Taxation and Inequality: Active and Passive Channels

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Abstract

This paper fills an important gap in our understanding of the role of the US tax system in changing household welfare and inequality. It deconstructs the mechanisms by which the federal income tax system operates to affect the transmission of income shocks to consumption, and therefore, consumption inequality. To this end, it links micro and macro models of the distribution of income and consumption to changes in the federal income tax system. We find important changes in the types of income shocks to which consumers are insured or not, as well as the extent to which tax policy contributes to insuring consumers from these shocks. Importantly, we find that without decomposing the tax system into the three mechanisms outlined in the model, economists might have erroneously inferred that the role of tax policy as a mechanism for consumption insurance did not change over time. We also find that tax policy changes have disproportional effects across socioeconomic groups, and that this contributes to increasing inequality.

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1. Introduction

In the last few decades, American households have experienced increased shocks to income due to major economic and political events. Household welfare depends on how these income shocks are transmitted to consumption, and this transmission directly affects inequality. This relationship has led academics to investigate whether households are insulated from these income shocks (Blundell et al., 2008; Kaplan and Violante, 2010, 2014). Answering these questions is exceptionally timely, as they contribute to a broader debate about rising income and consumption inequality in the United States, and have been central in political debates.[1] This debate includes academic studies focused on identifying the nature of these income shocks and evaluating their impacts on income inequality.[2] At the center of these studies is tax policy and its ability to reduce the variance of after-tax income compared to pre-tax income. This paper contributes to this debate by providing new evidence on how income taxes directly and indirectly affect household welfare.

The extent to which tax policy affects the transmission of income shocks to consumption and inequality remains an open question. On one hand, the evidence in Blundell et al. (2008) suggests a limited role for tax policy. Specifically, they find that while tax policy dampens income shocks, a substantial portion of permanent income shocks is transmitted to consumption, and the transmission of these shocks has remained steady over time – even through major tax reforms, such as the Tax Reform Act of 1986. On the other hand, Bargain et al. (2015) finds that tax policy changes in the US substantially increased income inequality, using micro-data of US tax revenue to simulate changes

[1] See, among others, *The Washington Post*, Sep 19, 2019 ‘‘Income inequality in America is the highest it's been since Census Bureau started tracking it, data shows.’’,https://www.washingtonpost.com/business/2019/09/26/income-inequality-america-highest-its-been-since-census-started-tracking-it-data-show/; *The New York Times*, Apr. 10, 2020, ‘‘America Will Struggle After Coronavirus. These Charts Show Why.’’ https://www.nytimes.com/interactive/2020/04/10/opinion/coronavirus-us-economy-inequality.html?smid=em-share; *The Wall Street Journal*, Nov 3, 2019, ‘‘ The Truth About Income Inequality.’’, https://www.wsj.com/articles/the-truth-about-income-inequality-11572813786; *The Economist*, Nov 11, 2019, ‘‘Economists are rethinking the numbers on inequality.’’ https://www.economist.com/briefing/2019/11/28/economists-are-rethinking-the-numbers-on-inequality.

[2] A large literature has modeled permanent and transitory components of income shocks (Heathcote et al., 2010; Moffitt and Gottschalk, 2012; Kovacs et al., 2019). Likewise, studies in labor, public finance, and macroeconomics have used various models and data to explain and measure the trends in inequality (Blundell et al., 2008; Cutler and Katz, 1992; Aguiar and Bils, 2015; Altonji and Siow, 1987; Attanasio et al., 2014; Attanasio and Pavoni, 2011; Attanasio and Weber, 1995).

between the pre- and post-tax incomes of taxpayers. To reconcile these two pieces of evidence, we combine these methods into a comprehensive model that deconstructs the effects of tax policy changes on the transmission of income shocks to consumption.

To get a more general perspective and gain traction on these important questions, we extend the literature in several ways. First, we expand the typical period analyzed to over four decades, covering 1968-2010, which enables us to cover a large number of minor and major tax policy changes. Second, to incorporate these additional years, we update the model that links transmission parameters with moments of income and consumption conditions. Third, we combine micro-simulations of changes in individual tax liabilities due to changes in tax policy, with a macro-labor model to directly link tax policy changes to the transmission of consumption from income shocks.

We find large changes in the transmission of permanent and transitory income shocks, which would not have been observable in the smaller period typically studied. In particular, we find that households have become more insured against permanent income shocks, but less insured against transitory income shocks over time. We also find that these changes were non-linear across income and education groups, revealing increased inequality in the transmission of income shocks to consumption.

We also find that there is more insurance to permanent income shocks than previously thought. This is in part due to the fact that the period typically studied (1979-1992) is an exceptional period with less insurance than the periods before or after it. We also show that previous estimates of this transmission might be limited by modeling choices and underlying assumptions, some of which might defy the data. Following pioneering work by Kaplan and Violante (2010), our model captures several key features of the data; for example, that some individuals are credit-constrained. We show that this generalization of the model leads to lower estimates of the transmission of permanent income shocks to consumption and, thus, greater insurance. Together, we find that 26% of permanent income shocks are transmitted to consumption, which is substantially lower than the 64% found by Blundell et al. (2008).

Additionally, we find that tax policy plays a major role in explaining the changes in the transmission of income shocks to consumption. These findings are the result of an important innovation in our model to describe tax policy changes. We decompose tax policy changes in three parts: *active* tax policy, *passive* tax policy, and *behavioral* changes in tax policy. Active tax changes measure the changes between pre- and post-tax incomes that are entirely due to legislative acts that affect tax rates or the tax code, such as the Tax Reform Act of 1986. These changes are the mechanical effects of tax policy found in studies that use micro-simulations of tax liability (Bargain et al., 2015). In practice, the change in insurance due to active tax policy changes is measured in the simulation by holding income fixed to a base year and allowing the tax schedule to change as observed. Our simulations of active tax policy changes show a dramatic decrease in the amount of insurance the federal income tax provides in 1987, corresponding exactly with the Tax Reform Act of 1986.

Passive tax policy changes measure the changes in the difference between pre- and post-tax incomes that are entirely due to exogenous changes in the distribution of income across individuals and how this distribution interacts with the tax code; for instance, tax brackets. In practice, they are measured by keeping the tax code fixed to a base year while allowing the income distribution to change as observed. To further ensure that passive changes are not affected by the tax system, we remove changes in observed income due to labor responses to changes in taxation. The resulting measure of passive tax policy changes is more likely to represent exogenous changes in income distribution (e.g., technological growth). Behavioral changes represent all other changes including individual responses to active and passive tax changes, precautionary savings, aversion to risk, and individuals' perceptions of the tax system. To measure them, we perform a Oaxaca-Blinder decomposition.

A simple thought experiment clarifies the specific roles of active and passive tax policy changes 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, 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 play 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 change. Specifically, consider an increase in the top marginal income tax rate from 25 to 29 percent, keeping constant the income distribution and behavioral responses to tax changes. 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 percent, but incomes increase by 20 percent to $12,000 and $72,000 for the two income groups, respectively. Suppose that this increase in income is entirely due to exogenous changes (e.g., technological growth), and keeping constant taxpayers' behavioral responses to changes in income distribution. 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 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. In particular, active tax policy changes increased the transmission – on average, across taxpayers – of both permanent and transitory shocks to consumption, by 35 and 47 percent, respectively. By contrast, passive changes in tax policy and behavioral changes operated in the opposite direction, sometimes more than undoing this increase.[3] These findings reveal that decomposing into three distinctive parts the mechanism by which the tax system affects the transmission of income shocks to consumption is critical in order to adequately quantify the impact of tax policy changes. In particular, without the decomposition, researchers might have erroneously estimated that tax policy did not affect the transmission of income shocks to consumption, or that the insurance provided by the tax system did

[3]Our evidence on the effect of behavioral changes is consistent with Domar and Musgrave (1944), who showed that although the income tax provides insurance, individuals may respond by taking on additional risk in ways that increase the variance of after-tax income.

not change.

To better understand the role of tax policy on consumption inequality, we extend this analysis by considering how these estimates change by income quartile and educational attainment. In general, we find similar patterns across socioeconomic groups. Differences in magnitudes and non-monotonic differences, however, highlight the fact that tax policy has had a heterogeneous impact across the population and has contributed to increasing consumption inequality. In particular, the bottom income quartile and the least-educated groups are the only groups for which the transmission of permanent income shocks has hardly decreased over time, and their transmission is significantly larger than the other groups. Meanwhile, the transmission of transitory income shocks has increased proportionately more for the bottom and top income quartiles. We also find noticeable differences in the role of tax policy on different socioeconomic groups. For instance, active tax policy increased the transmission of permanent income shocks for all but the top income group.

Our findings suggest important considerations for future tax policy. On one hand, tax policy changes can substantially influence the transmission of income shocks to consumption. On the other hand, the income tax system impacts the insurance of consumption to income shocks in non-linear ways across population groups. It affects inequality in unintended ways due to the complexity of the interactions between the direct and indirect effects of tax policy.

In many ways, our paper responds to the call by Kaplan and Violante (2010) to extend existing empirical and theoretical models of insurance by further studying the relative role of various insurance mechanisms beyond self-insurance through borrowing/saving. We specifically focus on the complexity of the insurance mechanism that occurs through the federal income tax system and how this mechanism has changed over time. We believe that this analysis is an important contribution to our understanding of how income taxation affects household welfare.

This paper is structured as follows: Section 2 provides an overview of methods in the literature, and how we combine and extend these methods; Section 3 provides a detailed description of the theory and empirical approaches; Section 4 describes the data and the imputation strategy; Section 5 presents the results; and Section 6 concludes.

2. Background

Although an extensive literature has shown that income and consumption inequality has increased, there are still open questions about the influence of taxes on this relationship. Specifically, we study the extent to which income taxation can affect consumption inequality and the mechanisms by which tax policy changes the transmission of income shocks to consumption. To answer these open questions, we build on the insights of the previous literature in several ways.

First, we follow the macro-labor literature in considering both permanent and transitory income shocks with a model-based approach (MaCurdy, 1982; Abowd and Card, 1989; Autor et al., 2008; Meghir and Pistaferri, 2004).[4] Models using levels and growth rates find that both permanent and transitory income shocks drove the sharp increase in income inequality over the past 40 years – particularly in the later 1980s and early 1990s (Blundell et al., 2008; Primiceri and Rens, 2009; Moffitt and Gottschalk, 2011, 2012; Heathcote et al., 2010; Debacker et al., 2013). Alternatively, Kopczuk et al. (2010) use US Social Security income data and a non-parametric method, and find permanent income shocks are an essential part of the increase in inequality.[5] Most studies that evaluate the evolution of income shocks over time focus either on male earnings or household income (see Appendix A.7 for a discussion). We focus on household income because it is likely to reflect household consumption and welfare more broadly.

Consumption inequality depends on how much permanent and transitory income 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 their income shocks (Cutler and Katz, 1992; Altonji and Siow, 1987; Attanasio and Weber, 1995; Aguiar and Bils, 2015; Attanasio and Pavoni, 2011; Attanasio et al., 2014). Moffitt and Gottschalk (2012) and

[4]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 substantial responses to permanent income shocks, and that permanent increases or decreases in taxes should result in proportional consumption responses (Carroll, 2009; Violante, 2002).

[5]Debacker et al. (2013) find that the model-based approaches attribute more weight to transitory shocks than non-parametric methods.

Heathcote et al. (2010) find that the overall increasing trend in consumption inequality is generally smaller than that 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. Kaplan and Violante (2010) generalize the methods in Blundell et al. (2008) within a standard incomplete-markets model. Using simulated panel data, they show that when consumers are constrained in their borrowing, the transmission of income shocks to consumption could be lower than those in Blundell et al. (2008).[7] Kaplan and Violante (2010) also show that one way to reduce this type of bias is to modify the model to include a mean-reverting shock with auto-correlation around 0.95 for the permanent component. We use both models and compare the estimates.

Generally, this literature suggests that the federal income tax is an important determinant of the transmission of permanent income shocks to consumption (Blundell et al., 2008; Heathcote et al., 2010; Debacker et al., 2013). For example, Heathcote et al. (2010) and Debacker et al. (2013) find that the variability in after-tax income shocks is at least 15 percent smoother than before-tax income. However, this literature typically finds that the transmission of income shocks to consumption did not change over time (Blundell et al., 2008).[8] This finding, however, is inconsistent with a public

[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 also 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] Kaplan and Violante (2014) and Kaplan et al. (2014) suggest that borrowing constrained and liquidity-constrained consumers is an important feature of the data.

[8] Blundell et al. (2008) 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.

finance literature that finds that changes in the federal income tax have lowered the amount of insurance households have against income shocks (Auerbach and Feenberg, 2000; Pechman, 1973; Bargain et al., 2015). We combine the micro-simulations typical of this public finance literature with a standard incomplete-markets macro-labor model to try and reconcile these findings.

3. Model of Income and Consumption Dynamics

The primary purpose of the model is to measure the transmission of income shocks to consumption over time. With these estimates, we can then decompose the changes in transmission and evaluate the contribution of different types of changes in the federal income tax system – 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 derive a set of moment conditions implied by the model, adapted to the specific nature of our panel data. Finally, we model the amount of transmission of income shocks to consumption as a function of active and passive tax changes.

3.1. 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).[9] Each household i maximizes the present discounted value of its future consumption:

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

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.

[9] We recognize that excluding unstable households and single-parent families limits the scope of our analysis, especially insofar as these families are arguably more likely both 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 4 discusses the limited impact that abstracting away from changes in family composition has on our findings.

Households are subject to an inter-temporal 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}

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

3.1.1. Income Process

The income of household i depends on their ability $N_{i,t}$ and their labor supply choice, which depends on the labor supply elasticity e and labor tax rate $\tau_{i,t}$; $Y_{i,t} = F(N_{i,t}, e, \tau_{i,t})$. Ability is separable from their labor supply choice, such that $log(Y_{i,t}) = log(N_{i,t}) + f(e, \tau_{i,t})$. Household i's ability is a combination of deterministic components, $\kappa_{i,t}$, and stochastic components $z_{i,t}$ and $v_{i,t}$. The deterministic component of income, $\kappa_{i,t}$, is known in year t and allowed to shift over time.[10] The stochastic component consists of a permanent, $z_{i,t}$, and transitory, $v_{i,t}$, shock to income, where the transitory component is a mean-reverting MA(q) process, and the permanent shock, following Kaplan and Violante (2010), is allowed to be persistent, described by

$$\begin{aligned} y_{i,t} &\equiv log(Y_{i,t}) - \kappa_{i,t} - f(e, \tau_{i,t}) = z_{i,t} + v_{i,t} \qquad (3) \\ z_{i,t} &= \rho z_{i,t-1} + \eta_{i,t}, \\ v_{i,t} &= \sum_{j=0}^{q} \theta_j \varepsilon_{i,t-j}, \end{aligned}$$

where $\theta_0 = 1$ and we determine the order q empirically. Following Kaplan and Violante (2010), we allow $\eta_{i,t}$ and $\varepsilon_{i,t}$ to be serially correlated.[11] For ease of exposition we demonstrate the model using $q = 1$.[12]

Our baseline measure of income is PSID's total family income, which includes transfers

[10] 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.

[11] We also follow Kaplan and Violante (2010) and loosen the no-foresight and short-memory assumptions implicit in Blundell et al. (2008), see Table A.9.

[12] 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 financial income.[13] We estimate the model in three steps: first, we isolate the unexplained component of income growth; second, we account for labor supply responses – in our baseline estimates, we assume a quasi-linear utility function such that $f(e,\tau_t) = e(1-\tau_{i,t})$, using observable tax rates, and an elasticity of labor supply of 0.25;[14] finally, we estimate income growth $\Delta y_{i,t}$, given that $\rho = 1$, and quasi income growth $\tilde{\Delta} y_{i,t}$, given that $\rho < 1$,

$$\begin{aligned} \Delta y_{i,t} &\equiv y_t - y_{t-1} = \eta_{i,t} + \varepsilon_{i,t} - \varepsilon_{i,t-1} && (4) \\ \tilde{\Delta} y_{i,t} &\equiv y_{i,t} - \rho y_{i,t-1} = \eta_{i,t} + \varepsilon_{i,t} - \rho \varepsilon_{i,t-1}, && (5) \end{aligned}$$

which are used to estimate the insurance parameters.

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 covariance of two-year differences in income and consumption, which can be derived from the model as,

$$\hat{\Delta} y_{i,t} \equiv y_{i,t} - y_{i,t-2} = \eta_{i,t} + \eta_{i,t-1} + \varepsilon_{i,t} - \varepsilon_{i,t-2}. \tag{6}$$

3.1.2. 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,[15]

$$\Delta c_{i,t} = \phi_t^{\eta} \eta_{i,t} + \phi_t^{\varepsilon} \varepsilon_{i,t} + \xi_{i,t}. \tag{7}$$

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

[14] We test the sensitivity of the estimates to the labor supply elasticity by using an elasticity of 0.1 and 0.4 as well. See Burtless and Hausman (1978) for exposition of the quasi-linear utility function.

[15] This tractable equation can be derived from the Taylor expansion of the Euler equation of a CRRA utility function, with the derivation given in Appendix B. See Kaplan and Violante (2010) for other interpretations and extensions.

This equation allows both permanent and transitory shocks to have an impact on consumption, and allows these impacts to vary over time t.[16] The parameters ϕ_t^η and ϕ_t^ε 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*, and the insurance coefficient is defined as $1-\phi_t$. While we expect the intermediate case where $\phi_t \in (0,1)$, this equation also allows us to consider the two polar cases of no insurance ($\phi_t = 1$), as predicted by the permanent income hypothesis (with only self-insurance through savings), or full insurance ($\phi_t = 0$), as predicted by models of complete markets.[17]

The moment conditions use both the one-year and two-year differences in consumption to account for the fact that after 1996, the PSID is reported biannually, where the latter is given by

$$\hat{\Delta} c_{i,t} = c_{i,t} - c_{i,t-2} = \phi_t^\eta \eta_t + \phi_t^\eta \eta_{t-1} + \phi_t^\varepsilon \varepsilon_t + \phi_t^\varepsilon \varepsilon_{t-1} + \xi_t + \xi_{t-1}. \tag{8}$$

3.2. Moment Conditions

We estimate the transmission coefficients using two different approaches – Blundell et al. (2008) and Kaplan and Violante (2010) – by updating their moment conditions based on one-year differences to include moment conditions based on two-year differences.

In Blundell et al. (2008), the diagonally weighted minimum distance estimation uses the entire variance-covariance matrix of $(\Delta c_{i,t}, \Delta y_{i,t})$, and simultaneously estimates the transmission coefficients and the variance of permanent and transitory income.[18] We report the full set of

[16]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, and 2004-2010. We often report our estimates using the periods 1968-1985, and 1986-2010 for expositional ease. These years correspond to the years before, during, and after most studies, and they roughly correspond to two different tax regimes as shown in Figure 1. Our findings are not sensitive to the grouping of years.

[17]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 macro-economic 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).

