Consumption Inequality across Heterogeneous Families

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Abstract

How much of consumption inequality across households is due to preference heterogeneity and how much due to wage and wealth inequality? This paper studies the link from wage to consumption inequality within a lifecycle model of consumption and family labor supply. Its distinctive feature is that households have general heterogeneous preferences over consumption and labor supply. The paper shows identification of the joint distribution of unobserved household preferences separately from the observed distributions of incomes and outcomes. Estimation on data from the Panel Study of Income Dynamics in the US reveals substantial heterogeneity in consumption preferences. Such heterogeneity accounts for approximately 52% of consumption inequality in recent years.

Keywords: unobserved preference heterogeneity, consumption inequality, family labor supply, wage shocks, lifecycle model, liquidity constraints, PSID

JEL classification: D12, D30, D91, E21

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1 Introduction

This paper studies the link between wage and consumption inequality using a lifecycle model of family labor supply, consumption and wealth. Its distinctive feature is that households have heterogeneous preferences over consumption and labor supply. The paper shows identification of the joint distribution of unobserved household preferences, namely consumption and labor supply elasticities, separately from the observed distributions of incomes and outcomes. It then asks how much of consumption inequality is due to preference heterogeneity, and how much due to wage and wealth inequality. To answer this, the model is implemented empirically on recent data from the Panel Study of Income Dynamics (PSID) revealing large amounts of preference heterogeneity across households with substantial implications for consumption inequality.

There is extensive empirical, experimental and survey evidence of preference heterogeneity.[1] Such heterogeneity has potentially important implications for consumption inequality. Consider two households who have similar wages, wealth and demographics but differ in their respective consumption preferences. This preference heterogeneity may reflect differences in the composition of their consumption baskets, in the complementarity between consumption goods and leisure, or a myriad other aspects. The households will likely adjust their consumption *differently* in response to a similar wage change and subsequent consumption inequality in this simple cross-section will reflect both the wage change *and* preference heterogeneity. This has implications for how much of inequality is policy-relevant as well as for how inequality responds to redistributive policies.

The paper formally incorporates unobserved preference heterogeneity into a lifecycle model for consumption and labor supply of two-earner households. Family labor supply plays a critical role in the transmission of wage into income (Hyslop, 2001) and consumption inequality (Blundell et al., 2016) so it is important to allow for it. The treatment of unobserved heterogeneity is general: (i) heterogeneity is nonseparable from within-period preferences; (ii) preferences are nonparametric; (iii) heterogeneity is not restricted to a single dimension (to a single parameter in the analog of parametric preferences); instead it is multi-dimensional meaning that any preference parameter in the parametric analog might be independently or jointly heterogeneous; (iv) the multi-variate distribution of preferences is itself nonparametric. The specific workings of the household are as follows: two spouses make unitary lifecycle choices over consumption and labor supply. They can borrow and save at the market interest rate. The spouses choose working hours endogenously and, for each hour of work, earn a market wage that is subject to permanent and transitory wage/productivity shocks. Such shocks, potentially correlated

[1]For example, Alan and Browning (2010) find heterogeneity in the discount factor and the elasticity of intertemporal substitution across education groups in the PSID. Andersen et al. (2008) and other experimental studies find substantial dispersion in risk and time preferences while Guiso and Paiella (2008) observe directly from survey data large amounts of unexplained heterogeneity in risky preferences. Abowd and Card (1989) find large unexplained dispersion in working hours at fixed wages. See Heckman (2001) for a theoretical discussion.

between spouses, are the only source of uncertainty the household faces. To the best of my knowledge, this is the first paper that models general unobserved heterogeneity at the nexus of lifecycle consumption and family labor supply.[2]

Following Blundell and Preston (1998) and a sequence of papers thereafter, I derive analytical expressions for consumption and earnings from Taylor approximations to the lifetime budget constraint and the problem's optimality conditions. These analytical expressions relate the growth rates of consumption and earnings to wage shocks, preferences (namely household-specific Frisch elasticities of consumption and labor supply), and parameters pertaining to financial and human wealth in the household. Thanks to these expressions, the second and higher moments of the empirical joint distribution of consumption, earnings and wage growth have straightforward theoretical counterparts. This mapping between data and theory provides restrictions that can be used to identify moments of the cross-sectional joint distribution of household preferences. The analytical expressions also permit the decomposition of consumption inequality into terms that pertain to wage inequality, wealth inequality, and preference heterogeneity. I establish that consumption inequality increases with each of these components.

I show that *any* moment of the distribution of wage elasticities of consumption and labor supply is identified separately from the distribution of consumption, earnings, wages or assets. Such elasticities describe preferences in an ordinal way and are not specific to a particular parametrization of the household utility function. Identification rests on the idea that cross-sectional dispersion in consumption and working hours that occurs at fixed prices/wages and fixed observables masks heterogeneity in consumption and labor supply preferences. Identification requires panel data on consumption, hours and earnings.

To illustrate these points empirically I fit second and third moments of the joint distribution of consumption, earnings and wages in the PSID in survey years 1999-2011. This permits the estimation of second and third moments of wage shocks as well as first and second moments of preferences (wage elasticities of consumption and labor supply). The model fits the data reasonably well. There are four main findings from this exercise.

First, the distributions of wage shocks have a long left tail. This is true for permanent and transitory shocks to both male and female wages. This negative skewness implies that negative shocks are more unsettling than positive ones as they are on average further away from the zero mean compared to positive shocks. This is consistent with Guvenen et al. (2015) who find negative skewness of *earnings* shocks using data from the US Social Security Administration.

Second, there is substantial heterogeneity in consumption preferences but little heterogeneity in labor supply preferences. Specifically, consumption in the average household (one with average preferences) is separable from leisure; however, two standard deviations of the wage elasticities of consumption about their means fall within the range $(-1.23, 1.15)$ implying sub-

[2] Alan et al. (2017) and Arellano et al. (2017) model consumption and income jointly allowing for heterogeneity but abstracting from labor supply. Blundell et al. (2016) model consumption and family labor supply but abstract from unobserved heterogeneity.

stantial cross-household heterogeneity in the magnitude and sign of the consumption-leisure complementarity. Male and female average labor supply elasticities at the intensive margin are lower than average estimates reported by Keane (2011) but still lie within the range of estimates therein. Their magnitudes drop as the model attempts to match third moments of wages and earnings. There is limited heterogeneity (in statistical or economic sense) in these labor supply elasticities after accounting for a large number of observables.

Third, preference heterogeneity accounts for about 52% of consumption inequality across US households, wage inequality for 43.8% and wealth inequality for 4.2%. Wage shocks account for less of consumption inequality than does heterogeneity in preferences and wealth. This is numerically similar to Huggett et al. (2011) who find that wage shocks account for less of the variation in lifetime utility than does heterogeneity in initial conditions at the start of working life.

Fourth, the model has implications for consumption partial insurance, namely the extent to which consumption is insured against wage shocks. On average consumption tracks permanent shocks more closely than the preference *homogeneity* benchmark of Blundell et al. (2016). Partial insurance is lower here because of a limited insurance role of family labor supply. As the model matches third moments of the data not targeted in the homogeneous case, labor supply elasticities drop and family labor supply becomes less effective in insuring against shocks. While on average 45% (31%) of a male (female) permanent shock passes through to consumption compared to 34% (20%) in Blundell et al. (2016), a non-negligible fraction of households lacks partial insurance completely as in Hryshko and Manovskii (2017).

Possible misspecification in the model may confound preference heterogeneity with omitted variables. I show that the empirical pattern of preference heterogeneity is not driven by *intra*-family inequality, taxes, household-specific consumption prices or wage heterogeneity, all of which the model abstracts from. I show, however, that such pattern is roughly consistent with an environment where households are differentially affected by unobserved liquidity constraints and adjustment costs of work. The data are inconclusive about this alternative.

Contribution and literature. The paper offers four contributions: (i) it embeds general unobserved preference heterogeneity into a lifecycle model of consumption and labor supply unlike related literature that imposes a representative agent condition or abstracts from labor supply; (ii) it establishes identification of any moment of the distribution of unobserved preferences, namely wage elasticities of consumption and labor supply; (iii) it estimates the location and spread of preferences (elasticities) in the US; (iv) it quantifies the implications of preference heterogeneity for consumption inequality.

The paper relates primarily to the literature that studies the mapping from income to consumption inequality. Blundell and Preston (1998), Krueger and Perri (2006) and Primiceri and van Rens (2009) investigate the link between income and consumption inequality abstracting from labor supply. Hyslop (2001) focuses explicitly on the role of family labor supply in the transmission of wage into earnings inequality while Attanasio et al. (2002) study the transmission of earnings into consumption inequality in two-earner households with stochastic labor market participation of the second earner. Huggett et al. (2011) develop an one-earner lifecycle model with labor supply to study the relative contributions of luck (wage shocks) and initial conditions (wealth, human capital) to inequality. Blundell and Etheridge (2010) and Heathcote et al. (2010) provide additional empirical evidence of the role of labor supply in the transmission of inequality. A slightly distinct but growing part in this literature focuses on consumption insurance and the mechanisms behind it, e.g. Blundell et al. (2008), Kaplan and Violante (2010), Guvenen and Smith (2014), Heathcote et al. (2014), Alan et al. (2017), Arellano et al. (2017), and Wu and Krueger (2018). Blundell, Pistaferri, and Saporta-Eksten (2016), BPS hereafter, study the transmission of wage shocks into consumption through a model of family labor supply, savings, and external insurance. BPS estimate preferences homogeneously and find that once family labor supply, wealth and the welfare system are accounted for, there is little room for additional insurance. The model in the present paper extends BPS to allow households to differ in their consumption and labor supply preferences, therefore also in their willingness, ceteris paribus, to smooth consumption. Using the same data (but augmented by one wave and using additional moments), heterogeneity turns out, as will be detailed subsequently, to be important for both consumption inequality and partial insurance. Jappelli and Pistaferri (2010) and Meghir and Pistaferri (2011) provide an overview of the extensive literature.

With the exception of the following three studies, a consistent feature in this literature is that households are ex ante identical: conditional on observables and idiosyncratic incomes, any two households behave the same when confronted with a given income change. Heathcote et al. (2014) admit that part of the cross-sectional dispersion in consumption and hours is unrelated to income or price variation and allow for unobserved heterogeneity which is, however, additively separable and specific to the parametrization of household preferences they employ. Alan et al. (2017) allow for joint heterogeneity in income and preferences but abstract from labor supply and parametrize preferences and their distribution. Arellano et al. (2017) develop a nonlinear framework for the consumption response to income allowing for flexible heterogeneity; they too abstract from labor supply. By contrast, I allow for joint heterogeneity in family labor supply and consumption while leaving preferences and their distribution nonparametric; however, I use a simpler process for wages than the last two papers (but one that fits the PSID well).

Finally, the paper shares a common goal with the extensive literature on consumer demand, namely the identification of preferences from observed behavior. Lewbel (2001) studies various forms of random preferences, with and without nonseparable heterogeneity, and argues that the usual practice to restrict heterogeneity to additive errors is similar to enforcing a representative agent assumption. A number of recent consumer demand and revealed preferences studies present identification results and empirical applications when preferences exhibit nonseparable heterogeneity; examples are Matzkin (2003), Blundell et al. (2017), Cosaert and Demuynck (2017), and Lewbel and Pendakur (2017). The paper complements these studies by point-identifying first and higher moments of elasticities of consumption and labor supply and then estimating a subset of them. These novel parameters can serve as inputs in welfare or program evaluations (e.g. French, 2005) where heterogeneity in the behavioral response of consumption and labor supply may crucially determine the policy conclusions.

The paper is organized as follows. Section 2 presents the model and the analytical expressions for consumption and earnings. Section 3 discusses identification. Section 4 presents the empirical implementation and the results. Section 5 discusses the implications of preference heterogeneity for consumption inequality and the transmission of shocks into consumption. It also investigates alternative explanations for preference heterogeneity. Section 6 concludes.

2 A Lifecycle Household Model for Consumption and Labor Supply

A household consists of two earners, each one subscripted by j. To fix ideas suppose the two earners are a male ($j = 1$) and a female ($j = 2$) spouse. In lifecycle period t the spouses make choices over household consumption C_t, future assets A_{t+1}, and hours of market work H_{1t} and H_{2t} respectively (intensive margin labor supply only). I model the household problem as unitary, that is, as the problem of a single economic agent. This facilitates the discussion of cross-household preference heterogeneity without confounding it with issues pertaining to intra-household heterogeneity and commitment.[3] The length of the lifecycle is a known T.

Household i in the cross-section chooses $\{C_{it}, A_{it+1}, H_{1it}, H_{2it}\}$ over its lifecycle to maximize its expected discounted lifetime utility

$$\max_{\{C_{it},A_{it+1},H_{1it},H_{2it}\}_{t=0}^{T}} \mathbb{E}_0 \sum_{t=0}^{T} U_{it}(C_{it}, H_{1it}, H_{2it}; \mathbf{Z}_{it}) \tag{1}$$

subject to a lifetime budget constraint, the sequential version of which at time t is

$$A_{it} + \sum_{j=1}^{2} W_{jit} H_{jit} = C_{it} + \frac{A_{it+1}}{1+r}. \tag{2}$$

Hours of work are subject to a standard upper bound that ensures spouses do not work more than 24 hours per day. In the budget constraint, A_{it} is beginning-of-period assets, W_{jit} is spouse j's hourly wage in the labor market, and r is the deterministic market interest rate.

In the objective function, U_{it} is household utility from consumption and disutility from labor supply; the dependence on time reflects discounting. Vector $\mathbf{Z}_{it}$ includes observable taste shifters, such as spouses' education or age, and captures *observed* preference heterogeneity. Preferences U_{it} are subscripted by i to reflect *unobserved* preference heterogeneity across

[3] In the absence of formal collective modeling of the household, cross-household and intra-household heterogeneity may interact in the spirit of Lise and Seitz (2011). I discuss this issue in section 5.3.

households, strictly speaking household-specific preferences not captured by the conditioning observables. This general way to model unobserved heterogeneity is consistent with various different sources heterogeneity may stem from, such as cross-household differences in the composition of the consumption basket (e.g. Aguiar and Hurst, 2013), in labor market attachment, consumption-leisure complementarities or discounting. I do not parameterize U_{it} but I do assume geometric discounting and continuous first and second order derivatives.

