

[28]Consumption variables from 1999 include healthcare expenses (e.g. hospital, doctor, and prescription expenses), housing expenses (e.g. mortgage payments, rent, property taxes, and homeowner's insurance), utilities, vehicle expenses (e.g. loan payments, down payments, repairs, car insurance, and gasoline costs), transportation expenses (e.g. taxi, bus, and train), education expenses, and adult care expenses. Additional consumption variables added in 2005 include cell phone, internet, and cable expenses, recreation and vacation expenses, furnishings, clothing, home repair, and charitable giving.

[29]Appendix Table A.5 provides further external validity to the imputation method by comparing imputed non-durable consumption with PSID data for the years in which non-durable consumption was collected in the PSID (post-1999).

parameters and present our results in section V.C. Finally, we provide additional insights into the importance of tax policy by estimating the model separately by income quartiles and education groups. Our estimates in sections V.D.1 and V.D.2 demonstrate that the impact of tax policy varies across groups.

V.A Variance of Permanent and Transitory Income Shocks

Figure 4 reports the permanent and transitory income shocks estimated with the minimum distance estimation method and moment conditions described in section III using the data on income and consumption described in section IV. Table B.6 reports the estimates with standard errors. Figure 4 reveals two key findings. First, from 1970 to the mid-1990s, the variance of transitory income shocks (solid line) follows an increasing trend while the variance of permanent income shocks (dotted line) remains relatively flat. This finding is consistent with the evidence from Figure 2 that the autocovariance of income did not increase during this period.[30] Second, both the variances of permanent and transitory income shocks increase in the late 1990s and remain elevated through the mid-2000s. This evidence is consistent with the increase in the covariance of income and its two-year lag after the mid-1990s. Without extending the moment conditions to include two-year differences, it would have been impossible to detect the increase in the variance of permanent income shocks in the late 1990s and after. After 2006, the variances of permanent and transitory income shocks move again in opposite directions.

These estimates suggest that the increase in the variance of income in the 1980s is essentially the result of transitory income shocks, while in the late 1990s and 2000s it results from a combination of both types of income shocks. This finding may have important policy implications, in particular, if tax policy provides different types and amounts of insurance against permanent and transitory income shocks. To answer this question, we first need to estimate the amount of insurance against each type of income shocks, their trends over time, and how much tax policy contributes to the resulting trends, which we do in the next subsection.

[30]These trends are very similar to those estimated by Blundell et al. (2008) for the years they cover (up to 1992) and to those found by Gottschalk and Moffitt (2009) in the extended period.

V.B The Transmission of Income Shocks to Consumption

The transmission of permanent and transitory income shocks to consumption is captured by the parameters ϕ and ψ, respectively. As explained in section III, at one extreme, when these parameters equal 1, income shocks are fully transmitted to consumption (zero insurance). At the other extreme, when the parameters equal 0, income shocks are not transmitted at all (full insurance). The most general situation is for income shocks to be partially transmitted (partial insurance), which occurs when the parameters lie between the two extremes. The smaller the parameter ϕ (respectively ψ), the lower the transmission of permanent (respectively transitory) income shocks, and the higher the amount of insurance.

We leverage our larger sample to estimate a time-varying transmission of income shocks to consumption. This is an important extension of previous work, notably Blundell et al. (2008) who estimate a single value of the transmission parameter for the period 1980 to 1992. Allowing the transmission of income shocks to change over time also allows us to quantify the contribution of tax policy to these changes.

Figure 5 depicts the transmission parameters for permanent income shocks, ϕ (dotted line), and the transmission parameters for transitory income shocks, ψ (solid line). Table B.7 reports the estimates with standard errors. It reveals two key facts. First, the transmission of permanent income shocks increases in the 1980s and decreases in the 2000s to a level below that in the 1970s.[31] The inverted-U shape of the changes in the transmission of permanent income to consumption is consistent with the inverted-U shape of the covariance of income and consumption depicted in Figure 2. Second, the transmission of transitory income shocks is close to zero (full insurance), on average over the period, but increases in the 1980s to the early 1990s, before decreasing again. These two facts suggest that the period most studied in the literature, from 1980 to 1992, is a period with particularly higher values of ϕ and ψ (low levels of insurance) than in other periods. This period also corresponds to substantial tax policy changes that decreased the amount of insurance

[31] Kniesner and Ziliak (2002) use a similar decomposition of income shocks into permanent and transitory shocks. They find that the 1980s tax reforms reduced the (total) insurance of policy stabilizers by 50 percent (p. 605) and that most of this change in insurance is due to permanent income shocks, which is very close to our finding.

provided by the tax system, as suggested in Figure 1. In the 1990s, the decrease in the transmission of permanent income shocks to consumption (Figure 5), combined with the very small and almost constant amount of insurance provided by active tax policy changes (Figure 1), suggest that either passive tax policy changes (i.e., due to changes in income distribution under a fixed tax code) or other behavioral/non-tax changes (e.g., individuals compensating for changes in the tax code by self-insuring more or changes in social programs) were the main cause of increased insurance during this period.

Panel A of Table 2 reports the average transmission of permanent and transitory income shocks to consumption. The average transmission over the full period 1968-2010, is 0.593 and 0.065 for permanent and transitory income shocks, respectively, reported in row 1. These estimates imply that almost all transitory income shocks are smoothed while permanent income shocks are only partially insured. These estimates are similar to those in Blundell et al. (2008), who report permanent and transitory transmission parameters of 0.642 and 0.0533, respectively, for the period 1979--1992. Our longer sample uncovers large changes over time in the transmission parameters. Specifically, the transmission parameter for permanent income shocks changed from 0.539 in 1968--1979 to 0.706 in 1980--1991, and 0.550 in 1992--2010. This result suggests that the transmission of permanent income shocks increased in the 1980s and subsequently decreased, echoing the evidence from Figure 5. In the next section, we combine our micro-simulations, structural model, and decomposition methods to estimate whether tax policy changes have contributed to these observed changes in the transmission of income shocks to consumption.

V.C Decomposition of the Transmission Parameters

Two of the main contributions of this paper are its ability to estimate the changes in the transmission of income shocks to consumption at different points in time, as well as its ability to separate and quantify the contribution of active and passive tax policy to these changes.

Our decomposition is motivated by two stylized facts. First, many studies acknowledge that the federal income tax system can be an important policy instrument to provide insurance by smoothing the transmission of income shocks to consumption. Previous studies have provided suggestive evidence using the difference between estimated variances of pre-tax and post-tax income (Debacker and Vidangos, 2013).[32] Our structural model enables us to extend this evidence by simultaneously estimating the time-varying transmission parameters, from the moment conditions, and explicitly considering both *active* and *passive* tax policy changes as determinants of changes in these parameters. Second, given the increase in observed income and consumption inequality, it is important to understand how active and passive tax policy changes affect the transmission of income shocks to consumption. These estimates are useful to provide a baseline understanding of the ability of the tax system to reduce income inequality.

Figure 5 and Table 2 show that over the whole period of 40 years, the transmission of permanent income shocks to consumption was partial, on average at 0.593 (partial insurance), and did not change significantly (by 0.011, from 0.539 to 0.550, as shown in Panels A and B of Table 2). The transmission of transitory shocks was close to zero, on average at 0.065 (full insurance), and also increased by a small amount (by 0.038, from 0.011 to 0.049 on average between the first and the last period, as shown in Panels A and C of Table 2). However this hides substantial changes between shorter periods, as reported in rows 2 and 3 in panels B and C. This also hides large contributions, though in different directions, of active and passive tax policy changes and *behavioral* changes, which includes all other unobserved changes in individuals situations and behaviors (e.g., changes in risk aversion or self insurance) or in non-tax public programs (e.g., unemployment insurance and welfare).

Active tax policy changes have increased the transmission of income shocks to consumption (reduced insurance), both over the whole period (by 0.297) and between sub-periods, as reported in Panel B of Table 2. In contrast, passive changes in tax policy have reduced the transmission of income shocks (increased insurance), both over the whole period (by -0.566) and between sub-periods. These results suggest that the impact of passive changes is much larger than would have been predicted given the micro-simulations depicted in Figure 1. For instance, over the whole

[32]For example, Blundell et al. (2008) find that the permanent insurance parameter drops by 50 percent when using total family earnings instead of family net income.

period (1968 to 2010) the reduction in the transmission of income shocks caused by passive tax policy changes (-0.566) was almost twice as large as the increase in the transmission caused by active tax policy changes (+0.297). Likewise, in the more recent period (1980s to 2010), the negative effect of passive tax policy changes on the transmission of income shocks (-0.423) was three times as large as the positive effects of active tax policy changes (+0.157). These magnitudes imply that individuals respond differently to changes in active and passive tax policy in ways that amplify the importance of passive changes.

Passive tax policy changes have also contributed twice as much to reducing the transmission of income shocks to consumption in the more recent sub-period (by -0.423 between the 1980s and 2010) than in the earlier sub-period (by -0.143 between 1968 and the 1980s). By contrast, active tax policy changes have increased the transmission of income shocks by the same amounts in both sub-periods. The residual component, or *behavioral effects* have had the tendency to increase the transmission of income shocks, over the whole period and between all sub-periods.

Taken together, these results imply that tax policy plays a sizeable role in the transmission of income shocks to consumption. Active tax policy changes increased the transmission of shocks by 55 percent between 1968 and 2010, which implies that tax policy is a leading factor contributing to the increase in the variance of consumption. Alternatively, this magnitude also implies that tax policy can be an effective tool to damp consumption volatility. For example, if tax policy changes caused the tax code to look more like it did in the early period 1968-1979, then the transmission of income shocks could decrease by up to 55 percent. However, passive tax policy changes more than offset the effect of active tax policy changes. This countervailing effect explains why previous studies fail to find large changes in the transmission (or insurance) of income shocks to consumption, in general, or due to the tax system. Said differently, without decomposing changes in the tax system into active and passive tax changes, researchers would erroneously find that tax policy has little impact on insurance or is an ineffective tool to smooth the transmission of income shocks to consumption.

V.D Estimates by Income and Education Group

This section investigates whether the contribution of tax policy changes to insurance is the same for all income quartiles and education groups. We define income quartiles using 1980 as the base year and holding income groups fixed over the full sample. We also consider three education groups; high school dropouts, high school graduates, and at least some college. Figure 1 shows that over the last 40 years, active tax policy has changed differently across income groups. Income growth also differed substantially across income quartiles and education groups, suggesting that the impact of passive changes on insurance may also differ across groups. Finally, different income quartiles and education groups have access to and rely on different types of insurance, which may have changed in different ways over the last 40 years. For example, low-income quartiles may depend more on other government programs, while high-income quartiles may rely more on self-insurance.

The results are shown in Figures 6-9, and Tables 3-6, which are reproductions of Figures 4, 5, and Table 2. We focus on changes in the transmission of permanent income shocks because these changes are larger. We report all estimates for transitory income shocks in Appendix B.1.

V.D.1 Estimates by Income Quartile

Income shocks vary across income groups. For instance, as shown in Figure 6, the variance of permanent income shocks increased only for the bottom income quartile in the early 1980s, then significantly for both the bottom and top income quartiles. The top income quartile also experienced a substantial increase in the variance of permanent income shocks during the financial crisis in 2008. The variance of transitory income shocks is mostly similar across income groups except after the mid-1990s when it increased for the bottom and the upper-middle income quartiles.

Figure 7 and Table 3 show that, in addition to experiencing different income shocks, income groups also experienced different transmission of these shocks to consumption. The transmission of permanent and transitory income shocks is small for the top income group, 0.301 and 0.076 on average, respectively. These estimates potentially reflect this income group's ability to smooth shocks through credit and savings. In contrast, the transmission of permanent and transitory income shocks is large for the bottom income group, 0.582 and 0.239 on average, respectively. Between the periods 1968--1979 and 1992--2010, the bottom income group also experienced an increase in the transmission of permanent income shocks from 0.507 to 0.729 and of transitory income shocks from 0.026 to 0.261. For this group, the increase in the transmission of permanent income shocks is due to a large increase from 0.446 in 1980--1991 to 0.729 in 1992--2010. In contrast, during this period all other income groups experienced a decrease in the transmission of permanent income shocks.

To understand why the transmission of income shocks varied across income groups, we decompose these changes and quantify the contributions of active and passive tax policy changes, and other behavioral changes. Table 4 reveals that over the 40 years, active tax policy changes increased the transmission of permanent income shocks for all but the bottom income quartile. The increase in the transmission of permanent income shocks for the bottom income quartile is mostly due to behavioral changes. From a policy perspective, these findings suggest that active tax policy changes such as the EITC and Child Tax Credit resulted in more insurance (lower transmission) for the bottom income group. Some of these increases in insurance, however, were offset by other factors such as changes in other government programs (e.g., welfare and unemployment insurance).

In contrast, active tax policy changes substantially increased the transmission of income shocks for the lower-middle income quartile. In spite of this effect, this income group still experienced an overall decrease in the transmission of permanent income shocks because of passive tax policy and behavioral changes. These findings suggest that this income group benefited less from tax policies targeted to the bottom income group and that tax policy had a larger impact for this group than the upper two income quartiles. In particular, active tax policy changes increased the transmission of permanent shocks for the upper two income groups but the magnitudes are much smaller, and they are not statistically significant. This highlights that the differential impact of overall tax policy across income groups is not only due to different types of tax policy changes across groups (observed in Figure 1) but also to these groups responding differently to tax policy changes.

For the upper-income quartiles, passive tax changes increased insurance of permanent income shocks (decreased transmission). The increase in insurance is especially evident in the later period of 1992--2010. This suggests that increasing income inequality pushed higher income groups to higher tax schedules, automatically increasing their insurance. The role of behavioral changes to explain insurance is much less critical for the top income quartile than other quartiles, consistent with the fact that this group is outside the scope of most government programs. Across the top three income quartiles, passive tax policy changes have counteracted active tax policy changes in ways that the combined net impact obscures the effectively substantial role of tax policy.

V.D.2 Estimates by Education Group

In this subsection, we disaggregate income shocks, their transmission to consumption, and the contribution of active and passive tax policy changes for three education groups based on household head's education attainment--high school dropouts, high school graduates, and some college or more. The results are shown in Figures 8, 9, and Tables 5 and 6. Considering that education is likely to be closely associated with household income, the results for education should generally support those based on income. For this reason, this section highlights novel differences due to education. For instance, changes in the economy, such as shifts in production and consumption from goods to services, have affected individuals differently, depending on their education. Different education groups may also perceive changes in tax burdens differently, or have access to different forms of insurance.

Figure 8 reveals that from the late 1960s until the mid-1990s, the variance of both permanent and transitory income shocks was much higher and more volatile for the least educated households. The variance of income shocks was the smallest for the most educated group. After the mid-1990s, the variance of permanent income shocks increased for all education groups. During this most recent period, however, the variance of transitory income shocks increased only for the least educated, and by large amounts. Overall, the least educated group has experienced large volatility of both permanent and transitory income shocks, in particular during the second part of the 1990s, and between 2005 and 2010.

Figure 9 and Table 5 show that the transmissions of both permanent and transitory income shocks are the most volatile for the two least educated groups, but not in the same periods. The least educated experienced large upswings in the transmission of permanent income shocks in the mid-1990s and after 2002. The next education group (high school graduates) experienced a high transmission in the 1980s only. The most educated group experienced little transmission of income shocks overall, and the smallest changes of all groups over the full period.

The contribution of active and passive tax policy changes provides a picture very similar to the one depicted by income groups. Active tax policy changes increased insurance for the least educated group and decreased insurance for the other two education groups. The magnitudes of active tax policy changes are large for the middle education group, similar to those found for the middle-income groups. Passive tax policy changes increased insurance for the least educated group, though this change is entirely due to the 1980s, and decreased insurance for the middle education group. Behavioral changes increased insurance for the top two education groups and decreased insurance for the least educated group.

Taken together these results demonstrate the important role of tax policy, both active and passive, in the transmission of income shocks to consumption. The impacts are heterogenous. Active tax policy changes decreased insurance in aggregate but increased insurance for the bottom income quartile and the least educated. Passive tax policy changes often counteracted active tax policy changes, and this pattern is consistent across income and education groups. In sum, combining a conventional structural model of income and consumption with micro-simulations of tax changes, and the decomposition of tax policy changes over time and by type of tax change, was necessary to uncover that, in effect, tax policy changes play an important role in the transmission of income shocks to consumption.