[18]Blundell et al. (2008) also assumes that there is no foresight or short memory. The latter two assumptions simplify the model by assuming that $cov(\varepsilon_{i,t}, \varepsilon_{i,t+1}) = 0$, $cov(\eta_{i,t}, \eta_{i,t+1}) = 0$, $cov(\varepsilon_{i,t}, \varepsilon_{i,t-1}) = 0$, $cov(\varepsilon_{i,t}, \varepsilon_{i,t-2}) = 0$, and $cov(\eta_{i,t}, \eta_{i,t-1}) = 0$. We loosen these assumptions in Appendix C.5.

moment conditions in Appendix C.[19] In comparison, Kaplan and Violante (2010) use two moment conditions to identify the transmission coefficients. Following this second approach, we identify the transmission coefficients as a function of these moment conditions

$$\phi_t^x = \frac{cov(\Delta c_{i,t}, g_t^x(y_i))}{cov(\Delta y_{i,t}, g_t^x(y_i))}, \tag{9}$$

where $g_t^x(y_i)$ is some measurable functions of income history.[20] We follow and extend Kaplan and Violante (2010) by considering different true data-generating processes that require different $g_t^x(y_i)$ to identify the transmission coefficient.

Our first model of income allows for persistent changes in the income process, $\rho < 1$.[21] In this case, we modify equation (9) by replacing $\Delta y_{i,t}$ with $\tilde{\Delta} y_{i,t}$, which is defined in equation (5), leading to[22],

$$g_{t,KV\rho}^{\varepsilon}(y_i) = \tilde{\Delta} y_{i,t+1} \tag{10}$$

$$g_{t,KV\rho}^{\eta}(y_i) = \rho^2 \tilde{\Delta} y_{i,t-1} + \rho \tilde{\Delta} y_{i,t} + \tilde{\Delta} y_{i,t+1}. \tag{11}$$

And again, using two-year differences, we define

$$g_{t,KV\rho 2y}^{\varepsilon}(y_i) = \bar{\Delta} y_{i,t+2} \tag{12}$$

$$g_{t,KV\rho 2y}^{\eta}(y_i) = \rho^4 \bar{\Delta} y_{i,t-2} + \rho^2 \bar{\Delta} y_{i,t} + \bar{\Delta} y_{i,t+2}. \tag{13}$$

where

$$\bar{\Delta} y_{i,t} \equiv y_{i,t} - \rho^2 y_{i,t-2} = \eta_{i,t} + \eta_{i,t-1} + \varepsilon_{i,t} - \rho^2 \varepsilon_{i,t-2}. \tag{14}$$

[19] Figure A.3 shows these moment conditions graphically. While Figure A.6 compares these moments when we either do or do not consider the effect of taxes on labor supply.

[20] See Kaplan and Violante (2010) for an explanation of this construction in terms of instrumental variables.

[21] See Appendix C for more.

[22] Figure A.4 and Figure A.5 graphically show these moment conditions for the covariances with income and consumption, respectively. Figure A.7 and Figure A.8 compare these moments when we do or do not consider the effect of taxes on labor supply.

Our second model of income allows for labor-supply responses to taxes.

3.3. The Role of the Federal Income Tax on the Transmission of Income Shocks

The coefficients given in equations (7), (8), and (9) capture the size of the transmission of income shocks to consumption. These coefficients partly depend on the amount of *statutory* insurance resulting from the federal individual income tax. For example, if $Y_{i,t}$ denotes pre-tax income and $Y_{i,t}^D$ denotes post-tax or disposable income, then the *statutory* amount of insurance to income shocks that results from tax policy can be written as

$$S_{i,t} = 1 - \frac{\Delta Y_{i,t}^D}{\Delta Y_{i,t}} = \frac{\Delta T_{i,t}}{\Delta Y_{i,t}}, \tag{15}$$

where $\Delta T_{i,t}$ is the change in household i's tax liability resulting from an income shock in year t. This equation measures many types of redistribution. At one extreme, if the federal income tax completely absorbs shocks to pre-tax income such that $\Delta Y_{i,t}^D = 0$, then $S_{i,t} = 1$. At the other extreme, in the absence of insurance, 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 changes in the amount of statutory insurance received from the federal income tax can be driven by two channels. 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*. From 1968 to 2010, there were 55 federal tax changes beginning with the Revenue Act of 1971 and ending with the American Recovery and Reinvestment Tax Act of 2009. Appendix A.2 provides a deeper discussion of the federal income tax and lists these changes. One of the largest changes was the Tax Reform Act of 1986. This tax act was a sweeping change designed to simplify the tax code and broaden the base. Some of the key aspects include (i) lowering the top tax rate on individuals from 50% to 33%, (ii) consolidating the 15 tax brackets to 4, and (iii) expanding the standard deduction, personal exemption, and earned income tax credit. We simulate how these changes – and all of the other tax changes – impact the amount of insurance the federal income tax provides to individuals by holding the income distribution fixed and allowing these changes to occur. How it ultimately affects the transmission of income shocks to consumption requires combining this simulation with the macro-labor model described in section 3.1.

The second channel is *passive* changes in tax policy – that is, changes in the distribution of after-tax income that result only from changes in pre-tax income distribution, with everything else fixed, including the nonlinear income tax. From 1968 to 2010, the income distribution shifts and flattens. In particular, the late 1990s is a period of substantial income growth. This shift causes individuals to interact more with higher tax brackets. If the upper part of the tax schedule is more progressive and income shifts in a way that cause more people to be in that range, then the federal income tax will, in general, provide people with more insurance. We simulate this channel holding the income tax schedule fixed and calculating how incomes would have changed in the absence of the income tax changes. Again, how this insurance affects the transmission of income shocks to consumption, and ultimately household welfare, requires the macro-labor model described in section 3.1.

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 income distribution changes interacting with the tax schedule.

3.3.1. 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.[23] The *active* and *passive* changes in tax policy insurance are expressed in changes in net tax liability, where we adjust for inflation to match the policy year's dollars.[24] We use NBER's TaxSim 27 software to simulate

[23]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).

[24]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).

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.[25]

To calculate the active changes in statutory 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 the household's income plus a shock $\xi_{i,t}$ in the base year, $Y^c_{i,1980}$.[26] The shock is randomly drawn from the observed distribution of income shocks that we estimate.[27] The difference in federal income tax liability using the household's actual income, $T(Y_{i,1980}, \tau_{i,t})$, and using its counterfactual income, $T(Y_{i,1980} + \xi_{i,t}, \tau_{i,t})$, is the change in after-tax income a household would experience if its (fixed) real value of pre-tax income increased by the shock $\xi_{i,t}$. We define the *active* changes in insurance as the difference in simulated tax liabilities divided by the size of the simulated income shock,

$$S^A_{i,t} = \frac{T(Y_{i,1980} + \xi_{i,t}, \tau_{i,t}) - T(Y_{i,1980}, \tau_{i,t})}{\xi_{i,t}}. \tag{16}$$

To calculate the *passive* changes in insurance, we simulate each individual's tax liability every year, assuming the tax code had not changed from a base year. To do this, we hold the tax code fixed to the base year and allow pre-tax income to change every year as reported by households, deflated for inflation. We simultaneously exclude labor supply responses to tax changes from reported income to account for the fact that income itself is endogenous to the tax code. We assumed previously that $Y_{i,t} = F(N_{i,t}, e, \tau_{i,t})$ and that ability is separable from labor supply choices such that $log(Y_{i,t}) = log(N_{i,t}) + f(e, \tau_{i,t})$. Following Burtless and Hausman (1978), we use quasi-linear utility that generates equilibrium income, $Y_{i,t} = N_{i,t}(1-\tau_{i,t})^e$. Therefore, changes in income over time are due to changes in ability, $N_{i,t}$, and tax rates, $(1-\tau_{i,t})$.

To exclude labor responses to taxes from income, we calculate a measure of income, $\bar{Y}_{i,t}$, that

[25] 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 et al. (2012) use Euromod, a similar tax simulation software, and TaxSim to isolate the effect of income and unemployment shocks on disposable income, and to compare the stabilization effect of fiscal policy in the United States and Europe over time.

[26] 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 use 1995 and 2010 as alternative base years for income distribution and find that it does not affect the implications of our results.

[27] Figure A.9 compares the active changes in insurance when using the observed distribution or a fixed 10% shock.

holds the tax rate fixed. We calculate this income measure using income in year t, the tax rate in the base year, the tax rates in years t, and an estimate of the elasticity $(Y_{i,t}, \tau_{i,1980}, \tau_{i,t}, e)$. Specifically,

$$\begin{aligned}\bar{Y}_{i,t} &\equiv N_{i,t}(1-\tau_{i,1980})^e \\ &= N_{i,t}(1-\tau_{i,1980})^e \frac{(1-\tau_{i,t})^e}{(1-\tau_{i,t})^e} \\ &= Y_{i,t}\frac{(1-\tau_{i,1980})^e}{(1-\tau_{i,t})^e}.\end{aligned} \tag{17}$$

We further evaluate the robustness of the estimates of insurance parameters to several modeling assumptions, including the importance of modeling labor supply responses to taxes and of different levels of the elasticity of labor supply in the Appendix. We also check the sensitivity of the results to the choice of the base year by using two different base years, 1995 and 2010.

We then calculate federal income tax liability using this income in years t and $t-1$. We believe that this corrected measure of income is more likely to be exogenous and depend essentially on factors that are out of individuals' reach – such as technological growth, globalization, or digitization.

We define *passive* changes in insurance as the difference in simulated tax liabilities due to observed income shocks divided by the size of the observed household income shock between two successive years,

$$S^P_{i,t} = \frac{T(\bar{Y}_{i,t}, \tau_{i,1980}) - T(\bar{Y}_{i,t-1}, \tau_{i,1980})}{\Delta\bar{Y}_{i,t}}. \tag{18}$$

Active and passive tax policy changes thus reflect the insurance of after-tax income from pre-tax income shocks. Figure 1 shows active and passive changes in insurance from 1967 to 2010. As expected from a progressive tax system, the level of income insurance provided by the federal income tax 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. The large drop in 1987 coincides exactly with the Tax Reform Act of 1986, which dramatically changed the tax schedule. For example, the act reduced the top tax rate for individuals from 50% to 33%.

This figure suggests that the amount of income insurance obtained from the federal income tax has decreased over time.

Other notable tax policy changes can also be observed in Figure 1. For example, four of the largest changes in active tax policy changes occur in 1971, 1982, 1987, and 2002. These correspond to the Revenue Act (1971), the Tax Equity and Fiscal Responsibility Act 1982, the Tax Reform Act of 1986, and the Job Creation and Worker Assistance Act 2002. We provide a full list of tax changes with some characteristics in Table A.2.

Insurance from passive tax policy changes has slightly increased for all income groups from 1967 to 2010. The passive tax policy changes increase in the late 1990s for all income quartiles, exactly during an economic boom. The increase during this period is strongest for the third income quartile. These changes are less abrupt than the active tax policy changes because income distributions move more slowly than tax policy changes.

We discuss the sensitivity of the estimated parameters to major modeling assumptions in Section 5.2.2 and in the Appendix. In Section 5.2.2, Appendix Table A.9, and Figure A.10, we compare the passive changes in insurance when labor supply responses to tax are excluded, or not. While labor supply responses to taxes are important, their inclusion does not substantially change the estimate of passive insurance changes, likely because other changes in the income distribution are large during this period. In addition, in Appendix Table A.9 and Figure A.11, we compare the estimates of the transmission of income shocks using labor supply to taxes of 0.1, 0.25, and 0.4 to estimate passive insurance changes. This figure reveals there are only slight differences between estimated insurance parameters. In Section 5.2.2. and Appendix Table A.9, we also report and discuss estimates from a model that relaxes the assumption of no-foresight in the permanent component of income. Together this analysis supports that our computation of passive tax policy changes essentially captures the effect of changes in the income distribution. Appendix Figure A.12 shows the sensitivity of the passive changes in insurance to using different values of the base year, 1980, 1995, and 2010. The trends are all very similar and the levels differ only slightly.

How these changes in insurance map into changes in the transmission of permanent and transitory shocks requires the macro-labor model in section 3.1. In the following section, we formalize the mapping from changes in the transmission coefficients estimated from the macro-labor model into those due to (i) active tax policy changes, (ii) passive tax policy changes, and (iii) behavioral changes.

3.3.2. Decomposing the Transmission of Income Shocks to Consumption

This section extends the macro-labor model to describe how active and passive tax policy changes might contribute to changes in the transmission coefficients. We formalize this in equation (19) by allowing the transmission parameters to be a function of active and passive tax policy changes and behavioral changes. The behavioral changes capture all other changes, such as changes in precautionary saving, access to credit, and reliance on family and friend networks. The behavioral changes also capture changes in how individuals internalize active and passive changes. For example, individuals may change how they react to active tax policy changes by changing savings or consumption in response to changes in tax liability. How active and passive tax policy changes map into the transmission of income to consumption could differ and are captured by the coefficients in the following equation:

$$\phi_t^x = \alpha + \beta_{A,t} S_{i,t}^A + \beta_{B,t} S_{i,t}^P + \varepsilon_{i,t}. \tag{19}$$

To quantify the contribution of active and passive tax policy changes and behavioral changes, we use a Oaxaca (1973) and Blinder (1973) decomposition of the change in the insurance coefficient

$$\Delta\phi_{1,0}^x = \phi_1 - \phi_0 = \alpha_1 + \beta_{A,1} S_{i,1}^A + \beta_{P,1} S_{i,1}^P + \varepsilon_{i,1} - (\alpha_0 + \beta_{A,0} S_{i,0}^A + \beta_{P,0} S_{i,0}^P + \varepsilon_{i,0}). \tag{20}$$

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

$$\Delta\phi^{x}_{1,0} = \beta_{A,1}(S^{A}_{i,1} - S^{A}_{i,0}) + \beta_{P,1}(S^{P}_{i,1} - S^{P}_{i,0}) \\ + S^{A}_{i,0}(\beta_{A,1} - \beta_{A,0}) + S^{P}_{i,0}(\beta_{P,1} - \beta_{P,0}) + \alpha_1 - \alpha_0 \\ + \varepsilon_{i,1} - \varepsilon_{i,0}. \tag{21}$$

The first two terms on the right side of equation (21) capture changes in active and passive tax policy, respectively. The terms on the second line capture all other *behavioral* changes (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 et al. (2011) provide a discussion of this identifying assumption and methods to loosen it.

In sum, we solve the macro-labor system extended by equation (21). On one hand, the macro-labor model estimates the insurance of pre-tax income shocks to consumption. On the other hand, the micro-simulations provide information on how much active and passive tax policy changes affect the insurance of pre-tax income shocks. These simulations, however, do not provide evidence on how individuals respond to these changes when making consumption decisions. Equation (21) describes the full contribution of tax policy changes to changes in the insurance of pre-tax income shocks to consumption. The contribution of changes in active tax policy is represented by $(S^{A}_{i,1} - S^{A}_{i,0})$, weighted by the impact active changes have on the insurance of pre-tax income to consumption, β_A. Similarly, the contribution of passive tax policy changes to changes in the insurance 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 contribution of behavioral changes to tax policy is represented by $(\beta_{A,1} - \beta_{A,0})$ for responses to active tax policy, and by $(\beta_{P,1} - \beta_{P,0})$ for responses to passive tax policy, weighted by the average active and passive insurance.

This combination of micro-simulations and the structural labor model is a key contribution of this paper. This combination can uncover, for instance, that even if a change in active tax policy is larger than a change in passive tax policy, passive changes can still affect the insurance of income shocks to consumption more than active changes if individuals respond more to passive tax changes.

4. 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) combined 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 et al., 2004, 2008).[28]

One innovation of our study is our expansion of the sample years to include the years 1967 through 2010. This allows for a comparison between the imputed values of non-durable consumption produced through this method with actual data on non-durable consumption collected in the PSID from 1999 to 2010. Additional data collection information is given in Appendix A.

4.1. Sample Selection

We begin 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 by a male (excluding 34 percent of remaining households).[29] 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

[28] 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.) 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).

[29] Additional details are provided in appendix table A.4. 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 are dropped otherwise. This restriction also limits the changes due to differences in education and retirement.

limitation since, for example, the percentage of single and joint households receiving the EITC are similar.[30]

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). Finally, within this sample, we focus on household heads ages 30-65 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 19,493 observations (7.4 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 of the US population and the low-income sample (SEO).[31] 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.

[30] 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.

[31] 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.

4.2. 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).[32]

We start with 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:

$$f_{i,t} = \boldsymbol{W}'_{i,t}\boldsymbol{\mu} + \boldsymbol{p}'_t\boldsymbol{\theta} + \beta(D_{i,t})c_{i,t} + u_{i,t}, \tag{22}$$

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 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 u. 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.[33] We construct a measure of

[32]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. 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.

[33]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, cloth-

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 2 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 the national income and product accounts (NIPA). Moments of imputed consumption and CEX consumption are also close throughout the period.[34]

5. Empirical Evidence

This section characterizes the evolution of the transmission coefficients of permanent and transitory income changes from 1968 to 2010. Starting with permanent income shocks, we find that in levels, there may be more insurance against permanent income shocks than previously thought. First, we show that the period typically studied, 1980 to 1992, had larger transmission of permanent income than the periods before or after. Second, when we modify the model to account for labor supply responses to taxes and other factors in Kaplan and Violante (2010), we find smaller transmission coefficients of permanent income shocks. Third, we show that although consumption insurance increased, this obfuscates the negative effect active tax policy changes had on insurance during this period. In particular, we find that the effect of active changes is masked by passive and other behavioral changes that increased insurance.

Our findings also reveal important changes in the transmission of permanent and transitory income shocks. Though over the whole period, the transmission of permanent income shocks has decreased, the transmission of transitory income shocks, which was small until the late 1990s, has dramatically increased in the last 10 years to surpass that of permanent income shocks. We also find differential changes by income quartile and education groups. The transmission of permanent income shocks is significantly larger for the lowest income quartile than any other quartile, and has not significantly decreased compared to other groups, while the transmission of transitory income

ing, home repair, and charitable giving.

[34] 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).

shocks has increased proportionately across income groups.

Section 5.1 begins with estimates of the variance of permanent and transitory income from 1968 to 2010 using Blundell et al. (2008)'s method. These estimates provide the context for the transmission coefficients. Next, Section 5.2 extends our analysis of the transmission coefficients over time, with varying identifying assumptions, including the more flexible approach in Kaplan and Violante (2010), by sub-periods, and across income and education subgroups. These estimates provide a fuller picture of how the transmission coefficients have changed from 1968 to 2010. Finally, Section 5.3 reports estimates of the decomposition of the changes in the transmission coefficients into changes due to active tax changes, passive tax changes, and behavioral changes. We again consider how these contributions differ by income quartile and education attainment. Taken together, this set of estimates extends our understanding of how tax policy affects household welfare.