I assume spousal wages follow a permanent-transitory process.[4] Specifically, log wage $\ln W_{jit}$ is the sum of a deterministic component, a permanent stochastic component that follows a unit root, and a transitory shock; namely

$$\ln W_{jit} = \mathbf{X}'_{jit}\boldsymbol{\alpha}_{W_j} + \ln W^p_{jit} + u_{jit}$$
$$\ln W^p_{jit} = \ln W^p_{jit-1} + v_{jit}.$$

Here $\mathbf{X}_{jit}$ is a vector of conditioning observables (such as age or education) with coefficient $\boldsymbol{\alpha}_{W_j}$. $\ln W^p_{jit}$ is the permanent component, u_{jit} is the transitory shock, and v_{jit} is the permanent shock; all for spouse $j = \{1, 2\}$ in household i at time $t = \{0, \ldots, T\}$. This wage process can be written compactly as

$$\Delta w_{jit} = v_{jit} + \Delta u_{jit} \tag{3}$$

where $\Delta w_{jit} = \Delta \ln W_{jit} - \Delta \mathbf{X}'_{jit}\boldsymbol{\alpha}_{W_j}$ and $\Delta(\cdot)$ denotes first difference. The permanent shock reflects a permanent change in the returns to one's skills in the labor market such as a skill-specific technical change; the transitory shock indicates short-lived mean reverting fluctuations in productivity. Wage shocks are the only source of uncertainty the household encounters. I explore the implications of an alternative, more general, wage process in section 5.3.

Properties of shocks. Wage shocks are idiosyncratic with zero cross-sectional means and n^{th} moments ($n > 1$) given by

$$\mathbb{E}(v^{\nu}_{1it}v^{n-\nu}_{2it+s}) = \begin{cases} m_{v_1^{\nu}v_2^{n-\nu}(t)} & \text{for } s = 0 \text{ and } \nu = \{0, \ldots, n\} \\ 0 & \text{otherwise} \end{cases}$$

$$\mathbb{E}(u^{\nu}_{1it}u^{n-\nu}_{2it+s}) = \begin{cases} m_{u_1^{\nu}u_2^{n-\nu}(t)} & \text{for } s = 0 \text{ and } \nu = \{0, \ldots, n\} \\ 0 & \text{otherwise} \end{cases}$$

and $v_{jit} \perp u_{j'it+s}$ for any combination of $j, j' = \{1, 2\}$ and $s = \{0, \ldots, T\}$.

[4] The permanent-transitory process has been used extensively in the income dynamics literature and beyond, for example in MaCurdy (1982), Abowd and Card (1989), Attanasio et al. (2002), Meghir and Pistaferri (2004), Attanasio et al. (2008), Blundell et al. (2008) and BPS. This process implies 'restricted income profiles' as agents have the same ex-ante income growth conditional on observables but face idiosyncratic shocks. An alternative family of income processes supports ex-ante idiosyncratic income growth and implies 'heterogeneous income profiles' (see, for example, Guvenen, 2007; Browning et al., 2010). In section 5.3 I generalize the wage process to allow for heterogeneity in the persistence of the stochastic component.

As an illustration for $s=0$, the second moments ($n=2$) of shocks are given by

$$\mathbb{E}(v_{1it}^{\nu}v_{2it+s}^{2-\nu}) = \begin{cases} \sigma^2_{v_j(t)} & \text{if } \nu=2, j=1 \text{ or } \nu=0, j=2 \\ \sigma_{v_1 v_2(t)} & \text{if } \nu=1 \end{cases}$$

$$\mathbb{E}(u_{1it}^{\nu}u_{2it+s}^{2-\nu}) = \begin{cases} \sigma^2_{u_j(t)} & \text{if } \nu=2, j=1 \text{ or } \nu=0, j=2 \\ \sigma_{u_1 u_2(t)} & \text{if } \nu=1 \end{cases}$$

and the third moments ($n=3$) by

$$\mathbb{E}(v_{1it}^{\nu}v_{2it+s}^{3-\nu}) = \begin{cases} \gamma_{v_j(t)} & \text{if } \nu=3, j=1 \text{ or } \nu=0, j=2 \\ \gamma_{v_1 v_2^2(t)} & \text{if } \nu=1 \\ \gamma_{v_1^2 v_2(t)} & \text{if } \nu=2 \end{cases}$$

$$\mathbb{E}(u_{1it}^{\nu}u_{2it+s}^{3-\nu}) = \begin{cases} \gamma_{u_j(t)} & \text{if } \nu=3, j=1 \text{ or } \nu=0, j=2 \\ \gamma_{u_1 u_2^2(t)} & \text{if } \nu=1 \\ \gamma_{u_1^2 u_2(t)} & \text{if } \nu=2. \end{cases}$$

Across all expressions above, $\mathbb{E}(\cdot)$ denotes the mean over i. I assume the spouses hold no advance information about future shocks; this assumption is testable and often not rejected (Meghir and Pistaferri, 2011).

I allow for non-zero *cross*-moments, a feature consistent with a general joint distribution of shocks. For example, assortative matching between spouses implies that the covariance between their shocks is non-zero, and possibly so for higher cross-moments too. The indexing of moments by t indicates that moments can vary with time. The logic is that different times may be associated with different amounts of wage inequality, skewness, etc (Guvenen et al., 2014). Note that lifecycle effects are partly captured by conditioning observables (age) in $\mathbf{X}_j$.

Dynamics of consumption and hours. I derive analytical expressions for the growth rates of consumption and individual labor supply in terms of (the growth in) spousal wages and the marginal utility of wealth. A first-order Taylor approximation to the intra-temporal first-order conditions of household problem (1) *s.t.* (2) yields

$$\begin{aligned} \Delta c_{it} &\approx \eta_{c,w_1(i)}\Delta w_{1it} + \eta_{c,w_2(i)}\Delta w_{2it} + \left(\eta_{c,p(i)} + \eta_{c,w_1(i)} + \eta_{c,w_2(i)}\right)\Delta \ln \lambda_{it} \\ \Delta h_{jit} &\approx \eta_{h_j,w_1(i)}\Delta w_{1it} + \eta_{h_j,w_2(i)}\Delta w_{2it} + \left(\eta_{h_j,p(i)} + \eta_{h_j,w_1(i)} + \eta_{h_j,w_2(i)}\right)\Delta \ln \lambda_{it} \end{aligned} \quad (4)$$

with details reported in appendix A. The notation is as follows: $\Delta c_{it} = \Delta \ln C_{it}$ and $\Delta h_{jit} = \Delta \ln H_{jit}$, both net of the effect of taste observables $\mathbf{Z}_{it}$ and wage observables $\mathbf{X}_{jit}$. λ_{it} is the marginal utility of wealth, namely the Lagrange multiplier on the sequential budget constraint. Parameters η are Frisch (λ-constant) elasticities defined at the household level. As an illustration, $\eta_{c,w_1(i)} = \frac{\partial C}{\partial W_1}\frac{W_1}{C}\Big|^{i}_{\lambda\text{-const.}}$ is the elasticity of consumption with respect to male wage W_1, $\eta_{c,p(i)}$ is the elasticity of consumption with respect to its price P, and $\eta_{h_j,w_2(i)}$ is the labor

Table 1 – Frisch Elasticities of Household i

Consumption elasticities		
$\eta_{c,w_1(i)}$	:	with respect to male wage W_1
$\eta_{c,w_2(i)}$	:	with respect to female wage W_2
$\eta_{c,p(i)}$	:	with respect to the price of consumption P
Male labor supply elasticities		
$\eta_{h_1,w_1(i)}$	:	with respect to male wage W_1
$\eta_{h_1,w_2(i)}$	:	with respect to female wage W_2
$\eta_{h_1,p(i)}$	:	with respect to the price of consumption P
Female labor supply elasticities		
$\eta_{h_2,w_1(i)}$	:	with respect to male wage W_1
$\eta_{h_2,w_2(i)}$	:	with respect to female wage W_2
$\eta_{h_2,p(i)}$	:	with respect to the price of consumption P

Notes: The table presents the Frisch (λ-constant) elasticities of household i. These elasticities constitute an ordinal representation of within-period preferences U_i. There are 9 elasticities in total, 3 own-price and 6 cross-price elasticities. The rule governing the notation of elasticities is: $\eta_{x,\chi(i)}$ is household i's elasticity of outcome variable $x = \{c, h_1, h_2\}$ with respect to price $\chi = \{w_1, w_2, p\}$. Each elasticity is subscripted by i to denote that elasticities are household-specific.

supply elasticity of spouse j with respect to female wage W_2; all are i-specific. The full list of elasticities appears in table 1 and defined formally in appendix B.

The Frisch elasticities, 9 in total per household, provide an ordinal representation of household i's within-period preferences U_i over consumption and labor supply. There is a multivariate distribution of elasticities across households because U_i is household-specific. This distribution, denoted by $F_{\boldsymbol{\eta}}$, is in the epicentre of unobserved preference heterogeneity in this paper.[5]

Expressions (4) are empirically unattractive because the marginal utility of wealth is unobserved. Following Blundell and Preston (1998) and BPS, I overcome this in two steps. First, I apply a second-order Taylor approximation to the Euler equation and decompose $\Delta \ln \lambda_{it}$ into two terms: the anticipated gradient of outcome growth (a function of the interest and discount rates) and an innovation that captures idiosyncratic revisions to λ due to wage shocks. Second, I apply a first-order Taylor approximation to the lifetime budget constraint and map the innovation to λ into wage shocks.[6] The details of both steps appear in appendix A.

[5]Any cross-household variation in Frisch elasticities, conditional on wages/prices and exogenous observables incl. age, qualifies as unobserved preference heterogeneity generalizing the homogeneity benchmark of BPS. I discuss the role of taxes and liquidity constraints in section 5.3. I do not model unobserved heterogeneity as function of the *level* of consumption or hours as its empirical implementation would require larger samples sizes. However, I do check the robustness of my empirical results in a number of subsamples of wealthy households. For simplicity $F_{\boldsymbol{\eta}}$ is calendar time invariant; this assumption is not needed for any of the results in the paper.

[6]See Blundell et al. (2013) for a detailed illustration of the approximation, as well as Campbell (1993).

These approximations combined lead to analytical expressions for the growth rates of outcomes as functions of wage shocks, Frisch elasticities, and two parameters pertaining to financial and human wealth (defined below). The analytical expressions are given by

$$\begin{aligned}\Delta c_{it} \approx\ & \eta_{c,w_1(i)}\Delta u_{1it} + \eta_{c,w_2(i)}\Delta u_{2it} \\ & + \left(\eta_{c,w_1(i)} + \bar{\eta}_{c(i)}\varepsilon_1(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i)\right) v_{1it} + \left(\eta_{c,w_2(i)} + \bar{\eta}_{c(i)}\varepsilon_2(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i)\right) v_{2it}\end{aligned} \tag{5}$$

$$\begin{aligned}\Delta h_{1it} \approx\ & \eta_{h_1,w_1(i)}\Delta u_{1it} + \eta_{h_1,w_2(i)}\Delta u_{2it} \\ & + \left(\eta_{h_1,w_1(i)} + \bar{\eta}_{h_1(i)}\varepsilon_1(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i)\right) v_{1it} + \left(\eta_{h_1,w_2(i)} + \bar{\eta}_{h_1(i)}\varepsilon_2(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i)\right) v_{2it}\end{aligned} \tag{6}$$

$$\begin{aligned}\Delta h_{2it} \approx\ & \eta_{h_2,w_1(i)}\Delta u_{1it} + \eta_{h_2,w_2(i)}\Delta u_{2it} \\ & + \left(\eta_{h_2,w_1(i)} + \bar{\eta}_{h_2(i)}\varepsilon_1(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i)\right) v_{1it} + \left(\eta_{h_2,w_2(i)} + \bar{\eta}_{h_2(i)}\varepsilon_2(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i)\right) v_{2it},\end{aligned} \tag{7}$$

where $\bar{\eta}_{c(i)} = \eta_{c,p(i)} + \eta_{c,w_1(i)} + \eta_{c,w_2(i)}$ and $\bar{\eta}_{h_j(i)} = \eta_{h_j,p(i)} + \eta_{h_j,w_1(i)} + \eta_{h_j,w_2(i)}$ for $j = \{1, 2\}$. The intercepts are absorbed by the conditioning observables on the left hand side.[7]

Unlike permanent shocks, transitory shocks have a negligible effect on the lifetime budget constraint or the marginal utility of wealth.[8] Consumption responds to such shocks because of the non-separability with labor supply in U_i. The response reflects the intertemporal substitution between consumption and leisure and measures the consumption-wage elasticity $\eta_{c,w_j(i)}$. Heterogeneity in such elasticity gives rise to (and is justified by) heterogeneity in the consumption response to transitory shocks. Similarly, hours of work respond to own transitory shocks reflecting the intertemporal substitution between hours and leisure induced by a temporary wage shift. By definition, such response measures the own-wage Frisch labor supply elasticity $\eta_{h_j,w_j(i)}$. Hours also respond to the partner's transitory shock due to the non-separability between spouses' hours in U_i. This response measures the cross-wage elasticity $\eta_{h_j,w_{-j}(i)}$ ($-j$ denotes the partner) and reflects the intertemporal substitution between spouses' leisure.

Permanent shocks induce the same *substitution* effects as transitory shocks; in addition, they induce *income* effects because they shift the lifetime budget constraint. While the response of consumption and hours to transitory shocks measures *Frisch* elasticities, the response to

[7]Growth in outcome variables is net of the effect of observable covariates. As per appendix A,

$$\begin{aligned}\Delta c_{it} =\ & \Delta \ln C_{it} - \eta_{c,p(i)}\Delta\left(\mathbf{Z}_{it}'\boldsymbol{\alpha}_C\right) - \eta_{c,w_1(i)}\Delta\left(\mathbf{Z}_{it}'\boldsymbol{\alpha}_{H_1}\right) - \eta_{c,w_2(i)}\Delta\left(\mathbf{Z}_{it}'\boldsymbol{\alpha}_{H_2}\right) \\ & - \eta_{c,w_1(i)}\Delta\left(\mathbf{X}_{1it}'\boldsymbol{\alpha}_{W_1}\right) - \eta_{c,w_2(i)}\Delta\left(\mathbf{X}_{2it}'\boldsymbol{\alpha}_{W_2}\right) - \bar{\eta}_{c(i)}\omega_{it} \\ \Delta h_{jit} =\ & \Delta \ln H_{jit} - \eta_{h_j,p(i)}\Delta\left(\mathbf{Z}_{it}'\boldsymbol{\alpha}_C\right) - \eta_{h_j,w_1(i)}\Delta\left(\mathbf{Z}_{it}'\boldsymbol{\alpha}_{H_1}\right) - \eta_{h_j,w_2(i)}\Delta\left(\mathbf{Z}_{it}'\boldsymbol{\alpha}_{H_2}\right) \\ & - \eta_{h_j,w_1(i)}\Delta\left(\mathbf{X}_{1it}'\boldsymbol{\alpha}_{W_1}\right) - \eta_{h_j,w_2(i)}\Delta\left(\mathbf{X}_{2it}'\boldsymbol{\alpha}_{W_2}\right) - \bar{\eta}_{h_j(i)}\omega_{it}.\end{aligned}$$

The $\boldsymbol{\alpha}$'s are 'structural' parameters for the effects of taste observables $\mathbf{Z}_{it}$ and wage observables $\mathbf{X}_{jit}$ on outcomes. $\bar{\eta}_{c(i)}\omega_{it}$ and $\bar{\eta}_{h_j(i)}\omega_{it}$ are the intercepts reflecting the anticipated and heterogeneous gradients of consumption and hours growth in the absence of wage shocks. The gradients are functions of the heterogeneous geometric discount factor (appendix A). Assuming measurement error away for now, one can obtain Δc_{it} (or Δh_{jit}) as the residual from a random coefficients regression of $\Delta \ln C_{it}$ (or $\Delta \ln H_{jit}$) on observables.