VI Conclusion

This paper identifies and estimates two mechanisms by which the federal income tax system has affected consumption inequality between 1968 to 2010. We define changes in the transmission of income shocks to consumption due to changes in the tax code as *active* tax policy changes. We define changes in the transmission of income shocks to consumption due to the interaction between changes in the income distribution and the nonlinear income tax schedule as *passive* tax policy changes. This decomposition of tax policy into active and passive changes allows us to uncover the important role played by tax policy changes in the transmission of income shocks to consumption over time.

We find that active tax policy changes between 1968 and 2010 increased the transmission of income shocks to consumption. Said differently, consumption inequality would have been substantially smaller during this period if, in real terms, the tax code had not changed since the 1970s. We also show that an important reason why previous studies have failed to find an important role of tax policy in the transmission of income shocks to consumption is that these studies do not identify the specific roles of active and passive tax policy changes. In fact, we find that passive tax changes have offset the effect of active tax changes such that, in the absence of active tax policy changes from 1968 to 2010, the transmission of income shocks to consumption would have substantially decreased (insurance would have increased).

These findings contribute to a better understanding of the role played by the income tax system in the transmission of income shocks to consumption. The federal income tax system, however, is a complex policy tool with many effects on the economy. Any change to the income tax system for the purpose of reducing inequality must be assessed in parallel with the possible costs that result from those changes. Deadweight losses resulting from tax changes that reduce incentives to work and to report income should be considered. A more general analysis would also consider the long run effects of changing the progressive structure of the income tax, such as its effect on income mobility. For instance, policies that would increase the progressivity of the income tax could decrease inequality initially but increase inequality in the long run through lower income mobility. Another important extension of the model would allow permanent and transitory income shocks to endogenously depend on the federal income tax. This would evaluate whether active tax policy changes have precipitated economic growth, hence changing the income distribution and increasing insurance from the income tax.

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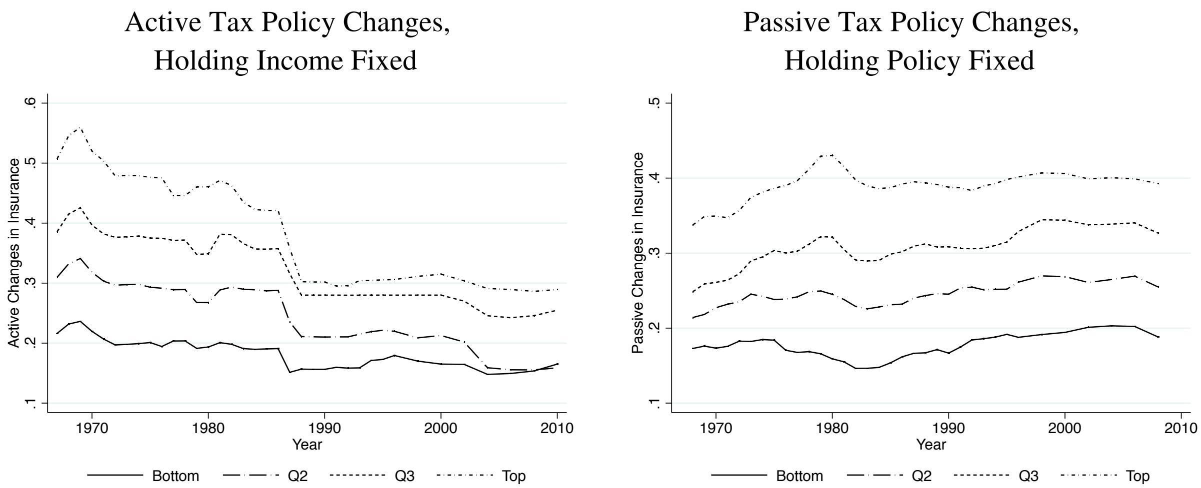
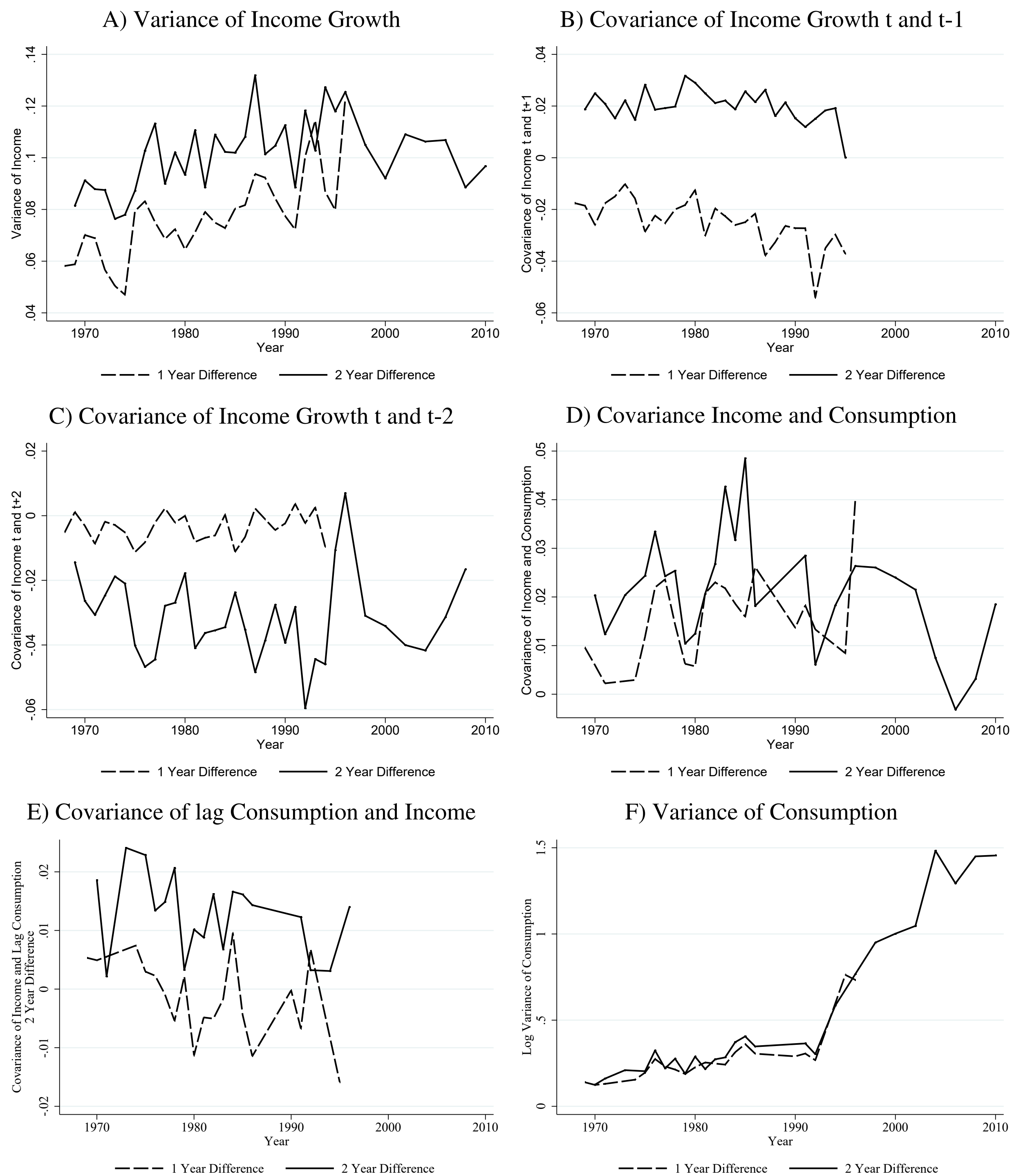
VII Tables and Figures

Figure 1: Active and Passive Tax Policy Changes, by Quartiles of Income



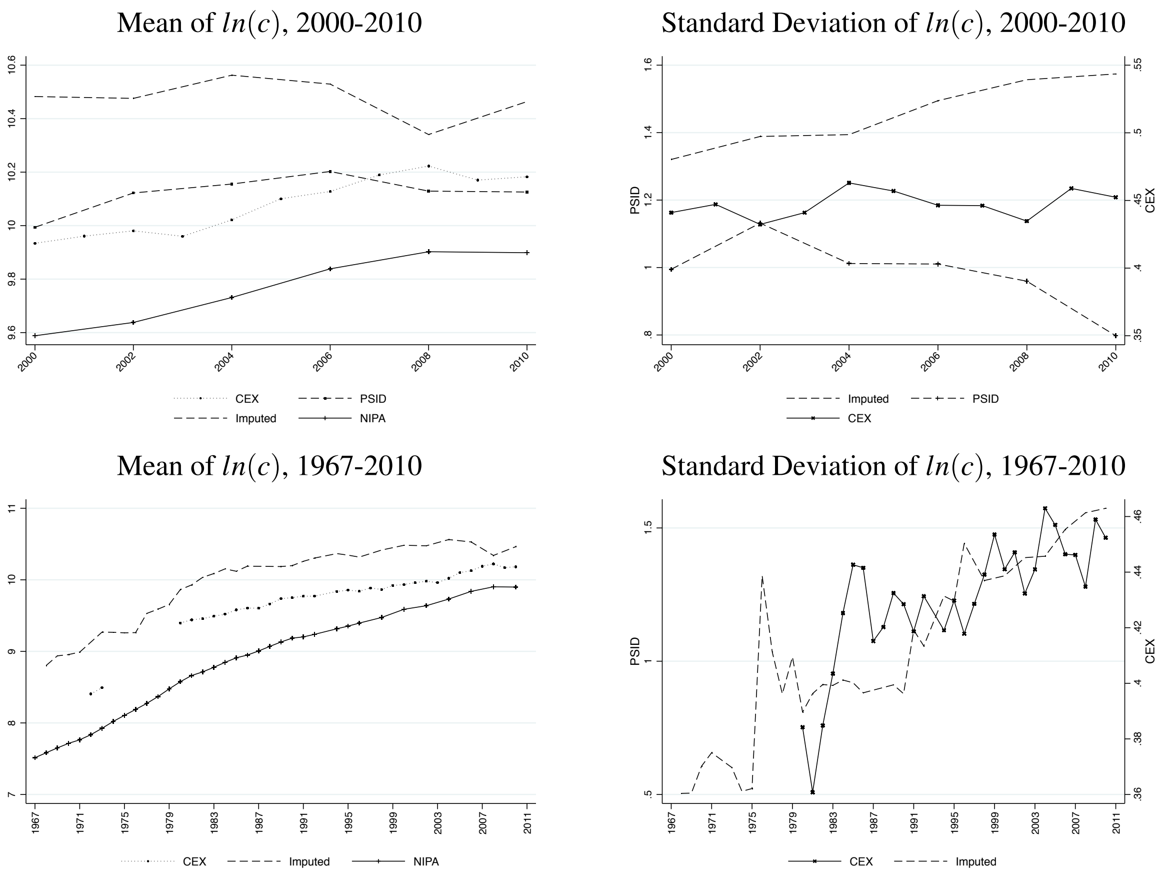
NOTE.— Figure 1 shows that active changes in tax policy decreased insurance and passive changes in tax policy increased insurance from 1968 to 2010. Active and passive changes in insurance are calculated using simulations from NBER's TaxSim program and are defined in equations (9) and (10). Income quartiles are defined in the base year 1980.

Figure 2: Moment Conditions



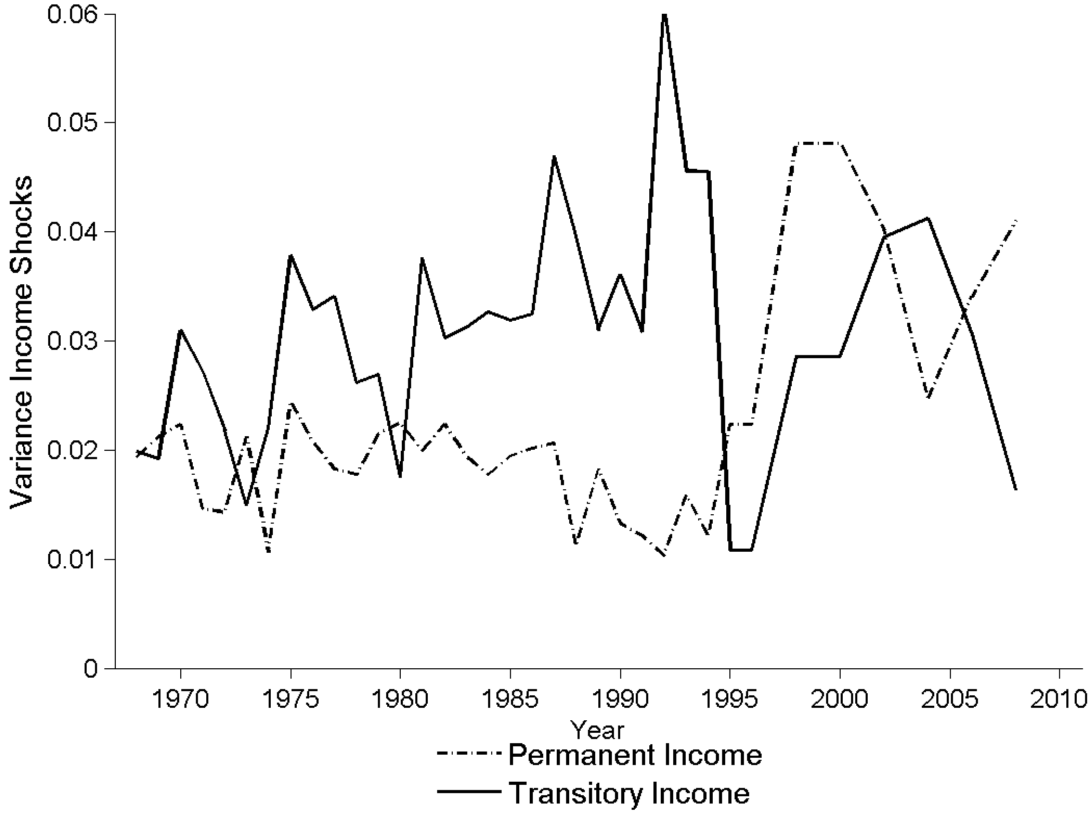
NOTE.— These panels depict the variance and covariance of income and consumption from the PSID after removing the deterministic characteristics, $Z_{i,t}$, using regressions of these variables on year dummies and a set of dummies for socio-demogrpahic characteristics.