5.1. Variance of Permanent and Transitory Income Shocks

Figure 3 reports the variance of permanent and transitory income shocks. These shocks are estimated with the minimum distance estimation method and moment conditions described in Section 3 allowing for labor-supply responses to taxes and using the data on income and consumption described in Section 4. This figure reveals two key findings. First, from 1970 to the mid-1990s, the variance of permanent income shocks (dotted line) remains relatively flat, while the variance of transitory income shocks (solid line) follows an increasing trend.[35] Second, the variance of permanent income shocks increases from the late 1990s through 2010, while the variance of transitory income shocks decreases from its peak in the early 1990s through 2010.[36] Without extending the moment conditions to include two-year differences, it would have been impossible to detect the increase (decrease) in the variance of permanent (transitory) income shocks beyond the

[35]This finding is consistent with the evidence from Figure A.3 that the auto-covariance of income did not increase during this period. These trends are very similar to those estimated by Blundell et al. (2008) for the years they cover (1979 to 1992) and to those found by Gottschalk and Moffitt (2009) in the extended period.

[36]This evidence is consistent with the increase in the covariance of income and its two-year lag after the mid-1990s.

early 1990s. Figure A.10 demonstrates that allowing for labor-supply responses to taxes increases the estimates of the variance of permanent and transitory income shocks. The trends, however, are very similar with and without labor-supply responses.

These estimates also reveal an increase in the variance of income over the whole period, and that permanent and transitory income shocks have tended to vary in opposite directions. They suggest that the increase in the variance of income stems essentially from transitory income shocks in the 1980s, and from permanent income shocks in the late 1990s and 2000s. We show that this finding, combined with the trends in insurance described in the next subsection 5.2, has important policy implications; in particular, the amount of insurance against each type of income shocks seems to move in the same direction as the variance of these shocks.

5.2. The Transmission of Income Shocks to Consumption

The transmission coefficients ϕ^{η} and ϕ^{ε} capture the transmission of permanent and transitory income shocks to consumption. At one extreme, when these coefficients equal 1, income shocks are fully transmitted to consumption, and there is zero insurance. At the other extreme, when the coefficients equal 0, income shocks are not transmitted at all, and there is full insurance. The most general situation is for income shocks to be partially transmitted, which occurs when the coefficients lie between the two extremes. The smaller the coefficients, the lower the transmission of income shocks, and the higher the amount of insurance.

We report the results using three methods that rely on different identifying assumptions and different sub-periods from 1968 to 2010. First, we estimate the transmission coefficients using the method in Blundell et al. (2008), which we update using two-year moment conditions. We refer to this model as the BPP updated model. Second, we allow for persistent shocks using the method in Kaplan and Violante (2010), and update it using two-year moment conditions. We refer to this model as the KV persistent model. Finally, we update the KV persistent model to allow for labor-supply responses to taxes, which we refer to as the KV persistent *e* 0.25 model. Our baseline specification assumes an elasticity of labor supply of 0.25, and Table A.9 reports estimates with other values.

5.2.1. Differences in estimates by periods

First, our larger sample allows us to complement and compare previous work that typically focuses on the period 1979-1992, notably Blundell et al. (2008). Table 2 reports estimates in three periods: 1968-1978, 1979-1992, and 1993-2010 – a period before and after the period Blundell et al. (2008) studied. Our estimates in 1979-1992 are similar to those in their paper. Column 1 reports the permanent transmission coefficient in Blundell et al. (2008) is 0.642 compared to our estimate of 0.661 reported in Column 2, which shows our estimates using their method, updated to incorporate additional two-year moment conditions.

Using a longer period, however, our estimates reveal that the transmission of permanent income shocks was significantly higher during 1979-1992 than either before or after. In particular, we find that over the whole period and using the same model as in Blundell et al. (2008), the average permanent transmission coefficient is 0.527, and decreased substantially from the period 1979-1992 to the last period. This evidence suggests that the insurance to permanent income shocks is larger than previously suggested, and has increased in recent years. Columns 3 and 4 report the estimates using the methodology in Kaplan and Violante (2010), showing a similar trend. We investigate the differences between models in the next section.

Figure 4 provides a more detailed picture of how the estimated transmission coefficients vary over periods, by depicting permanent and transitory transmission coefficients in Panels A and B, respectively. From 1968 to 2010, the permanent transmission coefficient decreases from roughly 0.5 to 0.1, suggesting that consumers have become better insulated from permanent income shocks recently than they were 40 years ago. This result is consistent across methods. This finding, that consumption insurance of permanent shocks increased, seems at odds with how tax policy has changed. Indeed, the micro-simulations shown in Figure 1 revealed that insurance from the federal income tax moved in the opposite direction, decreasing the amount of income insurance overall, or increasing the transmission of permanent income shocks from pre- to post-tax incomes. To reconcile these two pieces of evidence, it is necessary to decompose the changes in transmission coefficients into different types of tax policy changes, which we do in Section 5.3.

We find that our estimates of the transitory transmission coefficient are similar to the literature in 1979-1992, and that the estimates have an increasing trend 1968-2010. Table 2 Panel B reports that our estimate of the transitory transmission coefficient is 0.114 in 1979-1992, using the model in Blundell et al. (2008) reported in Column 2. This, however, hides that the transitory transmission coefficient has increased over time. Using a longer period, we find that in the 1970s, households were almost entirely insulated from transitory income shocks. Since then, the transmission coefficient has increased, reaching levels of around 0.2 after 1992 on average, up to around 0.4 in the late 1990s and early 2000s (Figure 4). This pattern suggests that while the permanent transmission coefficient decreased, the transitory transmission coefficient increased. Households are less insulated from transitory shocks now than they were 40 years ago.

5.2.2. Differences in estimates by method

Though the overall trends in transmission coefficients are consistent across methods, some differences exist based on the models we employ.

Figure 4 summarizes several insights from comparing estimates across methods.[37] The first insight is that during most of the period, the permanent and transitory transmission coefficients are smaller when estimated with the method in Kaplan and Violante (2010) than the method in Blundell et al. (2008). This difference in estimates across the two models is consistent with the findings in Kaplan and Violante (2010).[38] Though the overall trends are similar across the two methods, their variations differ in several places. Specifically, for the permanent transmission coefficients, their variations upward or downward tend to differ in the 1980s and 1990s, making the methods diverge, even though they move along the same trends. Then, they move back together in the late 1990s and after. In contrast, for the transitory transmission coefficients, the estimates only start to diverge in the 1990s and 2000s.

The divergence in estimates across models is likely due to a combination of the model as-

[37] Panels A and B of Table 3 provide the average permanent and transitory transmission coefficients, respectively, over the full period 1968-2010 and the two sub-periods.

[38] In particular, Kaplan and Violante (2010) say that their generalization of the model in Blundell et al. (2008) show that ‘‘the actual insurability of shocks in the US economy may be higher than what was measured by BPP.”

sumptions about liquidity constraints and tax policy changes. Kaplan and Violante (2010) show that because the model in Blundell et al. (2008) precludes the existence of liquidity-constrained consumers, their model overestimates the transmission of permanent income shocks. One of the largest changes in consumer liquidity constraints occurred as a result of the Tax Reform Act of 1986 (Ryan et al., 2011). Specifically, the act limited interest deductions for individuals from all personal loans – including credit cards – to only interest deductions on mortgages. In response, consumers became more leveraged in relatively non-liquid assets. While certainly not definitive, the timing of this change in consumer liquidity constraints is consistent with the timing of the divergence of the transmission coefficient estimates across models.[39] Therefore, in Table 3 and from now on, we present the estimates over two sub-periods – 1968-1985 and 1986-2010 – to correspond with the periods before and after the Tax Reform Act of 1986. We have shown already how this reform caused a notable change to insurance in the micro-simulations depicted in Figure 1, and here we can see how the differences between the Blundell et al. (2008) and Kaplan and Violante (2010) models diverge further after this reform regarding the transmission of permanent income shocks.

The second insight is that allowing for labor-supply responses to taxes reduces the permanent transmission coefficients slightly without affecting the trend. These estimates suggest that consumers adjust their choices relative to productivity to smooth their consumption. In particular, the estimates of the permanent transmission coefficient shown in Columns (2) and (3) of Panel A of Table 3 decrease from 0.277 to 0.264 over the entire sample when the method allows for labor-supply responses. The difference is similar in the first and second sub-periods. In contrast, the transitory transmission coefficients are slightly larger using the model that allows for labor-supply responses to taxes. The estimates increase from 0.038 to 0.043 (reported in Columns 2 and 3 of Panel B). Figure A.11 and Table A.9 consider other values for the elasticity of labor supply. The differences in the estimates of transmission coefficients across elasticities are relatively small, and

[39] Kaplan and Violante (2010) also explore the implications of information by relaxing assumptions about no foresight and short memory. We also consider these changes to the model. Unfortunately, we are unable to relax these assumptions and use two-year differences, which are necessary to use years after 1996, for the transitory transmission coefficients. We report the estimates for the permanent transmission coefficient, however, in Figure A.11 and Table A.9.

tend to be slightly smaller for larger labor-supply elasticities. In particular, the permanent and transitory transmission coefficients decrease to 0.272 and 0.058 respectively, for an elasticity of 0.1, to 0.257 and 0.045 respectively. for an elasticity of 0.4.

Overall, this suggests that the only assumption that significantly impacts the size of our estimates is the flexibility of the model to allow for liquidity constrained consumers, which is included in the model by Kaplan and Violante (2010) and in this paper, but not in Blundell et al. (2008). Assuming a range of intensity of labor supply responses, however, has only minor impacts on the results, possibly because this effect is indirectly captured by including liquidity constraints.

Moving forward, we focus on the estimates using the method in Kaplan and Violante (2010) that allows for both labor-supply responses and persistent shocks, because these estimates are based on the most realistic identifying assumptions, given our data.

5.2.3. Differences in estimates by income and education

Table 4 reports estimates of the transmission coefficients by income quartile and educational attainment. We define income quartiles using 1980 as the base year and holding income groups fixed over the full sample. We also consider two education groups, high-school graduates and individuals with at least some college education.[40] We consider these subgroups because their transmission coefficients could change in different ways and for different reasons. First, Figure 1 shows that active tax policy changes affected income quartiles differentially. Second, income growth differed for these income and education groups (changing passive tax changes). Third, these groups have varying access to different types of insurance. For example, low-income quartiles may depend more on government programs, while high-income quartiles may rely more on self-insurance.

As expected, the transmission coefficient of permanent income shocks is larger for lower-income quartiles and high-school graduates than higher-income quartiles and individuals with at least some college education. In particular, Panel A of Table 4 reports that the average permanent transmission coefficient is 0.538 for the bottom income quartile (Column 1) and 0.233 for the top income quartile

[40] We considered high-school dropouts, but that subset had very few observations.

(Column 4). Similarly, the average permanent transmission coefficient is 0.359 for high-school graduates (Column 5) and 0.220 for individuals with at least some college education (Column 6). The smaller permanent transmission coefficients for high-income quartiles likely reflect these groups' ability to smooth through credit, savings, and interacting with the federal income tax schedule in a different place. In addition, the difference in permanent transmission coefficient using the BPP updated and the KV persistent methods (reported in Tables A.10 and A.11, respectively) are less different for the top income quartile than the other income quartiles, likely because the methods differ most for subgroups that are liquidity-constrained.

The trends in the permanent transmission coefficient are similar across income and education groups, decreasing for all subgroups from 1968 to 2010. The magnitudes, however, differ somewhat across groups. For example, the middle income quartiles and those with some college education experienced larger decreases than the other income quartiles and educational attainment levels.

Households smooth a large proportion of transitory income shocks, and this seems to be true for all income quartiles and educational attainment levels. In particular, the estimates range from negative to 0.074. The general trend of an increase in the transitory transmission coefficient is observed in all but the second income quartile. The magnitudes of the increases in the transitory transmission coefficients differ somewhat across subgroup. For example, the top income quartile and households with at least some college education experienced larger increases than other income quartiles and educational attainment levels. To better understand the mechanisms for these changes and the potential role of tax policy, the next subsection decomposes the changes in transmission coefficients.

5.3. Decomposition of the Transmission Parameters

This section investigates the mechanisms driving the changes in transmission coefficients previously reported. As the progressive income tax and transfer system plays a key role in reducing inequality, we focus on the role of the federal income tax as a key mechanism behind changes in the transmission of income shocks. Because high-income people pay higher average tax rates than others, federal taxes reduce inequality. Previous studies have provided suggestive evidence of this mechanism by comparing differences in the variance of pre-tax and post-tax income (Debacker et al., 2013).[41] Evidence shows that before-tax income inequality has risen since the 1970s, despite an increase in government transfers, but that the mitigating effect of taxes on inequality is about the same today as before 1980. Thus, after-tax income inequality has increased about as much as before-tax inequality.[42] We use consumption as a more accurate and complete measure of economic well-being than after-tax income. How much the federal income tax affects consumption smoothing, however, is an open question. The ability of the federal income tax to smooth consumption has been called into question, in part because despite the fact that changes in active federal income tax policy have provided less insurance to households – as evidenced in the micro-simulations in Section 3.3.1 – macro-labor models have shown that the transmission of income shocks has stayed the same or decreased.

Our model reconciles these two pieces of evidence by suggesting that the transmission of income to consumption is affected by i) active changes in tax policy, ii) passive changes, resulting from the interaction between changes in the income distribution and the federal income tax schedules, and iii) behavioral changes or responses to tax changes, such as changes in precautionary savings and credit availability. These three channels could operate in opposite directions, which could effectively mask their individual contributions. Specifically, we observe a decrease in the permanent transmission coefficient of 0.246 over the sample period (Table 5, Panel A, Column 3, bottom row). This decrease, however, is a net change. For example, it could be the result of passive tax policy only, with no effect from active tax policy changes or behavioral changes. It could also be the combined result of changes in active tax policy that increases the parameter by 0.4 and of passive changes that decreased it by 0.646, with no impact from behavioral responses. In sum, to understand how federal income tax policy changes impacted households' consumption smoothing, it is necessary to decompose tax policy changes into passive and active changes and estimate their specific contribution to the transmission coefficients.

[41] 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.

[42] https://www.taxpolicycenter.org/briefing-book/how-do-taxes-affect-income-inequality

Table 5 reports the contribution of active tax policy changes, passive tax policy changes, and behavioral changes to the permanent and transitory transmission coefficients, in Panels A and B, respectively. Column (1) reports the estimates for the BPP updated model. Columns (2) and (3) report the estimates of the KV persistent and KV persistent *e* 0.25 model. The final row of each panel reports the difference over sub-periods in the transmission coefficients reported in Table 3.

5.3.1. Decomposition of permanent transmission coefficient changes

We find that active tax policy changes served to accentuate the transmission of permanent income shocks to consumption, despite the overall decrease in the permanent transmission coefficient (reported in the last row of Panel A of Table 5). In particular, our baseline estimate – reported in Column (3)– suggests that active tax policy changes increased the coefficient by 0.353. This finding is consistent and significant across models, and is larger using the BPP updated model reported in Column (1).

Passive tax policy changes operated in the opposite direction as active changes, decreasing the average transmission of permanent income shocks to consumption. Our baseline estimate suggests that passive changes reduced the permanent transmission coefficient by -0.051 from the first to the second sub-periods. Put in context, passive tax policy changes explain about 21 percent of the average decrease in permanent transmission coefficients from 1968 to 2010. This estimate also means that passive changes partly offset the increasing impact of active changes by 14 percent. The passive changes are due to several underlying changes to the income distribution that are beyond the control of taxpayers, such as increased trade and automation. Tax policy changes can also change labor-supply choices or productivity; however, our model explicitly accounts for labor-supply response to taxes, limiting this channel. Nevertheless, we cannot exclude the possibility that our model does not fully control for the impact of labor-supply changes on income distribution, and therefore, admit that some of the passive contribution could be hidden in the contribution of active tax changes that affect labor supply.

Behavioral changes – such as precautionary savings, borrowing, and increased credit – also acted to decrease the transmission of permanent income shocks to consumption, and to offset the positive effect of active changes. Our baseline estimate suggests that behavioral changes contributed to reduce the transmission coefficient by -0.548. In other words, behavioral changes more than countered the increase in the transmission coefficient due to active tax policy changes. This could be explained, for example, by increased access to credit via credit cards. The substantial contribution of behavioral changes, however, motivates future work to decompose the behavioral contribution into its components.

5.3.2. Decomposition of transitory transmission coefficient changes

Panel B of Table 5 shows that the transmission of transitory income shocks to consumption increased from 1968 to 2010. This increase contrasts with the decrease in the permanent transmission coefficient. Decomposing the contribution of tax policy changes to changes in the transitory coefficient reveals that active tax policy changes accentuated the coefficient by 0.468. This positive impact is similar to the findings for the permanent transmission coefficient. This positive effect of active tax policy is consistent across models, though substantially larger for estimates from the KV persistent and KV persistent e 0.25 models.

Passive tax policy changes operated in the same direction as active changes, increasing the transmission of transitory income shocks to consumption. Our baseline estimates in Column (3) suggest that the transitory transmission coefficient increased by 0.092 due to passive tax changes. This positive contribution of passive tax changes is much smaller than that of active tax changes. It is consistent across models, though smaller for BPP updated model.

Behavioral changes operated to dampen the transmission of transitory income shocks to consumption. Our baseline estimate in Column (3) suggests that behavioral changes decreased the transitory transmission coefficient by -0.409. In other words, the decreasing effect of behavioral changes attenuated 87 percent of the increasing effect of active tax policy changes. This negative contribution of behavioral changes differs between the models. This difference is likely due to divergences in the estimates of the transitory transmission coefficient in the late 1990s and 2000s. As these changes are not the focus of this paper, we leave for future work the investigation of how changes in household behavior contribute to the transmission of transitory income shocks to consumption.

5.3.3. Differences in estimates by income and education

Panel A of Table 6 reports the decomposition of the permanent transmission coefficients, by income quartile and education attainment, using the KV persistent *e* 0.25 model.[43] The last row of Panel A reveals that all income quartiles and education groups experienced a decrease in the permanent transmission coefficient between the two sub-periods. The contribution of tax policy changes reported in Table 5 for the full sample is similar for most of the subgroups. Specifically, active tax policy changes accelerated the transmission of income shocks to consumption, while passive and behavioral changes attenuated it. The one exception is the top income quartile, for which active tax policy changes attenuated the transmission of permanent shocks, while behavioral changes enhanced it.

While the general directions of how tax policy changes affect the permanent transmission coefficient are similar between the full sample and the subgroups, some changes are proportionately larger than others. For example, the third income quartile experienced the largest proportional increase in the permanent transmission coefficient due to active tax policy changes of 0.408, while that of the bottom and second income quartiles was much smaller at 0.115 and 0.080, respectively (reported in Columns 1-3 of Panel A of Table 6). The magnitudes of the decomposition are roughly similar for high-school graduates and those with at least some college education.

Panel B of Table 6 reports the decomposition of the transitory transmission coefficient by income quartile and education attainment. The last row reveals that the transmission of transitory income shocks increased for all subgroups except for the second income quartile. The contribution of tax policy changes reported in Table 5 for the full sample is similar for most of the subgroups. In particular, for most sub-groups, active and passive tax policy changes accentuated the transmission of transitory income shocks, while behavioral changes attenuated it. The main difference across subgroups lies in the contribution of the passive tax changes. For the second and top income quartile,

[43] Tables A.12 and A.13 report the decomposition using different models.

passive tax policy changes attenuated the transmission of transitory shocks, while for the third quartile, passive tax policy changes substantially accentuated it. This finding highlights that tax policy changes affect different types of households differently, and that the impact of these changes on inequality may be difficult to predict.