[8]Transitory shocks are mean-reverting and, as long as the time horizon of the household is sufficiently long, their effect on the lifetime budget constraint is negligible. Appendix A illustrates this point analytically.

permanent wage shocks approximately measures *Marshallian* elasticities. $\varepsilon_j(\cdot)$ in (5)-(7) reflects the impact of j's permanent shock on the budget constraint (more precisely, on the marginal utility of wealth λ), presented analytically in appendix A. It is a function of the household-specific vector of Frisch elasticities $\boldsymbol{\eta}_i$ as well as two financial and human wealth -or initial conditions- parameters, π_{it} and $\mathbf{s}_{it} = (s_{1it}, s_{2it})'$. $\pi_{it} \approx \text{Assets}_{it}/(\text{Assets}_{it} + \text{Human Wealth}_{it})$ is the 'partial insurance' coefficient (Blundell et al., 2008, and BPS); a higher π_{it} implies a smaller impact of permanent shocks on consumption because the household holds more assets to absorb such shocks. $s_{jit} \approx \text{Human Wealth}_{jit}/\text{Human Wealth}_{it}$ is the share of j's human wealth (expected lifetime earnings) in total human wealth at t. A high s_{jit} implies that j's permanent shocks are relatively more important because this spouse contributes a larger share into family earnings. BPS offer a comprehensive discussion of the transmission mechanisms of shocks in the *representative* household and I refer to them for details.

Expressions (5)-(7) are empirically tractable and provide a neat picture for how shocks, preferences and other factors contribute to consumption and hours growth. They offer a theoretical interpretation to the dynamics of consumption and hours and form the basis of identification of the distribution of preferences in the next section. These equations generalize BPS to allow for household-specific unobserved preference heterogeneity. Accounting for preference heterogeneity can have important implications for how wage inequality translates into consumption inequality, and for the overall transmission of wage shocks into consumption and earnings. For example, consumption may *on average* be fully insulated against some shock while at the same time, because of preference heterogeneity, some households may increase consumption in response to the shock while some other may reduce it.

3 Identification

3.1 Wage Process

Identification of the second moments of shocks ($\sigma^2_{v_j(t)}$, $\sigma^2_{u_j(t)}$, $\sigma_{v_1v_2(t)}$, $\sigma_{u_1u_2(t)}$; $j = \{1, 2\}$) follows Meghir and Pistaferri (2004) and earlier studies. Consider wage process (3) and assume measurement error away for now. The covariance between consecutive wage growths $\mathbb{E}\left(\Delta w_{jit} \Delta w_{jit+1}\right)$ identifies the variance of the transitory shock due to mean reversion. The covariance between contemporaneous wage growth and a sum of three consecutive wage growths $\mathbb{E}\left(\Delta w_{jit} \sum_{\varsigma=-1}^{\varsigma=1} \Delta w_{jit+\varsigma}\right)$ identifies the variance of the permanent shock as the sum strips Δw_{jit} of the time-t transitory shock. Analogous expressions identify the covariances between shocks.

Identification of the third moments ($\gamma_{v_j(t)}$, $\gamma_{u_j(t)}$, $\gamma_{v_1v_2^2(t)}$, $\gamma_{v_1^2v_2(t)}$, $\gamma_{u_1u_2^2(t)}$, $\gamma_{u_1^2u_2(t)}$; $j = \{1, 2\}$) uses third moments of the joint distribution of wages across households. As an illustration, $\gamma_{v_j(t)} = \mathbb{E}\left((\Delta w_{jit})^2(\Delta w_{jit-1} + \Delta w_{jit} + \Delta w_{jit+1})\right)$ and $\gamma_{u_j(t)} = -\mathbb{E}\left((\Delta w_{jit})^2 \Delta w_{jit+1}\right)$. The intuition parallels that for the second moments while there are many over-identifying restrictions. Analogous expressions identify the third cross-moments. I generalize these results to the n^{th}

moments ($n > 1$) and discuss measurement error in appendix C.[9]

3.2 Preferences

The preference parameters of interest are the unconditional first, second, and higher moments of the 9-dimensional joint distribution $F_{\boldsymbol{\eta}}$ of Frisch elasticities across households. There are 9 parameters for the unconditional first moment: $\mathbb{E}(\eta_{c,w_j(i)})$, $\mathbb{E}(\eta_{c,p(i)})$, $\mathbb{E}(\eta_{h_{j'},w_j(i)})$, and $\mathbb{E}(\eta_{h_{j'},p(i)})$ for $j, j' = \{1, 2\}$. There are 45 parameters for the unconditional second moment: the cross-sectional variance of each Frisch elasticity of table 1 (9 parameters) and all possible covariances between them (36 parameters). Appendix table C.1 lists these parameters. In general, there are $\prod_{i=1}^{8}(n+i)/8!$ parameters for the unconditional $n^{\text{th}} = \{1, 2, 3, \dots\}$ moment of $F_{\boldsymbol{\eta}}$, assuming that such moment exists and is finite. The focus of the paper is on moments of the Frisch elasticities rather than also of the geometric discount factor. The latter determines consumption and hours growth in the absence of shocks (the intercepts in (5)-(7) absorbed by the conditioning observables) and the present framework, revolving around the short-term response of outcomes to shocks, is not suited to identify moments of the discount factor (see appendix A).

Assumption 1. ***Independence of preferences and wage shocks.*** *Preferences are independent of wage shocks, namely $\boldsymbol{\eta}_i \perp v_{jit}, u_{jit}$ for all j, i, t, conditional on observables.*[10]

Suppose, for example, the spouses in a given household are strongly attached to the labor market and their labor supply is relatively insensitive to wage changes (namely they have small labor supply elasticities). The independence assumption states that, regardless the sign and magnitude of the idiosyncratic wage shocks, the spouses remain as strongly attached to the labor market as always. This is not saying that their hours do not respond to shocks. On the contrary, they do; but, conditional on observables, their hours respond to a shock of a given type in a constant proportion to the magnitude of the shock and irrespective of its sign.

That preferences $\boldsymbol{\eta}_i$ are independent of wage shocks obviously implies that wage shocks too are independent of household preferences. Nevertheless, the latter is harder to justify in a dynamic context as past choices that reflect preferences may affect current wages. I remove the effect of past choices on spousal wages by assuming such effect only materializes through observables. The independence of wage shocks and preferences boils down to restricting the effect of past choices to pass through observable characteristics only.[11]

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[9] In the permanent-transitory specification the variance of the transitory shock is not separately identified from the variance of measurement error (e.g. Blundell et al., 2008). The empirical application of section 4 addresses this in practice. Identification of the third moments of transitory shocks obtains under the assumption that wage measurement error has zero skewness (as in the case of a normally distributed error).

[10] Wage shocks are also independent of initial conditions π_{it} and s_{jit}. This is a result rather than an assumption as both π_{it} and s_{jit} pertain to $t-1$ expectations, therefore are non-random at t (see appendix A).

[11] The independence assumption is standard in the related consumer demand literature (e.g. Lewbel, 2001) and in structural incomplete-markets models where preference shocks are independent of productivity shocks

I group the parameters of $F_{\boldsymbol{\eta}}$ into three categories. The first involves exclusively moments of the 6 *wage elasticities* of consumption and labor supply ($\eta_{c,w_j(i)}$, $\eta_{h_1,w_j(i)}$, $\eta_{h_2,w_j(i)}$). The second involves moments of the 2 labor supply elasticities *with respect to the price of consumption* ($\eta_{h_1,p(i)}$, $\eta_{h_2,p(i)}$), including all cross-moments with the wage elasticities. The third includes all other parameters, namely moments that involve the *consumption substitution elasticity* $\eta_{c,p(i)}$.

Proposition 1. ***Identification of elasticities.*** *Let assumption 1 hold. If (1.) measurement error is classical and Gaussian and (2.) the second moments of wage and earnings measurement error are known, for example, from validation studies, then:*

- *All moments of the joint distribution of wage elasticities of consumption and labor supply $\eta_{c,w_j(i)}$, $\eta_{h_1,w_j(i)}$ and $\eta_{h_2,w_j(i)}$ are identified from panel data on wages, earnings and consumption - Identification does not require to parameterize household preferences or their distribution;*
- *The moments of the labor supply elasticities with respect to the price of consumption $\eta_{h_1,p(i)}$ and $\eta_{h_2,p(i)}$ are mechanically also identified;*
- *No moment of the elasticity of consumption with respect to its own price $\eta_{c,p(i)}$ is identified without collapsing its distribution to degenerate;*
- *The variance of consumption measurement error is identified under one of a number of alternative linear restrictions on the second moments of wage elasticities of consumption.*

The remaining of this section provides justifications for this proposition.

3.2.1 Wage Elasticities and Consumption Measurement Error

First moments. Identification follows BPS and relies on the transmission of transitory shocks into consumption and earnings. Such transmission is captured by the first-order autocovariance $\mathbb{E}(\Delta c_{it}\Delta w_{jit+1})$ in the case of consumption and $\mathbb{E}(\Delta y_{jit}\Delta w_{j'it+1})$, $j, j' = \{1, 2\}$, in the case of earnings y.[12] It reflects the variance of the mean-reverting transitory shock weighed by the average loading factor of such shock onto consumption and earnings, that is, by the average consumption-wage or labor supply elasticity respectively.

The rationale is as follows: $\mathbb{E}(\eta_{h_j,w_j(i)})$ reflects the average sensitivity of hours h_j to a lifetime-income-constant wage change u_j; this is precisely what the latter autocovariance captures. As transitory shocks temporarily shift labor supply, the average response of consumption

(e.g. Heathcote et al., 2014). The assumption is violated when households choose their education and occupation in expectation of a future distribution of shocks. However, this can still be addressed by controlling wages and outcomes for education and occupation. The same applies to health shocks that may affect wages and preferences simultaneously; yet changes in health are often observed in data such as the PSID or can be proxied for by abrupt changes in the work status of individuals.

[12] Earnings Y_j are given by the product of wage and hours of spouse j. Growth in log earnings net of observables is given by $\Delta y_{jit} = \Delta w_{jit} + \Delta h_{jit}$ with Δw_{jit} given by (3) and Δh_{jit} given by (6)-(7).

to such shocks (the former autocovariance) reflects the average complementarity of consumption and hours $\mathbb{E}(\eta_{c,w_j(i)})$. Similarly, the average response of hours to the partner's transitory shock uncovers the average complementarity between spouses' hours $\mathbb{E}(\eta_{h_j,w_{-j}(i)})$.

Second moments. Identification rests on the idea that cross-sectional variation in consumption or hours that occurs at *fixed* prices and covariates reflects heterogeneity in preferences. This is motivated empirically by the observation of Abowd and Card (1989, p.411) who find that "most of the covariation of earnings and working hours occurs at fixed wage rates". This suggests that the variation in hours that remains after removing variation in wages and observables masks heterogeneity in labor supply preferences. I extend the argument to consumption and consumption preferences.

As an illustration, consider expressions (5) and (6) for consumption and male hours/earnings growth; assume for now that female transitory shocks are zero ($u_{2it} = 0$) and there is no measurement error. Variation in consumption growth across consecutive periods, given by the first-order autocovariance $\mathbb{E}(\Delta c_{it} \Delta c_{it+1}) = -\mathbb{E}(\eta^2_{c,w_1(i)})\sigma^2_{u_1(t)}$, is due to the variance of the mean-reverting transitory shock *and* heterogeneity in the consumption response to such shock, that is, in the consumption elasticity η_{c,w_1}. Similarly, intertemporal variation in earnings growth, given by $\mathbb{E}(\Delta y_{1it} \Delta y_{1it+1}) = -\mathbb{E}\big((1 + \eta_{h_1,w_1(i)})^2\big)\sigma^2_{u_1(t)}$, is due to the variance of the shock *and* heterogeneity in the male labor supply elasticity, while covariation in consumption and earnings growth across periods, given by $\mathbb{E}(\Delta c_{it} \Delta y_{1it+1}) = -\mathbb{E}\big(\eta_{c,w_1(i)}(1+\eta_{h_1,w_1(i)})\big)\sigma^2_{u_1(t)}$, is due to the variance of the shock *and* the *joint* variation in the consumption and male labor supply elasticities. Scaling these covariances by the inverse variance of the shock removes variation in wages and identifies $\mathbb{E}(\eta^2_{c,w_1(i)})$, $\mathbb{E}(\eta^2_{h_1,w_1(i)})$ and $\mathbb{E}(\eta_{c,w_1(i)}\eta_{h_1,w_1(i)})$ respectively. Covariates are kept fixed by using consumption, earnings and wage moments net of observables.

The previous lines convey the intuition behind identification in the simplest terms. Reinstating the female transitory shock and allowing for measurement error renders identification slightly more demanding but the basic logic remains unchanged. One has to take into account all possible covariances between different elasticities and the joint variation in spouses' shocks.

As an illustration, suppose that observed consumption growth is $\Delta c^*_{it} = \Delta c_{it} + \Delta e^c_{it}$ where Δc_{it} is given by (5) and e^c_{it} is consumption measurement error with variance $\sigma^2_{e^c(t)}$. The first-order autocovariance becomes

$$\mathbb{E}(\Delta c^*_{it} \Delta c^*_{it+1}) = -\mathbb{E}(\eta^2_{c,w_1(i)})\sigma^2_{u_1(t)} - \mathbb{E}(\eta^2_{c,w_2(i)})\sigma^2_{u_2(t)} - 2\mathbb{E}(\eta_{c,w_1(i)}\eta_{c,w_2(i)})\sigma_{u_1u_2(t)} - \sigma^2_{e^c(t)}.$$

Assume temporarily that $\sigma^2_{e^c(t)} = 0$. The autocovariance reflects variation in spouses' transitory shocks as well as marginal and joint heterogeneity in all consumption-wage elasticities. It no longer identifies $\mathbb{E}(\eta^2_{c,w_1(i)})$ so we are in need of additional identifying equations. Consumption preference heterogeneity affects a number of higher joint moments of consumption and wages such as the intertemporal covariances between wage and squared consumption growth $\mathbb{E}((\Delta c_{it})^2 \Delta w_{jit-1})$, $j = \{1, 2\}$, a form of 'impulse response' functions. The extent to which squared consumption growth varies intertemporally with wage growth reflects skewness in the distribution of shocks scaled up by dispersion in consumption preferences, thus provides the additional information to (in this case, just-) identify such dispersion, namely $\mathbb{E}(\eta^2_{c,w_j(i)})$ and $\mathbb{E}(\eta_{c,w_1(i)}\eta_{c,w_2(i)})$. Similar arguments apply to the identification of all other second own- and cross-moments of wage elasticities. Appendix C provides analytical statements for the identification of all second moments, as well as an extension to higher moments.