Figure 3: Mean and Standard Deviation of Log Non-durable Expenditures



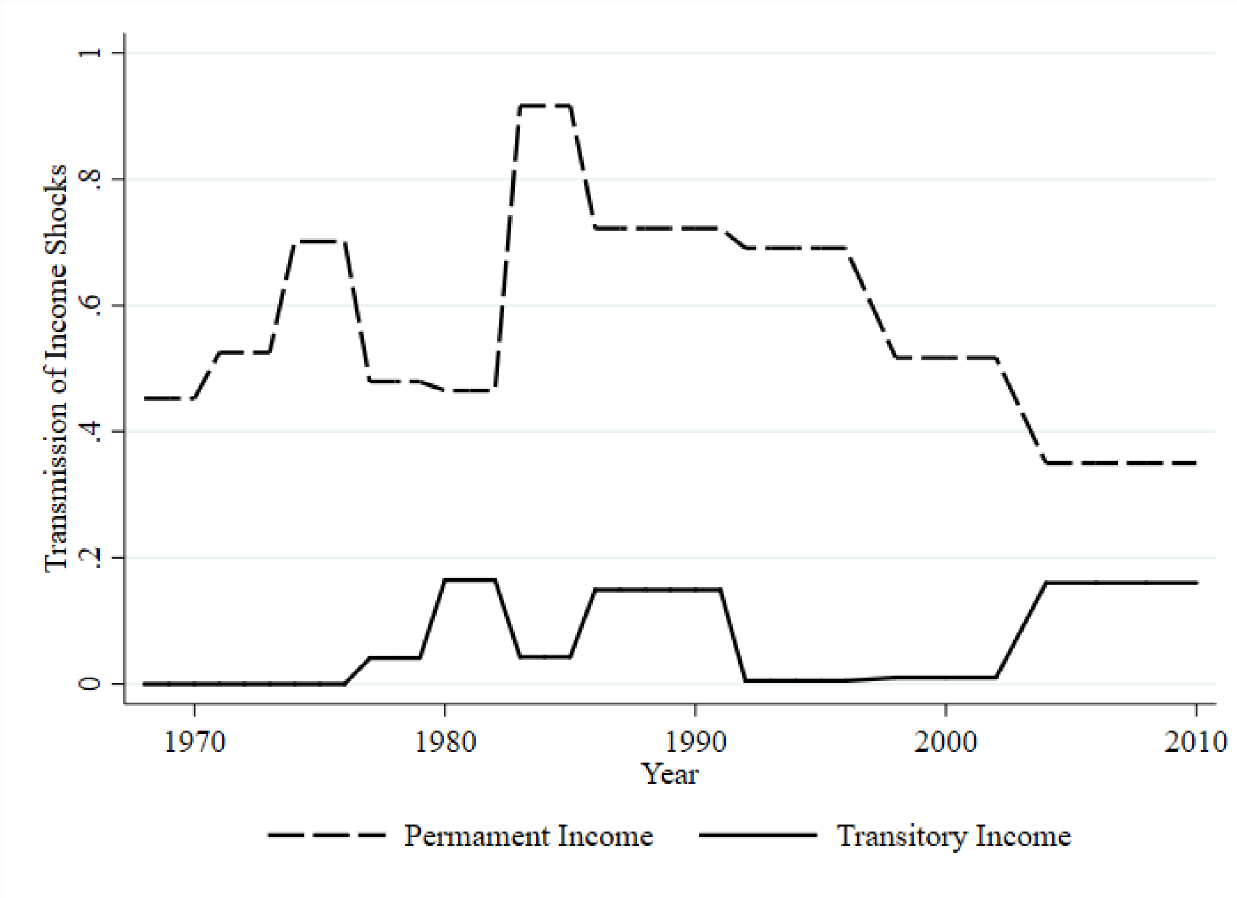
NOTE.— See Table A.4 notes for an explanation of the NIPA average and non-durable consumption imputation (PSID imp.)

Figure 4: Variance of Permanent and Transitory Income Shocks



NOTE.— Estimates from the minimum distance estimation. Point estimates and standard errors are reported in Table B.6. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984).

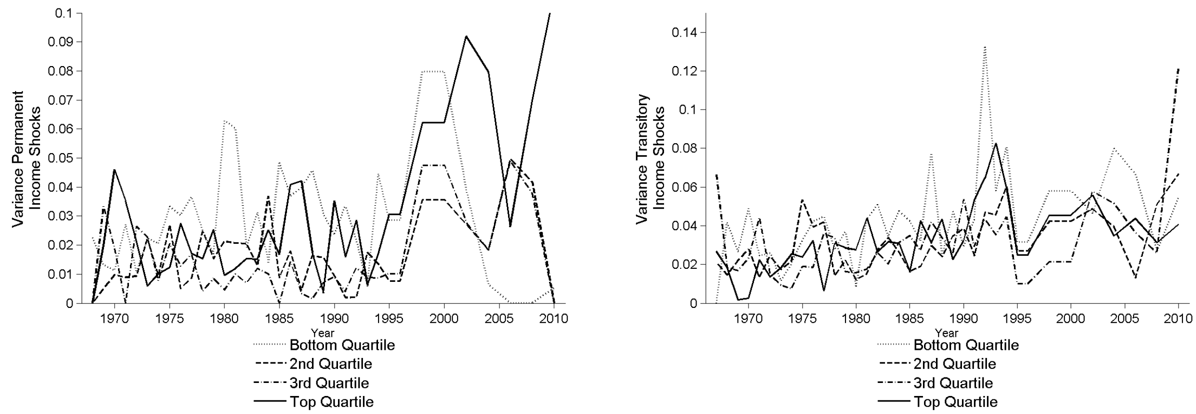
Figure 5: Transmission of Income Shocks



NOTE.— Estimates from the minimum distance estimation. Point estimates and standard errors are reported in Table B.7. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984).

Figure 6: Variance of Permanent and Transitory Income Shocks, by Income Quartiles

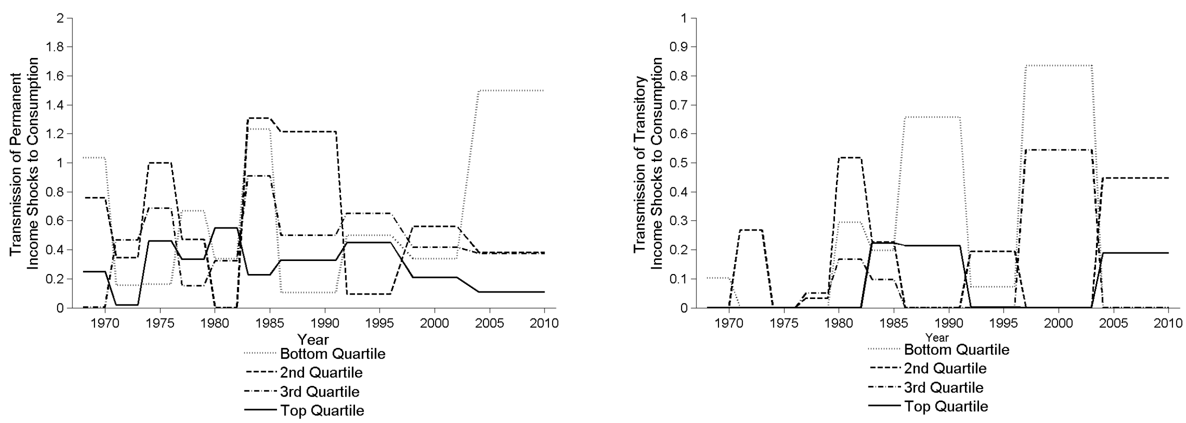
A) Variance of Permanent Income Shocks B) Variance of Transitory Income Shocks



NOTE.— Estimates from the minimum distance estimation. We define income quartiles using 1980 as the base year and hold income groups fixed over the full sample. Panel A reports the variance of permanent income shocks by income quartiles. Panel B reports the variance of transitory income shocks by income quartiles.

Figure 7: Transmission of Income Shocks to Consumption, by Income Quartiles

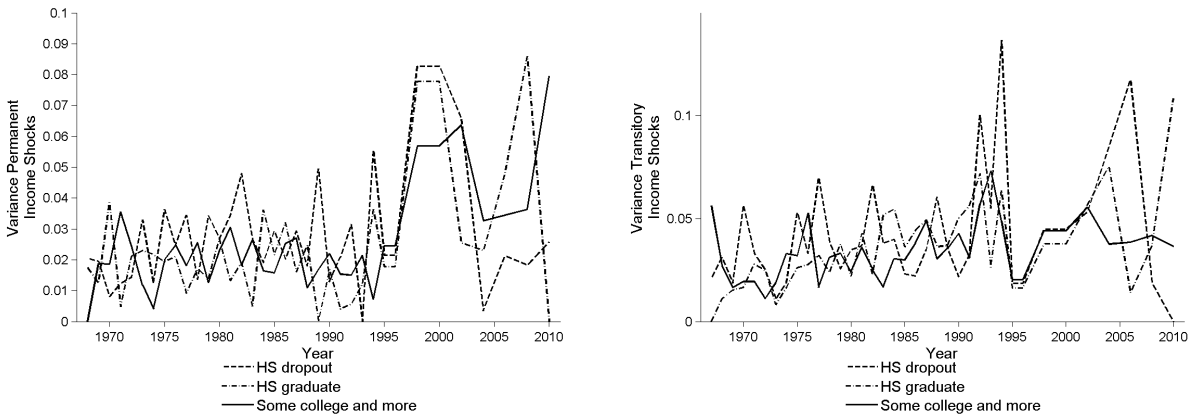
A) Transmission of Permanent Income Shocks B) Transmission of Transitory Income Shocks



NOTE.— Estimates from the minimum distance estimation. We define income quartiles using 1980 as the base year and hold income groups fixed over the full sample. Panel A reports the transmission of permanent income shocks by income quartiles. Panel B reports the transmission of transitory income shocks by income quartiles.

Figure 8: Variance of Permanent and Transitory Income Shocks, by Education

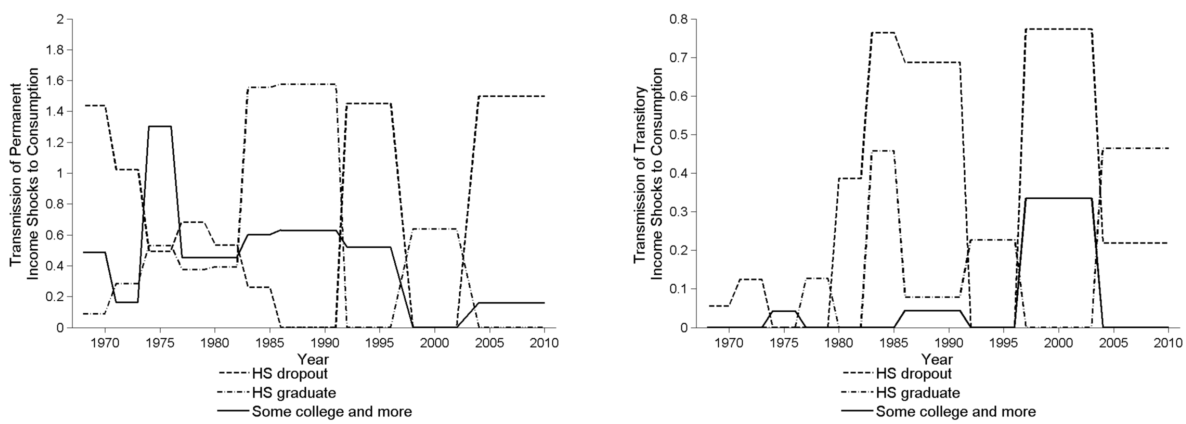
A) Variance of Permanent Income Shocks B) Variance of Transitory Income Shocks



NOTE.— Estimates from the minimum distance estimation. We consider three education groups, high school dropouts, high school graduates, and some college or more. Panel A reports the variance of permanent income shocks by education groups. Panel B reports the variance of transitory income shocks by education groups.

Figure 9: Transmission of Income Shocks to Consumption, by Education

A) Transmission of Permanent Income Shocks B) Transmission of Transitory Income Shocks



NOTE.— Estimates from the minimum distance estimation. We consider three education groups, high school dropouts, high school graduates, and some college or more. Panel A reports the transmission of permanent income shocks by education groups. Panel B reports the transmission of transitory income shocks by education groups.

Table 1: Comparison of Means (Variances)—PSID and CEX

	1973		1982		1990		1998		2004		2010	
	PSID(R)	CEX	PSID(R)	CEX	PSID(R)	CEX	PSID(R)	CEX	PSID(R)	CEX	PSID(R)	CEX
Age	42.13	44.36	43.63	44.85	44.94	45.98	45.23	47.03	45.74	48.17	46.79	48.93
	(6.669)	(8.933)	(9.820)	(9.643)	(10.02)	(9.879)	(8.968)	(9.458)	(9.933)	(9.291)	(10.24)	(9.839)
Family Size	4.173	4.069	3.513	3.782	3.382	3.609	3.438	3.371	3.342	3.387	3.396	3.449
	(1.614)	(1.759)	(1.234)	(1.512)	(1.206)	(1.444)	(1.330)	(1.280)	(1.298)	(1.358)	(1.374)	(1.449)
No. of Kids	1.772	1.648	1.228	1.228	1.100	1.163	1.109	1.045	1.043	1.038	1.111	1.039
	(1.536)	(1.603)	(1.213)	(1.280)	(1.184)	(1.272)	(1.215)	(1.172)	(1.181)	(1.215)	(1.273)	(1.240)
White	0.895	0.925	0.919	0.895	0.934	0.875	0.792	0.877	0.855	0.868	0.859	0.848
	(0.307)	(0.264)	(0.272)	(0.307)	(0.248)	(0.330)	(0.406)	(0.328)	(0.352)	(0.339)	(0.349)	(0.359)
Food expenditures	2,953	2,433	4,672	4,385	6,034	6,171	7,393	6,549	8,773	7,636	9,602	9,298
	(1,178)	(968.8)	(2,299)	(1,837)	(2,718)	(2,939)	(3,713)	(2,937)	(4,969)	(3,436)	(5,027)	(4,546)
Disposable income	15,891	19,687	30,819	30,083	51,265	45,500	66,909	59,553	80,168	86,540	92,657	95,420
	(6,587)	(8,787)	(14,485)	(17,844)	(31,538)	(29,527)	(45,191)	(43,467)	(63,709)	(61,429)	(86,405)	(72,393)
HS dropout	0.280	0.317	0.180	0.187	0.135	0.151	0.162	0.120	0.127	0.104	0.107	0.113
	(0.449)	(0.465)	(0.384)	(0.390)	(0.342)	(0.358)	(0.368)	(0.326)	(0.333)	(0.305)	(0.309)	(0.317)
HS graduate	0.321	0.347	0.315	0.326	0.308	0.284	0.279	0.282	0.258	0.255	0.259	0.261
	(0.467)	(0.476)	(0.465)	(0.469)	(0.462)	(0.451)	(0.449)	(0.450)	(0.438)	(0.436)	(0.438)	(0.439)
At least some college	0.399	0.336	0.505	0.486	0.557	0.565	0.560	0.597	0.614	0.641	0.634	0.626
	(0.490)	(0.472)	(0.500)	(0.500)	(0.497)	(0.496)	(0.497)	(0.491)	(0.487)	(0.480)	(0.482)	(0.484)
Northeast	0.259	0.204	0.223	0.235	0.234	0.225	0.211	0.170	0.187	0.164	0.181	0.187
	(0.439)	(0.403)	(0.416)	(0.424)	(0.424)	(0.418)	(0.408)	(0.376)	(0.390)	(0.370)	(0.385)	(0.390)
Midwest	0.305	0.286	0.299	0.282	0.303	0.265	0.277	0.255	0.278	0.254	0.275	0.251
	(0.461)	(0.452)	(0.458)	(0.450)	(0.460)	(0.442)	(0.448)	(0.436)	(0.448)	(0.435)	(0.447)	(0.434)
South	0.284	0.297	0.313	0.274	0.295	0.272	0.283	0.341	0.297	0.303	0.296	0.332
	(0.451)	(0.457)	(0.464)	(0.446)	(0.456)	(0.445)	(0.450)	(0.474)	(0.457)	(0.460)	(0.457)	(0.471)
West	0.152	0.213	0.165	0.208	0.168	0.238	0.229	0.234	0.238	0.280	0.249	0.230
	(0.360)	(0.410)	(0.372)	(0.406)	(0.374)	(0.426)	(0.420)	(0.424)	(0.426)	(0.449)	(0.432)	(0.421)
Husband working	0.984	0.941	0.950	0.928	0.924	0.912	0.946	0.893	0.927	0.891	0.890	0.872
	(0.127)	(0.237)	(0.217)	(0.259)	(0.266)	(0.284)	(0.227)	(0.309)	(0.261)	(0.311)	(0.313)	(0.334)
Wife working	0.551	0.525	0.723	0.662	0.804	0.729	0.802	0.735	0.800	0.729	0.781	0.675
	(0.498)	(0.499)	(0.448)	(0.473)	(0.397)	(0.444)	(0.399)	(0.441)	(0.401)	(0.445)	(0.414)	(0.469)
Observations	486	3,850	745	1,094	851	1,301	1,065	1,395	1,242	1,241	1,238	1,723

NOTE.— R = Representative PSID households (drawn from the national survey only); CEX = Consumer Expenditure Survey. Standard errors are in parentheses.