The evidence by subgroups reinforces the overall findings in the full sample. Active tax policy changes accentuated the transmission of both permanent and transitory income shocks to consumption, while passive and behavioral tax changes often operated in the opposite direction. This evidence suggests that households used other, private types of insurance mechanisms to offset the decrease in insurance due to changes in tax rates and the tax code, and that simply looking at the overall impact of tax policy changes masks these balancing forces.

6. Conclusion

This paper provides a detailed analysis of the evolution of the transmission of (or insurance to) different types of income shocks to consumption. It proposes a methodology to explain the mechanisms by which federal income tax policy has contributed to changes in insurance over time. Combining panel data on individual incomes and longitudinal consumption data across consumers and households from 1967 to 2010, it uses multiple modeling approaches borrowed from the micro- and macro-economic literature to estimate the levels of insurance of consumption to permanent and transitory income shocks over the long term. It also compares the trends in insurance across different socio-economic groups, based on income or educational attainment.

We find important changes in the levels of insurance to permanent and transitory income shocks over time. In particular, while consumers were on average only partly insured to permanent income shocks in the 1980s and early 1990s, insurance to permanent income shocks has increased in recent decades. We find the opposite for transitory income shocks: while the transmission of transitory income shocks to consumption was small a few decades ago, consumers have become less insured to transitory income shocks in recent years. Though the trends are similar across socio-economic groups, low income and less educated taxpayers still experience significantly less insurance to permanent income shocks than any other group. Meanwhile, the transmission of transitory income shocks has increased proportionately more for both the bottom- and top-income groups. This suggests increased inequality in the transmission of income shocks to consumption.

We go one step further to identify and estimate the mechanisms by which the federal income tax system has contributed to changes in insurance trends over time. To this end, we use a tax model covering changes in the tax code over the designated period to simulate two types of exogenous changes in the tax system that have affected the degree of insurance provided by the tax code. We define changes in the tax code, such as changes in tax rates or subsidies or changes in tax design, as *active* tax policy changes. We define changes due to exogenous changes in the income distribution and how these changes interact with the non-linear income tax schedule as *passive* tax policy changes. Finally, we define changes in the difference between pre-and post-tax incomes that are not due to active or passive tax policy as behavioral responses, such as aversion to risk or private insurance. This decomposition allows us to not only uncover the overall role of the tax system to change the insurance of final consumption, but also separate and evaluate the different mechanisms by which tax policy operates.

We find that the overall effect of tax policy on insuring consumers to income shocks hides strikingly different contributions of active, passive, and behavioral tax policy changes. Active tax policy changes have operated to accentuate the transmission of both permanent and transitory income shocks to consumption. By contrast, passive tax policy changes have moderately decelerated the transmission of both income shocks. Behavioral tax policy changes, or consumers' responses to active and passive tax policy changes, have decelerated the transmission of both income shocks, sometimes enough to offset the accelerating trend of active tax policy changes. The contribution of active tax policy to reduce the insurance to permanent income shocks is not significantly different across income groups, but active tax policy reduced the insurance to transitory income shocks significantly more for the bottom- and the top-income groups. Nevertheless, for the top-income group, insurance to transitory income shocks was mostly offset by behavioral responses that increased insurance, while for the lowest income group, behavioral tax policy changes reinforced further the reduction in insurance to transitory shocks. This suggests that the impact of tax policy changes on inequality is complex, and that evaluating the average effect of tax changes on insurance and inequality hides important, non-linear effects of different components of the tax system.

These findings contribute to a better understanding of the role played by the federal income tax system in transmitting income shocks to consumption, as well as in changing inequality of consumption. Any direct change to the income tax system to reduce inequality must be evaluated in context, and assessed in parallel with the possible costs or deadweight loss that result from its interactions with indirect changes in tax policy, including exogenous changes in the distribution of income across consumers, and taxpayers' behavioral responses. Tax policy aimed to dampen inequality must also consider the types of income shocks that affect consumers, how these shocks change over time, and how they interact with the tax system.

A more general analysis would also consider the long-term 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 broadening the income distribution.

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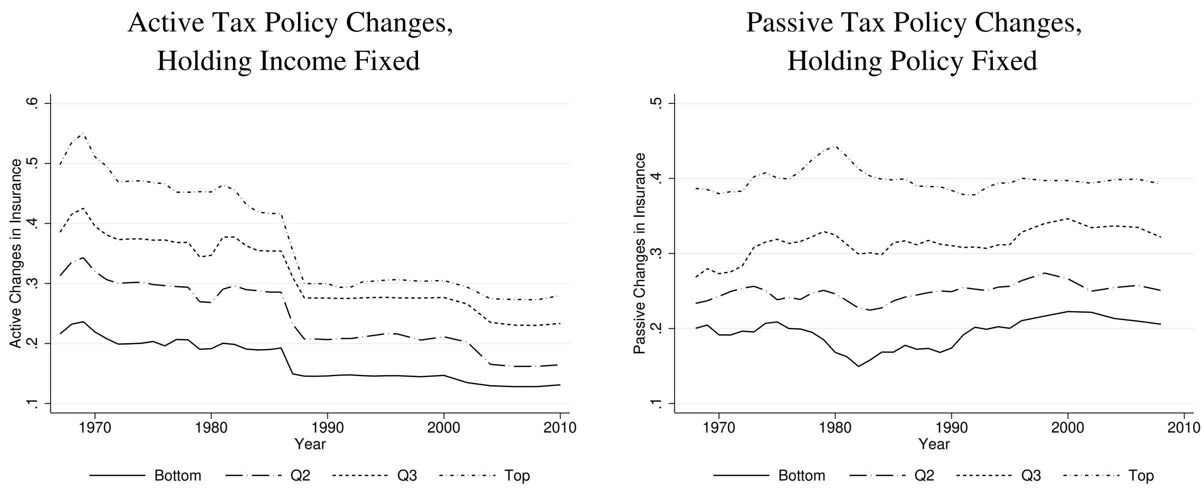
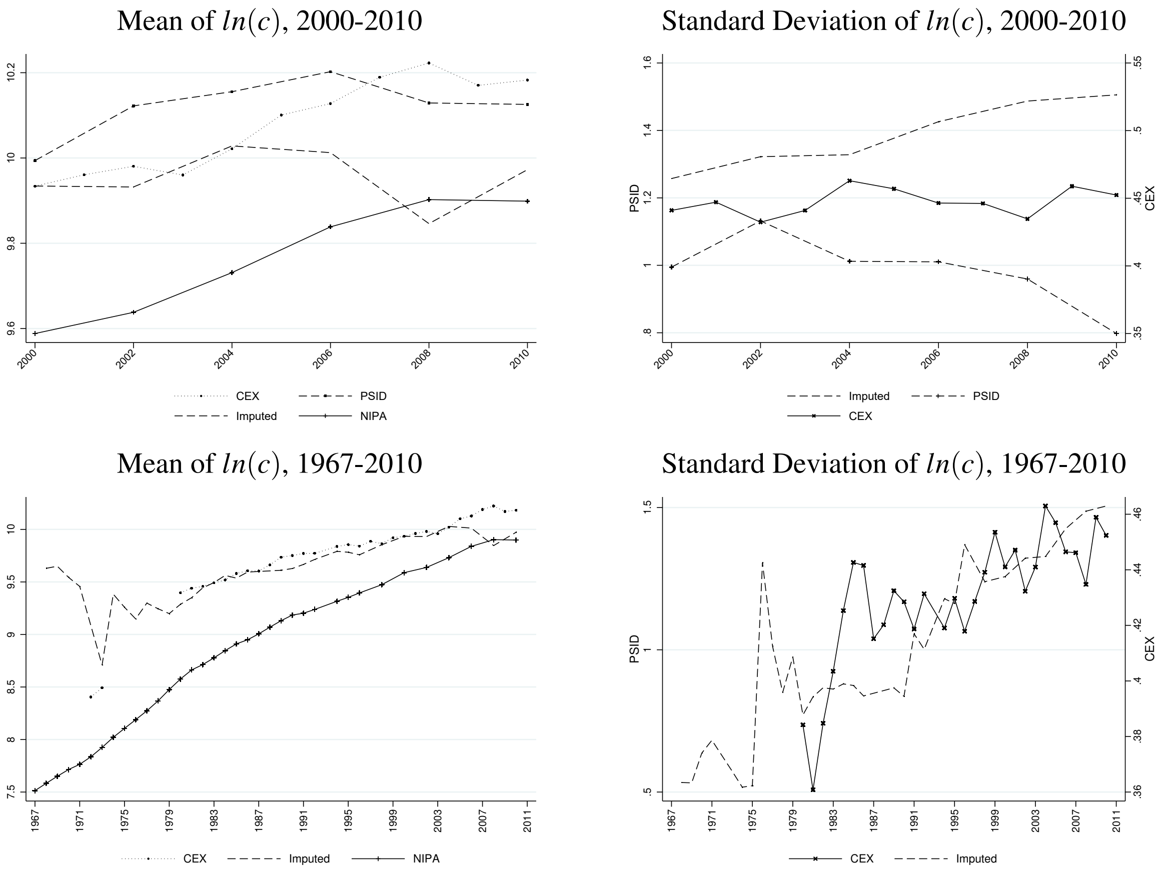
Figure 1: Active and Passive Tax Policy Changes, by Quartiles of Income



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 (16) and (18). Income quartiles are defined in the base year 1980.

Figure 2: Mean and Standard Deviation of Log Non-Durable Expenditures

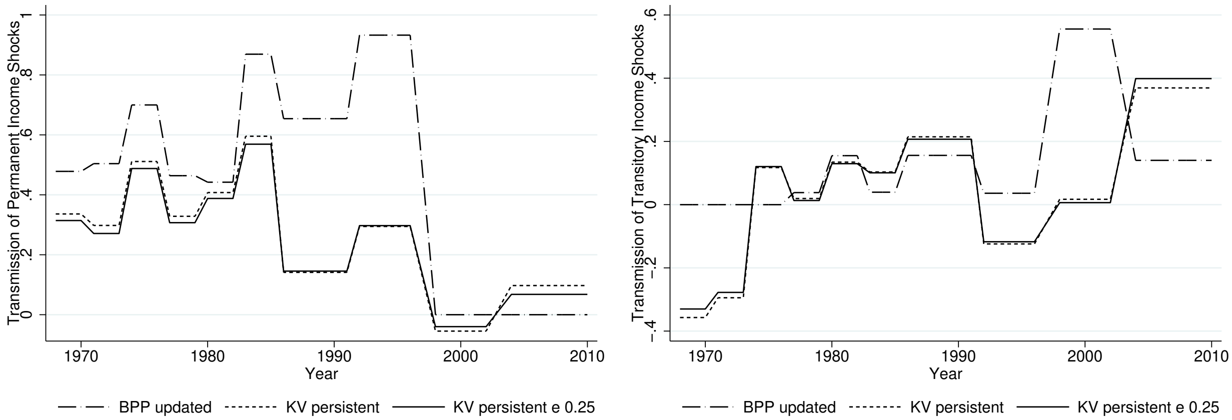


NOTE.— See Table A.5 notes for an explanation of the NIPA average and non-durable consumption imputation (PSID imp.).

Figure 3: Variance of Permanent and Transitory Income Shocks

NOTE.— Estimates from the minimum distance estimation following Blundell et al. (2008), accounting for the effect of federal income tax on income with an elasticity of 0.25.

Figure 4: Transmission of Income Shocks



NOTE.— BPP updated reports estimates using the minimum distance estimation described by Blundell et al. (2008). KV persistent reports estimates based on the methods in Kaplan and Violante (2010), with a persistent permanent shock with parameter 0.95. KV persistent *e* 0.25 reports estimates based on Kaplan and Violante (2010) allowing for the effect of federal income tax on income with an elasticity of 0.25 and a persistent permanent shock with parameter 0.95.

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	92,654	95,420
	(6,587)	(8,787)	(14,485)	(17,844)	(31,538)	(29,527)	(45,191)	(43,467)	(63,709)	(61,429)	(86,407)	(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)

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

Table 2: Transmission of Permanent and Transitory Income Shocks

Periods	BPP (2008)	BPP updated	KV persistent	KV persistent e 0.25
	(1)	(2)	(3)	(4)
Panel A: Average Transmission Levels of Permanent Income Shocks				
Average 1968--2010		0.527	0.277	0.264
		(0.0553)	(0.0012)	(0.0011)
Average 1968--1978		0.543	0.372	0.348
		(0.0207)	(0.0011)	(0.0011)
Average 1979--1992	0.642	0.661	0.320	0.311
	(0.0945)	(0.0407)	(0.0013)	(0.0013)
Average 1993--2010		0.339	0.128	0.122
		(0.1083)	(0.0032)	(0.0030)
Panel B: Average Transmission Levels of Transitory Income Shocks				
Average 1968--2010		0.112	0.038	0.043
		(0.0103)	(0.0013)	(0.0012)
Average 1968--1978		0.007	-0.142	-0.130
		(0.0045)	(0.0015)	(0.0014)
Average 1979--1992	0.053	0.114	0.135	0.131
	(0.0435)	(0.0041)	(0.0010)	(0.0009)
Average 1993--2010		0.216	0.094	0.104
		(0.0239)	(0.0036)	(0.0035)

NOTE.— Column (1) reports estimates from Blundell et al. (2008), designated BPP (2008). Column (2) reports estimates using the methods in Blundell et al. (2008), designated BPP updated. Column (3) reports estimates based on the methods in Kaplan and Violante (2010) allowing for persistence with a parameter $\rho = 0.95$, designated KV persistent. Column (4) reports estimates based on the methods in Kaplan and Violante (2010) allowing for persistence with a parameter $\rho = 0.95$, and accounting for the effect of federal income tax on income with an elasticity of 0.25, designated KV persistent e 0.25. Standard errors are reported in parentheses.

Table 3: Transmission of Permanent and Transitory Income Shocks

Periods	BPP updated	KV persistent	KV persistent *e* 0.25
	(1)	(2)	(3)
Panel A: Average Transmission Levels of Permanent Income Shocks			
Average 1968--2010	0.527	0.277	0.264
	(0.0553)	(0.0012)	(0.0011)
First half average 1968--1985	0.576	0.413	0.389
	(0.0224)	(0.0009)	(0.0008)
Second half average 1986--2010	0.477	0.141	0.139
	(0.0881)	(0.0022)	(0.0021)
Panel B: Average Transmission Levels of Transitory Income Shocks			
Average 1968--2010	0.112	0.038	0.043
	(0.0103)	(0.0013)	(0.0012)
First half average 1968--1985	0.039	-0.046	-0.041
	(0.0042)	(0.0011)	(0.0010)
Second half average 1986--2010	0.186	0.122	0.126
	(0.0163)	(0.0023)	(0.0023)

NOTE.— Column (1) reports estimates using the methods in Blundell et al. (2008), designated BPP updated. Column (2) reports estimates based on the methods in Kaplan and Violante (2010) allowing for persistence with a parameter $\rho = 0.95$, designated KV persistent. Column (3) reports estimates based on the methods in Kaplan and Violante (2010) allowing for persistence with a parameter $\rho = 0.95$, and accounting for the effect of federal income tax on income with an elasticity of 0.25, designated KV persistent *e* 0.25. Standard errors are reported in parentheses.

Table 4: Transmission of Permanent and Transitory Income Shocks by Income Quartiles and Education using KV persistent *e* 0.25

Periods	Income quartiles Bottom	2nd	3rd	Top	HS graduate	Some college +
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Average Transmission Levels of Permanent Income Shocks						
Average 1968--2010	0.538	0.211	0.004	0.233	0.359	0.220
	(1.197)	(0.031)	(0.321)	(0.113)	(0.203)	(0.002)
Average 1968--1985	0.569	0.527	0.099	0.292	0.385	0.342
	(2.296)	(0.050)	(0.643)	(0.134)	(0.405)	(0.002)
Average 1986--2010	0.507	-0.105	-0.090	0.174	0.333	0.099
	(0.678)	(0.036)	(0.011)	(0.182)	(0.015)	(0.002)
Panel B: Average Transmission Levels of Transitory Income Shocks						
Average 1968--2010	-0.002	-0.130	0.074	0.013	0.072	0.006
	(0.049)	(0.005)	(0.009)	(0.095)	(0.009)	(0.902)
Average 1968--1985	-0.042	0.062	-0.108	-0.362	0.031	-0.129
	(0.098)	(0.004)	(0.018)	(0.189)	(0.014)	(1.804)
Average 1986--2010	0.038	-0.322	0.257	0.387	0.113	0.141
	(0.004)	(0.010)	(0.005)	(0.004)	(0.012)	(0.002)

NOTE.— Estimates using the methods in Kaplan and Violante (2010) allowing for persistence with a parameter $\rho = 0.95$ and accounting for the effect of federal income tax on income with an elasticity of 0.25. Column (1)-(4) reports estimates based on income quartiles. Column (5) reports estimates where the household head is a high-school graduate. Column (6) reports estimates where the household head has at least some college education. Standard errors are reported in parentheses.

Table 5: Decomposition of Changes in the Transmission of Income Shocks to Consumption

	BPP updated	KV persistent	KV persistent *e* 0.25
	(1)	(2)	(3)
*Panel A: **Permanent** Income Shocks*			
Active	0.626	0.364	0.353
	(0.210)	(0.153)	(0.153)
Passive	-0.134	-0.055	-0.051
	(0.054)	(0.040)	(0.040)
Behavioral	-0.563	-0.578	-0.548
	(0.228)	(0.150)	(0.150)
Difference			
(1968--1985) to (1986--2010)	-0.071	-0.269	-0.246
*Panel B: **Transitory** Income Shocks*			
Active	0.015	0.500	0.468
	(0.057)	(0.176)	(0.167)
Passive	0.030	0.100	0.092
	(0.021)	(0.065)	(0.062)
Behavioral	0.104	-0.446	-0.409
	(0.064)	(0.172)	(0.164)
Difference			
(1968--1985) to (1986--2010)	0.150	0.153	0.151

NOTE.— Column (1) reports estimates using the minimum distance estimation described by Blundell et al. (2008), designated BPP updated. Column (2) reports estimates based on the methods in Kaplan and Violante (2010) allowing for persistence with a parameter $\rho = 0.95$, designated KV persistent. Column (3) reports estimates based on the methods in Kaplan and Violante (2010) allowing for persistence with a parameter $\rho = 0.95$, and accounting for the effect of federal income tax on income with an elasticity of 0.25, designated KV persistent e 0.25. The transmission parameters are decomposed using a Oaxaca (1973) and Blinder (1973) decomposition according to equation (21). Bootstrapped standard errors are reported in parentheses.