A few remarks are in order. First, identification obtains even if $\sigma_{u_1u_2} = 0$ *or* $\gamma_{u_1^2u_2} = \gamma_{u_1u_2^2} = 0$. If all cross-moments of shocks are zero, the variances of wage elasticities are still identified but most covariances are not. Second, identification of selected covariances relies on symmetry of the matrix of Frisch substitution effects, a natural theoretical restriction discussed in appendix B and Phlips (1974). Frisch symmetry also identifies the moments of the labor supply elasticities with respect to the price of consumption $\eta_{h_j,p(i)}$; these are simply linear transformations of the moments of the wage elasticities of consumption $\eta_{c,w_j(i)}$.

Consumption measurement error. If $\sigma^2_{e^c(t)} \neq 0$ the variance of the error is not separately identified from dispersion in consumption preferences. Imposing $\text{Var}(\eta_{c,w_1(i)}) = \text{Var}(\eta_{c,w_2(i)})$ or fixing $\text{Cov}(\eta_{c,w_1(i)}, \eta_{c,w_2(i)})$ enables identification of both preference dispersion *and* the variance of the error. The unrestricted estimation of the model in section 4 supports both restrictions.

3.2.2 Consumption Substitution Elasticity

The consumption substitution elasticity $\eta_{c,p(i)}$ matters for the sensitivity of the lifetime budget constraint to permanent shocks. In the absence of observed cross-sectional variation in the price of consumption, identification of $\eta_{c,p(i)}$ must come from the transmission of permanent shocks into consumption and hours. In practice, however, such transmission can identify at most the first moment of this elasticity, and this is not without strong additional assumptions.

Assume for simplicity that utility is separable in its arguments, $\pi_{it} = 0$ (no financial wealth) and $s_{1it} = s_{2it} = 1/2$ (the spouses have equal expected lifetime earnings). The transmission of the male permanent shock into consumption is given by the quasi-reduced-form parameter

$$\kappa_{c,v_1(i)} \equiv \frac{\eta_{c,p(i)}(1 + \eta_{h_1,w_1(i)})}{2\eta_{c,p(i)} - \eta_{h_1,w_1(i)} - \eta_{h_2,w_2(i)}}.[13]$$

Identification of the average Marshallian elasticity $\mathbb{E}(\kappa_{c,v_1(i)})$ is straightforward from concurrent consumption and wage data. Abstracting from preference heterogeneity, BPS recover a homogeneous $\eta_{c,p}$ from $\mathbb{E}(\kappa_{c,v_1(i)})$: conditional on the labor supply elasticities, the level of the Marshallian elasticity reflects the willingness of households to trade consumption intertemporally, thus pins down $\eta_{c,p}$. In the presence of preference heterogeneity, however, $\mathbb{E}(\kappa_{c,v_1(i)})$ depends on a plethora of parameters, namely the mean and variance of $\eta_{c,p(i)}$, its covariance

[13]One can obtain this simplified Marshallian elasticity from expression (5) for consumption growth by plugging in $\eta_{c,w_j(i)} = \eta_{h_j,p(i)} = \eta_{h_j,w_{j'}} = 0$, $\pi_{it} = 0$ and $s_{jit} = 0.5$.

with the labor supply elasticities, higher own and cross-moments, as well as moments pertaining exclusively to $\eta_{h_j,w_j(i)}$. One can verify this by a Taylor expansion of $\kappa_{c,v_1(i)}$ around mean preferences. Even if the latter moments are identified as per section 3.2.1, one cannot separate the mean of $\eta_{c,p(i)}$ from its variance or any of its covariances. Identification even of $\mathbb{E}(\eta_{c,p(i)})$ fails and no other average Marshallian elasticity (e.g. of hours) or other moments can help overcome this as the number of involved parameters is large, especially so when preferences are nonseparable. When the marginal distribution of $\eta_{c,p(i)}$ is degenerate, however, $\mathbb{E}(\kappa_{c,v_1(i)})$ *does* identify a homogeneous $\eta_{c,p}$. $\mathbb{E}(\kappa_{c,v_1(i)})$ still depends on first and higher moments of wage elasticities, thus necessitating to either parametrize their joint distribution or approximate $\mathbb{E}(\kappa_{c,v_1(i)})$ by a Taylor series whose order would practically need to be low.

To understand why $\mathbb{E}(\kappa_{c,v_1(i)})$ depends on various moments of $\eta_{c,p(i)}$, abstract from female labor supply and consider households who, on average, dislike fluctuations in consumption ($\mathbb{E}(\eta_{c,p(i)}) \to 0^-$) and male labor supply ($\mathbb{E}(\eta_{h_1,w_1(i)}) \to 0^+$). Furthermore, suppose that households *less* reluctant to intertemporal consumption fluctuations ($\eta_{c,p(i)}$ more negative) have also *less* elastic labor supply (low $\eta_{h_1,w_1(i)}$; correlates positively with $\eta_{c,p(i)}$). Because those who barely use labor supply to smooth shocks (smallest η_{h_1,w_1}) are also those who do not resent passing such shocks into consumption (largest absolute $\eta_{c,p}$), average consumption across households is more responsive to permanent shocks (higher Marshallian elasticity) than without the preference correlation.[14] Ignoring the correlation results in overestimating $|\mathbb{E}(\eta_{c,p(i)})|$ and mistakenly deeming the average household more willing to trade consumption intertemporally.

4 Application

In the empirical application I fit second and third moments of the cross-sectional joint distribution of consumption, earnings, and wage growth in the PSID. This enables me to estimate second and third moments of shocks as well as first and second moments of wage elasticities.

4.1 Data and Implementation

Data. I use data from 7 waves of the PSID (1999-2011; biennial data).[15] The PSID started in 1968 tracking a -then- nationally representative sample of households ('SRC' sample) as well as a second sample of lower-income households ('SEO' sample). Repeated annually until 1997 the survey collected detailed information on incomes, employment, food expenditure and demographics of the adult household members and their linear descendants should they split off and establish their own households. The survey became biennial after 1997 to enable the

[14] For example, $\mathbb{E}(\eta_{c,p(i)}) = -0.05$ and $\mathbb{E}(\eta_{h_j,w_j(i)}) = 0.2$ imply $\partial\mathbb{E}(\kappa_{c,v_1(i)})/\partial\text{Cov}(\eta_{c,p(i)}, \eta_{h_1,w_1(i)}) = 1.28$. At these values $\mathbb{E}(\kappa_{c,v_1(i)})$ increases more than 1-to-1 with a positive correlation in preferences.

[15] I also use data from 1997 for the estimation of wage shocks. More information on the PSID, as well as access to the data, is available online at psidonline.isr.umich.edu.

collection of detailed information on household consumption and wealth. The PSID is ideal for the empirical implementation of this model because it provides longitudinal information jointly on demographics, hours, earnings and consumption in the household.

I follow closely the sample selection criteria and variable definition of BPS. I select married opposite-sex couples between 30 and 60 years old from the 'SRC' sample with consistent information on age, education, race and no missing information on employment and state of residence. I focus on stable couples; if a spouse remarries, I drop the household in the year when remarriage occurs and reinstate it subsequently as a new household. As the estimating equations are in first differences, I drop households that appear in the sample only once.

Identification requires wages for both spouses; therefore I select spouses who participate in the labor market and earn positive amounts. I discuss potential selectivity issues below. I construct hourly wages as earnings over total hours of work on a yearly basis and I drop observations for which wages are below half the applicable state minimum wage.[16]

I construct consumption (expenditure) as the Hicksian aggregate of a number of elementary consumption items.[17] I treat missing values in elementary items as zeros and I drop a few observations for which (i) total consumption is zero, or (ii) an elementary item is censored, or (iii) the reported time period of a given expenditure is missing. I impute the expenditure value of housing for homeowners as 6% of the self-reported value of their house.

Finally, I remove observations for which wages, earnings or consumption experience an extreme drop (jump) in a given period followed by an extreme jump (drop) in the next one as such movements may reflect measurement error.[18] I also remove households with wealth[19] higher than \$20M or whose wages, earnings or consumption lie in the top 0.25% of the respective (where applicable, spouse-specific) distribution by age. Table 2 presents descriptive statistics for the baseline sample (columns (1)-(3)) and for four subsamples of relatively wealthy households (columns (W1)-(W4)). Table 3 presents measures of volatility and skewness. I postpone the discussion of the wealthy until section 5.3.

[16]Earnings are defined as labor income from all jobs (including overtime, tips, bonuses, commissions etc.) plus the labor part of business income from unincorporated businesses. I exclude the labor part of farm income because this is not measured consistently over time. Participation requires strictly positive earnings *and* hours of work. The latter is defined as actual realized (but self-reported) hours on all jobs including overtime.

[17]Elementary items are: food (prepared or delivered at home and food away from home; all food items are for recipients and non-recipients of food stamps), vehicle expenses (car insurance, repairs, parking, gasoline), transportation costs (bus and train tickets, taxicabs, other costs), child care, school expenses for children, medical costs (health insurance, nursing homes and hospital bills, doctor, surgery, and dentist costs, prescriptions), utilities (gas, electricity, water and sewage costs, other utilities such as telecommunications), home insurance, rent for renters and rent equivalent for homeowners or people in other housing arrangements.

[18]Given the biennial nature of the data, I construct the distribution of $(\chi_{it} - \chi_{it-2})(\chi_{it+2} - \chi_{it})$ by available year and I drop observations with values in the bottom 0.25% ($\chi_{it} = \{\ln W_{jit}, \ln Y_{jit}, \ln C_{it}\}$, $j = \{1, 2\}$).

[19]Household wealth comprises the present value of the primary dwelling net of outstanding mortgages, and other real estate, savings, IRA and annuities, the value of vehicles, farms and businesses, investments in stocks and shares, and other assets net of credit card debt, student loans, medical or legal bills and loans from relatives.

Table 2 – Descriptive Statistics: General

	baseline sample			$A > \overline{C}$	$A > 2\overline{C}$	$A > \overline{C}$ no debt	$A > \overline{C}$ liquid
	(1) Mean	(2) Median	(3) St.dev	(W1) Mean	(W2) Mean	(W3) Mean	(W4) Mean
Male earner							
Earnings	71159	57717	56281	77784	82168	78075	85054
Hours of work	2253	2202	610	2257	2262	2228	2252
Hourly wage	32.2	26.1	25.5	35.3	37.3	35.4	38.4
Age	45.1	45.0	7.8	46.9	47.4	47.4	47.9
Some college %	66.8	100.0	47.1	71.2	74.7	70.0	75.6
Female earner							
Earnings	40023	34190	30102	42484	43869	41176	44033
Hours of work	1727	1880	659	1723	1712	1673	1665
Hourly wage	23.2	19.4	15.3	24.8	25.8	24.9	26.9
Age	43.4	43.0	7.6	45.2	45.7	45.6	46.1
Some college %	70.3	100.0	45.7	73.2	75.6	72.0	76.1
Household consumption							
Total consumption	46212	40536	23768	49725	52451	47334	50504
food at home	7058	6523	3505	7170	7278	6840	6930
food out	2951	2313	2594	3140	3271	2986	3194
vehicles[a]	7087	5264	6582	7327	7524	6557	6728
public transport	313	0.0	2339	369	419	294	329
childcare	921	0.0	3008	842	828	687	701
education	3303	0.0	8772	4048	4504	3428	3877
medical expenses[b]	3591	2536	3860	3723	3849	3437	3700
utilities	4798	4413	2726	4843	4905	4388	4465
housing[c]	16191	12871	12371	18264	19873	18716	20581
Household assets and debt [in thousands]							
Total wealth	382.9	177.5	790.0	503.0	587.5	624.2	751.9
Home equity[d]	126.0	80.3	160.1	163.8	186.8	193.3	218.0
Other debt	12.2	2.7	28.7	9.1	8.9	0.1	0.1
All other assets	269.1	81.6	721.6	348.3	409.5	431.0	534.1
other real estate	42.1	0.0	289.6	54.1	64.7	61.0	71.1
savings accounts	25.0	6.9	61.7	31.6	36.3	46.1	56.7
stocks-shares	45.7	0.0	299.5	61.0	72.8	84.5	108.8
# of children	1.0	1.0	1.1	0.9	0.9	0.9	0.8
Obs. [households × years]		8177		5635	4649	2336	1794

Notes: The table presents summary statistics for the baseline sample (columns (1)-(3)) and for four subsamples of relatively wealthy households (columns (W1)-(W4)) in 1999-2011. All monetary amounts are in 2010 dollars. Earnings, hours, consumption and wealth/debt are annual. Column (W1) is for households with wealth A_t at least as much as average consumption $\overline{C}_t$ in the baseline sample. Column (W2) is for households with wealth at least twice as much as average consumption. Column (W3) is like column (W1) with the additional condition that households hold real debt that does not exceed $2K. Column (W4) is like column (W3) but the relevant measure of wealth excludes home equity, thus better proxies for liquid assets. [a]including gasoline; [b]including health insurance and prescriptions; [c]including home insurance, rent and rent equivalent for homeowners and people in alternative housing arrangements; [d]the present value of owned house net of outstanding mortgages.

Average earnings of men in the baseline sample are 78% higher than average earnings of women; men, however, work on average 526 hours more, almost a third more than women. Women are 70% likely to have had some college education; men are slightly less likely. Household consumption is, on average, a fraction of men's earnings but greater than women's. The largest single component within the consumption basket is housing, followed by vehicles (including gasoline) and food at home. On average, there is one child under 18 in the household.