Table 2: Decomposition of Changes in the Transmission of Income Shocks to Consumption

Panel A: Average Transmission Levels of Income Shocks

Periods	Permanent ϕ	Transitory ψ
	(1)	(2)
Average 1968--2010	0.593	0.065
	(0.027)	(0.012)
Average 1968--1979	0.539	0.011
	(0.029)	(0.005)
Average 1980--1991	0.706	0.126
	(0.048)	(0.015)
Average 1992--2010	0.550	0.049
	(0.045)	(0.022)

Panel B: Changes In Transmission of Permanent Income Shocks

Periods	Change in ϕ	Active	Passive	Behavioral
	(1)	(2)	(3)	(4)
(1968--1979) to (1992--2010)	0.011	0.297	-0.566	0.280
	(0.022)	(0.062)	(0.026)	(0.049)
(1968--1979) to (1980--1991)	0.167	0.140	-0.143	0.170
	(0.013)	(0.015)	(0.021)	(0.021)
(1980--1991) to (1992--2010)	-0.156	0.157	-0.423	0.110
	(0.023)	(0.016)	(0.034)	(0.033)

Panel C: Transmission of Transitory Income Shocks

Periods	Change in ψ	Active	Passive	Behavioral
	(1)	(2)	(3)	(4)
(1968--1979) to (1992--2010)	0.038	-0.020	0.158	-0.100
	(0.005)	(0.008)	(0.004)	(0.007)
(1968--1979) to (1980--1991)	0.116	-0.009	0.040	0.086
	(0.004)	(0.004)	(0.006)	(0.006)
(1980--1991) to (1992--2010)	-0.078	-0.010	0.118	-0.185
	(0.011)	(0.004)	(0.011)	(0.010)

NOTE.— Estimates from the minimum distance estimation. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984). The transmission of permanent and transitory income shocks to consumption is given by,

$$\Delta c_{i,t} = \phi_t \zeta_{i,t} + \psi_t \varepsilon_{i,t} + \xi_{i,t}.$$

where $\zeta_{i,t}$ and $\varepsilon_{i,t}$ are permanent and transitory income shocks, respectively. The transmission parameters are decomposed using a Oaxaca (1973) and Blinder (1973) decomposition according to equation (13).

Table 3: Average Levels of Transmission of Income Shocks to Consumption, by Income Quartiles

Periods	Income Quartile Bottom (1)	2nd (2)	3rd (3)	Top (4)
Panel A: Transmission of Permanent Income Shocks ϕ				
Average 1968--2010	0.582	0.629	0.463	0.301
	(0.080)	(0.075)	(0.039)	(0.025)
Average 1968--1979	0.507	0.645	0.329	0.266
	(0.112)	(0.077)	(0.080)	(0.049)
Average 1980--1991	0.446	0.934	0.559	0.359
	(0.140)	(0.163)	(0.065)	(0.035)
Average 1992--2010	0.729	0.301	0.512	0.291
	(0.151)	(0.063)	(0.041)	(0.047)
Panel B: Transmission of Transitory Income Shocks ψ				
Average 1968--2010	0.239	0.164	0.072	0.076
	(0.049)	(0.031)	(0.026)	(0.017)
Average 1968--1979	0.026	0.076	0.013	0.001
	(0.014)	(0.034)	(0.007)	(0.001)
Average 1980--1991	0.453	0.186	0.066	0.164
	(0.063)	(0.064)	(0.021)	(0.028)
Average 1992--2010	0.261	0.211	0.149	0.053
	(0.112)	(0.053)	(0.077)	(0.026)

NOTE.— Estimates from the minimum distance estimation. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984). The transmission of permanent and transitory income shocks to consumption is given by,

$$\Delta c_{i,t} = \phi_t \zeta_{i,t} + \psi_t \varepsilon_{i,t} + \xi_{i,t}.$$

where $\zeta_{i,t}$ and $\varepsilon_{i,t}$ are permanent and transitory income shocks, respectively.

Table 4: Decomposition of Changes in the Transmission of Permanent Income Shocks to Consumption, by Income Quartiles

Periods	Change ϕ	Percent of Total Change		
		Active	Passive	Behavioral
	(1)	(2)	(3)	(4)
Panel A: bottom income quartile				
(1968--1979) to (1992--2010)	0.222	-0.300	-0.435	0.957
	(0.044)	(0.059)	(0.061)	(0.109)
(1968--1979) to (1980--1991)	-0.061	-0.184	0.682	-0.559
	(0.042)	(0.082)	(0.177)	(0.249)
(1980--1991) to (1992--2010)	0.283	-0.116	-1.117	1.516
	(0.049)	(0.052)	(0.290)	(0.255)
Panel B: 2nd income quartile				
(1968--1979) to (1992--2010)	-0.344	1.677	-1.246	-0.774
	(0.024)	(0.184)	(0.113)	(0.105)
(1968--1979) to (1980--1991)	0.289	0.748	0.191	-0.650
	(0.043)	(0.079)	(0.047)	(0.090)
(1980--1991) to (1992--2010)	-0.633	0.928	-1.437	-0.124
	(0.041)	(0.095)	(0.161)	(0.120)
Panel C: 3rd income quartile				
(1968--1979) to (1992--2010)	0.183	0.128	-0.619	0.674
	(0.022)	(0.174)	(0.060)	(0.132)
(1968--1979) to (1980--1991)	0.230	0.059	-0.182	0.353
	(0.025)	(0.019)	(0.030)	(0.039)
(1980--1991) to (1992--2010)	-0.047	0.069	-0.437	0.321
	(0.018)	(0.023)	(0.050)	(0.043)
Panel D: top income quartile				
(1968--1979) to (1992--2010)	0.025	0.058	-0.032	-0.002
	(0.016)	(0.094)	(0.012)	(0.097)
(1968--1979) to (1980--1991)	0.093	0.031	0.085	-0.024
	(0.014)	(0.011)	(0.015)	(0.021)
(1980--1991) to (1992--2010)	-0.068	0.027	-0.117	0.022
	(0.014)	(0.010)	(0.012)	(0.013)

NOTE.— Estimates from the minimum distance estimation. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984). The transmission of permanent and transitory income shocks to consumption is given by,

$$\Delta c_{i,t} = \phi_t \zeta_{i,t} + \psi_t \varepsilon_{i,t} + \xi_{i,t}.$$

where $\zeta_{i,t}$ and $\varepsilon_{i,t}$ are permanent and transitory income shocks, respectively. The transmission parameters are decomposed using a Oaxaca (1973) and Blinder (1973) decomposition according to equation (13).

Table 5: Average Transmission of Income Shocks to Consumption, by Education

Periods	HS dropout (1)	HS graduate (2)	Some college + (3)
Panel A: Transmission of Permanent Income Shocks ϕ			
Average 1968--2010	0.738	0.585	0.483
	(0.099)	(0.102)	(0.054)
Average 1968--1979	0.910	0.321	0.601
	(0.108)	(0.048)	(0.128)
Average 1980--1991	0.199	1.276	0.578
	(0.067)	(0.153)	(0.022)
Average 1992--2010	1.069	0.174	0.280
	(0.207)	(0.090)	(0.072)
Panel B: Transmission of Transitory Income Shocks ψ			
Average 1968 -- 2010	0.314	0.145	0.039
	(0.053)	(0.029)	(0.015)
Average 1968--1979	0.045	0.032	0.011
	(0.015)	(0.017)	(0.006)
Average 1980--1991	0.631	0.154	0.022
	(0.044)	(0.054)	(0.007)
Average 1992--2010	0.271	0.230	0.091
	(0.102)	(0.054)	(0.047)

NOTE.— Estimates from the minimum distance estimation. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984). The transmission of permanent and transitory income shocks to consumption is given by,

$$\Delta c_{i,t} = \phi_t \zeta_{i,t} + \psi_t \varepsilon_{i,t} + \xi_{i,t}.$$

where $\zeta_{i,t}$ and $\varepsilon_{i,t}$ are permanent and transitory income shocks, respectively.

Table 6: Decomposition of Changes in the Transmission of Permanent Income Shocks to Consumption, by Education

Periods	Change ϕ	Percent of Total Change		
		Active	Passive	Behavioral
	(1)	(2)	(3)	(4)
Panel A: HS dropout				
(1968--1979) to (1992--2010)	-0.003	-0.308	-0.163	0.468
	(0.183)	(0.083)	(0.036)	(0.223)
(1968--1979) to (1980--1991)	-0.711	-0.176	-0.212	-0.323
	(0.029)	(0.015)	(0.020)	(0.032)
(1980--1991) to (1992--2010)	0.708	-0.131	0.049	0.791
	(0.181)	(0.016)	(0.015)	(0.183)
Panel B: HS graduate				
(1968--1979) to (1992--2010)	-0.146	0.981	0.209	-1.336
	(0.024)	(0.047)	(0.008)	(0.057)
(1968--1979) to (1980--1991)	0.955	0.479	0.615	-0.139
	(0.037)	(0.039)	(0.048)	(0.057)
(1980--1991) to (1992--2010)	-1.102	0.502	-0.406	-1.198
	(0.041)	(0.039)	(0.051)	(0.068)
Panel C: Some college and more				
(1968--1979) to (1992--2010)	-0.321	0.186	-0.025	-0.481
	(0.035)	(0.243)	(0.046)	(0.225)
(1968--1979) to (1980--1991)	-0.023	0.102	0.020	-0.145
	(0.031)	(0.007)	(0.004)	(0.032)
(1980--1991) to (1992--2010)	-0.298	0.084	-0.045	-0.337
	(0.018)	(0.006)	(0.005)	(0.018)

NOTE.— Estimates from the minimum distance estimation. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984). The transmission of permanent and transitory income shocks to consumption is given by,

$$\Delta c_{i,t} = \phi_t \zeta_{i,t} + \psi_t \varepsilon_{i,t} + \xi_{i,t}.$$

where $\zeta_{i,t}$ and $\varepsilon_{i,t}$ are permanent and transitory income shocks, respectively. The transmission parameters are decomposed using a Oaxaca (1973) and Blinder (1973) decomposition according to equation (13).

APPENDIX FOR ONLINE PUBLICATION

Appendix A Data

A.1 Imputation of Non-durable Expenditures

For the imputation method, we pool consumption data from available years in the Consumer Expenditure Surveys (CEX) over the period considered, as well as socio-economic individual variables that are both in the PSID and the CEX, and we run the following demand equation for food:

The imputation method uses pooled cross-section data from the CEX in 1972 and 1973 and from 1980 to 2010 and the following demand equation (following Blundell et al. (2008)'s notation) for food, f, expressed in logs:

$$f_{i,t} = \boldsymbol{W}'_{i,t}\boldsymbol{\mu} + \boldsymbol{p}'_t\boldsymbol{\theta} + \beta(D_{i,t})c_{i,t} + e_{i,t}, \tag{A.1}$$

where W includes individual demographic and socio-economic characteristics for each household i in period t, and p denotes relative prices of goods obtained from the Bureau of Labor Statistics' series of the CPI index components (All Urban Consumers). Demand shifters controlling for non-durable expenditure are given by c, expressed in logs, and the budget elasticity β is allowed to vary with observed household characteristics, D. Finally, we allow for unobserved heterogeneity in the measurement error in food expenditures given by e. The budget elasticity is also allowed to vary with time, except in years that do not exist in the PSID, that is every year until 1996 and every other year afterwards. To control for other years we include a quadratic time trend, which is also allowed to shift the budget elasticity.

Food consumption f is constructed as the sum of food at home and away from home, reported in both the PSID and CEX. Our baseline and preferred measure of non-durable consumption is constructed from the CEX as the sum of food, alcohol, tobacco, services, heating fuel, public and private transport (including gasoline), personal care, clothing, and footwear, as proposed by Attanasio and Weber (1995). To provide some external validity to the imputation method, we take advantage of the fact that--starting in 1999--the PSID provides limited consumption variables. We construct a measure of PSID-non-durable consumption for selected years from 2000 to 2010 and use them as a gauge for the the quality of our imputed values of non-durables.

Table A.1 reports the results of a 2SLS of equation (A.1), where we instrument for total expenditures to account for measurement error. Instruments include average hourly wages of husbands and wives by year, number of kids, and education. External instruments include demographics such as age, ethnicity, region, family size, and cohorts. This specification passes the test of over-identifying restrictions, as the test fails to reject the null hypothesis that instrumental variables are uncorrelated with the residuals (p-value of 14.6 percent).[33] The estimates generally have the expected sign and magnitude. The budget elasticity is 0.806, and the price elasticity is -0.577 . We reject the null hypothesis that the budget elasticity has remained constant over the period (p-value less than 0.001 percent). The estimates show that the budget elasticity decreases in the 1980s (as in Blundell et al. (2008), except for the late 1980s, and continues to decrease in the years afterwards. The elasticity of food to total consumption was the largest in the 1970s. If we limit the estimation period to the period covered in Blundell et al. (2008), we estimate a similar budget elasticity of 0.84. We run the same regressions for the three broader measures of consumption. As the results are consistent, for exposition purposes, we only report these results in Appendix A.6.[34] These estimates allow us to invert the demand function and impute non-durable consumption for all households selected from the PSID.[35]

[33]We also include a test for the power of external instruments, which passes as its p-value is close to 1.

[34]In Tables A.5, A.6, and A.7, the budget elasticity and price elasticity for total expenditures are 0.93 and -0.64, respectively. The budget elasticity of non-durables and total expenditures, including services from durable goods, are of the same order of magnitude (around 0.98 and 0.92, respectively).

[35]We also impute in the PSID the three broader measures of consumption by inverting the specifications presented in Appendix A.6.

Table A.1: The Demand for Food in the CEX-Non-durable goods

Variable	Estimate	Variable	Estimate	Variable	Estimate	Variable	Estimate
ln c	0.806***	ln c x 1989	-0.00816	lc x ytrend2	5.70e-05	Born 1960-64	0.0151
	0.171		0.054		0.000		0.053
ln c x HS dropout	0.0590**	ln c x 1990	-0.00644	Age	0.0452***	Born 1955-59	-0.0158
	0.027		0.054		0.005		0.047
ln c x HS graduate	0.170***	ln c x 1991	-0.0299	Age^2	-0.000424***	Born 1950-54	-0.0171
	0.055		0.065		5.24e		0.040
ln c x one child	-0.0489***	ln c x 1992	-0.0281	p_{food}	-0.577**	Born 1945-49	-0.0277
	0.010		0.068		0.242		0.034
ln c x two children	-0.0665***	ln c x 1993	-0.0234	$p_{alcohol+tobacco}$	3.181*	Born 1940-44	-0.0384
	0.010		0.068		1.888		0.030
ln c x three children +	-0.0898***	ln c x 1994	-0.0148	$p_{fuel+utils}$	0.817	Born 1935-40	-0.0254
	0.013		0.067		2.363		0.023
ln c x 1973	0.00426	ln c x 1995	-0.00381	$p_{transports}$	-2.329	Born 1930-34	-0.00685
	0.012		0.068		3.606		0.017
ln c x 1981	-0.00280	ln c x 1996	-0.00678	HS dropout	-0.530**	Born 1925-29	-0.00533
	0.005		0.068		0.256		0.012
ln c x 1982	-0.0152	ln c x 1998	-0.00947	HS graduate	-1.605***	One Child	0.517***
	0.013		0.074		0.536		0.102
ln c x 1983	-0.0183	ln c x 2000	-0.000837	Northeast	0.0154***	Two children	0.712***
	0.024		0.067		0.005		0.104
ln c x 1984	-0.0126	ln c x 2002	-0.00956	Midwest	-0.0194**	Three children+	0.937***
	0.024		0.065		0.008		0.130
ln c x 1985	-0.0105	ln c x 2004	-0.00608	South	-0.00810	Family Size	0.0480***
	0.027		0.050		0.009		0.006
ln c x 1986	-0.0244	ln c x 2006	0.000276	Born 1975-79	0.0766	White	0.0977***
	0.049		0.026		0.072		0.010
ln c x 1987	-0.0165	ln c x 2008	0.00379	Born 1970-74	0.0587	Constant	0.454
	0.049		0.009		0.065		0.815
ln c x 1988	-0.0105	lc x ytrend	-0.0101	Born 1965-69	0.0318		
	0.053		0.018		0.059		
Number of observations	5,883	R-squared	0.472				
Test of overidentifying restrictions			38.601				
			(d.f. 30; χ^2 p-value 0.135)				
Test time consistency of income elasticity			75.930				
			(d.f. 31; χ^2 p-value 0.000)				

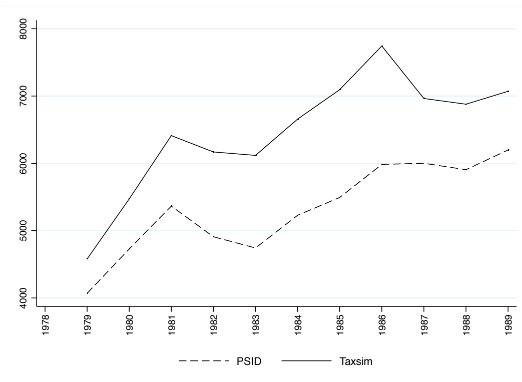
NOTE.— This table reports IV estimates of the demand equation for (the logarithm of) food spending in the CEX. We use family composition-education-year specific average of the log of husbands' and wives' hourly wages as instruments for the log of total non-durable expenditure and its interactions with year, education, and kids dummies. Standard errors are in parentheses. *** Significant at the 1 percent level. ** Significant at the 5 percent level. * Significant at the 10 percent level.