Table 6: Decomposition of Changes in the Transmission of Income Shocks to Consumption by Income Quartiles and Education using KV persistent *e* 0.25

	Income quartiles				HS	Some
	Bottom	2nd	3rd	Top	graduate	college +
	(1)	(2)	(3)	(4)	(5)	(6)
*Panel A: **Permanent** Income Shocks*						
Active	0.115	0.080	0.408	-0.724	0.290	0.300
	(0.278)	(0.258)	(0.513)	(0.235)	(0.227)	(0.126)
Passive	-0.044	-0.296	-0.369	-0.176	0.019	-0.012
	(0.106)	(0.151)	(0.204)	(0.096)	(0.049)	(0.019)
Behavioral	-0.132	-0.416	-0.228	0.782	-0.362	-0.530
	(0.444)	(0.249)	(0.399)	(0.284)	(0.271)	(0.135)
Difference (1968--1985) to (1986--2010)	-0.062	-0.632	-0.189	-0.118	-0.052	-0.242
*Panel B: **Transitory** Income Shocks*						
Active	0.402	0.389	-0.037	1.740	1.422	0.668
	(0.215)	(0.299)	(0.369)	(0.449)	(0.232)	(0.163)
Passive	0.008	-0.048	0.893	-0.088	0.004	-0.020
	(0.066)	(0.126)	(0.220)	(0.045)	(0.023)	(0.028)
Behavioral	-0.331	-0.726	-0.490	-0.904	-1.345	-0.378
	(0.291)	(0.287)	(0.280)	(0.441)	(0.254)	(0.149)
Difference (1968--1985) to (1986--2010)	0.080	-0.385	0.365	0.748	0.082	0.270

NOTE.— The transmission parameters based on the methods in Kaplan and Violante (2010) allowing for persistence with a parameter $\rho = 0.95$, and accounting for the effect of federal income tax on income with an elasticity of 0.25 are decomposed using a Oaxaca (1973) and Blinder (1973) decomposition according to equation (21). Columns (1)-(4) report estimates based on income quartiles. Column (5) reports estimates where the household head is a high-school graduate. Column (6) reports estimates where the household head has at least some college education. Bootstrapped standard errors are reported in parentheses.

Online Appendix.

This supplemental material includes additional information on data (Appendix A), model notes (Appendix B), and finally moment conditions (Appendix C). At the end, we also include additional tables and figures that are referenced in the text or supplemental material.

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.

The imputation method uses pooled cross-section data from the CEX in 1972, 1973, and from 1980 to 2010. We run the following demand equation for food, where f is expressed in logs:

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

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 expenditures 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 u. The budget elasticity is also allowed to vary with time, except in years that do not exist in the PSID, which 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 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).[44] 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.[45] These estimates allow us to invert the demand function and impute non-durable consumption for all households selected from the PSID.[46]

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

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

[45]In Tables A.6, A.7, and A.8, 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).

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

accounts.

A.2. Federal Income Tax

To estimate the impact of the tax system on insurance, as described in equation (16), 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. 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 onward and state tax liability from 1977 onward. 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 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, 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 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 husbands' 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.

Over our sample there 55 pieces of legislation with major tax provisions. These changes impact the active shocks. They include base changes, such as changes to standard deductions, changes in excise taxes, and rate changes to individual income. Table A.2 classifies them based on its more significant contribution. For an overview of these changes see the tax policy center.[47]

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, renter, or the family unit. Since the PSID systematically defines 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, and home supplies. The latter 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.[48] 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

[47] See https://www.taxpolicycenter.org/laws-proposals/major-enacted-tax-legislation-2000-2009.

[48] Attanasio et al. (2014) provide evidence from 1980 to 2010 that the trends in consumption inequality are consistent, regardless of using the Diary or the Interview surveys.

consumer durables: owner-occupied housing and owned vehicles. CEX surveys from 1980 onward 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.[49]

The step-by-step selection of the CEX sample is provided in Table A.3. 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 households are interviewed over 12 months covering two successive years, we compute annual spending by pooling all months and assigning 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, 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.

All Stata programs to construct CEX consumption variables are available on the author's https://sites.google.com/site/estelledauchy/home/researchwebsite, including: *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*, and *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*.

Service Flow of Owner-Occupied Housing To calculate the value of the service flow from

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

owner-occupied housing, we use the definition provided by the Bureau of Labor Statistics.[50] 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, owned parking, property management costs, and owned repair equipment. 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 https://sites.google.com/site/estelledauchy/home/researchwebsite.

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 et al. (1984), Slesnick (1994) and Johnson et al. (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 vehicle 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

[50] See Johnson et al. (2005).

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.[51]

Vehicles are grouped into bins for each year, by type, brand, old-new status, and year acquired, 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 website https://sites.google.com/site/estelledauchy/home/research*Script_-vehicles_[year].py*. Vehicles data from the CEX are publicly available on the ICPSR website.

A.4. Panel Study 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; hence the confusion of whether participants' answers best

[51] 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.

represent the amount spent in calendar year t or t-1. We assume the answers are retrospective.

Household data is 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, insurance and vehicle payments), using the PSID family files.[52]

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 wife (e.g., we eliminate divorced couples, but we keep couples with a new child). We eliminate couples 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.4. The full PSID sample includes a Latino sub-sample for which individual data are not available. Starting from an unbalanced panel (excluding the Latino sub-sample) 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 https://sites.google.com/si which includes: *PSIDFamilyFiles.do*, *PSIDIndividualFile.do*, and *SampleSelection.do*. PSID data are publicly available on the ICPSR website.

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

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.5 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 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.5. In addition, imputed and PSID reported non-durable expenditures exhibit similar trends and variation, as shown in Figure 2.[53] 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 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

[53]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).

last decade of the four decades covered in this paper.[54]

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-durable 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 et al. (2005) and Slesnick (1994) to calculate the rental equivalent value of owned homes and owned vehicles.[55]

1. Non-durables: includes total food and beverage 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, electronic + 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.

[54] Andreski et al. (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.

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

Tables A.6, A.7, and A.8 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.

A.7. Income Measures

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 et al., 2010; Debacker et al., 2013). 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 reflect household consumption and welfare more broadly. 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 et al., 2010; Debacker et al., 2013). Debacker et al. (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.

Heathcote et al. (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 than other income groups, but not enough to reduce the overall increasing trend. Debacker et al. (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 changes were partly offset by increases in earned income credits and child tax credits.

Guvenen (2007), Primiceri and Rens (2009), and Storesletten et al. (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 et al. (2004b) also find that, although predictable, idiosyncratic income risk is countercyclical. Storesletten et al. (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 the data well.

Appendix B. Model Notes

B.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 et al. (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 still 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 et al. (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 tend 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.

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

It is useful to take a step back and consider more carefully what direct estimations of these parameters should capture. Estimating $\phi_{i,t}^{\eta} < \pi_{i,t}$ and $\phi_{i,t}^{\varepsilon} < \gamma_{t,L}\pi_{i,t}$ would provide evidence of ''excess-smoothing,'' over and above self-insurance through asset accumulation, and would 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 macro-economic literature as resulting from imperfect markets, due either 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.

Appendix C. 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 only moment conditions with one-year differences. In this appendix, we replicate the derivation of moments using one-year differences in Blundell et al. (2008), add the derivation of moments using two-year differences, list the variables and moment conditions used to estimate all of them, and compare the 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 (5) and (7). The restrictions due to the covariance of income across different leads is given by

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

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 ν is serially uncorrelated ($\nu_t = \varepsilon_t$), then $var(\Delta \nu_t) = 2var(\Delta \varepsilon_t)$. 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 (C.2).[56]

[56] 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 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.

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

$$cov(\Delta c_t, \Delta c_{t+s}) = \phi^{\eta 2}_t var(\zeta_t) + \phi^{\varepsilon 2}_t var(\varepsilon_t) + var(\xi_t),$$

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

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

In particular, if v is serially uncorrelated ($v_t = \varepsilon_{i,t}$), then $cov(\Delta y_{t+s}, \Delta c_t) = -\psi_t var(\varepsilon_t)$ for $s = 1$, and 0 if $s > 1$.[57] Equations (C.2), (C.3), and (C.4) 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 are used to estimate 122 parameters.

C.2. Two-Year Difference Moments

In this subsection, we derive 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. Because PSID data after 1996 are reported only 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

$$\tilde{\Delta} y_t = \zeta_t + \zeta_{t-1} + \tilde{\Delta} v_t, \text{ and} \tag{C.1}$$

[57] 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).

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

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 C, 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,

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

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,

$$cov(\tilde{\Delta} c_t, \tilde{\Delta} c_{t+s}) = \begin{cases} \phi_t^{\eta 2} var(\zeta_t) + \phi_t^{\eta 2} var(\zeta_{t-1}) + \phi_t^{\varepsilon 2} var(\varepsilon_t) & \\ \qquad + \phi_t^{\varepsilon 2} var(\varepsilon_{t-1}) + 2 var(\xi) & if\, s = 0 \\ \phi_t^{\eta 2} var(\zeta_t) + \phi_t^{\varepsilon 2} var(\varepsilon_t) + var(\xi) & if\, s = 1 \\ 0 & if\, s > 1 \end{cases}. \tag{C.3}$$

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

$$cov(\tilde{\Delta} y_{t+s}, \tilde{\Delta} c_t) = \begin{cases} \phi_t^{\eta} var(\zeta_t) + \phi_t^{\eta} var(\zeta_{t-1}) & \\ \qquad + \phi_t^{\varepsilon} cov(\varepsilon_t, \tilde{\Delta} v_t) + \phi_t^{\varepsilon} cov(\varepsilon_{t-1}, \tilde{\Delta} v_t) & if\, s = 0 \\ \phi_t^{\eta} var(\zeta_t) + \phi_t^{\varepsilon} cov(\varepsilon_t, \tilde{\Delta} v_{t+1}) + \phi_t^{\varepsilon} cov(\varepsilon_{t-1}, \tilde{\Delta} v_{t+1}) & if\, s = 1 \\ \phi_t^{\varepsilon} cov(\varepsilon_t, \tilde{\Delta} v_{t+2}) + \phi_t^{\varepsilon} cov(\varepsilon_{t-1}, \tilde{\Delta} v_{t+2}) & if\, s = 2 \end{cases}. \tag{C.4}$$

These 310 moment conditions are used to estimate the 122 parameters from the model. The parameters of interest are the partial insurance parameters ϕ_t^{η} and ϕ_t^{ε}. 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, and 2004-2010, noting that the later years have data only 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 C provides more details on deriving each of the moment conditions and calculating the standard errors following Chamberlain's 1984 method.[58]

C.3. One- and Two-Year Difference Moment Conditions

To estimate the six sets of variables, there are six 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 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 next set consists of the covariance of the growth in income in year t and the growth in income 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 310 moment conditions, of which only 145 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 $\tilde{\Delta}$.

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

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

[58] 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.

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

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

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

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

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

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

$$cov(\Delta c_t, \Delta y_t) = \phi^{\eta} var(\zeta_t) + \phi^{\varepsilon} var(\varepsilon_t) \tag{C.9}$$

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

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

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

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.4. Comparison of Methods

Figure A.2 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 two-year moments 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 after 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.

All panels of Figure A.2 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 overall.

C.5. Foresight and Short-Memory Assumptions

Here we loosen the no foresight and short memory assumptions. We start with the case where permanent income is a martingale $\rho = 1$. In this case. for one-year differences,

$$g^{\varepsilon}_{t,KVrelax}(y_i) = \Delta y_{i,t+2} \tag{C.5}$$

$$g^{\eta}_{t,KVrelax}(y_i) = \Delta y_{i,t-3} + \Delta y_{i,t-2} + \Delta y_{i,t-1} + \Delta y_{i,t} + \Delta y_{i,t+1} + \Delta y_{i,t+2}. \tag{C.6}$$

For the case of two-year differences,

$$g^{\eta}_{t,KVrelax}(y_i) = \hat{\Delta} y_{i,t-4} + \hat{\Delta} y_{i,t-2} + \hat{\Delta} y_{i,t} + \hat{\Delta} y_{i,t+2}. \tag{C.7}$$

In this case, there is no function of income history that allows us to calculate the transmission coefficient for an income transitory shock.

Finally, we consider the case that allows for persistent changes in the income process, $\rho < 1$, and loosen the no foresight and no short memory assumptions. In this case, we again modify equation (9) by replacing $\Delta y_{i,t}$ with $\tilde{\Delta} y_{i,t}$ and define:

$$g^{\varepsilon}_{t,KVboth}(y_i) = \tilde{\Delta} y_{i,t+2} \tag{C.8}$$

$$g^{\eta}_{t,KVboth}(y_i) = \rho^5 \tilde{\Delta} y_{i,t-3} + \rho^4 \tilde{\Delta} y_{i,t-2} + \rho^3 \tilde{\Delta} y_{i,t-1} + \rho^2 \tilde{\Delta} y_{i,t} + \rho \tilde{\Delta} y_{i,t+1} + \tilde{\Delta} y_{i,t+2}. \tag{C.9}$$

For the case of two-year differences,

$$g^{\eta}_{t,KVboth2y}(y_i) = \rho^6 \bar{\Delta} y_{i,t-4} + \rho^4 \bar{\Delta} y_{i,t-2} + \rho^2 \bar{\Delta} y_{i,t} + \bar{\Delta} y_{i,t+2}. \tag{C.10}$$

Here, it is also not possible to find an adequate function to calculate the transmission coefficient for transitory income shocks.

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

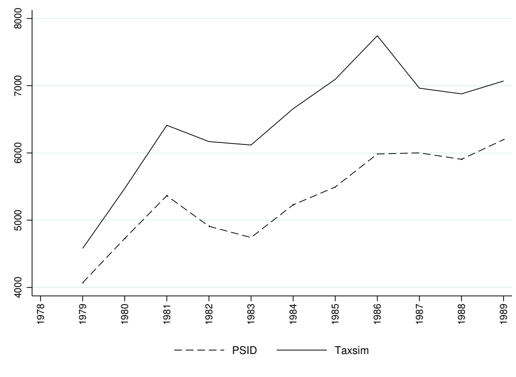
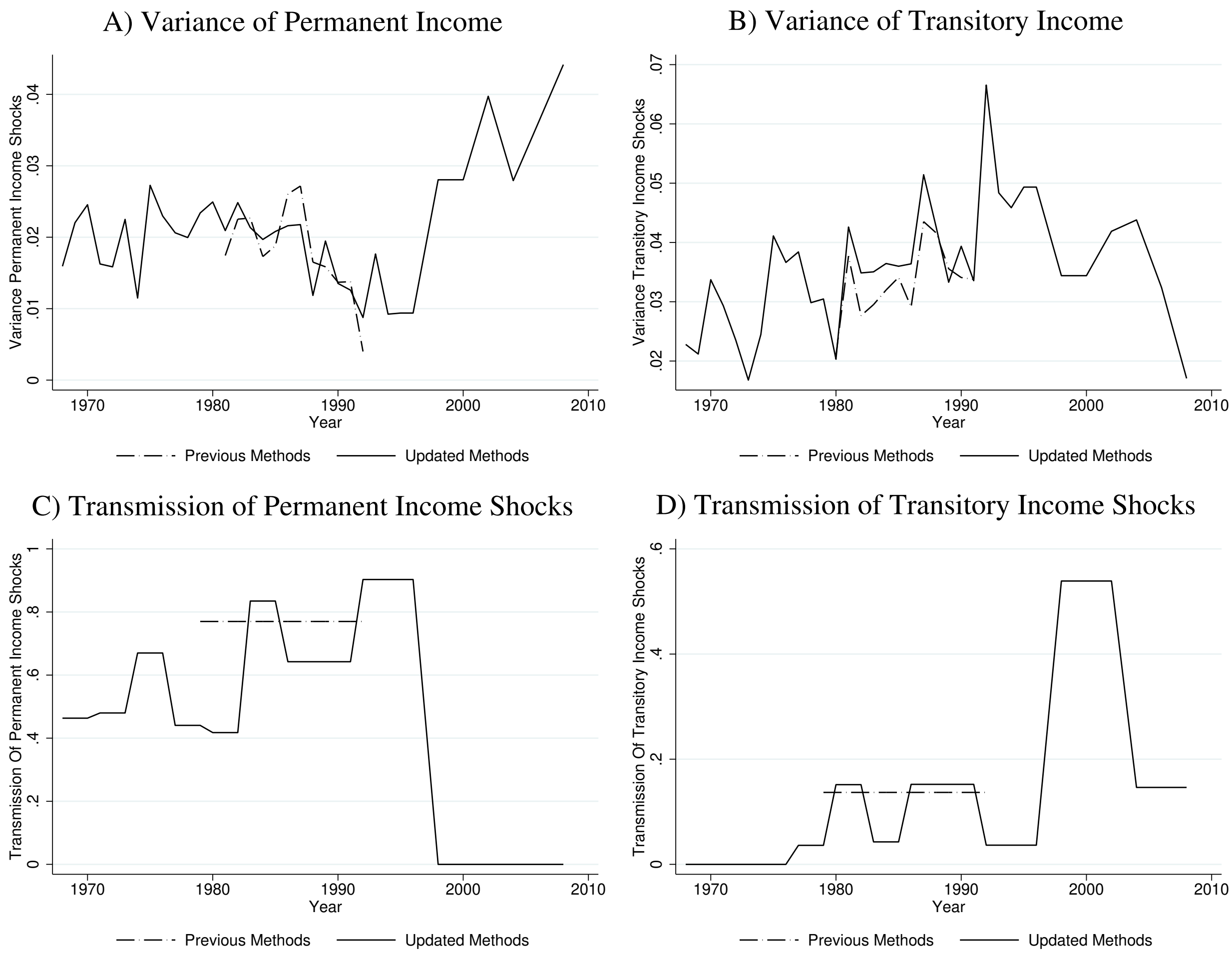
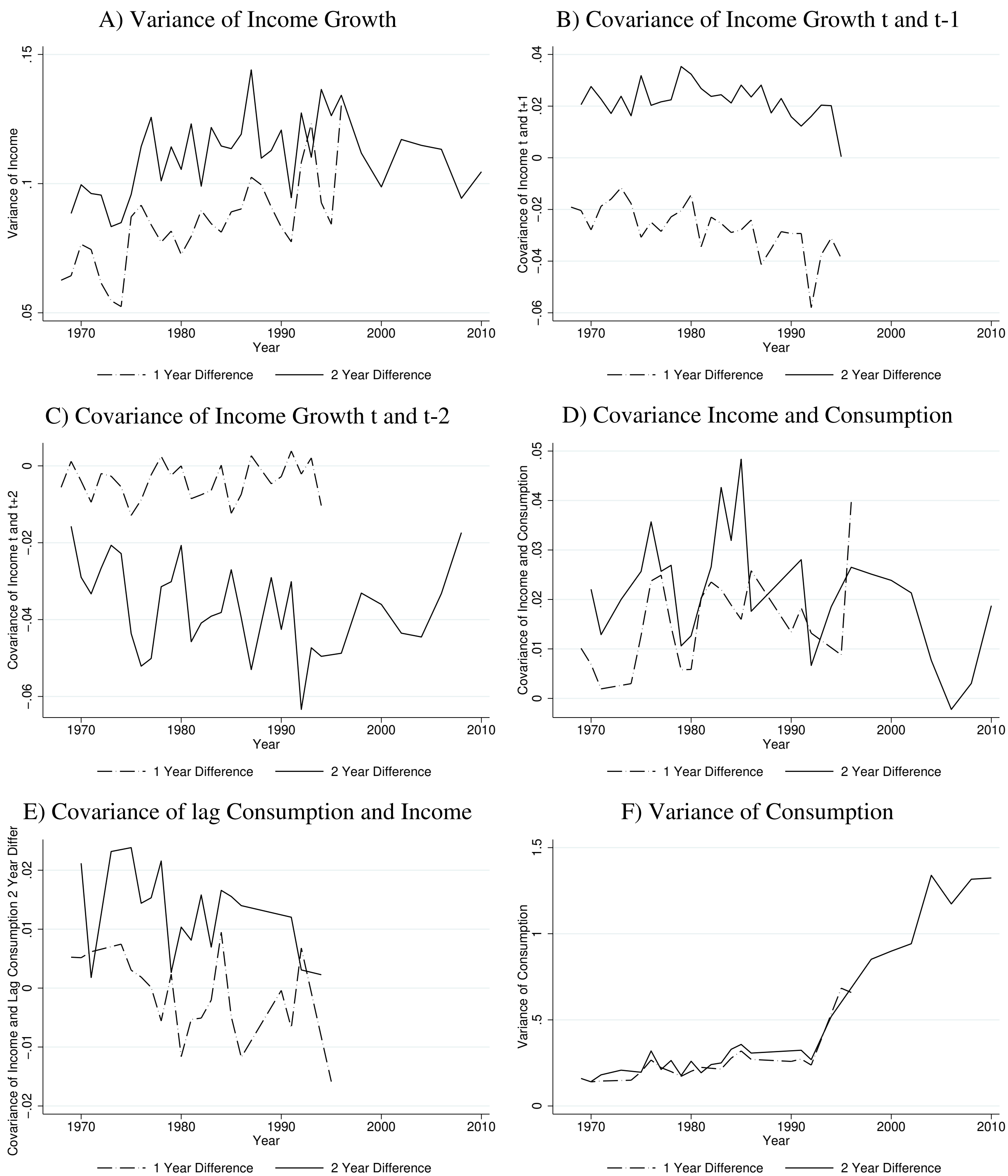