Implementation. The estimation is implemented in three stages corresponding respectively to covariates, wages, and preferences. In the first stage, I regress $\Delta \ln W_{jit}$ on a set of observable characteristics including year, age, education, race, and state of residence dummies, as well as year-education and year-race interactions. I carry out the regression separately by spouse. The residual is $\Delta w^*_{jit} = \Delta w_{jit} + \Delta e^w_{jit}$ where w_{jit} is the unexplained part of wages and e^w_{jit} is wage measurement error. The statistical/theoretical counterpart of Δw_{jit} is given by (3).[20]

I regress earnings growth $\Delta \ln Y_{jit}$ on the above set of observable characteristics for oneself *and* their spouse, as well as on indicators for the number of children in the household, the number of household members, employment status of either spouse, and whether the household supports or receives income from members outside the household. I also include changes in the variables over time and interactions with year dummies. I carry out the regression separately by spouse. The residual is $\Delta y^*_{jit} = \Delta y_{jit} + \Delta e^y_{jit}$ where y_{jit} is the unexplained part and e^y_{jit} is measurement error. The theoretical counterpart of Δy_{jit} is $\Delta w_{jit} + \Delta h_{jit}$ with Δh_{jit} given by (6)-(7). Similarly, I regress consumption growth $\Delta \ln C_{it}$ on the same covariates as in the case of earnings. The residual is $\Delta c^*_{it} = \Delta c_{it} + \Delta e^c_{it}$ where c_{it} is the unexplained part and e^c_{it} is consumption measurement error. The theoretical counterpart of Δc_{it} is (5).

The purpose of all first-stage regressions is to remove the effect of observables on wages and outcomes. In other words, the conditioning covariates serve to capture *observed* heterogeneity in wages, earnings, and consumption ($\mathbf{X}_{jit}$ and $\mathbf{Z}_{it}$ in model notation). Following the model and abstracting from measurement error, any remaining variation in wages is due to wage shocks and any remaining variation in earnings or consumption is due to wage shocks, *unobserved* preference heterogeneity, and heterogeneity in initial conditions π_{it} and $\mathbf{s}_{it}$.

In the second stage, I fit second and third moments of the joint distribution of residual wages to estimate second and third moments of permanent and transitory shocks. Conditional on these, in the third stage I fit selected *second* and, depending on the model specification, *third* moments of the joint distribution of residual wages, earnings, and consumption to estimate *first* and *second* moments of wage elasticities. I deal with multiple moments and over-identifying restrictions using GMM and the identity weighting matrix.

Parameters π_{it} and $\mathbf{s}_{it}$, which can be inferred directly from the data, enter the earnings

[20] Given the biennial nature of the data, the theoretical notation $\Delta \ln W_{jit} = \ln W_{jit} - \ln W_{jit-1}$ points to the empirical $\Delta^2 \ln W_{jit} = \ln W_{jit} - \ln W_{jit-2}$. I maintain the first notation throughout the text and for all variables, even though it actually refers to a first difference over two years.

and consumption moments through the transmission of permanent shocks. Such transmission, however, also depends on the consumption substitution elasticity whose distribution is not identified in the presence of preference heterogeneity (section 3.2.2). To avoid subjecting the estimation of wage elasticities to parametric form restrictions, I fit moments of earnings and consumption that pertain to the transmission of transitory shocks only. These are joint moments across *consecutive* rather concurrent time periods. Therefore I am not using information on the transmission of permanent shocks and π_{it} and $\mathbf{s}_{it}$ are not needed in the estimation of wage elasticities. Appendix E lists all moments targeted in the second and third stages.

Measurement error. I remove a priori the variability in wages and earnings that is due to measurement error. I obtain the error variance from Bound et al. (1994) who report findings from a validation study of the PSID.[21] As in BPS, wage and earnings measurement errors are related because wages are constructed as earnings over hours. I report these details in a companion report (Theloudis, 2017). The validation study neither provides information on consumption measurement error nor goes beyond the error's second moments. Although I show identification of the consumption error variance, there is not much I can do about higher moments. This is why proposition 1 requires that the error is Gaussian.

Selection into labor market. Participation in the labor market is relatively high in the (prior to participation selection) sample: around 95% of men and 82% of women work. Given the focus on stable married couples, most of female non-participation is attributed to the presence of young children (included in the conditioning observables) rather than, for example, involuntary unemployment. BPS account for endogenous participation of women following two empirical approaches: the first corrects participation using conditional covariance restrictions in the spirit of Low et al. (2010); the second assumes the decision to work is driven by wages and demographics. Neither approach makes a difference to their results and average preferences are indistinguishable with or without the correction. In the light of the high participation rates and given the difficulty to find a convincing exclusion restriction or to model participation explicitly (this would render the approximations infeasible), I do not apply a participation correction. Importantly, volatility of $\Delta \ln C_{it}$ among all participating and non-participating individuals is 0.293 while skewness equals -0.086, both very similar to the baseline sample in table 3.

[21] The PSID validation study used by Bound et al. (1994) surveys workers from a single manufacturing company in 1983 and 1987. The study obtains information on earnings and hours in a way that parallels the PSID questionnaire and coding practises. It compares the responses to administrative data obtained directly from the firm. The main caveat is that the sample of workers comes from two decades prior to the data I am using in this paper. Whether and how the nature of measurement error changed ever since, especially after the redesign of the PSID in 1997, is unknown. Another caveat comes from using the same estimates to correct male and female earnings or wages, even though the validation study sampled male workers only.

Table 3 – Descriptive Statistics: Volatility and Skewness

	baseline sample	$A > \overline{C}$	$A > 2\overline{C}$	$A > \overline{C}$ no debt	$A > \overline{C}$ liquid
	(1)	(W1)	(W2)	(W3)	(W4)
Volatility [standard deviation of corresponding variable]					
$\Delta \ln W_{1it}$	0.485	0.504	0.519	0.486	0.518
$\Delta \ln W_{2it}$	0.441	0.438	0.443	0.445	0.448
$\Delta \ln Y_{1it}$	0.536	0.538	0.547	0.559	0.588
$\Delta \ln Y_{2it}$	0.606	0.588	0.593	0.614	0.623
$\Delta \ln C_{it}$	0.288	0.280	0.280	0.265	0.267
Skewness [third standardized moment of corresponding variable]					
$\Delta \ln W_{1it}$	-0.280	-0.327	-0.421	-0.707	-0.720
$\Delta \ln W_{2it}$	-0.551	-0.592	-0.526	-0.580	-0.522
$\Delta \ln Y_{1it}$	-1.036	-1.163	-1.151	-1.579	-1.541
$\Delta \ln Y_{2it}$	-0.384	-0.266	-0.312	1.194	1.226
$\Delta \ln C_{it}$	-0.068	-0.097	0.002	0.029	0.012

Notes: The table reports the volatility (standard deviation) and skewness (third standardized moment or Pearson's moment coefficient of skewness) in the main variables in the baseline sample (column (1)) and in four subsamples of relatively wealthy households (columns (W1)-(W4)) in 1999-2011. See notes in table 2 for variable and sample definitions.

Inference. Given the multi-stage estimation, I adopt the block bootstrap as means to conduct inference (Horowitz, 2001). I draw 1,000 random samples from the baseline sample and I repeat each stage of the estimation for each such sample. A major challenge arises because some parameters are on the boundary of the parameter space and the bootstrap is inconsistent in such cases (Andrews, 2000). This applies to all heterogeneity parameters that are subject to non-negativity inequality constraints, namely the variances $\text{Var}(\eta_{c,w_j(i)})$, $\text{Var}(\eta_{h_1,w_j(i)})$, $\text{Var}(\eta_{h_2,w_j(i)})$, $j = \{1, 2\}$. Practically, it does not apply to the variances of wage shocks whose estimates are always away from the zero lower bound.

I adopt the following rule to overcome this challenge. I report standard errors $\hat{\sigma}$ for wage or preference parameters *not* subject to non-negativity constraints. I calculate $\hat{\sigma}$ as $\hat{\sigma} = (\hat{F}^{-1}(0.75) - \hat{F}^{-1}(0.25))/(\Phi^{-1}(0.75) - \Phi^{-1}(0.25))$; the numerator is the interquartile range of the bootstrap distribution $\hat{F}$ of the relevant parameter and Φ is the standard normal cdf.[22] For parameters subject to non-negativity constraints I report the p-value associated with the

[22]For normal distributions $iqr = \sigma(\Phi^{-1}(0.75) - \Phi^{-1}(0.25))$ where iqr is the interquartile range of the distribution (the difference between the 75$^{\text{th}}$ and 25$^{\text{th}}$ percentiles), σ is its standard deviation, and Φ is the standard normal cdf. Calculating the standard errors in this way is equivalent to applying a normal approximation to the distribution of bootstrap replications, thus shielding standard errors from extreme bootstrap draws. Before imposing normality I verify that the unrestricted distribution is approximately normal.

Table 4 – Estimates of Wage Parameters

	(1) Men		(2) Women		(3) Family			
				Panel A: *Second moments*				
permanent	$\sigma^2_{v_1}$	0.0370	$\sigma^2_{v_2}$	0.0356	$\sigma_{v_1 v_2}$	0.0041	$\rho_{v_1 v_2}$	0.1132
		(0.0049)		(0.0037)		(0.0018)		(0.0545)
transitory	$\sigma^2_{u_1}$	0.0290	$\sigma^2_{u_2}$	0.0132	$\sigma_{u_1 u_2}$	0.0041	$\rho_{u_1 u_2}$	0.2105
		(0.0054)		(0.0042)		(0.0022)		(0.1325)
				Panel B: *Third moments*				
permanent	γ_{v_1}	-0.0050	γ_{v_2}	-0.0174	$\gamma_{v_1 v_2^2}$	0.0006	$\gamma_{v_1^2 v_2}$	0.0037
		(0.0085)		(0.0051)		(0.0015)		(0.0018)
transitory	γ_{u_1}	-0.0167	γ_{u_2}	-0.0077	$\gamma_{u_1 u_2^2}$	-0.0004	$\gamma_{u_1^2 u_2}$	0.0003
		(0.0075)		(0.0051)		(0.0013)		(0.0039)

Notes: The table presents GMM estimates of the parameters of the wage process under stationarity over time. Block bootstrap standard errors are in parentheses based on 1,000 bootstrap replications subject to a normal approximation to the interquartile range of bootstrap replications. Panel A presents the second moments and panel B presents the third moments.

null hypothesis that the respective parameter θ is zero ($\mathcal{H}_0 : \theta = 0$) against the one-sided alternative ($\mathcal{H}_a : \theta > 0$). I obtain the p-value as one minus the share of bootstrap replications for which $n^{1/2}\hat{\theta} > n^{1/2}(\hat{\theta}^* - \hat{\theta})$, where $\hat{\theta}^*$ is a bootstrap estimate of θ and $\hat{\theta}$ is the original parameter estimate. Andrews (2000) shows that the bootstrap test of $\mathcal{H}_0$ against $\mathcal{H}_a$ has the correct asymptotic rejection rate for $p \in (0, 1/2)$.

4.2 Empirical Results

Wage parameters. Table 4 presents the estimates of second and third moments of wage shocks assuming stationarity over time. Given that time effects are captured by first-stage conditioning covariates, relaxing stationarity makes little difference to the estimates but inflates the standard errors as smaller samples are applicable per parameter.[23]

Panel A presents the second moments. The variance of permanent shocks is similar between men and women. Permanent shocks covary within the couple (the correlation coefficient is $\rho_{v_1 v_2} = 0.113$) suggesting that spouses face similar wage risks due to possessing similar skills, working in similar industries, or pursuing similar occupations (perhaps as a result of assortative matching). The variance of men's transitory shocks is more than double that of women's signaling higher wage instability possibly due to higher job mobility (Gottschalk and Moffitt, 2009). Transitory shocks covary positively ($\rho_{u_1 u_2} = 0.211$) but statistically insignificantly.

Panel B presents the third moments; these are needed in the estimation of the second

[23]BPS allow the second moments of shocks to vary over pre-defined age brackets. The variance of permanent shocks follows an U-shape over the lifetime but this does not affect their estimates of average preferences.

moments of preferences (see section 3.2 and appendix C). Three points are worth noting. First, permanent and transitory shocks to both male and female wages feature left skewness, that is, they have a long left tail. The corresponding third standardized moments are $\widetilde{\gamma}_{v_1} = -0.70$, $\widetilde{\gamma}_{v_2} = -2.59$, $\widetilde{\gamma}_{u_1} = -3.38$ and $\widetilde{\gamma}_{u_2} = -5.08$. Such left tail suggests that negative shocks are more devastating and unsettling than positive ones because they are on average further away from the zero mean. Guvenen et al. (2015) obtain the same result for earnings shocks of million of workers using data from the Social Security Administration. Second, all cross-moments except $\gamma_{v_1^2 v_2}$ are effectively zero implying there is limited co-skewness between spouses' shocks. Third, women's distribution of permanent shocks is substantially more left skewed than men's pointing to gender differences in the left tail of permanent shocks. Wage penalties that hit women in particular, for example due to incidents of fertility, may explain this discrepancy.

Preference parameters. Tables 5 and 6 present the main results under a number of alternative specifications. Column (1) presents estimates of wage elasticities of consumption and labor supply *without* preference heterogeneity targeting *second* moments of wages, earnings and consumption.[24] Two things are worth noting. First, the consumption-wage elasticities $\eta_{c,w_1} \equiv \mathbb{E}(\eta_{c,w_1(i)}) = 0.08$ and $\eta_{c,w_2} \equiv \mathbb{E}(\eta_{c,w_2(i)}) = -0.15$ have opposite signs and are not statistically different from zero.[25] In a statistical sense this implies $\mathbb{E}(\partial \Delta c_{it}/\partial \Delta u_{jit}) = \mathbb{E}(\eta_{c,w_j(i)}) \approx 0$ reflecting and confirming that, on average, transitory shocks do not pass through into consumption (e.g. Blundell et al., 2008). It also implies separability (lack of complementarity) between consumption and labor supply at the intensive margin. However, the response to transitory shocks alone may partially reflect liquidity constraints. If the true preference relationship between consumption and labor supply is one of Frisch substitution ($\eta_{c,w_j} < 0$), the presence of binding liquidity constraints biases such substitution towards zero as a liquidity constrained household tends to move consumption in the same direction with wages. Second, the own-wage labor supply elasticities are substantial and, in line with the literature, men's elasticity $\eta_{h_1,w_1} \equiv \mathbb{E}(\eta_{h_1,w_1(i)}) = 0.24$ is notably lower than women's $\eta_{h_2,w_2} \equiv \mathbb{E}(\eta_{h_2,w_2(i)}) = 0.59$. Keane (2011) surveys the labor supply literature and reports estimates in the range $0.03 - 6.25$ for men's Frisch elasticity (the reported average is 0.85 while the median is lower) and $0.03 - 3.05$ for women's; the present estimates fall well within those ranges. The cross-elasticities of labor supply $\eta_{h_1,w_2} \equiv \mathbb{E}(\eta_{h_1,w_2(i)})$ and $\eta_{h_2,w_1} \equiv \mathbb{E}(\eta_{h_2,w_1(i)})$ are statistically zero (marginally and jointly) ruling out complementarities between spouses' leisure.

Column (2) presents estimates of wage elasticities *without* preference heterogeneity targeting second *and third* moments of wages, earnings and consumption. This specification

[24]These results are the closest to the benchmark of BPS, reported and discussed in appendix E. BPS estimate preferences homogeneously from wage, earnings and consumption second moments.