The imputed values of non-durable consumption are provided in Appendix A.5, where we further ensure the accuracy of reported non-durable consumption using recent PSID data and NIPA accounts.

A.2 Federal Income Tax

To estimate the impact of the tax system on insurance, as described in equation (9), we use information on family income to simulate tax liabilities over time using the National Bureau of Economic Research's TaxSim 27 software with income information obtained from the PSID such as wages, other income, marital status, and number of children. NBER TaxSim 27 software. We simulate federal tax liability after tax credits and refunds, for all years covered in our sample. The NBER's Taxsim v.27 program can estimate federal tax liability from 1960 to 2017 and state tax liability from 1977 to 2017. The program takes into account up to 27 income, deduction, and personal characteristics in the calculation of taxes. From 1970 to 1991, the PSID asked respondents their total household federal income tax. Other studies, notably Blundell, Pistaferri, and Preston (2008), and Blundell et al. (2008), use the PSID reported federal tax liability from 1980 to 1991 and combine it with simulations of federal tax liability in 1992 and 1993, using NBER TaxSim v.9. For consistency purposes throughout the period we simulate tax liability using TaxSim throughout the period. Figure A.1 compares the average federal tax liability observed in the PSID with tax liability simulated from TaxSim. Some of the difference is a result of deductions. On the one hand, TaxSim assumes that individuals take all deductions for which they are eligible, regardless of what the household actually takes. On the other hand, the PSID may not include enough income information, in which case using PSID income data to simulate tax liability from TaxSim would not account for all possible deductions that a household could take. To test whether TaxSim systematically under- or over- simulates federal tax liability, relative to the PSID, we regress the difference between federal tax payments reported in the PSID and simulated tax payments using TaxSim from 1967 to 1992, on year and state dummies, number of children, age of husbands and wives, their labor incomes, other income, and rent. We find that only labor income and other income are significant (p-values < 0.05 percent). The coefficients suggest that, relative to the PSID, for an additional \$100 of husband's or wives' labor income, TaxSim under-reports federal tax liability by \$5, and for an additional \$100 of other taxable income TaxSim under-reports \$16 of tax liability. Despite these limitations, we feel that TaxSim's estimates are sufficient to capture the insurance embedded in the tax system, which is the main focus of this paper.

Figure A.1: Mean Federal Tax Liability—Taxsim-PSID



A.3 Consumer Expenditure Survey

Consumption data are obtained from the Consumer Expenditure Survey (CEX) for all available years including 1972, 1973, and from 1980 to 2010, provided by the bureau of Labor Statistics for the primary purpose of the CPI. The CEX defined a household head as the primary owner or renter or the family unit. Since the PSID systematically define a household head as the husband in a family, we make the two definitions compatible across databases before the imputation. The CEX is a cross-section that provides two components, the Diary and the Interview surveys. The former covers two consecutive weeks and is designed to collect detailed expenditure data on small and frequently purchased items such as food, clothes, home supplies. The Interview sample is collected over a period of 5 quarters, with basic and inventory purchase data collected only in the first quarter. This sample covers 95 percent of all expenditures, excluding housekeeping supplies, non-prescription drugs, and personal care products. We follow previous research (Blundell et al.,

2008) by focusing on the Interview survey.[36] We match the timing of income information in the CEX to that of the PSID by using income measured in the fifth quarter, which refers to income information for the previous twelve months.

To collect information on non-durable consumption, semi-durables (including education and health services), and durables (e.g., jewelry, vehicles), we use monthly expenditure files (MTAB) for each quarter. To obtain socioeconomic and income information, we use member files and family files (MEMB and FMLY). We also calculate the value of service flows from two important consumer durables: owner-occupied housing and owned vehicles. CEX surveys from 1980 onwards have a consistent format. However, in the 1972-73 surveys, Universal Classification Codes (UCC) are different from those in 1980 and after. We carefully match our definition of consumption variables between these two formats. To construct non-durable and durable consumption, we adapt Blundell et al. (2008)'s methodology.[37]

The step-by-step selection of the CEX sample is provided in Table A.2. Our initial CEX sample over 1972-1973, and 1980-2010 includes 288,479 households. We drop those with missing data on food and/or no total non-durable expenditures. To ensure that we obtain a consistent measure of annual consumption, we drop households who did not complete 12 successive survey months. As many household are interviewed over 12 months covering two successive years, we compute annual spending by pooling all months and assign the spending period to the year that covers at least 6 months. Prices are adjusted accordingly. We construct food expenses as the sum of food at home and away from home. We drop those with no pretax-income, missing information on region or education, single households and those with unstable family composition. We also eliminate households with heads born before 1920 or after 1980, aged less than 30 or more than 6 years old, and income outliers defined as an amount of income lower than expenditures on food, and incomplete income responses. Our final sample includes 55,257 households over 1972-1973 and 1980-2010.

[36] Attanasio and Pistaferri (2014) provide evidence over 1980 to 2010 that the trends in consumption inequality are consistent regardless of using the Diary or the Interview surveys.

[37] Programs to construct variables are available on demand.

Table A.2: Sample selection in the CEX

(Initial sample, 1980-2011)	N/A	288,479
Missing expenditure data	2,499	285,980
Present for less than 12 months	139,529	146,451
Zero before tax income	4,627	141,824
Missing values	5,345	136,479
Missing marital status	57,990	78,489
Born before 1920 or after 1979	5,252	73,237
Born before 1911 or after 1952	1,339	71,898
Born before 1912 or after 1953	1,276	70,622
Aged less than 30 or more than 65	13,854	56,768
Income outliers and incompatible income response	1,511	55,257

All Stata programs to construct CEX consumption variables are available on the author's Web site, which include: *readmemb.do*, *readfmly.do*, *readmtab.do*, *cexall.do*, and *cexall_plus.do*.

Python programs used to construct consumption data in 1972 and 1973 include *Script1972.py*, *Script1973.py*.

CEX data and dictionaries are publicly available on the ICPSR & BLS websites. CPI Index data from the BLS are named *natpr59_12.dta*.

A.3.1 Service Flow of Owner-Occupied Housing

To calculate the value of the service flow from owner-occupied housing, we use the definition provided by the Bureau of Labor Statistics.[38] Housing includes expenses associated with owning or renting a home or apartment, including rental payments, mortgage interest and charges, property taxes, contracted repairs and maintenance, insurance, and utilities, both for owner-occupied housing and for vacation homes. (Rental payments are not provided in years 1972 and 1973.) Certain expenditures for other lodging and household operations are not included because they already appear in the definition of non-durable consumption. These include owner-occupied housing and vacation home insurance, parking owned, property management costs, and owned repair equipment.

[38] See Johnson and Torrey (2005).

Expenditures for principal payments on existing mortgages are excluded. The data are directly obtained from CEX expenditures files.

Additional data used to construct the service flow of owner-occupied housing are available on the author's Web site.

A.3.2 Service Flow of Owned Vehicles

For the value of the service flow from vehicles, we use two additional CEX surveys: ''inventory and purchases of owned vehicles'' and ''vehicle make/model code titles.'' For cars and trucks, we follow the methodology developed by Danziger and Smolensky (1984), Slesnick (1994) and Johnson and Torrey (2005), and define the service flow of cars and trucks as the annual change in the value of vehicles, using the purchase price of a vehicle (P_0) and its age (a). The service flow of vehicles in year t is given by:

$$S_t = (r+d).(1-d)^a.P_0, \tag{A.2}$$

where r is the interest rate and d is the depreciation rate. (We assume that $r = .05$ and $d = .1$.)

We collect data on vehicles for all households surveyed in the CEX. The CEX does not collect vehicles information in five survey years: 1980-1983 and 1992. The survey provides information on the age, the model type, the brand, the year acquired, the status of the car (''old'' or ''new''), the trade-in allowance, and the amount paid for the vehicle after trade-in and transmission. However, the purchase price is only provided for vehicles purchased at most 12 months before the interview year (i.e., years t and $t-1$ of a given survey year). We impute the value of vehicles purchased before $t-1$ as the average price of comparable cars, after inflation and depreciation. For this, we group cars in each year of the CEX survey into bins that depend on detailed car characteristics and calculate their average price based on the price of recently purchased cars, adjusting for inflation.[39]

Vehicles are grouped into bins for each year, by type, brand, old-new status, and year acquired,

[39] We use a \$3 average inflation per year, based on the Consumer Price Index for All Urban Consumers: New vehicles (CUUR0000SETA01) provided by The Federal Reserve Bank of St. Louis.

to construct an average purchase price, for recently purchased cars by group and year as the sum of the trade-in amount and the amount paid after the trade-in. The service flow value for vehicles purchased in earlier years is computed using equation (A.2).

Programs are provided on the author's Web site *Script_vehicles_[year].py*. Vehicles data from the CEX are publicly available on the ICPSR website.

A.4 Panel Survey of Income Dynamics

The Panel Study of Income Dynamics started collecting information on roughly 3,000 households representing the US population as a whole starting in 1968. Children have been followed since they moved out of their family's home. The PSID engaged in a large recontact effort initiated in 1992 for households that had previously dropped out. Starting with the 1999 wave, the PSID switched to a biennial interview, rather than annual. For robustness and to investigate possible heterogeneity in results by income, we also use the Census Bureau's Survey of Economic Opportunities, or SEO sample, which is a sample of roughly 2,000 low-income families.

The questions from the PSID vary from year to year, but a core group of socioeconomic characteristics of households are almost always reported, including income and food spending. Questions about income are retrospective in nature; thus answers in 1985 refer to income in 1984. The timing of other variables is not always as clear. For instance, survey questions on food have been interpreted both as retrospective and contemporaneous (Hall and Mishkin, 1982; Altonji and Siow, 1987). Interviews are typically conducted in March, and participants are asked how much they spent on food in an average week; thus the confusion of whether participants' answers best represents the amount spent in calendar year t or t-1. We assume the answers are retrospective.

Household data are obtained from the Panel Study of Income Dynamics for the years 1967 to 2010. We obtain information on household demographics (e.g., age, sex, race), income (including wages of husbands and wives and hours worked), family composition (including number of kids and marital status), and consumption expenditures (e.g., food at home and out and insurance and

Table A.3: Sample selection in the PSID

Reason for exclusion	# dropped	# remain
(Initial period, 1967-2011)	NA	264,810
Latino subsample	12,343	252,467
Intermittent headship	48,170	204,297
Change in family composition	53,454	150,843
Female head	50,864	99,979
Missing values	5,789	94,190
Change in marital status	11,111	83,079
Income outliers	8,835	74,244
Born before 1920 or after 1979	10,417	63,827
Aged less than 30 or more than 65	17,416	46,411

vehicle payments), using the PSID family files.[40]

To ensure that we capture changes in consumption that are related to income risk rather than due to changes in family composition, we limit the sample to continuously married couples headed by a male (with or without children). We eliminate households experiencing significant changes in family composition by keeping families with no change in family composition and families that have experienced a change other than that of the head or the the wife (e.g., we eliminate divorced couples but we keep couples with a new child). We eliminate couple headed by a female. We also eliminate families with inconsistent or missing information on important covariates including missing education and region, as well as income outliers (households with extreme income growth by more than 500 percent or loss of more than 80 percent). We also eliminate families with heads born before 1920 or after 1980. The step-by-step selection of the PSID sample is provided in Table A.3. The full PSID sample includes a latino-subsample for which individual data are not available. Starting from an unbalanced panel (excluding the latino subsample) consisting of 37 years from 1967 to 2010, 13,623 households followed over periods, and 252,467 observations, our final sample includes 9,373 households and 46,411 observations.

All Stata programs to construct PSID household variables are provided on the author's Web

[40]The full list and exact variable identification in the PSID are given in the do file, PSIDFamilyFiles.do.

site, which includes: *PSIDFamilyFiles.do*, *PSIDIndividualFile.do*, and *SampleSelection.do*. PSID data are publicly available on the ICPSR website.

A.5 Comparison of CEX and PSID Data and Imputations

To further ensure accuracy of the demand equation, we compare food consumption and other covariates obtained from the PSID (representative and SEO samples) with the CEX, as well as a measure of food consumption obtained from national aggregates in NIPA accounts. Table 1 shows the summary statistics of these variables in selected years. To account for the discrepancy between food expenses included in the two databases, we apply an annual weight to PSID observations calculated as the difference in logs of annual averages between NIPA and PSID measures. Because this weight is uniformly applied to all observations, its only effect is to adjust the sample mean. The means of food consumption are close in the PSID and CEX. As expected, since the purpose of the CEX is to follow household consumption, food consumption is less volatile in the CEX. In all other categories, the demographics look very similar between the representative subsample of the PSID and the CEX. Overall, this validates the imputation method to construct our panel data of consumption for PSID households based on the CEX.

Table A.4 compares the imputed values of non-durable consumption with reported non-durable consumption in the PSID for the years in which non-durable consumption was collected in the PSID (post-1999). The first three rows demonstrate the closeness in fit between food expenditures reported in the PSID and the CEX. The measures of average non-durable consumption are also compared to a non-durable personal expenditures per person obtained from NIPA accounts. The imputed value is around 1 percent or less than the PSID and the CEX values, as shown in Table A.4. In addition, imputed and PSID reported non-durable expenditures exhibit similar trends and variation, as shown in Figure 3.[41] Finally, the imputed PSID values of consumption lie between the PSID and the NIPA values (where, as was the case for food expenses, the NIPA trend lies

[41] The large changes in the variance of total spending in the PSID from 1998 to 2002 are not surprising, as the 1999 and 2001 questionnaires were slightly different from those used in later years. Moreover, several expenditure items were added to PSID waves in 2004 and after (Li et al., 2010).

consistently below the PSID and CEX trends). These descriptive statistics support the ability of the imputation method to capture non-durable expenditures, although this evidence includes only the last decade of the four decades covered in this paper.[42]

[42] Andreski, Li, Samancioglu and Schoeni (2014) also compare the sum of all expenditures reported in the PSID (as opposed to non-durable consumption, which includes durable goods such as imputed housing and vehicles) with the CEX from 1999 to 2003. Combining all PSID categories, annual spending totals $25,961, 2 percent greater than CEX spending. Estimates for 1999 and 2003 are similar, with PSID total spending being 4 percent smaller than CEX spending in 1999 and 1 percent larger than in 2003. As reported by the CEX in 2001, spending on categories included in the PSID totals $25,340, which accounts for 72 percent of total spending across all CEX categories. This spending gap falls largely into five categories not measured in the 1999, 2001, or 2003 PSID waves: home repairs and maintenance, household furnishings and equipment, clothing and apparel, trips and vacations, and recreation and entertainment. PSID added questions covering these spending items in the 2005 and subsequent waves.