Figure A.2: Comparison of BPP (2008) with Updated Methods



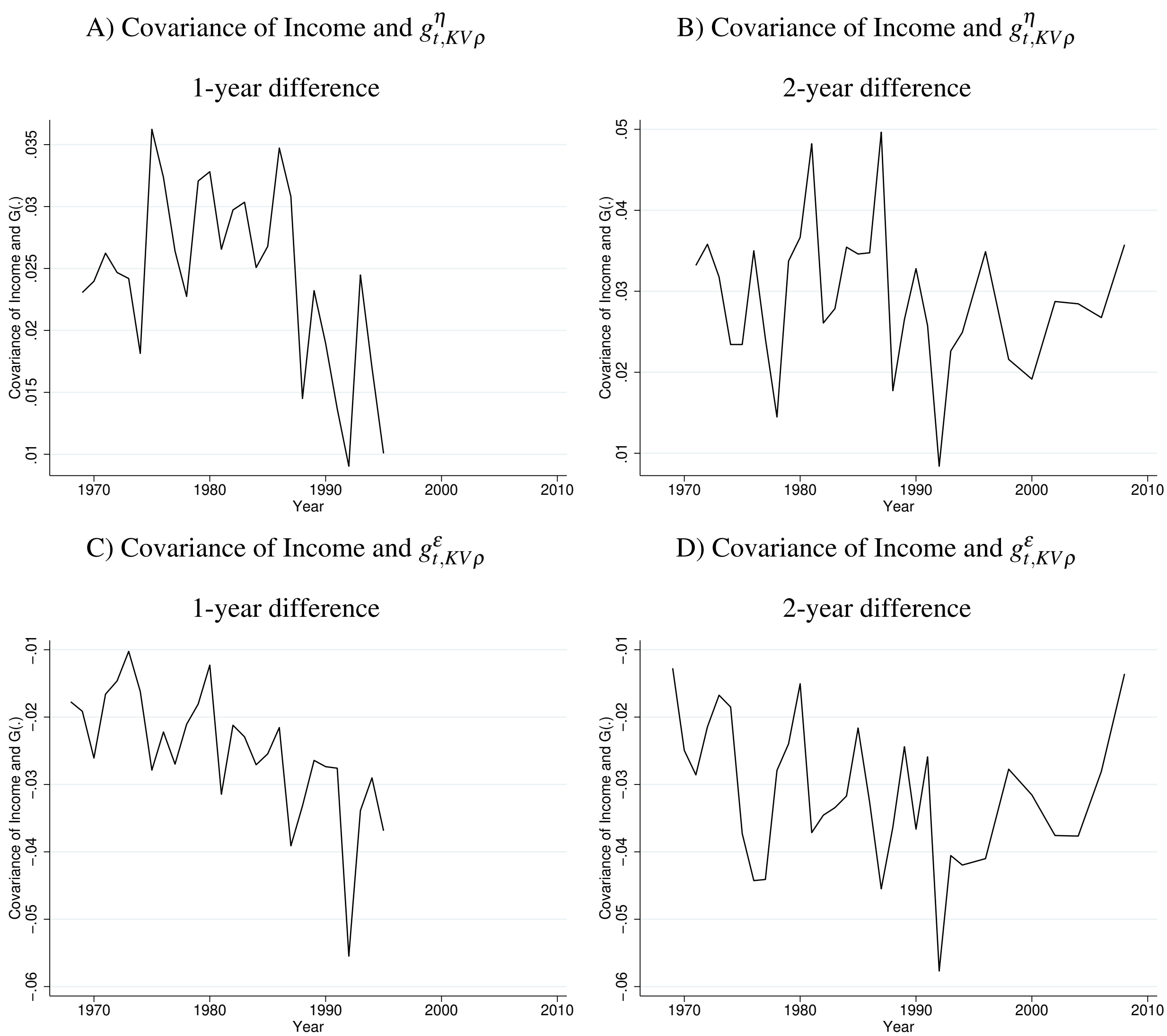
NOTE.— This figure compares BPP (2008) method that uses only moment conditions with one-year differences for the years 1979-1992, with updated methods in this paper that use moments with one- and two-year differences and years 1968-2010.

Figure A.3: Moment Conditions BPP with *e* 0.25



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-demographic characteristics.

Figure A.4: Moment Conditions KV Persistent *e* 0.25 and Income



NOTE.— These panels depict the covariance of income and function g(), where g() is defined to get the insurance parameter using Kaplan and Violante (2010) method. A) for the permanent shock in 1 year differences, as in equation 11, and B) in 2-year differences, as in equation 13 . And C) and D) for the transitory shocks in 1 and 2 years, as in equation 10 and as in equation 12, respectively.

Figure A.5: Moment Conditions KV Persistent *e* 0.25 and Consumption

A) Covariance of Consumption and $g^{\eta}_{t,\rho}$

1-year difference

B) Covariance of Consumption and $g^{\eta}_{t,\rho}$

2-year difference

C) Covariance of Consumption and $g^{\varepsilon}_{t,\rho}$

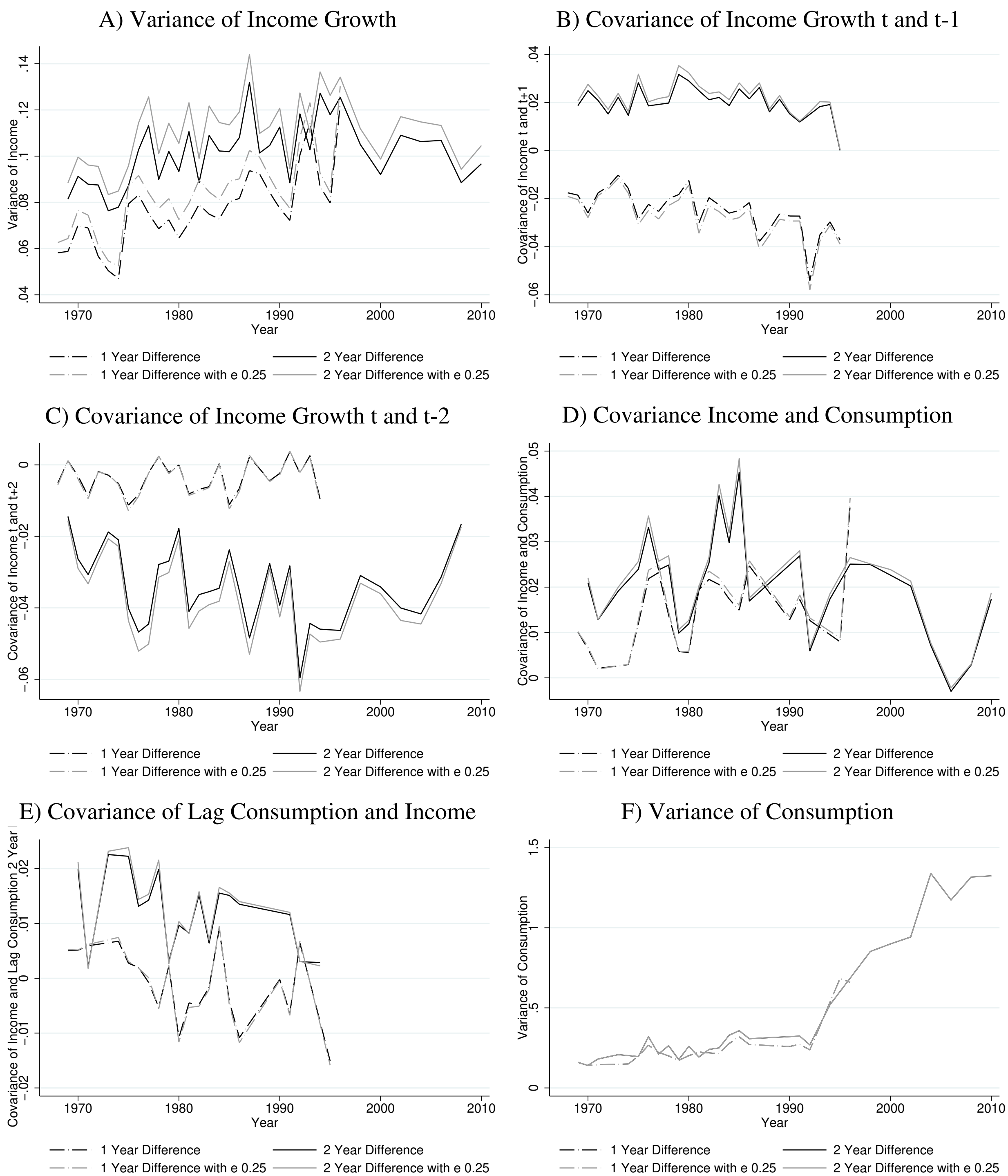
1-year difference

D) Covariance of Consumption and $g^{\varepsilon}_{t,\rho}$

2-year difference

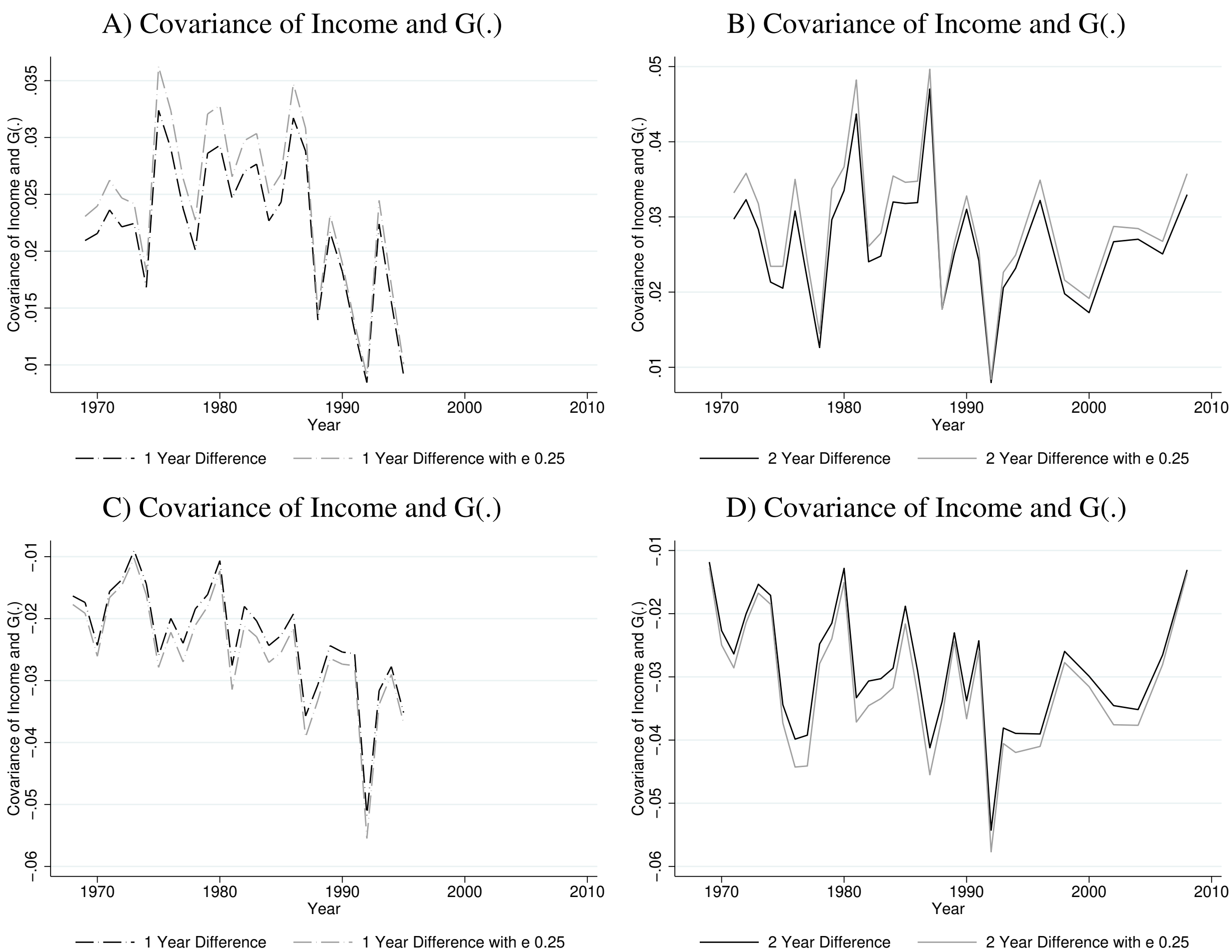
NOTE.— These panels depict the covariance of consumption and function g(), where g() is defined to get the insurance parameter using Kaplan and Violante (2010) method. A) for the permanent shock in 1-year differences, as in equation 11, and B) in 2- year differences, as in equation 13 . And C) and D) for the transitory shocks in 1 and 2 years, as in equation 10 and as in equation 12, respectively.

Figure A.6: Moment Conditions BPP Comparison



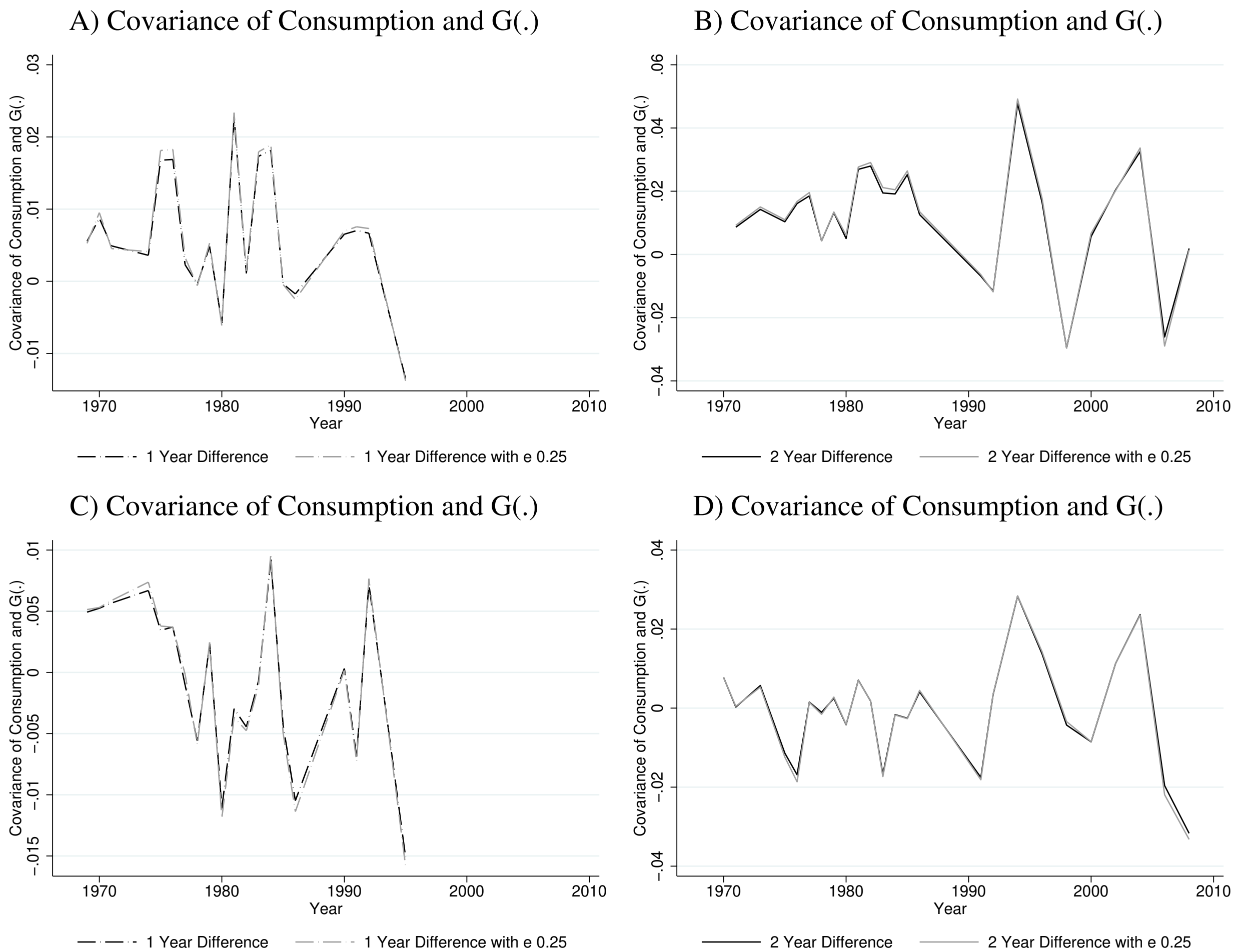
NOTE.— These panels compare the variance and covariance of income and consumption from the PSID after removing the deterministic characteristics, $Z_{i,t}$, using regressions of these variables on year dummies and a set of dummies for socio-demographic characteristics, when accounting or not for the effect of federal income tax on income with an elasticity of 0.25.