[25]A joint test of the hypothesis $\mathcal{H}_0 : \mathbb{E}(\eta_{c,w_1(i)}) = \mathbb{E}(\eta_{c,w_2(i)}) = 0$ has p-value $= 0.76$. I implement this as a standard Wald test. No parameter is subject to inequality constraints in this specification, therefore the bootstrap covariance matrix of the relevant parameters is consistent.

estimates the same parameters as column (1) but uses additional information from selected third moments of the joint distribution of wages and outcomes. Third moments will later contribute to the estimation of second moments of preferences. Three things are worth noting. First, the consumption-wage elasticities are attenuated as the model attempts to match third moments of consumption and wages, particularly $\mathbb{E}((\Delta w_{jit})^2 \Delta c_{it+1})$. Both remain statistically insignificant reflecting again that, on average, transitory shocks do not transmit into consumption. Second, the wedge between the male and female own-wage labor supply elasticities $\eta_{h_1,w_1} \equiv \mathbb{E}(\eta_{h_1,w_1(i)}) = 0.27$ and $\eta_{h_2,w_2} \equiv \mathbb{E}(\eta_{h_2,w_2(i)}) = 0.38$ is reduced compared to column (1). The model attenuates the female elasticity in its attempt to match joint third moments of female earnings and wages. Third, the cross-elasticities of labor supply are also attenuated. In line with previous evidence, women's labor supply, described ordinally by $\eta_{h_2,w_2} \equiv \mathbb{E}(\eta_{h_2,w_2(i)})$ and $\eta_{h_2,w_1} \equiv \mathbb{E}(\eta_{h_2,w_1(i)})$, is always more elastic than men's; however the differences are not significant in a statistical sense.

Column (3) presents estimates of preferences and preference heterogeneity from second and third moments of wages, earnings and consumption. The treatment of heterogeneity in this specification is restricted as preferences can vary across households independently per parameter. In other words, preferences do not *co*-vary. Three things are worth noting.

First, the variances of consumption elasticities $\text{Var}(\eta_{c,w_1(i)}) = 0.30$ and $\text{Var}(\eta_{c,w_2(i)}) = 0.57$ are large pointing to substantial heterogeneity in consumption preferences across households. Although these estimates are not statistically significant at conventional levels, at face value they imply that: (i) two standard deviations of η_{c,w_1} about its cross-sectional mean fall approximately within $(-1.08; 1.12)$; (ii) two standard deviations of η_{c,w_2} about its mean fall approximately within $(-1.54; 1.47)$. These intervals suggest that for some households consumption responds negatively to *transitory* shocks (as in the case of consumption and hours being Frisch substitutes) while for other households consumption co-moves with such shocks (as in the case of binding liquidity constraints or when consumption and hours are Frisch complements).

Second, the variances of male and female labor supply elasticities are economically or statistically zero implying that there is not much heterogeneity in *intensive margin* labor supply elasticities once wage variation and observables are accounted for. While this result could at first indicate some sort of misspecification in the model, all earnings moments that over-identify these variances are fit very well. In reality, the lack of heterogeneity in these elasticities arises primarily from the specificities of the sample of working stable families. With measurement error taken into account, the variation in female and (especially) male hours is a small fraction of the variation in their respective wages and earnings. The model can match the involved earnings moments scaling up the wage moments by the appropriate average labor supply elasticities. This is not the case for consumption where average elasticities are zero and the model requires consumption preference heterogeneity in order to match the consumption second moments. Note that as the bootstrap covariance matrix of parameters is inconsistent near the boundary of the parameter space, I cannot implement a Wald test for the joint significance of

Table 5 – Estimates of Preferences: Means and Variances

	(1)	(2)	(3)	(4)	(5)
moments:	2^{nd}	2^{nd} & 3^{rd}	2^{nd} & 3^{rd}	2^{nd} & 3^{rd}	2^{nd} & 3^{rd}
heterogeneity:	no	no	marginal	joint	preferred
Mean consumption elasticities					
$\mathbb{E}(\eta_{c,w_1(i)})$	0.084	0.024	0.017	-0.054	-0.056
	(0.088)	(0.060)	(0.047)	(0.066)	(0.070)
$\mathbb{E}(\eta_{c,w_2(i)})$	-0.152	-0.061	-0.037	-0.009	-0.024
	(0.164)	(0.120)	(0.076)	(0.081)	(0.074)
Mean male labor supply elasticities					
$\mathbb{E}(\eta_{h_1,w_1(i)})$	0.239	0.266	0.250	0.240	0.239
	(0.101)	(0.080)	(0.095)	(0.093)	(0.095)
$\mathbb{E}(\eta_{h_1,w_2(i)})$	-0.044	-0.018	-0.017	-0.018	0
	(0.053)	(0.043)	(0.043)	(0.042)	
Mean female labor supply elasticities					
$\mathbb{E}(\eta_{h_2,w_1(i)})$	-0.092	-0.038	-0.036	-0.037	0
	(0.113)	(0.090)	(0.090)	(0.088)	
$\mathbb{E}(\eta_{h_2,w_2(i)})$	0.588	0.380	0.380	0.379	0.366
	(0.301)	(0.208)	(0.221)	(0.222)	(0.194)
Variances [p-values in brackets]					
$\mathrm{V}(\eta_{c,w_1(i)})$			0.303	0.287	0.346
			[0.107]	[0.099]	[0.003]
$\mathrm{V}(\eta_{c,w_2(i)})$			0.565	0.489	0.346
			[0.188]	[0.146]	[0.003]
$\mathrm{V}(\eta_{h_1,w_1(i)})$			0.052	0.081	0.076
			[0.314]	[0.260]	[0.249]
$\mathrm{V}(\eta_{h_1,w_2(i)})$			0.000	0.000	0
			[0.274]	[0.285]	
$\mathrm{V}(\eta_{h_2,w_1(i)})$			0.001	0.002	0
			[0.270]	[0.287]	
$\mathrm{V}(\eta_{h_2,w_2(i)})$			0.000	0.002	0
			[0.055]	[0.183]	

Notes: The table presents GMM estimates of the first and second moments of wage elasticities. Column (1) reports estimates without heterogeneity from second moments of wages, earnings and consumption. Column (2) reports estimates without heterogeneity from second *and* third moments of wages, earnings and consumption. Column (3) reports estimates allowing for marginal heterogeneity in preferences. Column (4) reports estimates from the unrestricted multivariate preference distribution. Column (5) reports the 'preferred' specification where I shut down parameters previously estimated at zero (economically or statistically). Standard errors appear in parentheses and, whenever applicable, p-values in square brackets for the one-sided test that the respective parameter equals zero.

Table 6 – Estimates of Preferences: Covariances

	(1)	(2)	(3)	(4)	(5)
moments:	2[nd]	2[nd] & 3[rd]	2[nd] & 3[rd]	2[nd] & 3[rd]	2[nd] & 3[rd]
heterogeneity:	no	no	marginal	joint	preferred
$C(\eta_{c,w_1(i)}, \eta_{c,w_2(i)})$				0.373	0.346
				(0.352)	(0.092)
$C(\eta_{c,w_1(i)}, \eta_{h_1,w_1(i)})$				0.127	0.136
				(0.068)	(0.071)
$C(\eta_{c,w_1(i)}, \eta_{h_1,w_2(i)})$				-0.001	0
				(0.011)	
$C(\eta_{c,w_1(i)}, \eta_{h_2,w_1(i)})$				-0.002	0
				(0.023)	
$C(\eta_{c,w_1(i)}, \eta_{h_2,w_2(i)})$				-0.019	0
				(0.041)	
$C(\eta_{c,w_2(i)}, \eta_{h_1,w_1(i)})$				0.160	0.136
				(0.131)	(0.071)
$C(\eta_{c,w_2(i)}, \eta_{h_1,w_2(i)})$				-0.002	0
				(0.012)	
$C(\eta_{c,w_2(i)}, \eta_{h_2,w_1(i)})$				-0.004	0
				(0.026)	
$C(\eta_{c,w_2(i)}, \eta_{h_2,w_2(i)})$				-0.025	0
				(0.044)	
$C(\eta_{h_1,w_1(i)}, \eta_{h_1,w_2(i)})$				0.002	0
				(0.014)	
$C(\eta_{h_1,w_1(i)}, \eta_{h_2,w_1(i)})$				0.004	0
				(0.030)	
$C(\eta_{h_1,w_1(i)}, \eta_{h_2,w_2(i)})$				-0.010	0
				(0.066)	
$C(\eta_{h_1,w_2(i)}, \eta_{h_2,w_1(i)})^{\#}$			0.000	0.000	0
			(0.020)	(0.024)	
$C(\eta_{h_1,w_2(i)}, \eta_{h_2,w_2(i)})$				0.000	0
				(0.004)	
$C(\eta_{h_2,w_1(i)}, \eta_{h_2,w_2(i)})$				0.000	0
				(0.008)	
value obj. function	*0.0208*	*0.0691*	*0.0673*	*0.0670*	*0.0671*

See notes of table 5 and: In the estimation of the covariances I require that the Pearson correlation coefficients of any pair of elasticities are within $[-1;1]$ and that the matrix of preference second moments is positive semi-definite.
#Frisch symmetry implies that $\text{Cov}(\eta_{h_1,w_2(i)}, \eta_{h_2,w_1(i)})$ is a positive transformation of $\text{Var}(\eta_{h_1,w_2(i)})$. The standard error is consistent because the covariance is on the space boundary defined by an *equality* constraint (Andrews, 2000).

the variances. However, table 6 reports the value of the objective function (the GMM criterion) as evidence for the importance of each specification for fitting the data. The value of the criterion drops substantially with the addition of the variances.

Third, the first moments remain effectively unchanged from column (2) despite the introduction of the variances. The consumption elasticities are attenuated slightly more.

Column (4) presents estimates of preferences and preference heterogeneity from second and third moments of wages and outcomes. The treatment of heterogeneity here is the most general as preference parameters can vary jointly. Three things are worth noting.

First, the variances of consumption elasticities $\text{Var}(\eta_{c,w_1(i)}) = 0.29$ and $\text{Var}(\eta_{c,w_2(i)}) = 0.49$ are only sightly smaller than in column (3) reflecting again that consumption preferences exhibit substantial heterogeneity across households. The first variance is marginally significant at the 10% level while the second one remains insignificant (p-value $= 0.15$). At face value these numbers imply that: (i) two standard deviations of η_{c,w_1} about its cross-sectional mean fall approximately within $(-1.13; 1.02)$; and (ii) two standard deviations of η_{c,w_2} within $(-1.41; 1.39)$. Consumption elasticities correlate almost perfectly across households; I estimate $\text{Cov}(\eta_{c,w_1(i)}, \eta_{c,w_2(i)}) = 0.37$ implying a Pearson correlation of 0.996. The positive correlation, albeit statistically insignificant, helps the model better fit (i) all joint third-moments of consumption and wages, and (ii) the auto-covariance of consumption growth.

Second, while the variances of labor supply elasticities remain economically or statistically zero, η_{h_1,w_1} co-varies positively with the consumption elasticities: $\text{Cov}(\eta_{c,w_1(i)}, \eta_{h_1,w_1(i)}) = 0.13$ ($corr = 0.83$) and $\text{Cov}(\eta_{c,w_2(i)}, \eta_{h_1,w_1(i)}) = 0.16$ ($corr = 0.80$). Although the first only covariance is statistically significant at the 10% level, both parameters help the model better fit the auto-covariance between male earnings and consumption growth, as well as other moments.

Third, with the exception of $\text{Cov}(\eta_{c,w_1(i)}, \eta_{c,w_2(i)})$ and $\text{Cov}(\eta_{c,w_j(i)}, \eta_{h_1,w_1(i)})$, $j = \{1, 2\}$, all other covariances are economically and statistically zero. The fully flexible model, albeit appealing from a theoretical perspective, does not add much to explaining the joint distribution of wages and outcomes across households. This is also seen in the small only drop in the value of the GMM metric from column (3). The first moments remain effectively unchanged from column (3) with the exception of the mean consumption elasticities that are now both negative.

Interim summary and preferred specification. A summary of the results so far is: (1.) consumption elasticities exhibit substantial heterogeneity across households; (2.) once wage variation and observable characteristics are accounted for, there is little evidence of heterogeneity in intensive margin labor supply elasticities; (3.) average consumption-wage elasticities are statistically zero implying that preferences for the *average* household are separable between consumption and hours; (4.) labor supply elasticities are smaller than in the literature as the model attempts to match third moments of earnings and wages; (5.) cross-elasticities of labor supply are zero; (6.) preference heterogeneity helps better fit the joint distribution of wages and outcomes but the fully unrestricted model, albeit theoretically appealing, does not fare much better over a version with restricted preference heterogeneity.

Despite parameters such as the variances of consumption elasticities being economically large, statistical significance is at best rather weak. The estimation is underpowered due to the large number of parameters, the moderate sample sizes in the PSID and the fact that few only moments contribute to the estimation of heterogeneity as information from the response to permanent shocks cannot be used without strong additional assumptions. To improve power I shut down preference parameters that are consistently zero in statistical *and* economic sense.[26] In addition, I restrict the variances of consumption elasticities to equal and the correlation between these elasticities to 1. Both restrictions are strongly supported by the unrestricted baseline estimates and most bootstrap replications.

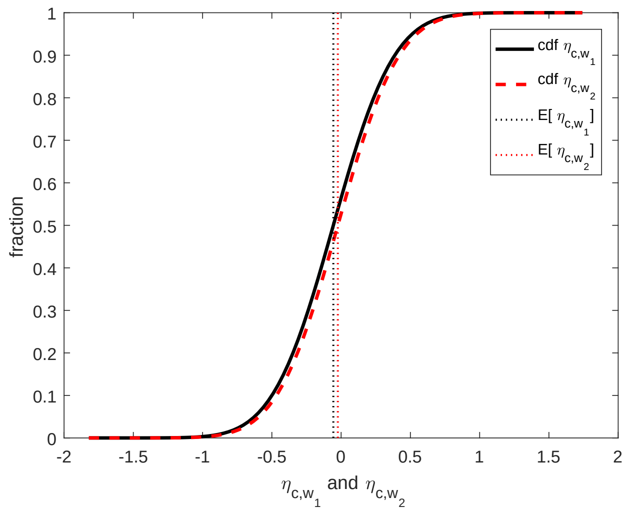
Five observations emerge from the preferred specification of column (5). First, consumption preference heterogeneity remains substantial. The variance of consumption elasticities, now significant at $< 1\%$, implies that two st.d. of η_{c,w_1} about its mean fall approximately in the range $(-1.23; 1.12)$ while two st.d. of η_{c,w_2} in $(-1.20; 1.15)$. The variance of consumption measurement error is $\sigma^2_{e^c(t)} = 0.006$ (not identified in previous specifications) accounting for 15% of the variance of consumption growth.[27] Second, the consumption elasticities correlate positively and significantly with men's labor supply elasticity ($corr = 0.84$) while the variance of men's labor supply elasticity remains insignificant. Third, the average consumption-wage elasticities are statistically zero implying that preferences in the representative household are separable between consumption and leisure (their standard errors drop by about 1/2 if I impose equality of these elasticities). Fourth, the average labor supply elasticities remain small and female labor supply is more elastic than male. Fifth, the restricted version of the model improves greatly on the efficiency of the estimates without substantially increasing the value of the GMM metric, thus without providing a worse fit compared to the unrestricted version. Appendix E provides numerical evidence for the fit of the preferred model (tables E.2-E.4), a discussion of how my results compare to BPS, and a number of robustness checks (table E.5). All results are robust to trimming extreme observations in wages, earnings and consumption.