Table A.4: Comparisons of PSID, CEX, and Imputed Consumption

	2000				2002				2004			
	PSID	CEX	PSID (imp)	NIPA	PSID	CEX	PSID (imp.)	NIPA	PSID	CEX	PSID (imp.)	NIPA
Food expenses	8.747	8.758	8.747	8.120	8.745	8.795	8.745	8.164	8.826	8.851	8.826	8.256
	(0.757)	(0.429)	(0.757)	-	(0.773)	(0.433)	(0.773)	-	(0.776)	(0.443)	(0.776)	-
Non-durable expenses	9.994	9.934	10.48	9.588	10.12	9.981	10.48	9.638	10.16	10.02	10.56	9.731
	(0.995)	(0.441)	(1.320)	-	(1.132)	(0.432)	(1.389)	-	(1.012)	(0.463)	(1.394)	-
Non-&semi-durable expenses	-	10.31	11.42	9.977	-	10.37	11.59	10.04	-	10.38	11.80	10.14
	-	(0.528)	(1.361)	-	-	(0.529)	(1.498)	-	-	(0.572)	(1.527)	-
Non-durable and durable expenses	-	10.01	10.92	-	-	10.07	11.06	-	-	10.10	11.24	-
	-	(0.430)	(1.160)	-	-	(0.420)	(1.257)	-	-	(0.453)	(1.271)	-
Total expenses	-	10.36	11.77	-	-	10.43	12.10	-	-	10.44	12.41	-
	-	(0.516)	(1.359)	-	-	(0.515)	(1.542)	-	-	(0.560)	(1.594)	-
Observations	1,296	2,043	1,296	1,065	1,396	2,135	1,396	1,155	1,509	1,342	1,509	1,242

	2006				2008				2010			
	PSID	CEX	PSID (imp)	NIPA	PSID	CEX	PSID (imp.)	NIPA	PSID	CEX	PSID (imp.)	NIPA
Food expenses	8.834	8.924	8.834	8.352	8.822	9.075	8.822	8.423	8.904	9.043	8.904	8.421
	(0.808)	(0.454)	(0.808)	-	(0.841)	(0.437)	(0.841)	-	(0.817)	(0.466)	(0.817)	-
Non-durable expenses	10.20	10.13	10.53	9.839	10.13	10.22	10.34	9.902	10.13	10.18	10.46	9.899
	(1.010)	(0.446)	(1.495)	-	(0.959)	(0.435)	(1.557)	-	(0.798)	(0.452)	(1.574)	-
Non-&semi-durable expenses	-	10.47	11.86	10.24	-	10.54	11.77	10.29	-	10.48	12.07	10.29
	-	(0.531)	(1.636)	-	-	(0.511)	(1.734)	-	-	(0.534)	(1.804)	-
Non-durable and durable expenses	-	10.22	11.33	-	-	10.31	11.29	-	-	10.26	11.54	-
	-	(0.431)	(1.350)	-	-	(0.420)	(1.419)	-	-	(0.441)	(1.462)	-
Total expenses	-	10.54	12.57	-	-	10.60	12.59	-	-	10.54	13.09	-
	-	(0.514)	(1.718)	-	-	(0.495)	(1.846)	-	-	(0.521)	(1.962)	-
Observations	1,580	2,125	1,580	1,303	1,685	1,978	1,685	1,386	1,504	1,863	1,504	1,238

NOTE.— Average non-durable consumption in NIPA is the difference of the logs of non-durable personal expenditures and mid-period population. Non-durable personal expenditures include non-durables, housing goods, utilities, transportation and communication services, personal services (food & accommodation, household care, etc.) and professional services (Table 2.4.5—Personal Consumption Expenditures by Type of Product). *PSID* and *CEX* are the observed PSID and CEX averages, respectively. PSID (imp.) represents the measures of consumption imputed in the PSID using the CEX-based demand equation, and NIPA weights (as described in table 1's footnote). Four measures of consumption are imputed, as described in the text and in Appendix A.6.

A.6 Demand for Food in CEX—Alternative Measures of Total Consumption

To test the durability of our findings we also consider three broader measures of consumption that alternatively include semi-durables, services from durable goods, or both, following Blundell et al. (2008). The first includes non-durable goods and services (G&S). The second adds semi-durables G&S to the first measure. The third and fourth expand the first two measures with the service flow of durable goods. These measures can be summarized below. To obtain services from durable goods, we use an external additional CEX database over the same period and for the same sets of households and apply a methodology similar to Johnson and Torrey (2005) and Slesnick (1994) to calculate the rental equivalent value of owned homes and owned vehicles.[43]

1. Non-durables: includes total food and beverages consumption (including food stamps), insurance, housing maintenance costs (equipment, contractors), lodging (including vacation), utilities, personal services (e.g., nursing, housekeeping), clothing, transportation expenditures, rentals, memberships, etc.

2. Total consumption = Non-durables and semi-durables such as luxury goods (e.g., jewelry, boats, etc.), art, vehicles and parts, home furniture and appliances, electronics + Education and health expenses.

3. Non-durables-Plus= Non-durables + Service flow of owned vehicles and homes.

4. Total consumption-Plus = Total consumption + Service flow of owned vehicles and homes.

Tables A.5, A.6, and A.7 show the results of the imputation method using equation A.1) for these alternative measures. Tests of over-identifying restrictions and of the strength of excluded instruments are presented in the bottom of each table and are all passed.

[43]See Appendix A.3 for details on the construction of proxies for the rental values of owned homes and vehicles.

Table A.5: The Demand For Food in the CEX-Total Expenditures

Variable	Estimate	Variable	Estimate	Variable	Estimate	Variable	Estimate
ln c	0.802***	ln c x 1989	-0.0648	lc x ytrend2	-0.000209	Born 1960-64	0.0198
	0.176		0.055		0.000		0.057
ln c x HS dropout	0.0340	ln c x 1990	-0.0599	Age	0.0463***	Born 1955-59	-0.0119
	0.030		0.054		0.005		0.050
ln c x HS graduate	0.125**	ln c x 1991	-0.101	Age^2	-0.000435***	Born 1950-54	-0.0161
	0.057		0.066		5.42e		0.043
ln c x one child	-0.0518***	ln c x 1992	-0.103	p_{food}	-0.678**	Born 1945-49	-0.0303
	0.011		0.070		0.264		0.037
ln c x two children	-0.0706***	ln c x 1993	-0.0951	$p_{alcohol+tobacco}$	5.610***	Born 1940-44	-0.0459
	0.011		0.068		1.963		0.032
ln c x three children +	-0.0967***	ln c x 1994	-0.0791	$p_{fuel+utils}$	1.939	Born 1935-40	-0.0244
	0.013		0.066		2.227		0.025
ln c x 1973	-0.00680	ln c x 1995	-0.0615	$p_{transports}$	-5.649	Born 1930-34	-0.00953
	0.013		0.064		3.856		0.018
ln c x 1981	-0.00247	ln c x 1996	-0.0622	HS dropout	-0.332	Born 1925-29	-0.0107
	0.005		0.063		0.293		0.013
ln c x 1982	-0.0279**	ln c x 1998	-0.0729	HS graduate	-1.260**	One Child	0.567***
	0.013		0.071		0.567		0.117
ln c x 1983	-0.0445*	ln c x 2000	-0.0510	Northeast	0.0290***	Two children	0.793***
	0.025		0.062		0.006		0.117
ln c x 1984	-0.0401	ln c x 2002	-0.0659	Midwest	-0.0312***	Three children+	1.076***
	0.026		0.063		0.007		0.149
ln c x 1985	-0.0434	ln c x 2004	-0.0511	South	-0.0228***	Family Size	0.0405***
	0.030		0.049		0.008		0.007
ln c x 1986	-0.0826	ln c x 2006	-0.0255	Born 1975-79	0.0816	White	0.0591***
	0.053		0.027		0.078		0.015
ln c x 1987	-0.0738	ln c x 2008	-0.00675	Born 1970-74	0.0578	Constant	-0.322
	0.053		0.010		0.070		0.924
ln c x 1988	-0.0685	lc x ytrend	0.000777	Born 1965-69	0.0268		
	0.056		0.018		0.064		
Number of observations	5,882	R-squared	0.376				
Test of overidentifying restrictions				28.16			
				(d.f. 30; χ^2 p-value 0.562)			
Test time consistency of income elasticity				66.84			
				(d.f. 31; χ^2 p-value 0.000)			

NOTE.— This table reports IV estimates of the demand equation for (the logarithm of) food spending in the CEX. We use family composition-education-year specific average of the log of husbands' and wives' hourly wages as instruments for the log of total non-durable expenditure and its interactions with year, education, and kids dummies. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.6: The Demand For Food in the CEX-Non-durables & Services from Durables

Variable	Estimate	Variable	Estimate	Variable	Estimate	Variable	Estimate
ln c	0.834***	ln c x 1990	-0.0627	Age	0.0414***	Born 1960-64	-0.0236
	0.194		0.061		0.006		0.060
ln c x HS dropout	0.0464*	ln c x 1991	-0.105	Age^2	-0.000389***	Born 1955-59	-0.0479
	0.027		0.074		6.19e		0.053
ln c x HS graduate	0.150***	ln c x 1993	-0.0979	p_{food}	-0.759***	Born 1950-54	-0.0486
	0.057		0.077		0.279		0.046
ln c x one child	-0.0528***	ln c x 1994	-0.0837	$p_{alcohol+tobacco}$	5.496**	Born 1945-49	-0.0535
	0.011		0.076		2.286		0.039
ln c x two children	-0.0748***	ln c x 1995	-0.0650	$p_{fuel+utils}$	1.571	Born 1940-44	-0.0664*
	0.011		0.076		2.722		0.034
ln c x three children +	-0.0987***	ln c x 1996	-0.0667	$p_{transports}$	-5.489	Born 1935-40	-0.0461*
	0.014		0.076		4.107		0.026
ln c x 1973	-0.00484	ln c x 1998	-0.0786 HS dropout	-0.434*	Born 1930-34	-0.0186	
	0.013		0.083	0.263		0.019	
ln c x 1981	-7.22e-05	ln c x 2000	-0.0564	HS graduate	-1.466***	Born 1925-29	-0.0103
	0.005		0.075		0.556		0.013
ln c x 1984	-0.0364	ln c x 2002	-0.0715	Northeast	0.0152**	One Child	0.561***
	0.027		0.074		0.006		0.111
ln c x 1985	-0.0405	ln c x 2004	-0.0546	Midwest	-0.00785	Two children	0.798***
	0.030		0.056		0.009		0.113
ln c x 1986	-0.0798	ln c x 2006	-0.0262	South	0.00156	Three children+	1.032***
	0.055		0.029		0.011		0.147
ln c x 1987	-0.0725	ln c x 2008	-0.00564	Born 1975-79	0.0215	Family Size	0.0480***
	0.055		0.010		0.082		0.007
ln c x 1988	-0.0701	lc x ytrend	0.00354	Born 1970-74	0.0183	White	0.0956***
	0.059		0.019		0.074		0.011
ln c x 1989	-0.0664	lc x ytrend2	-0.000243	Born 1965-69	-0.00737	Constant	-0.694
	0.060		0.000		0.067		0.992
Number of observations	9,204	R-squared	0.438				
Test of overidentifying restrictions				26.61			
				(d.f. 28; χ^2 p-value 0.539)			
Test time consistency of income elasticity				55.869			
				(d.f. 29; χ^2 p-value 0.002)			

NOTE.— This table reports IV estimates of the demand equation for (the logarithm of) food spending in the CEX. We use family composition-education-year specific average of the log of husbands' and wives' hourly wages as instruments for the log of total non-durable expenditure and its interactions with year, education, and kids dummies. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table A.7: The Demand For Food in the CEX-Total Expenditures & Services from Durables

Variable	Estimate	Variable	Estimate	Variable	Estimate	Variable	Estimate
ln c	0.748***	ln c x 1990	-0.0886	Age	0.0471***	Born 1960-64	0.00709
	0.196		0.063		0.005		0.063
ln c x HS dropout	0.0230	ln c x 1991	-0.138*	Age^2	-0.000444***	Born 1955-59	-0.0250
	0.029		0.077		5.71e		0.056
ln c x HS graduate	0.113*	ln c x 1993	-0.131	p_{food}	-0.595**	Born 1950-54	-0.0277
	0.058		0.080		0.283		0.048
ln c x one child	-0.0531***	ln c x 1994	-0.111	$p_{alcohol+tobacco}$	6.686***	Born 1945-49	-0.0382
	0.012		0.077		2.301		0.041
ln c x two children	-0.0746***	ln c x 1995	-0.0864	$p_{fuel+utils}$	3.183	Born 1940-44	-0.0555
	0.012		0.075		2.570		0.035
ln c x three children +	-0.0961***	ln c x 1996	-0.0865	$p_{transports}$	-8.440*	Born 1935-40	-0.0284
	0.014		0.074		4.344		0.027
ln c x 1973	-0.0154	ln c x 1998	-0.104	HS dropout	-0.222	Born 1930-34	-0.0116
	0.014		0.083		0.292		0.020
ln c x 1981	-0.000583	ln c x 2000	-0.0717	HS graduate	-1.135*	Born 1925-29	-0.0102
	0.006		0.073		0.581		0.014
ln c x 1984	-0.0596**	ln c x 2002	-0.0933	Northeast	0.0277***	One Child	0.586***
	0.028		0.074		0.006		0.123
ln c x 1985	-0.0651*	ln c x 2004	-0.0739	Midwest	-0.0262***	Two children	0.833***
	0.033		0.057		0.008		0.124
ln c x 1986	-0.120**	ln c x 2006	-0.0400	South	-0.0196**	Three children+	1.066***
	0.060		0.030		0.009		0.156
ln c x 1987	-0.108*	ln c x 2008	-0.0133	Born 1975-79	0.0567	Family Size	0.0458***
	0.060		0.011		0.086		0.007
ln c x 1988	-0.104	lc x ytrend	0.00939	Born 1970-74	0.0428	White	0.0706***
	0.064		0.020		0.078		0.014
ln c x 1989	-0.0965	lc x ytrend2	-0.000391	Born 1965-69	0.0135	Constant	-0.484
	0.064		0.000		0.071		0.971
Number of observations	9,203	R-squared	0.365				
Test of overidentifying restrictions				20.17 (d.f. 28; χ^2 p-value 0.858)			
Test time consistency of income elasticity				57.759 (d.f. 29; χ^2 p-value 0.001)			

NOTE.— This table reports IV estimates of the demand equation for (the logarithm of) food spending in the CEX. We use family composition-education-year specific average of the log of husbands' and wives' hourly wages as instruments for the log of total non-durable expenditure and its interactions with year, education, and kids dummies. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Appendix B Additional Estimates

B.1 Transmission of Transitory Income Shocks to Consumption

Table B.1: Decomposition of Changes in the Transmission of Transitory Income Shocks to Consumption By Income Quartile

Periods	Change ψ	Percent of Total Change		
		Active	Passive	Behavioral
	(1)	(2)	(3)	(4)
Panel A: bottom income quartile				
(1968--1979) to (1992--2010)	0.235	0.303	0.176	-0.244
	(0.027)	0.007	(0.004)	(0.028)
(1968--1979) to (1980--1991)	0.427	0.186	-0.276	0.517
	(0.015)	(0.026)	(0.053)	(0.074)
(1980--1991) to (1992--2010)	-0.192	0.117	0.452	-0.761
	(0.087)	(0.017)	(0.087)	(0.078)
Panel B: 2nd income quartile				
(1968--1979) to (1992--2010)	0.135	-0.691	0.309	0.517
	(0.015)	0.081	(0.050)	(0.049)
(1968--1979) to (1980--1991)	0.111	-0.308	-0.047	0.466
	(0.017)	(0.029)	(0.013)	(0.031)
(1980--1991) to (1992--2010)	0.025	-0.382	0.357	0.050
	(0.053)	(0.034)	(0.053)	(0.044)
Panel C: 3rd income quartile				
(1968--1979) to (1992--2010)	0.136	-0.180	0.049	0.267
	(0.018)	0.012	(0.004)	(0.019)
(1968--1979) to (1980--1991)	0.054	-0.083	0.014	0.122
	(0.005)	(0.006)	(0.005)	(0.006)
(1980--1991) to (1992--2010)	0.082	-0.097	0.035	0.145
	(0.010)	(0.007)	(0.010)	(0.019)
Panel D: top income quartile				
(1968--1979) to (1992--2010)	0.053	0.038	0.021	-0.007
	(0.006)	0.000	0.000	(0.006)
(1968--1979) to (1980--1991)	0.164	0.020	-0.058	0.201
	(0.006)	(0.008)	(0.010)	(0.014)
(1980--1991) to (1992--2010)	-0.111	0.018	0.079	-0.208
	(0.008)	(0.007)	(0.008)	(0.007)

NOTE.— Estimates from the minimum distance estimation. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984). The transmission of permanent and transitory income shocks to consumption is given by,

$$\Delta c_{i,t} = \phi_t \zeta_{i,t} + \psi_t \varepsilon_{i,t} + \xi_{i,t}.$$

where $\zeta_{i,t}$ and $\varepsilon_{i,t}$ are permanent and transitory income shocks, respectively. The transmission parameters are decomposed using a Oaxaca (1973) and Blinder (1973) decomposition according to equation (13).