Figure A.7: Moment Conditions KV Income Comparison



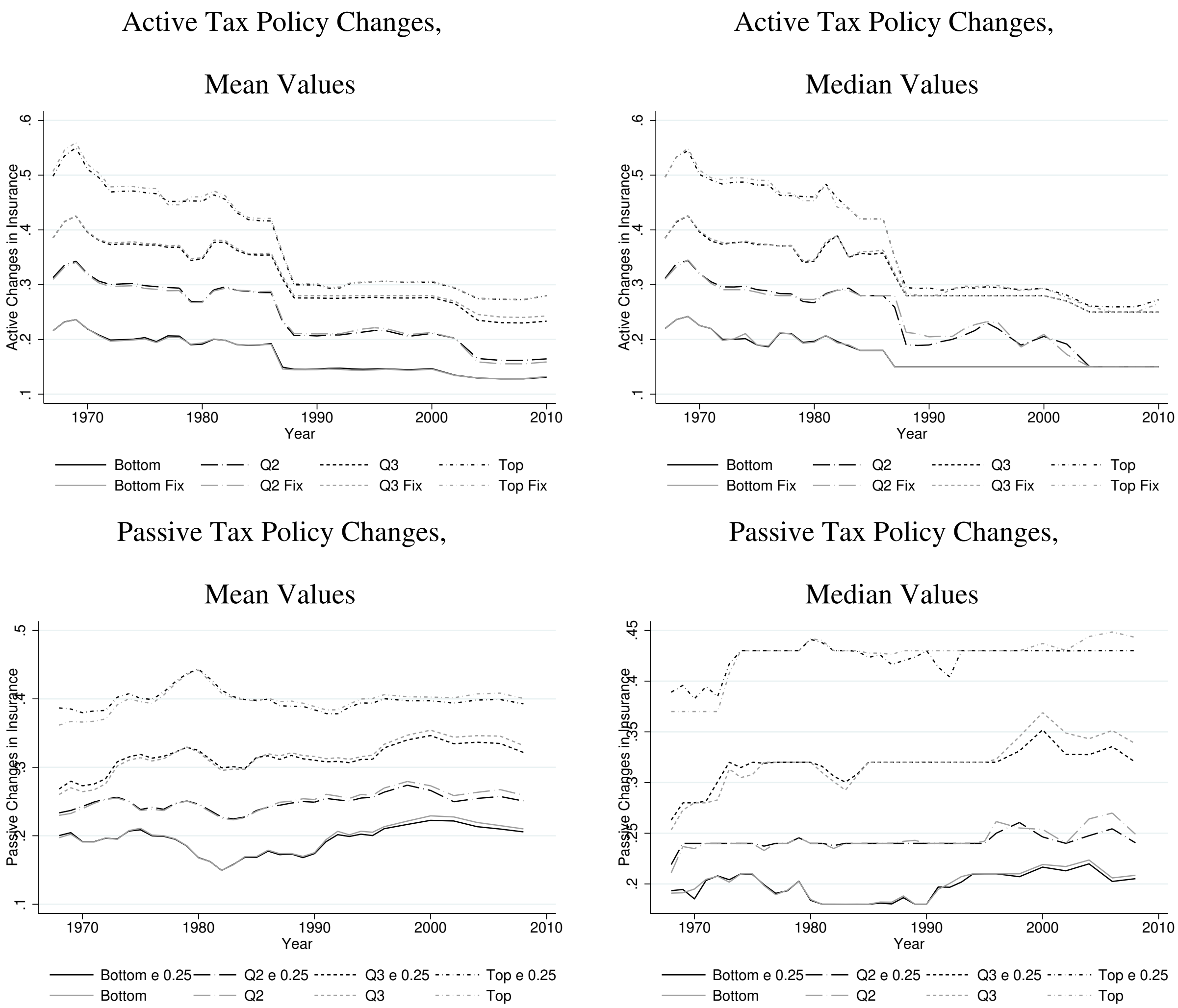
NOTE.— These panels compare the covariance of income and function g(), where g() is defined to get the insurance parameter using Kaplan and Violante (2010) method, when accounting or not for the effect of federal income tax on income with an elasticity of 0.25. A) for the permanent shock in 1-year differences, as in equation 11, and B) in 2-year differences, as in equation 13 . And C) and D) for the transitory shocks in 1 and 2 years, as in equation 10 and as in equation 12, respectively.

Figure A.8: Moment Conditions KV Consumption Comparison



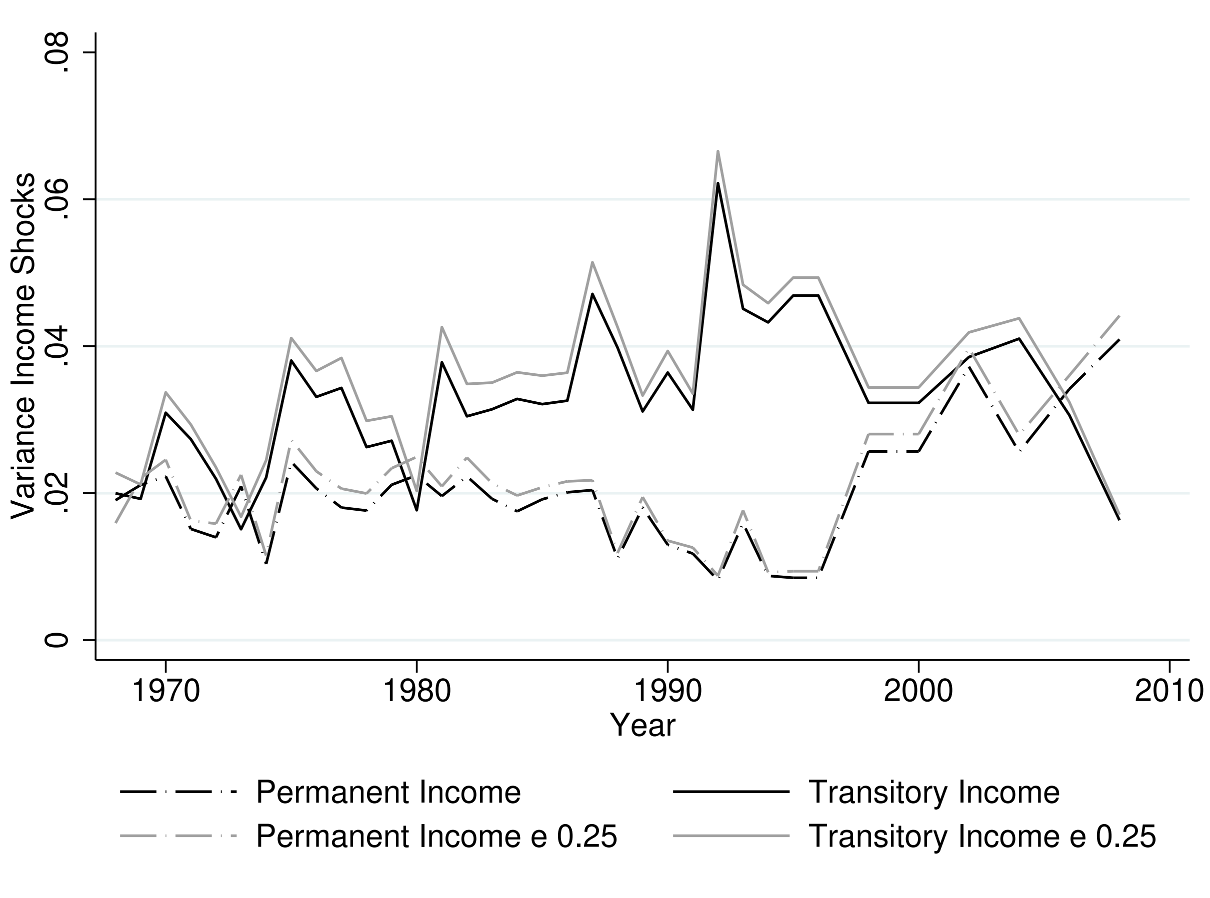
NOTE.— These panels compare the covariance of consumption and function g(), where g() is defined to get the insurance parameter using Kaplan and Violante (2010) method, when accounting or not for the effect of federal income tax on income with an elasticity of 0.25. A) for the permanent shock in 1-year differences, as in equation 11, and B) in 2-year differences, as in equation 13 . And C) and D) for the transitory shocks in 1 and 2 years, as in equation 10 and as in equation 12, respectively.

Figure A.9: Active Tax Policy Changes Depending on Shock and Passive Depending on Effects of Taxes in Labor, by Quartiles of Income



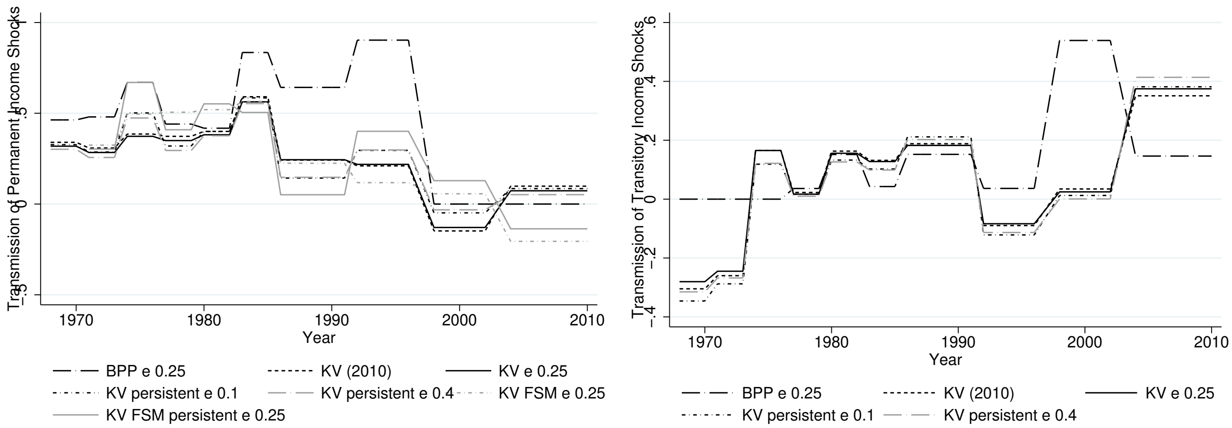
NOTE.—Top panels compare active changes in insurance by quartile of income when we assume an income shock based on its actual distribution, or we assume a 10% fix shock. Bottom panels compare passive changes in insurance by quartile of income when we consider the effect of federal income tax on income with an elasticity of 0.25, or when we do not. Income quartiles are defined in the base year 1980.

Figure A.10: Comparison Variance of Permanent and Transitory Income Shocks



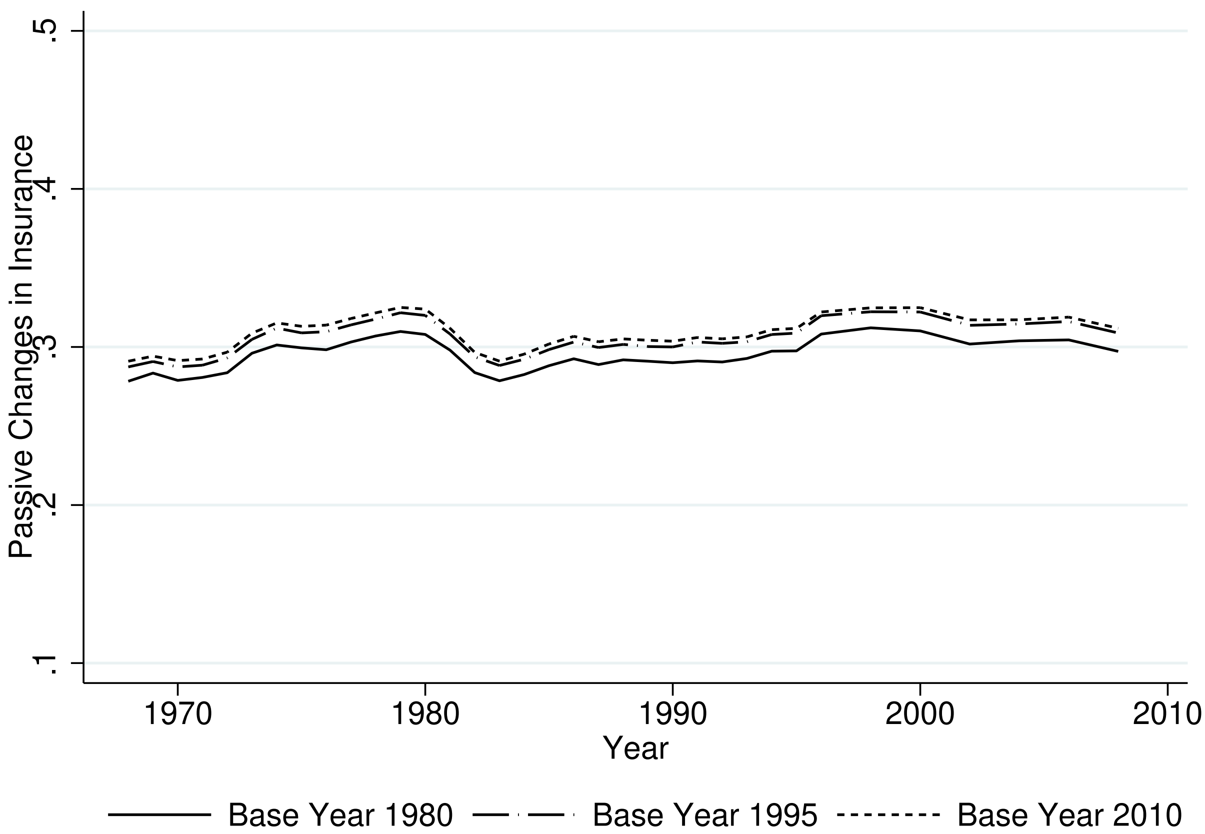
NOTE.— Estimates from the minimum distance estimation following Blundell et al. (2008), comparing whether we account for the effect of federal income tax on income with an elasticity of 0.25.

Figure A.11: Transmission of Income Shocks



NOTE.— BPP *e* 0.25 reports estimates using the minimum distance estimation described by Blundell et al. (2008) allowing for the effect of federal income tax on income with an elasticity of 0.25. KV (2010) reports estimates based on the methods in Kaplan and Violante (2010). KV *e* 0.25 reports estimates based on Kaplan and Violante (2010) allowing for the effect of federal income tax on income with an elasticity of 0.25. KV persistent *e* 0.1 reports estimates based on Kaplan and Violante (2010) allowing for the effect of federal income tax on income with an elasticity of 0.1 and a persistent permanent shock with parameter 0.95. KV persistent *e* 0.4 reports estimates based on Kaplan and Violante (2010) allowing for the effect of federal income tax on income with an elasticity of 0.4 and a persistent permanent shock with parameter 0.95. KV FSM *e* 0.25 reports estimates based on Kaplan and Violante (2010) allowing for the effect of federal income tax on income with an elasticity of 0.25, and relaxing the no foresight and short memory assumptions. KV FSM persistent *e* 0.25 reports estimates based on Kaplan and Violante (2010) allowing for the effect of federal income tax on income with an elasticity of 0.25, relaxing the no foresight and short memory assumptions, and a persistent permanent shock with parameter 0.95.

Figure A.12: Robustness of Passive Insurance to Base Year



NOTE.— This figure graphs the passive changes in insurance using different base years to exclude labor supply changes due to tax rate changes. The solid line is our baseline estimate with a base year of 1980. The dash-dotted line uses a base year of 1995 and the dotted line uses a base year of 2010.

Table A.1: The Demand for Food in the CEX-Non-Durable Goods

Variable	Estimate	Variable	Estimate	Variable	Estimate	Variable	Estimate
ln c	0.720***	ln c x 1988	-0.0796*	ln c x 2010	-0.221*	Born 1960-64	0.0151
	0.100		0.045		0.132		0.054
ln c x HS dropout	0.0590**	ln c x 1989	-0.0854*	Age	0.0452***	Born 1955-59	-0.0158
	0.027		0.049		0.005		0.047
ln c x HS graduate	0.170***	ln c x 1990	-0.0917*	Age^2	-0.000424***	Born 1950-54	-0.0171
	0.056		0.054		5.24e-5		0.041
ln c x one child	-0.0489***	ln c x 1991	-0.123*	p_{food}	-0.577**	Born 1945-49	-0.0277
	0.011		0.064		0.242		0.035
ln c x two children	-0.0665***	ln c x 1992	-0.129*	$p_{alcohol+tobacco}$	3.181*	Born 1940-44	-0.0384
	0.011		0.067		1.888		0.030
ln c x three children +	-0.0898***	ln c x 1993	-0.132*	$p_{fuel+utils}$	0.817	Born 1935-40	-0.0254
	0.013		0.070		2.363		0.024
ln c x 1972	0.0764	ln c x 1994	-0.131*	$p_{transports}$	-2.329	Born 1930-34	-0.00685
	0.012		0.071		3.606		0.017
ln c x 1973	0.0707	ln c x 1995	-0.127*	HS dropout	-0.530**	Born 1925-29	-0.00533
	0.115		0.073		0.256		0.012
ln c x 1981	-0.0118	ln c x 1996	-0.138*	HS graduate	-1.605***	One Child	0.517***
	0.017		0.077		0.536		0.102
ln c x 1982	-0.0331	ln c x 1998	-0.155*	Northeast	0.0154***	Two children	0.712***
	0.028		0.080		0.005		0.104
ln c x 1983	-0.0451	ln c x 2000	-0.160*	Midwest	-0.0194**	Three children+	0.937***
	0.036		0.088		0.009		0.130
ln c x 1984	-0.0480	ln c x 2002	-0.182*	South	-0.00810	Family Size	0.0480***
	0.040		0.094		0.010		0.007
ln c x 1985	-0.0545	ln c x 2004	-0.191*	Born 1975-79	0.0766	White	0.0977***
	0.042		0.104		0.073		0.010
ln c x 1986	-0.0769*	ln c x 2006	-0.198*	Born 1970-74	0.0587	Constant	0.454
	0.047		0.118		0.066		0.815
ln c x 1987	-0.0774*	ln c x 2008	-0.206	Born 1965-69	0.0318		
	0.043		0.131		0.059		
Number of observations	35,883	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.