Consumption substitution elasticity. While estimation of the wage elasticities does not require parametric form restrictions on preferences and their distribution, estimation of $\eta_{c,p}$ is not possible without stronger assumptions. I use the variance of consumption growth $\text{Var}(\Delta c_{it})$

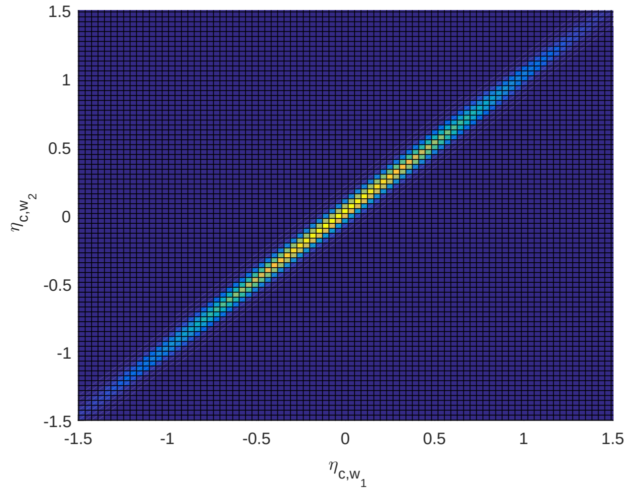
[26] I shut down the cross-elasticities of labor supply (all moments), the variance of the female labor supply elasticity $\text{Var}(\eta_{h_2,w_2(i)})$, and all covariances except $\text{Cov}(\eta_{c,w_1(i)}, \eta_{c,w_2(i)})$ and $\text{Cov}(\eta_{c,w_j(i)}, \eta_{h_1,w_1(i)})$. I retain the mean consumption-wage elasticities although this does not change the results. Although there is no formal specification search here, shutting down these parameters has a similar flavor to the 'general-to-specific' search of Alan et al. (2017) in the sense that I restrict the very general model in order to improve power.

[27] For comparison, Bound et al. (1994) report that 4% of the earnings variance in the PSID is due to error, 13% for wages and 23% for hours. An alternative approach to estimating consumption measurement error is to fix a priori its magnitude to a reasonable fraction of the consumption variance, say at 20%, and then estimate preferences without the linear restriction used to identify it. These results are available upon request.

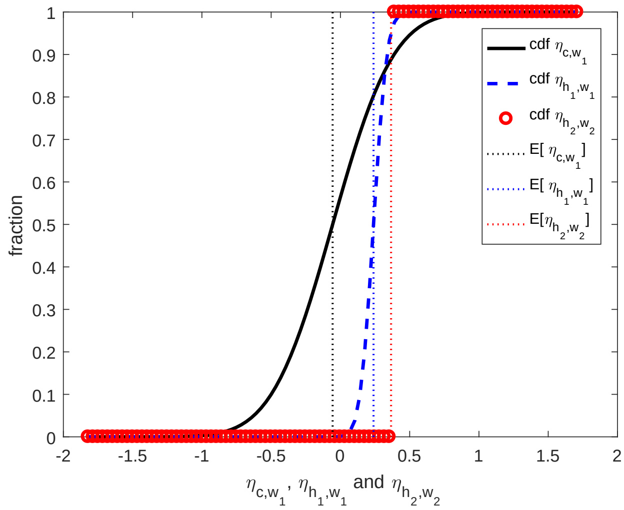
Figure 1 – Distributions of Selected Frisch Elasticities



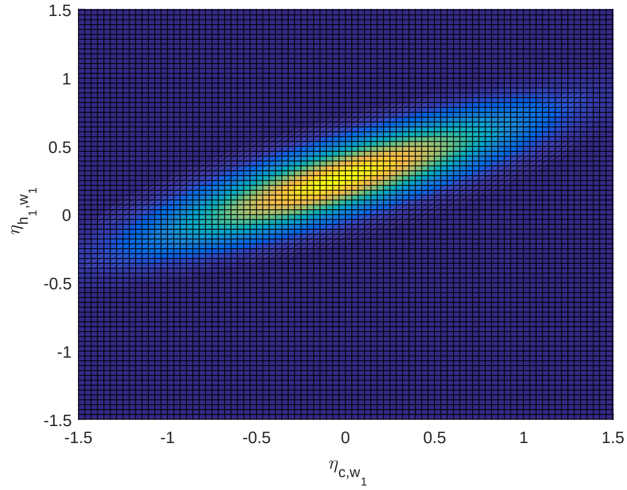
(a) marginal cdf's of η_{c,w_1} and η_{c,w_2}



(b) joint pdf of η_{c,w_1} and η_{c,w_2}



(c) marginal cdf's of η_{c,w_1}, η_{h_1,w_1} and η_{h_2,w_2}



(d) joint pdf of η_{c,w_1} and η_{h_1,w_1}

Notes: The figures visualize the distributions (marginal and joint) of selected pairs of Frisch elasticities. Labels in or under each figure report the parameters each distribution corresponds to. The joint densities are viewed from above: an area of darker color implies less mass in that area, while an area of brighter color implies more mass.

to estimate a homogeneous $\eta_{c,p}$; this variance involves moments of the Marshallian elasticities $\kappa_{c,v_j(i)}$ that were shown in section 3.2.2 to depend on $\eta_{c,p}$. However, the Marshallian elasticities also depend on the *entire* distribution of wage elasticities thus necessitating assumptions on their joint distribution. A natural benchmark is to restrict that distribution to joint normal and parameterize it at the first and second moments from the preferred specification. Estimation of $\eta_{c,p}$ is then conditional on (rather than joint with) the wage elasticities. While a full parametric approach would subject all parameters to distributional assumptions, this two-step approach only subjects $\eta_{c,p}$. Normality of preferences does not contradict the previous use of third moments as consumption and hours can still exhibit skewness because wage shocks are skewed.

I operationalize this estimation using a simulated minimum distance (*simulated* because, despite joint normality, $\text{Var}(\Delta c_{it})$ does not have a straightforward closed-form expression). Specifically, I simulate preferences for 10 million households, I calculate the variance of consumption growth across them, and I estimate $\eta_{c,p}$ minimizing a quadratic distance metric between the simulated variance and its empirical counterpart. This estimation now requires information on initial conditions π_{it} and $\mathbf{s}_{it}$ for which I draw random values from their empirical distributions (appendix E details the estimation of their empirical distributions). The distance metric is minimized at $\eta_{c,p} = -0.75$ (simulated and empirical variances matched to the fourth decimal digit) implying a coefficient of relative risk aversion approximately equal to 1.33.[28]

Distribution of preferences. Figure 1 visualizes the distribution of wage elasticities in the preferred specification. While the moments are estimated without distributional assumptions, the plots visualize the distributions assuming joint normality (parameterized as per the preferred specification). The cumulative distributions of η_{c,w_1} and η_{c,w_2} are gradual and centered around zero (plot a); the distribution of η_{h_1,w_1} is steeper than that of η_{c,w_1} and the distribution of η_{h_2,w_2} is degenerate (plot c). The joint densities of η_{c,w_1} and η_{c,w_2} (viewed from above in plot b) and of η_{c,w_1} and η_{h_1,w_1} (plot d) illustrate the substantial joint heterogeneity.

5 Discussion

5.1 Implications for Consumption Inequality

I focus on lifecycle consumption inequality, which I define as the variance of consumption growth across households like Blundell et al. (2008) and BPS. Deaton and Paxson (1994) and Blundell and Preston (1998) use cross-sectional data only and define consumption inequality as the variance of log consumption. Invoking expression (5), the properties of shocks and assumption 1, consumption inequality is given by

$$\begin{aligned} \text{Var}\left(\Delta c_{it}\right) \approx & \sum_{j=1}^{2} \underbrace{\mathbb{E}(\eta^2_{c,w_j(i)})}_{\text{involves heterogeneity in } \eta_{c,w_j(i)}} \times \left(\sigma^2_{u_j(t)} + \sigma^2_{u_j(t-1)}\right) \\ & + 2\,\underbrace{\mathbb{E}(\eta_{c,w_1(i)}\eta_{c,w_2(i)})}_{\text{involves joint heterogeneity in } \eta_{c,w_1(i)} \text{ and } \eta_{c,w_2(i)}} \times \left(\sigma_{u_1u_2(t)} + \sigma_{u_1u_2(t-1)}\right) \end{aligned} \tag{8}$$

[28]The coefficient of relative risk aversion is approximately equal to $-\eta_{c,p}^{-1}$ (exactly equal if preferences are separable). Chetty (2006) uses labor supply data and restrictions from a life-cycle model to calculate an upper bound on this parameter at 0.97 when consumption and labor supply are complements. Abstracting from labor supply, Kimball et al. (2009) impute the coefficient of relative risk aversion from hypothetical gamble responses in the PSID and report a range of 1.4-6.7. Guiso and Sodini (2013) calculate household risk aversion based on portfolio risk shares in the US Survey of Consumer Finances. They report a median coefficient of relative risk aversion at 3.5 with the central 90% of the distribution lying in the range 1.6-30.8 skewed to the left. Cohen and Einav (2007) estimate risk preferences from a structural model of deductible choices in the auto insurance market and find a median coefficient at 0.37 with the average being much higher.

$$+\sum_{j=1}^{2}\underbrace{\mathbb{E}\left(\left(\eta_{c,w_j(i)}+\bar{\eta}_{c(i)}\varepsilon_j(\pi_{it},\mathbf{s}_{it};\boldsymbol{\eta}_i)\right)^2\right)}_{\text{involves heterogeneity in initial conditions and joint heterogeneity in preferences}}\times\sigma^2_{v_j(t)}$$

$$+\,2\underbrace{\mathbb{E}\left(\left(\eta_{c,w_1(i)}+\bar{\eta}_{c(i)}\varepsilon_1(\pi_{it},\mathbf{s}_{it};\boldsymbol{\eta}_i)\right)\left(\eta_{c,w_2(i)}+\bar{\eta}_{c(i)}\varepsilon_2(\pi_{it},\mathbf{s}_{it};\boldsymbol{\eta}_i)\right)\right)}_{\text{involves heterogeneity in initial conditions and joint heterogeneity in preferences}}\times\sigma_{v_1v_2(t)}.$$

To obtain (8) I use results for the second moments of products of random variables from Goodman (1960) and Bohrnstedt and Goldberger (1969). Appendix D details this derivation.

Theoretical interpretations. Expression (8) shows that consumption inequality is the result of three distinct forces: (1.) wage inequality (second moments of wage shocks),[29] (2.) average preferences and preference heterogeneity, (3.) heterogeneity in initial conditions (financial and human wealth).

Consumption inequality can be decomposed into two parts given the type of wage inequality behind it: *consumption instability* due to transitory wage shocks (first two lines in (8)) and *permanent inequality* due to permanent wage shocks (last two lines).[30] For given preferences, preference heterogeneity and heterogeneity in initial conditions, the higher the variances of wage shocks, the higher consumption inequality is. Expression (8) allows different types of wage inequality to have different welfare consequences as each distinct variance and covariance is associated with a unique loading factor onto inequality. For example, Blundell et al. (2008) find that wage instability does not translate into consumption inequality, implying $\mathbb{E}(\eta^2_{c,w_j(i)})\approx 0$ and $\mathbb{E}(\eta_{c,w_1(i)}\eta_{c,w_2(i)})\approx 0$ in the present context.

Preferences contribute to consumption inequality through their first and second moments. Consider the loading factor of the variance of the transitory shock $\sigma^2_{u_j(t)}$, given by

$$\mathbb{E}(\eta^2_{c,w_j(i)})=\left(\mathbb{E}(\eta_{c,w_j(i)})\right)^2+\text{Var}\left(\eta_{c,w_j(i)}\right). \tag{9}$$

Consumption inequality increases with the absolute value of the mean consumption-wage elasticity as well as with its variance. A large average elasticity implies that the representative household is relatively more responsive to transitory wage fluctuations while a large variance (large heterogeneity) implies there are households for whom consumption responds even more substantially. Both propagate the transmission of wage into consumption inequality. Now consider the loading factor of the variance of the permanent shock $\sigma^2_{v_j(t)}$. Suppose for the sake of the illustration that $\varepsilon_j(\cdot)=1$. The loading factor is

$$\begin{aligned}\mathbb{E}\left(\left(\eta_{c,w_j(i)}+\bar{\eta}_{c(i)}\varepsilon_j\right)^2\mid\varepsilon_j=1\right)&=\left(\mathbb{E}(\eta_{c,w_j(i)})\right)^2+\left(\mathbb{E}(\bar{\eta}_{c(i)})\right)^2+2\mathbb{E}(\eta_{c,w_j(i)})\mathbb{E}(\bar{\eta}_{c(i)})\\&\quad+\text{Var}\left(\eta_{c,w_j(i)}\right)+\text{Var}\left(\bar{\eta}_{c(i)}\right)+2\text{Cov}\left(\eta_{c,w_j(i)},\bar{\eta}_{c(i)}\right),\end{aligned}\tag{10}$$

[29] Higher moments do not enter the variance of consumption growth because I abstract from terms higher than first-order in the approximations to the budget constraint and the intra-temporal first-order conditions.

[30] Gottschalk and Moffitt (2009) use the term 'income instability' to refer to short-term transitory fluctuations in income that contribute to overall income inequality.

where Var $\left(\bar{\eta}_{c(i)}\right)$ involves the variances of all three consumption elasticities of table 1 (marginal heterogeneity) as well as their respective covariances (joint heterogeneity). Like before, consumption inequality increases with the absolute value of the mean consumption elasticities (first line in (10)) as well as with unobserved preference heterogeneity (last line in (10)).