Table B.2: Decomposition of Changes in the Transmission of Transitory Income Shocks to Consumption By Education

Periods	Change ψ	Percent of Total Change		
		Active	Passive	Behavioral
	(1)	(2)	(3)	(4)
Panel A: HS dropout				
(1968--1979) to (1992--2010)	0.226	0.044	0.105	0.076
	(0.025)	0.017	(0.008)	(0.033)
(1968--1979) to (1980--1991)	0.586	0.022	0.210	0.354
	(0.011)	(0.011)	(0.020)	(0.018)
(1980--1991) to (1992--2010)	-0.361	0.023	-0.105	-0.278
	(0.015)	(0.012)	(0.015)	(0.036)
Panel B: HS graduate				
(1968--1979) to (1992--2010)	0.199	-0.105	0.084	0.220
	(0.013)	0.020	(0.007)	(0.027)
(1968--1979) to (1980--1991)	0.122	-0.051	0.248	-0.074
	(0.013)	(0.013)	(0.021)	(0.027)
(1980--1991) to (1992--2010)	0.076	-0.054	-0.164	0.294
	(0.021)	(0.014)	(0.021)	(0.028)
Panel C: Some college and more				
(1968--1979) to (1992--2010)	0.081	0.060	0.001	0.021
	(0.011)	0.011	(0.002)	(0.015)
(1968--1979) to (1980--1991)	0.011	0.033	0.001	-0.021
	(0.002)	(0.002)	(0.001)	(0.002)
(1980--1991) to (1992--2010)	0.070	0.027	0.001	0.042
	(0.001)	(0.002)	(0.001)	(0.012)

NOTE.— Estimates from the minimum distance estimation. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984). The transmission of permanent and transitory income shocks to consumption is given by,

$$\Delta c_{i,t} = \phi_t \zeta_{i,t} + \psi_t \varepsilon_{i,t} + \xi_{i,t}.$$

where $\zeta_{i,t}$ and $\varepsilon_{i,t}$ are permanent and transitory income shocks, respectively. The transmission parameters are decomposed using a Oaxaca (1973) and Blinder (1973) decomposition according to equation (13).

Table B.3: Decomposition of Changes in the Transmission of Transitory Income Shocks to Consumption By Age

Periods	Change ψ	Percent of Total Change		
		Active	Passive	Behavioral
	(1)	(2)	(3)	(4)
Panel A: Age 30--40				
(1968--1979) to (1992--2010)	0.052	-0.441	-0.129	0.622
	(0.004)	0.000	0.000	(0.004)
(1968--1979) to (1980--1991)	0.247	-0.132	-0.179	0.557
	(0.017)	(0.018)	(0.064)	(0.068)
(1980--1991) to (1992--2010)	-0.194	-0.309	0.050	0.065
	(0.018)	(0.024)	(0.018)	(0.027)
Panel B: Age 41--55				
(1968--1979) to (1992--2010)	0.085	-0.260	0.244	0.100
	(0.010)	0.000	0.000	(0.010)
(1968--1979) to (1980--1991)	0.092	-0.094	0.131	0.055
	(0.008)	(0.010)	(0.015)	(0.013)
(1980--1991) to (1992--2010)	-0.007	-0.166	0.114	0.045
	(0.012)	(0.013)	(0.012)	(0.017)
Panel C: Age 56--65				
(1968--1979) to (1992--2010)	0.125	0.638	0.042	-0.554
	(0.008)	0.006	(0.001)	(0.009)
(1968--1979) to (1980--1991)	0.348	0.338	0.030	-0.020
	(0.017)	(0.024)	(0.014)	(0.023)
(1980--1991) to (1992--2010)	-0.222	0.300	0.012	-0.534
	(0.006)	(0.021)	(0.006)	(0.021)

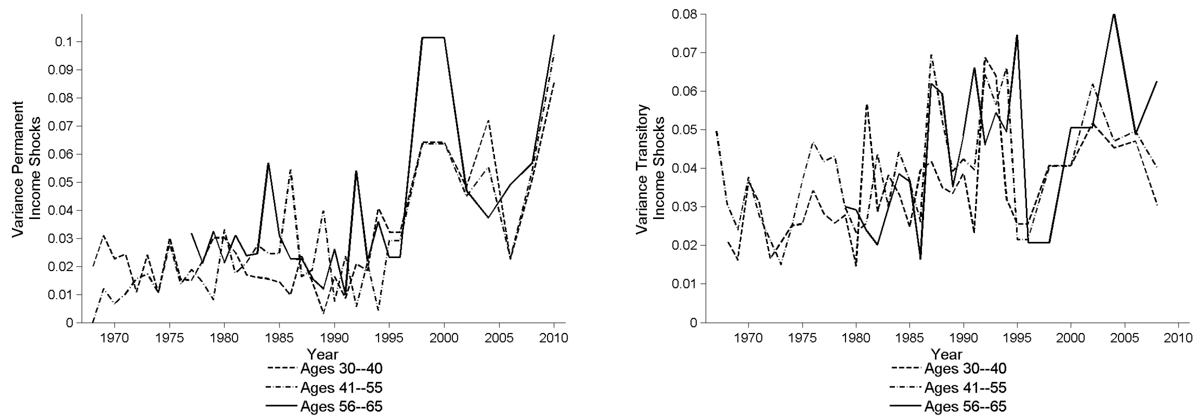
NOTE.— Estimates from the minimum distance estimation. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984). The transmission of permanent and transitory income shocks to consumption is given by,

$$\Delta c_{i,t} = \phi_t \zeta_{i,t} + \psi_t \varepsilon_{i,t} + \xi_{i,t}.$$

where $\zeta_{i,t}$ and $\varepsilon_{i,t}$ are permanent and transitory income shocks, respectively. The transmission parameters are decomposed using a Oaxaca (1973) and Blinder (1973) decomposition according to equation (13).

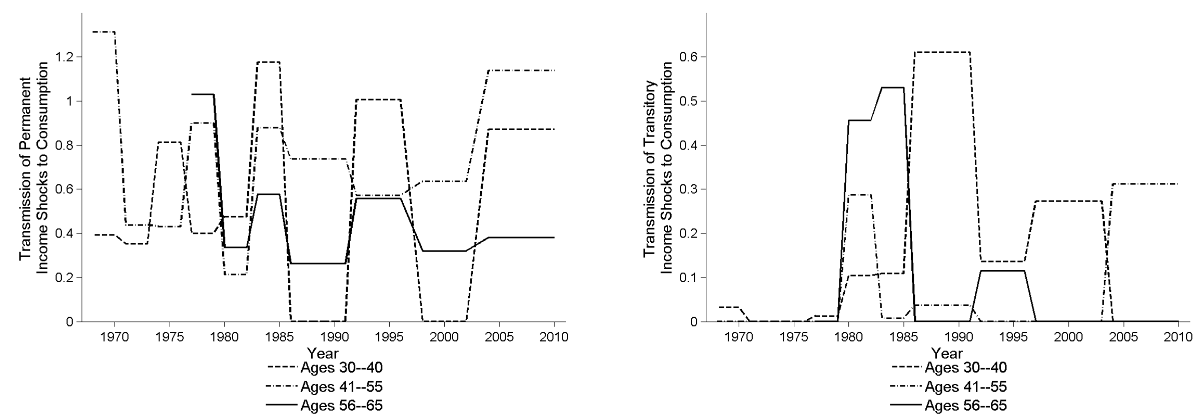
B.2 Age

Figure B.1: VARIANCE OF PERMANENT AND TRANSITORY INCOME SHOCKS BY AGE



NOTE.— Estimates from the minimum distance estimation.

Figure B.2: TRANSMISSION OF INCOME SHOCKS TO CONSUMPTION BY AGE



NOTE.— Estimates from the minimum distance estimation.

Table B.4: Transmission of Income Shocks to Consumption By Age (in 1980)

	Ages		
Periods	30--40	41--55	56--65
	(1)	(2)	(3)
Panel A: Transmission of Permanent Income Shocks ϕ			
Average 1968--2010	0.538	0.730	0.470
	(0.068)	(0.051)	(0.045)
Average 1968--1979	0.490	0.771	1.030
	(0.056)	(0.110)	(0.001)
Average 1980--1991	0.413	0.642	0.360
	(0.145)	(0.077)	(0.039)
Average 1992--2010	0.696	0.744	0.445
	(0.136)	(0.077)	(0.033)
Panel B: Transmission of Transitory Income Shocks ψ			
Average 1968--2010	0.165	0.065	0.131
	(0.036)	(0.020)	(0.039)
Average 1968--1979	0.011	0.001	0.001
	(0.004)	(0.001)	(0.001)
Average 1980--1991	0.359	0.092	0.247
	(0.076)	(0.034)	(0.075)
Average 1992--2010	0.137	0.085	0.052
	(0.032)	(0.044)	(0.018)

NOTE.— Estimates from the minimum distance estimation. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984). The transmission of permanent and transitory income shocks to consumption is given by,

$$\Delta c_{i,t} = \phi_t \zeta_{i,t} + \psi_t \varepsilon_{i,t} + \xi_{i,t}.$$

where $\zeta_{i,t}$ and $\varepsilon_{i,t}$ are permanent and transitory income shocks, respectively.

Table B.5: Decomposition of Changes in the Transmission of Permanent Income Shocks to Consumption By Age (in 1980)

Periods	Change ϕ	Percent of Total Change		
		Active	Passive	Behavioral
	(1)	(2)	(3)	(4)
Panel A: Age 30--40				
(1968--1979) to (1992--2010)	-0.585	-0.167	0.150	-0.568
	(0.008)	0.000	0.000	(0.008)
(1968--1979) to (1980--1991)	-0.670	-0.050	0.209	-0.829
	(0.009)	(0.008)	(0.039)	(0.041)
(1980--1991) to (1992--2010)	0.085	-0.117	-0.059	0.261
	(0.012)	(0.013)	(0.012)	(0.017)
Panel B: Age 41--55				
(1968--1979) to (1992--2010)	-0.027	0.545	-0.589	0.017
	(0.031)	(0.125)	(0.045)	(0.109)
(1968--1979) to (1980--1991)	-0.130	0.197	-0.315	-0.012
	(0.031)	(0.022)	(0.035)	(0.039)
(1980--1991) to (1992--2010)	0.103	0.348	-0.274	0.028
	(0.025)	(0.030)	(0.028)	(0.029)
Panel C: Age 56--65				
(1968--1979) to (1992--2010)	0.206	-0.682	-0.384	1.271
	(0.035)	(0.143)	(0.026)	(0.127)
(1968--1979) to (1980--1991)	-0.077	-0.361	-0.272	0.557
	(0.037)	(0.045)	(0.045)	(0.062)
(1980--1991) to (1992--2010)	0.283	-0.320	-0.111	0.714
	(0.047)	(0.040)	(0.021)	(0.055)

NOTE.— Estimates from the minimum distance estimation. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984). The transmission of permanent and transitory income shocks to consumption is given by,

$$\Delta c_{i,t} = \phi_t \zeta_{i,t} + \psi_t \varepsilon_{i,t} + \xi_{i,t}.$$

where $\zeta_{i,t}$ and $\varepsilon_{i,t}$ are permanent and transitory income shocks, respectively. The transmission parameters are decomposed using a Oaxaca (1973) and Blinder (1973) decomposition according to equation (13).

B.3 Diagonally Weighted Minimum Distance Estimates

This subsection reports point estimates and standard errors from the diagonally weighted minimum distance estimates for the full sample that corresponds to Figures 4 and 5 and Table 2.

Table B.6: Diagonally Weighted Minimum Distance Estimates

	Variance Income			Variance Income			Variance Income	
Year	Perm.	Trans.	Year	Perm.	Trans.	Year	Perm.	Trans.
1967	NA	0.0001	1979	0.0214	0.0269	1991	0.0122	0.0308
		(0.2108)		(0.0021)	(0.0016)		(0.0026)	(0.0015)
1968	0.0188	0.0199	1980	0.0225	0.0175	1992	0.0103	0.0607
	(0.2408)	(0.0128)		(0.0013)	(0.0011)		(0.0041)	(0.0014)
1969	0.0212	0.0192	1981	0.0199	0.0376	1993	0.0159	0.0456
	(0.0168)	(0.0054)		(0.0015)	(0.0009)		(0.0050)	(0.0029)
1970	0.0223	0.0310	1982	0.0223	0.0303	1994	0.0121	0.0455
	(0.0050)	(0.0035)		(0.0024)	(0.0014)		(0.0040)	(0.0029)
1971	0.0146	0.0272	1983	0.0194	0.0312	1995-1996	0.0224	0.0108
	(0.0011)	(0.0008)		(0.0026)	(0.0014)		(0.0045)	(0.0048)
1972	0.0143	0.0218	1984	0.0177	0.0327	1997-2000	0.0481	0.0286
	(0.0014)	(0.0009)		(0.0019)	(0.0011)		(0.0143)	(0.0063)
1973	0.0212	0.0149	1985	0.0194	0.0319	2001-2002	0.0402	0.0395
	(0.0010)	(0.0010)		(0.0017)	(0.0014)		(0.0105)	(0.0101)
1974	0.0106	0.0220	1986	0.0201	0.0325	2003-2004	0.0246	0.0412
	(0.0007)	(0.0012)		(0.0027)	(0.0012)		(0.0100)	(0.0010)
1975	0.0244	0.0378	1987	0.0207	0.0470	2005-2006	0.0341	0.0306
	(0.0021)	(0.0017)		(0.0008)	(0.0009)		(0.0008)	(0.0011)
1976	0.0208	0.0329	1988	0.0112	0.0396	2007-2008	0.0410	0.0163
	(0.0015)	(0.0013)		(0.0009)	(0.0010)		(0.0006)	(0.0009)
1977	0.0183	0.0341	1989	0.0182	0.0310	2009-2010	0.0001	0.0794
	(0.0041)	(0.0010)		(0.0009)	(0.0009)		(0.0738)	(0.0732)
1978	0.0178	0.0261	1990	0.0133	0.0361			
	(0.0031)	(0.0010)		(0.0017)	(0.0014)			
Serial correlation transit shock					0.1132			
					(0.0176)			
Variance unobserved slope heterogeneity					0.0154			
					(0.0019)			

NOTE.— Estimates from the minimum distance estimation. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984).

Table B.7: Transmission of Income Shocks to Consumption

Periods	Permanent ϕ	Transitory ψ
1968--1970	0.452	0.001
	(0.064)	(0.001)
1971--1973	0.525	0.001
	(0.028)	(0.001)
1974--1976	0.701	0.001
	(0.035)	(0.001)
1977--1979	0.479	0.041
	(0.048)	(0.012)
1980--1982	0.465	0.164
	(0.035)	(0.010)
1983--1985	0.916	0.043
	(0.050)	(0.008)
1986--1991	0.722	0.149
	(0.092)	(0.008)
1992--1996	0.691	0.005
	(0.121)	(0.001)
1998--2002	0.517	0.010
	(0.112)	(0.001)
2004--2010	0.350	0.160
	(0.111)	(0.020)

NOTE.— Estimates from the minimum distance estimation. We follow Blundell et al. (2008) and calculate the standard errors using the method proposed by Chamberlain (1984). The transmission of permanent and transitory income shocks to consumption is given by,

$$\Delta c_{i,t} = \phi_t \zeta_{i,t} + \psi_t \varepsilon_{i,t} + \xi_{i,t}.$$

where $\zeta_{i,t}$ and $\varepsilon_{i,t}$ are permanent and transitory income shocks, respectively.

Appendix C Model Notes

C.1 Consumption Process

The Taylor expansion of the Euler equation is given by,

$$\Delta c_{i,t} \cong \xi_{i,t} + \pi_{i,t}\zeta_{i,t} + \gamma_{t,L}\pi_{i,t}\varepsilon_{i,t},$$

where a detailed derivation is given in Blundell and Preston (2013). Carroll (2009) simulates a buffer-stock model that directly explains changes in $\pi_{i,t}$. In particular, an increase in the permanent shock may temporarily increase the amount of precautionary savings because it reduces the ratio of assets to permanent income rather than increasing precautionary savings. The term $\xi_{i,t}$ has also been characterized as an innovation to higher moments of the income process. For example, Caballero (1990) presents a stochastic model in which $\xi_{i,t}$ captures revisions to the variance forecast of consumption growth as a response to income shocks, which contrasts with effects that occur to the mean of consumption growth and which are captured by $\zeta_{i,t}$ and $\varepsilon_{i,t}$.