Table A.2: Major Changes in Tax Legislation from 1968 to 2010

Period	1968-1985	1986-2010
Panel A: Increase in Taxes		
Individual Income Tax Rates		Omnibus Budget Reconciliation Act (1993) Omnibus Budget Reconciliation Act (1990)
Capital Gains or Dividens Rates		
Other	Consolidated Omnibus Budget Reconciliation Act (1985) Deficit Reduction Act (1984) Social Security Amendments (1983) Railroad Retirement Revenue Act (1983) Tax Equity and Fiscal Responsibility Act (1982) Highway Revenue Act (1982) Crude Oil Windfall Profit Tax Act (1980)	Medicare Prescription Drug, Improvement, and Modernization Act (2003) Surface Transportation Revenue Act (1998) Financial Institutions Reform, Recovery, and Enforcement Act (1989) Medicare Catastrophic Coverage Act (1988) Airport and Airway Trust Fund Extension (1987) Omnibus Budget Reconciliation Act (1987) Superfund Amendments and Reauthorization Act (1986) Omnibus Budget Reconciliation Act (1986)
Panel B: Decrease in Taxes		
Individual Income Tax Rates	Economic Recovery Tax Act (1981) Revenue Act (1978)	Economic Growth and Tax Relief Reconciliation Act (EGTRRA) (2001) Tax Reform Act (1986)
Capital Gains or Dividens Rates		Jobs and Growth Tax Relief Reconciliation Act (2003) Taxpayer Relief Act (2003)
Increase in Standard Deductions	Tax Reduction and Simplification Act (1977) Tax Reform Act (1976) Tax Reduction Act (1975) Revenue Act (1971)	
Other	Interest and Dividends Tax Compliance Act (1983)	The American Recovery and Reinvestment Tax Act (2009) Emergency Economic Stabilization Act (2008) Housing Assistance Tax Act of the Housing and Economic Recovery Act (2008) Economic Stimulus Act (2008) Tax Increase Prevention Act (2007) Mortgage Forgiveness Debt Relief Act (2007) Tax Relief and Health Care Act (2007) Pension Protection Act (2006) Tax Increase Prevention and Reconciliation Act (TIPRA) (2005) Gulf Opportunity Zone Act (2005) Katrina Emergency Tax Relief Act (2005) Energy Tax Incentives Act of the Energy Policy Act (2005) American Jobs Creation Act (AJCA) (2004) Working Families Tax Relief Act (WFTRA) (2004) Military Family Tax Relief Act (2003) Job Creation and Worker Assistance Act (JCWAA) (2002) Community Renewal Tax Relief Act (2001) Revenue Provisions of the Health Insurance and Portability Act (1996) Revenue Provisions of the Small Business Job Protection Act (1996) Tax Extension Act (1991) Omnibus Budget Reconciliation Act (1989) Medicare Catastrophic Coverage Repeal Act (1989) Technical and Miscellaneous Revenue Act (1988) The Family Security Act (1988)

NOTE.— This table reports major changes in tax legislation from 1968 to 2010. It does not include Internal Revenue Service Restructuring Act (1998), Taxpayer Bill of Rights 2 (1996), Continuing Resolution for Fiscal Year 1988, or Continuing Resolution for Fiscal Year 1987, as these regulations were more technical and did not substantially affect household tax liabilities.

Table A.3: 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

Table A.4: 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

Table A.5: 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.

Table A.6: The Demand For Food in the CEX-Total Expenditures

Variable	Estimate	Variable	Estimate	Variable	Estimate	Variable	Estimate
ln c	0.792***	ln c x 1988	-0.106**	ln c x 2010	-0.278**	Born 1960-64	0.0198
	0.113		0.041		0.119		0.057
ln c x HS dropout	0.0340	ln c x 1989	-0.109**	Age	0.0463***	Born 1955-59	-0.0119
	0.030		0.047		0.005		0.051
ln c x HS graduate	0.125**	ln c x 1990	-0.111**	Age^2	-0.000435***	Born 1950-54	-0.0161
	0.058		0.053		5.42e-5		0.044
ln c x one child	-0.0518***	ln c x 1991	-0.159***	p_{food}	-0.678**	Born 1945-49	-0.0303
	0.012		0.061		0.264		0.038
ln c x two children	-0.0706***	ln c x 1992	-0.169***	$p_{alcohol+tobacco}$	5.610***	Born 1940-44	-0.0459
	0.012		0.065		1.963		0.032
ln c x three children +	-0.0967***	ln c x 1993	-0.169**	$p_{fuel+utils}$	1.939	Born 1935-40	-0.0244
	0.014		0.067		2.227		0.026
ln c x 1972	0.0105	ln c x 1994	-0.162**	$p_{transports}$	-5.649	Born 1930-34	-0.00953
	0.122		0.070		3.856		0.019
ln c x 1973	0.00389	ln c x 1995	-0.153**	HS dropout	-0.332	Born 1925-29	-0.0107
	0.116		0.075		0.293		0.013
ln c x 1981	-0.00567	ln c x 1996	-0.164**	HS graduate	-1.260**	One Child	0.567***
	0.017		0.078		0.567		0.117
ln c x 1982	-0.0347	ln c x 1998	-0.195**	Northeast	0.0290***	Two children	0.793***
	0.024		0.079		0.006		0.117
ln c x 1983	-0.0553*	ln c x 2000	-0.195**	Midwest	-0.0312***	Three children+	1.076***
	0.030		0.088		0.008		0.149
ln c x 1984	-0.0555	ln c x 2002	-0.233***	South	-0.0228***	Family Size	0.0405***
	0.034		0.090		0.009		0.008
ln c x 1985	-0.0636*	ln c x 2004	-0.243**	Born 1975-79	0.0816	White	0.0591***
	0.037		0.097		0.078		0.015
ln c x 1986	-0.108***	ln c x 2006	-0.245**	Born 1970-74	0.0578	Constant	-0.322
	0.040		0.108		0.071		0.924
ln c x 1987	-0.105***	ln c x 2008	-0.255**	Born 1965-69	0.0268		
	0.038		0.118		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.7: The Demand for Food in the CEX-Non-Durables & Services from Durables

Variable	Estimate	Variable	Estimate	Variable	Estimate	Variable	Estimate
ln c	1.044***	ln c x 1986	-0.0789	$p_{fuel+utils}$	0.808	Born 1940-44	-0.0464
	0.210		0.154		9.176		0.054
ln c x HS dropout	-0.0267	ln c x 1987	-0.0677	$p_{transports}$	-17.05	Born 1935-39	-0.0369
	0.041		0.127		15.37		0.042
ln c x HS graduate	-0.0302	ln c x 1988	-0.0705	HS dropout	0.247	Born 1930-34	-0.0204
	0.087		0.127		0.395		0.030
ln c x one child	-0.0537***	ln c x 1989	-0.0537	HS graduate	0.234	Born 1925-29	-0.00949
	0.013		0.125		0.848		0.017
ln c x two children	-0.0770***	ln c x 1990	-0.0358	Northeast	0.0648***	One Child	0.566***
	0.013		0.127		0.010		0.123
ln c x three children +	-0.0805***	ln c x 1991	-0.144	Midwest	0.0370**	Two children	0.813***
	0.014		0.171		0.018		0.124
ln c x 1972	-0.533**	ln c x 1993	-0.134	South	0.0254	Three children+	0.850***
	0.263		0.180		0.022		0.145
ln c x 1973	-0.511**	Age	0.0596***	Born 1960-64	0.0914	Family Size	0.0592***
	0.255		0.007		0.094		0.010
ln c x 1981	0.0725**	Age^2	-0.000567***	Born 1955-59	0.0363	White	0.104***
	0.036		7.63e-5		0.081		0.016
ln c x 1984	0.0607	p_{food}	-0.720*	Born 1950-54	0.0248	Constant	-4.291**
	0.102		0.402		0.072		1.791
ln c x 1985	0.0502	$p_{alcohol+tobacco}$	15.11**	Born 1945-49	-0.00336		
	0.104		7.373		0.063		
Number of observations	14,903	R-squared	0.376				
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.8: The Demand for Food in the CEX-Total Expenditures & Services from Durables

Variable	Estimate	Variable	Estimate	Variable	Estimate	Variable	Estimate
ln c	0.916***	ln c x 1986	-0.0521	$p_{fuel+utils}$	-1.872	Born 1940-44	-0.0254
	0.188		0.143		8.682		0.053
ln c x HS dropout	-0.0390	ln c x 1987	-0.0555	$p_{transports}$	-11.84	Born 1935-39	-0.0137
	0.044		0.118		14.39		0.043
ln c x HS graduate	-0.0358	ln c x 1988	-0.0621	HS dropout	0.378	Born 1930-34	-0.00876
	0.088		0.118		0.425		0.030
ln c x one child	-0.0594***	ln c x 1989	-0.0541	HS graduate	0.323	Born 1925-29	-0.00463
	0.014		0.118		0.877		0.017
ln c x two children	-0.0840***	ln c x 1990	-0.0461	Northeast	0.0693***	One Child	0.636***
	0.014		0.121		0.011		0.137
ln c x three children +	-0.0787***	ln c x 1991	-0.137	Midwest	0.0163	Two children	0.904***
	0.015		0.161		0.015		0.140
ln c x 1972	-0.454*	ln c x 1993	-0.134	South	-0.00256	Three children+	0.869***
	0.248		0.170		0.017		0.162
ln c x 1973	-0.433*	Age	0.0631***	Born 1960-64	0.130	Family Size	0.0587***
	0.239		0.007		0.096		0.010
ln c x 1981	0.0632*	Age^2	-0.000594***	Born 1955-59	0.0689	White	0.0838***
	0.034		7.33e-5		0.083		0.021
ln c x 1984	0.0666	p_{food}	-0.601	Born 1950-54	0.0578	Constant	-3.400**
	0.096		0.401		0.073		1.698
ln c x 1985	0.0537	$p_{alcohol+tobacco}$	13.16*	Born 1945-49	0.0267		
	0.098		6.874		0.063		
Number of observations	14,902	R-squared	0.352				
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.

Table A.9: Transmission of Permanent and Transitory Income Shocks

Periods	BPP *e* 0.25	KV (2010)	KV *e* 0.25	KV persistent *e* 0.1	KV persistent *e* 0.4	KV FSM *e* 0.25	KV FSM persistent *e* 0.25
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Average Transmission Levels of Permanent Income Shocks							
Average 1968--2010	0.508	0.268	0.258	0.272	0.257	0.258	0.287
	(0.0459)	(0.0011)	(0.0011)	(0.0011)	(0.0010)	(0.0130)	(0.0029)
Average 1968--1985	0.551	0.400	0.378	0.403	0.376	0.482	0.488
	(0.0181)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0281)	(0.0034)
Average 1986--2010	0.465	0.136	0.137	0.141	0.138	0.071	0.120
	(0.0736)	(0.0021)	(0.0020)	(0.0021)	(0.0020)	(0.0035)	(0.0045)
Panel B: Average Transmission Levels of Transitory Income Shocks							
Average 1968--2010	0.111	0.054	0.058	0.040	0.045		
	(0.0090)	(0.0011)	(0.0011)	(0.0011)	(0.0011)		
Average 1968--1985	0.038	-0.014	-0.010	-0.044	-0.038		
	(0.0036)	(0.0010)	(0.0009)	(0.0009)	(0.0009)		
Average 1986--2010	0.183	0.122	0.125	0.124	0.128		
	(0.0144)	(0.0020)	(0.0020)	(0.0020)	(0.0019)		

NOTE.— Column (1) reports estimates using the minimum distance estimation described by Blundell et al. (2008), accounting for the effect of federal income tax on income with an elasticity of 0.25. Column (2) reports estimates based on the methods in Kaplan and Violante (2010). Column (3) reports estimates based on the methods in Kaplan and Violante (2010), accounting for the effect of federal income tax on income with an elasticity of 0.25. Column (4) reports estimates based on the methods in Kaplan and Violante (2010), allowing for persistence with a parameter $\rho = 0.95$ and accounting for the effect of federal income tax on income with an elasticity of 0.1. Column (5) reports estimates based on the methods in Kaplan and Violante (2010), allowing for persistence with a parameter $\rho = 0.95$ and accounting for the effect of federal income tax on income with an elasticity of 0.4. Column (6) reports estimates based on the methods in Kaplan and Violante (2010) after relaxing the no foresight and short memory assumptions, and accounting for the effect of federal income tax on income with an elasticity of 0.25. Column (7) reports estimates based on the methods in Kaplan and Violante (2010), allowing for persistence with a parameter $\rho = 0.95$, relaxing the no foresight and short memory assumptions, and accounting for the effect of federal income tax on income with an elasticity of 0.25. Standard errors are reported in parentheses.

Table A.10: Transmission of Permanent and Transitory Income Shocks, by Income Quartiles and Education using BPP Updated

Periods	Income quartiles Bottom	2nd	3rd	Top	HS graduate	Some college +
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Average Transmission Levels of Permanent Income Shocks						
Average 1968--2010	0.372	0.674	0.680	0.294	0.542	0.516
	(0.0001)	(0.0808)	(0.0565)	(0.0596)	(0.0993)	(0.0828)
Average 1968--1985	0.463	0.632	0.639	0.299	0.497	0.543
	(0.0001)	(0.0995)	(0.0546)	(0.0525)	(0.1428)	(0.0424)
Average 1986--2010	0.281	0.717	0.721	0.288	0.586	0.489
	(0.0001)	(0.0620)	(0.0584)	(0.0667)	(0.0557)	(0.1233)
Panel B: Average Transmission Levels of Transitory Income Shocks						
Average 1968--2010	0.349	0.096	0.113	0.051	0.131	0.039
	(0.0001)	(0.0697)	(0.0418)	(0.0320)	(0.0440)	(0.0300)
Average 1968--1985	0.073	0.141	0.068	0.023	0.010	0.016
	(0.0001)	(0.0663)	(0.0572)	(0.0283)	(0.0517)	(0.0175)
Average 1986--2010	0.625	0.050	0.158	0.078	0.163	0.061
	(0.0001)	(0.0732)	(0.0265)	(0.0358)	(0.0363)	(0.0426)

NOTE.— Estimates using the methods in Blundell et al. (2008). Column (1)-(4) reports estimates based on income quartiles. Column (5) reports estimates where the household head is a high-school graduate. Column (6) reports estimates where the household head has at least some college education. Standard errors are reported in parentheses.

Table A.11: Transmission of Permanent and Transitory Income Shocks, by Income Quartiles and Education using KV Persistent

Periods	Income quartiles				HS	Some
	Bottom	2nd	3rd	Top	graduate	college +
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Average Transmission Levels of Permanent Income Shocks						
Average 1968--2010	0.556	0.200	0.003	0.238	0.363	0.232
	(0.0969)	(0.0694)	(0.0403)	(0.0745)	(0.0294)	(0.0017)
Average 1968--1985	0.599	0.549	0.100	0.301	0.404	0.361
	(0.0905)	(0.0967)	(0.0757)	(0.0277)	(0.0134)	(0.0023)
Average 1986--2010	0.513	-0.149	-0.094	0.175	0.322	0.103
	(0.1716)	(0.0996)	(0.0275)	(0.1462)	(0.0572)	(0.0027)
Panel B: Average Transmission Levels of Transitory Income Shocks						
Average 1968--2010	-0.014	-0.127	0.084	0.012	0.075	-0.001
	(0.0560)	(0.0310)	(0.7359)	(0.3404)	(0.0093)	(0.0455)
Average 1968--1985	-0.057	0.063	-0.107	-0.378	0.025	-0.136
	(0.1120)	(0.0612)	(1.4719)	(0.6809)	(0.0097)	(0.0910)
Average 1986--2010	0.028	-0.317	0.274	0.402	0.126	0.136
	(0.0036)	(0.0092)	(0.0046)	(0.0044)	(0.160)	(0.0024)

NOTE.— Estimates using the methods in Kaplan and Violante (2010), allowing for persistence with a parameter ρ 0.95. Column (1)-(4) reports estimates based on income quartiles. Column (5) reports estimates where the household head is a high-school graduate. Column (6) reports estimates where the household head has at least some college education. Standard errors are reported in parentheses.

Table A.12: Decomposition of Changes in the Transmission of Income Shocks to Consumption with Estimates from BPP Updated Estimator

	Income quartiles				HS	Some
	Bottom	2nd	3rd	Top	graduate	college +
	(1)	(2)	(3)	(4)	(5)	(6)
*Panel A: **Permanent** Income Shocks*						
Active	-0.575	0.042	2.931	1.037	0.962	0.004
	(0.365)	(0.476)	(1.675)	(0.147)	(0.323)	(0.278)
Passive	-0.117	-0.297	-0.966	0.217	0.061	-0.012
	(0.108)	(0.287)	(0.648)	(0.047)	(0.096)	(0.036)
Behavioral	0.510	0.339	-1.883	-1.265	-0.934	-0.046
	(0.401)	(0.392)	(1.389)	(0.178)	(0.397)	(0.295)
Difference						
(1968--1985) to (1986--2010)	-0.182	0.085	0.082	-0.011	0.089	-0.054
*Panel B: **Transitory** Income Shocks*						
Active	-0.126	0.212	-0.138	0.208	0.413	0.009
	(0.154)	(0.200)	(0.141)	(0.081)	(0.129)	(0.018)
Passive	-0.122	0.005	0.150	0.018	-0.001	-0.002
	(0.080)	(0.094)	(0.066)	(0.011)	(0.019)	(0.003)
Behavioral	0.800	-0.309	0.077	-0.171	-0.347	0.037
	(0.295)	(0.175)	(0.105)	(0.101)	(0.150)	(0.023)
Difference						
(1968--1985) to (1986--2010)	0.552	-0.092	0.089	0.055	0.065	0.045

NOTE.— The transmission parameters based on the methods in Blundell et al. (2008) are decomposed using a Oaxaca (1973) and Blinder (1973) decomposition according to equation (21). Column (1)-(4) reports estimates based on income quartiles. Column (5) reports estimates where the household head is a high-school graduate. Column (6) reports estimates where the household head has at least some college education. Bootstrapped standard errors are reported in parentheses.

Table A.13: Decomposition of Changes in the Transmission of Income Shocks to Consumption with Estimates from Kaplan and Violante (2010) with Persistent Shocks

	Income quartiles				HS	Some
	Bottom	2nd	3rd	Top	graduate	college +
	(1)	(2)	(3)	(4)	(5)	(6)
*Panel A: **Permanent** Income Shocks*						
Active	-0.624	-0.011	2.695	-0.145	0.937	-0.097
	(0.372)	(0.465)	(1.874)	(0.130)	(0.323)	(0.256)
Passive	-0.119	-0.274	-0.884	-0.032	0.059	0.009
	(0.108)	(0.273)	(0.722)	(0.045)	(0.090)	(0.033)
Behavioral	0.558	0.384	-1.757	0.184	-0.904	0.068
	(0.406)	(0.388)	(1.546)	(0.155)	(0.396)	(0.274)
Difference						
(1968--1985) to (1986--2010)	-0.185	0.099	0.054	0.007	0.092	-0.020
*Panel B: **Transitory** Income Shocks*						
Active	-0.127	0.205	-0.123	0.193	0.412	0.009
	(0.149)	(0.198)	(0.127)	(0.076)	(0.121)	(0.014)
Passive	-0.120	-0.008	0.134	0.017	-0.001	-0.002
	(0.078)	(0.092)	(0.059)	(0.010)	(0.017)	(0.002)
Behavioral	0.794	-0.275	0.082	-0.166	-0.350	0.041
	(0.285)	(0.176)	(0.095)	(0.093)	(0.141)	(0.020)
Difference						
(1968--1985) to (1986--2010)	0.546	-0.078	0.093	0.044	0.061	0.048

NOTE.— The transmission parameters based on the methods in Kaplan and Violante (2010) with a persistent shock with parameter equal to 0.95, are decomposed using a Oaxaca (1973) and Blinder (1973) decomposition according to equation (21). Column (1)-(4) reports estimates based on income quartiles. Column (5) reports estimates where the household head is a high-school graduate. Column (6) reports estimates where the household head has at least some college education. Bootstrapped standard errors are reported in parentheses.