For individuals many years from retirement age, it is commonly assumed that the present value of financial assets is small relative to the remaining value of labor income, implying $\pi_{i,t} \approx 1$, which means that no part of permanent income shocks is self-insured. Carroll (2009) estimates values of $\pi_{i,t}$ between 0.85 and 0.95, and Blundell and Preston (2013) find an average of 0.8 and evidence of smaller values as age increases (from 0.85 at age 30 to 0.78 at age 50), using panel data for Britain. Below, we discuss results that allow estimates of insurance loading factors to vary by age and cohorts. Although we find some evidence that insurance factors tends to be smaller for earlier cohorts and older age groups, implying that π_i is smaller than one (and therefore insurance is larger) for these groups, we do not find a significant difference across groups.

$$\Delta c_{i,t} = \phi_{i,t}\zeta_{i,t} + \psi_{i,t}\varepsilon_{i,t} + \xi_{i,t}.$$

It is useful to take a step back and consider more carefully what direct estimations of these parameters should capture. Estimating $\phi_{i,t} < \pi_{i,t}$ and $\psi_{i,t} < \gamma_{t,L}\pi_{i,t}$ would provide evidence of ‘‘excess-smoothing,’’ over and above self-insurance through asset accumulation, and justify that individuals should insure relatively more against transitory shocks than against permanent income shocks. This ‘‘excess-smoothing’’ of consumption to income shocks has alternatively been explained by the macroeconomic literature as resulting from imperfect markets either due to the existence of private information or to limited contract enforcements. Under these models, households engage in more precautionary saving (insure more) than with a single, non-contingent bond but less than with complete markets. In turn, these models allow the relationship between income shocks and consumption to depend on the degree of persistence of income shocks (Alvarez and Jermann, 2000). Other explanations of the excess-smoothness of consumption in response to perfectly anticipated permanent income shocks has been attributed to the severity of informational problems, such as moral hazard (Attanasio and Pavoni, 2011).

The income process presented in equation (3) assumes that permanent and transitory shocks constitute new information to agents. Instead, if advance information about future income shocks was available to consumers, consumption growth should not directly react to current income shocks because agents would already have internalized them in previous periods. Advance information would lead the econometrician to underestimate the impact of income shocks on consumption volatility. However the empirical evidence suggests advance information does not seem to be a concern in our sample.

Table C.1: List of Variables

Variable	Description	Number of Variables
var(ζ)	Variance of permanent shock to income	34
var(ε)	Variance of transitory shock to income	36
ψ_t	Partial insurance parameter transitory shock to income	10
ϕ_t	Partial insurance parameter permanent shock to income	10
var(u^y)	Variance of measurement error of income	30
var(ξ)	Variance of heterogeneous shocks to consumption	1
θ	Serial correlation factor MA(1) process	1
Total		122

Appendix D Moment Conditions

We use moment conditions derived from one- and two-year differences in income and consumption. Previous papers, notably Blundell et al. (2008), use moment conditions with one-year differences and, therefore, we only derive the moment conditions with two-year differences in the text. In this appendix, we replicate the derivation of moments using one-year differences in Blundell et al. (2008), list the variables and moment conditions used to estimate them, and compare previous methods that use only moments with one-year differences with our updated method that uses moments with one- and two-year differences.

C. 1 One-Year Difference Moments

We derive one-year difference covariance restrictions using equations (6) and (7). The restrictions due to the covariance of income across different leads is given by,

$$cov(\Delta y_t, \Delta y_{t+s}) = \begin{cases} var(\zeta_t) + var(\Delta v_t) & if\, s = 0 \\ -cov(v_t, v_{t+s}) & if\, 0 < |s| \leq q+1 \\ 0 & if\, |s| > q+1 \end{cases},$$

where $cov(.,.)$ and $var(.)$ denote the cross-sectional covariance and variance, respectively, and can be easily computed from observed data on households. If $q = 0$ and v is serially uncorrelated ($v_t = \varepsilon_t$), then $var(\Delta v_t) = 2var(\Delta\varepsilon_t)$. In this case, and ignoring issues of measurement error, two years of data are enough to compute the moments of the income process shown in (15).[44]

The consumption growth restriction from equation (7) leads to the restrictions

$$cov(\Delta c_t, \Delta c_{t+s}) = \phi_t^2 var(\zeta_t) + \psi_t^2 var(\varepsilon_t) + var(\xi_t),$$

for $s = 0$, and zero otherwise (because consumption follows a martingale process). Finally, the covariance between income and consumption at various lags is

$$cov(\Delta y_{t+s}, \Delta c_t) = \begin{cases} \phi_t var(\zeta_t) + \psi_t var(\Delta \nu_t) & if\ s = 0 \\ \psi_t cov(\varepsilon_t, \Delta \nu_{t+s}) & if\ s > 0 \end{cases}.$$

In particular, if ν is serially uncorrelated ($\nu_t = \varepsilon_{i,t}$), then $cov(\Delta y_{t+s}, \Delta c_t) = -\psi_t var(\varepsilon_t)$ for $s = 1$, and 0 if $s > 1$.[45] Equations (15), (16), and (17) define eight types of moment conditions using the covariance of one-year differences in income and consumption. The combined number of moments from one-year and two-year differences across years is 312, which is used as a robustness test to estimate 122 parameters.

C. 2 One and Two Year Difference Moment Conditions

To estimate the eight sets of variables, there are eight sets of moment conditions. Each of these sets consists of two subsets of moment conditions. The first defines the growth in income and consumption as the difference from year t and $t-1$. The second subset defines the growth in

[44] Meghir and Pistaferri (2004) show that with a more general model where transitory shocks have MA(q) with $q \geq 1$, $q+1$ years of observations are necessary to estimate the parameters of the income process. If measurement error is added to the model, they show that $q+4$ years of observations are required. Since our empirical approach uses more than 40 years of income data from the PSID, this limitation is satisfied. Although classical measurement error could be captured by the innovations in the MA process, previous work suggests that measurement error in earnings are serially correlated (Bound and Krueger, 1991). Ludvigson and Paxson (2001) show that the the Taylor expansion traditionally used to linearize inter-temporal changes in consumption and income can also lead to approximation error, which would inflate existing measurement error in observed values. They further discuss the extent to which instrumental variables' techniques can correct some of the approximation bias.

[45] As shown, for instance, in Abowd and Card (1989), and further discussed in the empirical methodology, consumption and income are likely to be contaminated with measurement error. With independent errors, the model above still fully identifies ψ_t, while with dependent errors only a lower bound for ψ_t is identifiable (Blundell et al., 2008).

income and consumption as the difference from year t and $t-2$. The first two sets consist of the variance of the growth in income and growth in consumption. The second two sets consist of the covariance of the growth in income in year t and the growth in income in year $t+1$ and the growth in consumption in year t and the growth in consumption in year $t+1$. The next set is the covariance of the growth in income in year t and the growth in income in year $t+2$. The final sets consist of the covariance of the growth in consumption in year t and the growth in income in years t, $t+1$, and $t+2$. In total, there are 477 moment conditions, of which only 225 are from defining the growth in income and consumption as one year apart. To distinguish the moment conditions, those that define the growth as one year differences are denoted by Δ, and those that define the growth as two year differences are denoted by $\tilde{\Delta}$.

$$var(\Delta y_t) = var(\zeta_t) + (\theta - 1)^2 var(\varepsilon_{t-1}) + var(\varepsilon_t) + \theta^2 var(\varepsilon_{t-2}) \tag{C.1}$$

$$var(\tilde{\Delta} y_t) = var(\zeta_t) + var(\zeta_{t-1}) + var(\varepsilon_t) + (\theta^2) var(\varepsilon_{t-1}) + var(\varepsilon_{t-2}) + \theta^2 var(\varepsilon_{t-3}) \tag{C.2}$$

$$var(\Delta c_t) = \phi^2 var(\zeta_t) + \psi^2 var(\varepsilon_t) + var(\xi_t) \tag{C.3}$$

$$var(\tilde{\Delta} c_t) = \phi^2 var(\zeta_t) + \phi^2 var(\zeta_{t-1}) + \psi^2 var(\varepsilon_t) + \psi^2 var(\varepsilon_{t-1}) + 2var(\xi_t) \tag{C.4}$$

$$cov(\Delta y_t, \Delta y_{t+1}) = (\theta - 1) var(\varepsilon_t) - \theta(\theta - 1) var(\varepsilon_{t-1}) - var(u_t^y) \tag{C.5}$$

$$cov(\tilde{\Delta} y_t, \tilde{\Delta} y_{t+1}) = var(\zeta_t) + \theta var(\varepsilon_t) - \theta var(\varepsilon_{t-1}) + \theta var(\varepsilon_{t-2}) \tag{C.6}$$

(C.7) $$cov(\Delta y_t, \Delta y_{t+2}) = -\theta var(\varepsilon_t)$$

(C.8) $$cov(\tilde{\Delta} y_t, \tilde{\Delta} y_{t+2}) = -var(\varepsilon_t) - \theta^2 var(\varepsilon_{t-1}) - var(u_t^y)$$

(C.9) $$cov(\Delta c_t, \Delta y_t) = \phi var(\zeta_t) + \psi var(\varepsilon_t)$$

(C.10) $$cov(\tilde{\Delta} c_t, \tilde{\Delta} y_t) = \phi var(\zeta_t) + \phi var(\zeta_{t-1}) + \psi var(\varepsilon_t) + \psi\theta var(\varepsilon_{t-1})$$

(C.11) $$cov(\Delta c_t, \Delta y_{t+1}) = \psi(\theta - 1) var(\varepsilon_t)$$

(C.12) $$cov(\tilde{\Delta} c_t, \tilde{\Delta} y_{t+1}) = \phi var(\zeta_t) + \psi\theta var(\varepsilon_t) - \psi var(\varepsilon_{t-1})$$

Most variables appear in numerous moment conditions. Sometimes the variable enters in a lagged value as well and is denoted by (t-1) for one lag and (t-2) for two lags.

C. 3 Comparison of Methods

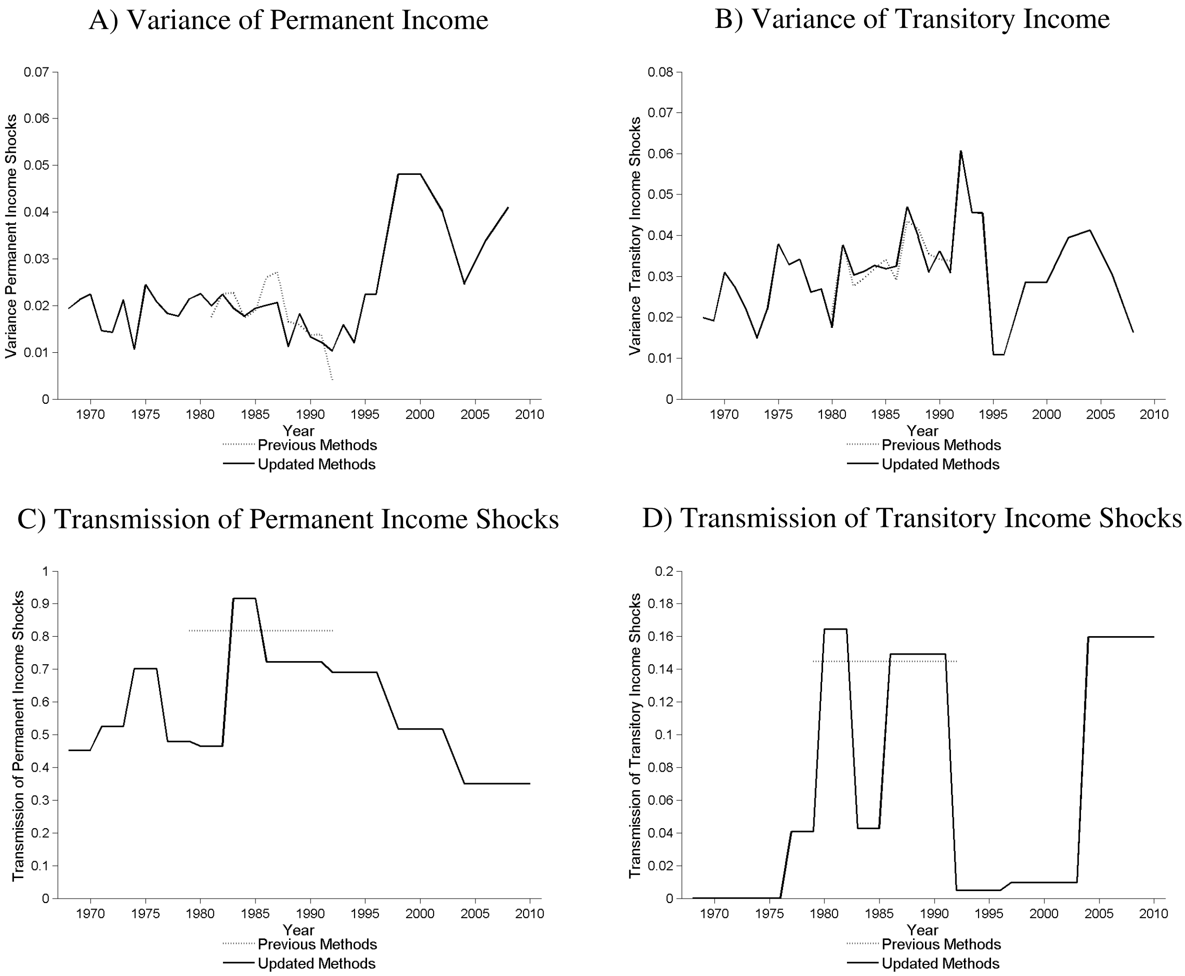
Figure C.1 compares the estimates of the variance and transmission of permanent and transitory income shocks using previous methods outlined by Blundell et al. (2008) and the updated methods in this paper. One of the main advantages of updating the methods to include moments with one- and two-year differences is to expand the years that we can use. The previous methods typically use 1979 through 1992 because afterward 1996 the PSID is reported every other year. With our updated methods we are able to extend this period to 1968 through 2010. The extended period allows us to consider how the transmission of income shocks have changed over time. We then decompose those changes and quantify the impact of active and passive tax policy changes.

Table C.2: Number of Moment Conditions by Set

Moment Condition	Range of Years	Total Years
var(Δy_t)	1968 - 1995	28
var($\tilde{\Delta} y_t$)	1969 - 2010	35
var(Δc_t)	69--71, 74--86, 90--92, 95--96	21
var($\tilde{\Delta} c_t$)	70-71, 73, 75-86, 91-92, 94-(by2)-2010	26
cov(Δy_t,Δy_{t+1})	1968 - 1995	28
cov($\tilde{\Delta} y_t$,$\tilde{\Delta} y_{t+1}$)	1969 - 1995	27
cov(Δy_t,Δy_{t+2})	1968 - 1994	27
cov($\tilde{\Delta} y_t$,$\tilde{\Delta} y_{t+2}$)	1969 - 2006	34
cov(Δc_t,Δy_t)	69-71, 74-86, 90-92, 95-96	21
cov($\tilde{\Delta} c_t$,$\tilde{\Delta} y_t$)	70-71, 73, 75-86, 91-92, 94-(by2)-2010	26
cov(Δc_t,Δy_{t+1})	69-71, 74-86, 90-92, 95-96	20
cov($\tilde{\Delta} c_t$,$\tilde{\Delta} y_{t+1}$)	70-71, 73, 75-86, 91-93, 95	19
Total		312

All panels of Figure C.1 demonstrate the additional richness we are able to provide with the updated method. All of the panels also show that the previous methods and updated methods produce similar estimates between 1979 and 1992. The similarity in estimates provide support for the use of the moments using two-year differences and the model generally.

Figure C.1: Comparing Updated Methods With Previous Methods



NOTE.— This figure compares previous methods that only uses moment conditions with one year differences for the years 1979--1992 with the updated methods in this paper that uses moments with one- and two-year differences and years 1968--2010.