Expressions (9) and (10) show that, conditional on wage inequality and an arbitrary value for $\varepsilon_j(\cdot)$ (this conditioning is for facilitating the illustration; more on this to follow), marginal preference heterogeneity *always* increases consumption inequality. Let ϕ_{it} be a generic transmission parameter of a shock into consumption (i.e. $\phi_{it} = \eta_{c,w_1(i)}$ for u_{1it} or $\phi_{it} = \eta_{c,w_1(i)} + \bar{\eta}_{c(i)}$ for v_{1it}). It follows from (8)-(10) that $\partial \text{Var}(\Delta c_{it})/\partial \text{Var}(\phi_{it}) > 0$ and preference heterogeneity increases consumption inequality compared to the homogeneity benchmark ($\text{Var}(\phi_{it}) = 0$). The logic is straightforward: households who differ in preferences respond differently to a given wage shock and drive their consumption apart. The greater preference heterogeneity is, the further apart their consumption responses are and the higher consumption inequality is.

While this analytical result is *always* true for consumption instability, it is derived for permanent inequality under the ad hoc assumption that $\varepsilon_j = 1$. $\varepsilon_j(\cdot)$ is a complicated function of preferences and initial conditions and cannot be written analytically as function of the first and second moments of preferences without strong additional assumptions. However, simulations of consumption inequality (reported subsequently) that fully account for the structure of $\varepsilon_j(\cdot)$ confirm that preference heterogeneity indeed *always* increases permanent inequality.

Heterogeneity in initial conditions (financial and human wealth) induces heterogeneity in the ability households have to insulate their lifetime incomes from permanent shocks. As π_{it} and $\mathbf{s}_{it}$ enter $\varepsilon_j(\cdot)$, I cannot sign analytically how heterogeneity in them affects consumption inequality. However, simulations of inequality (reported below) illustrate that heterogeneity in π_{it} and $\mathbf{s}_{it}$ *always* increases consumption inequality.

Three final remarks are due here. First, positive assortative matching between spouses, captured for example by a positive correlation between wage shocks, may not always increase consumption inequality. Consider the loading factor of the *covariance* of transitory shocks given by $\mathbb{E}(\eta_{c,w_1(i)}\eta_{c,w_2(i)}) = \mathbb{E}(\eta_{c,w_1(i)})\mathbb{E}(\eta_{c,w_2(i)}) + \text{Cov}\left(\eta_{c,w_1(i)}, \eta_{c,w_2(i)}\right)$). What matters for loading such covariance is (also) the correlation between consumption-wage elasticities. If $\mathbb{E}(\eta_{c,w_1(i)}\eta_{c,w_2(i)})$ is negative due to a strong negative correlation between elasticities, positive assortative matching on wages actually decreases inequality. Second, neglecting preference heterogeneity understates consumption inequality. Third, failing to account for heterogeneity while estimating average preferences from consumption and wage inequality data (as in BPS) biases mean preferences upwards. For completeness, appendix D presents expressions for earnings and hours inequality.

Empirical results. The wage and preference parameters enable the decomposition of observed consumption inequality to *consumption instability* and *permanent inequality*. Table 7 reports the results. Consumption instability accounts for a substantial 45.2% of overall con-

Table 7 – Accounting Decomposition of Consumption Inequality

		share in $\text{Var}(\Delta c_{it})$	share in cons. instability	share in perm. inequality
$\text{Var}(\Delta c_{it})^{\#}$	0.0606	100%		
standard error	(0.0019)			
consumption instability	0.0274	45.2%	100%	
without pref. heterogeneity	0.0002		0.8%	
pref. heterogeneity induced	0.0272		99.2%	
permanent inequality	0.0332	54.8%		100%
without heterogeneity	0.0261			78.4%
heterogen. in preferences only	0.0307			92.3%
heterogen. in preferences, π_{it}, $\mathbf{s}_{it}$	0.0332			100%

Notes: The table presents the accounting decomposition of consumption inequality into consumption instability and permanent inequality. $\text{Var}(\Delta c_{it})$ is estimated biennially using GMM pooling all years together. A block bootstrap standard error from 1,000 replications is reported in parentheses. Consumption instability is the fraction of consumption inequality that is due to transitory shocks. Permanent inequality is the fraction of consumption inequality that is due to permanent shocks. Simulations of permanent inequality assume that preferences are jointly normal and maintain $\eta_{c,p} = -0.75$ homogeneously. Initial conditions parameters π_{it} and $\mathbf{s}_{it}$ are drawn from their empirical distributions. $^{\#}\text{Var}(\Delta c_{it})$ is net of consumption measurement error.

sumption inequality while permanent inequality accounts for the remaining 54.8%. The two components add up to overall consumption inequality by definition.

Consumption preference heterogeneity is responsible for nearly all (99.2% of) consumption instability. This is because the average consumption-wage elasticities are almost zero and preferences in the representative household are separable in consumption and leisure. Consumption would hardly respond to transitory shocks if every household had the same average preferences and consumption instability would measure a mere 0.8% of the baseline figure implied by the parameter estimates (0.0274). In practice, a distribution of consumption-wage elasticities about the mean implies a distribution of consumption responses to transitory shocks inducing consumption instability. In such case, a 99.2% reduction in the second moments of transitory shocks is needed to compensate for instability induced by preference heterogeneity.

While the contribution of preference heterogeneity to consumption instability is deduced analytically (equation 9), its contribution to permanent inequality is not. Term $\varepsilon_j(\cdot)$ that captures the effect of permanent shocks on lifetime income is an implicit function of preferences, thus necessitating a numerical investigation of the quantitative role of heterogeneity. To address this I simulate permanent inequality across 10 million households with and without heterogeneity. For the simulations *with* heterogeneity, I assume again that preferences are jointly normal. All simulations maintain $\eta_{c,p} = -0.75$ from section 4.

In a first simulation, households exhibit no heterogeneity in preferences or initial conditions: they all have the same average preferences from the preferred specification and share the same initial conditions $\pi_{it} = \mathbb{E}(\pi_{it}) = 0.187$ and $s_{1it} = \mathbb{E}(s_{1it}) = 0.616$ (appendix E). Permanent inequality in this case (0.0261) amounts to 78.4% of the baseline figure (0.0332). Even without heterogeneity, wage inequality at average preferences implies a substantial amount of inequality. In a new simulation, households exhibit preference heterogeneity but still share the same initial conditions like before. Permanent inequality increases by approximately 18% (to 0.0307) amounting to 92.3% of the baseline figure. In a final simulation, I introduce independent heterogeneity in assets and human wealth, in addition to heterogeneity in preferences. Permanent inequality rises further by 8% (to 0.0332) to match the baseline figure.[31]

The simulations suggest that preference heterogeneity increases permanent inequality. This result is not driven by a few extreme preference draws. Partitioning the 10 million households in a big number of random subgroups, and calculating inequality with and without heterogeneity in each subgroup, I observe that preference heterogeneity *always* increases inequality within each subgroup (I report these details in table 9 in Theloudis, 2017). The result is also robust to trimming the distribution of preferences at a number of alternative thresholds. The same applies to heterogeneity in assets and human wealth; such heterogeneity *always* increases consumption inequality vis-à-vis the homogeneity benchmark. However, it increases inequality by less than preference heterogeneity and has a larger impact on inequality when coupled *with* preference heterogeneity rather than without it.

A back-of-the-envelope calculation over the different components of the accounting decomposition suggests that preference heterogeneity accounts for 52% of *overall* consumption inequality (99.2% of consumption instability and 13.9% of permanent inequality), while heterogeneity in initial conditions (assets and human wealth) for 4.2% (7.7% of permanent inequality). Wage inequality accounts for the remaining portion of consumption inequality, that is, for approximately 43.8% of the empirical figure. This is numerically similar to the contribution of wage shocks (vs. initial conditions) into inequality in Huggett et al. (2011). Unsurprisingly, heterogeneity in assets and human wealth plays a minor role in the dynamics of inequality *over* the lifecycle; one expects a greater influence of wealth on consumption dispersion at the *start* of the lifecycle. Additional simulations not shown here indicate that the means $\mathbb{E}(\pi_{it})$ and $\mathbb{E}(\mathbf{s}_{it})$ have much greater effect on consumption inequality than dispersion around them.

5.2 Implications for Consumption Partial Insurance

The degree of consumption partial insurance is the fraction of a wage shock that does *not* pass through to consumption. The *pass-through rate* of transitory shocks is measured by the partial derivative $\partial\Delta c_{it}/\partial u_{jit}$ whereas that of permanent shocks by $\partial\Delta c_{it}/\partial v_{jit}$. Then $1-|\partial\Delta c_{it}/\partial u_{jit}|$ and $1-|\partial\Delta c_{it}/\partial v_{jit}|$ are the degrees of partial insurance against transitory and permanent shocks respectively. Preference heterogeneity implies a distribution of partial insurance across

[31] It matches the baseline figure by construction because the last simulation mimics the baseline estimation where empirical and simulated inequality are exactly matched at $\eta_{c,p} = -0.75$.

Table 8 – Pass-Through Rates of Transitory Shocks into Consumption

	$\mathbb{E}(\frac{\partial \Delta c_{it}}{\partial u_j})$	$\partial \Delta \mathbf{c_{it}} / \partial \mathbf{u_j}$ **for household with preferences at:** mean	mean + 0.5 s.d.	mean + 1.5 s.d.	mean − 0.5 s.d.	mean − 1.5 s.d.
u_{1it}	-0.056	-0.056	0.238	0.826	-0.350	-0.939
u_{2it}	-0.024	-0.024	0.270	0.859	-0.318	-0.906

Notes: The table presents the pass-through rates of transitory wage shocks into consumption. The first column reports the average pass-through rates across households; these equal the pass-through rates for the representative household (the household with average preferences) in the second column. The remaining columns report pass-through rates for households with preferences 0.5 and 1.5 standard deviations away from the mean.

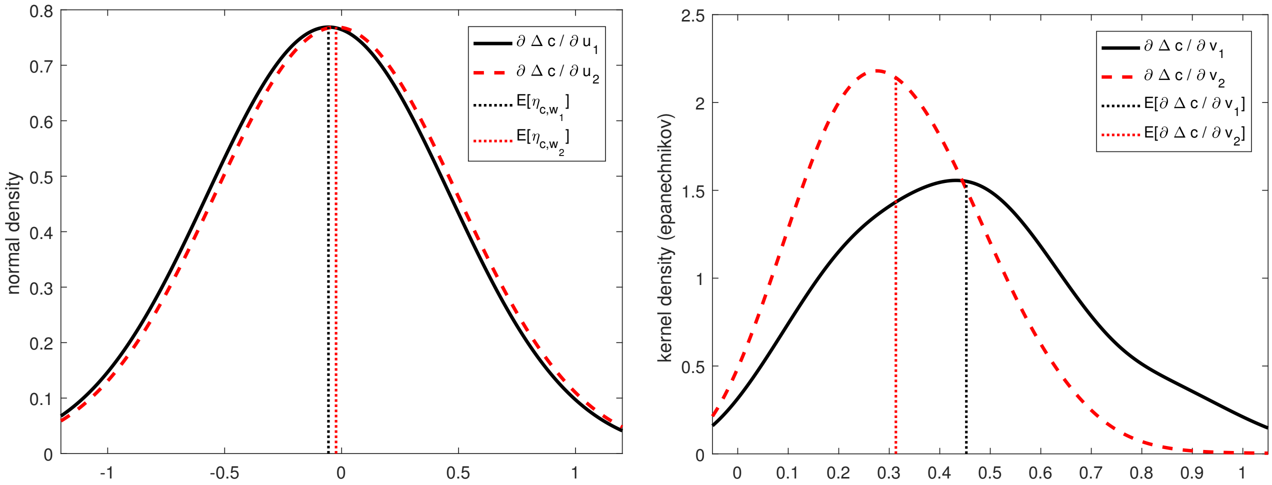
households; and the restrictions of the structural model together with the parameter estimates allow me to infer this distribution.

Insurance against transitory shocks. The average pass-through rate of transitory shocks is $\mathbb{E}(\partial \Delta c_{it} / \partial u_{jit}) = \mathbb{E}(\eta_{c,w_j(i)})$, estimated at -0.056 (*s.e.* 0.070) for male and -0.024 (*s.e.* 0.074) for female shocks in the preferred specification. By construction, these are also the pass-through rates in the representative household (the household with average preferences). The numbers imply that on average 94.4% of a male and 97.6% of a female shock is insured. Both are indistinguishable from the full insurance benchmark reflecting that consumption is *on average* fully insured against transitory shocks (e.g. Attanasio and Davis, 1996), which Blundell et al. (2008) attribute to self insurance over the lifecycle.

Away from the average, however, transitory shocks do transmit into consumption. Panel (a) of figure 2 illustrates the implied distribution of pass-through rates when the consumption-wage elasticities are jointly normal parameterized at the estimated first and second moments (recall that these moments are estimated without the normality restriction). While consumption for many households is fully insured against transitory shocks, there are households for whom consumption moves considerably with or against such shocks. Heterogeneity in the consumption-wage elasticities implies and is implied by heterogeneity in the transmission of transitory shocks into consumption. Two remarks are in place: First, the discussion so far is about the consumption response to a *lifetime-income-constant* wage change; this reflects the typical substitution between consumption and leisure *net* of income effects (contrast this with the response to permanent shocks below). Second, figure 2 artificially puts mass over various pass-through rates of transitory shocks, including extreme values like ± 1. This is a byproduct of the normality assumption used in the production of this figure. There is no information in the estimated parameters about *how many* households really exhibit these extreme responses unless I also estimate third and higher preference moments.

Table 8 reports the pass-through rates for households with preferences $x = \{0.5, 1.5\}$ stan-

Figure 2 – Distributions of Pass-Through Rates of Shocks into Consumption



(a) transitory shocks (b) permanent shocks

Notes: The figures visualize the distributions of pass-through rates of transitory and permanent shocks across 10 million households whose preferences are drawn from the joint normal parameterized at the estimates of the preferred specification. Extreme preference draws are trimmed. For the pass-through rates of permanent shocks, $\eta_{c,p} = -0.75$ and π_{it} and $\mathbf{s}_{it}$ are drawn from their empirical distributions (appendix E). The mass placed over specific pass-through rates is arbitrary: it follows the normality assumption that is neither used in nor inferred by the estimation.

dard deviations above and below the mean ($\partial \Delta c_{it} / \partial u_{jit}|_{\eta_{c,w_j(i)}=\text{mean}\pm x \text{ s.d.}}$); these numbers are *not* specific to a particular preference distribution. The consumption response to transitory shocks already becomes substantial ($\approx \pm 0.3$) when preferences are 0.5 standard deviation from the mean; at 1.5 standard deviations consumption responds approximately 1-to-± 1. Moreover, the positive correlation between elasticities implies that in households where consumption responds substantially to one spouse's transitory shock, it also responds substantially to the other spouse's shock magnifying the overall response. The heterogeneity in pass-through rates reflects heterogeneity in the complementarity between consumption and leisure but it may also reflect liquidity constraints. If the true relationship between consumption and hours is one of negative complementarity ($\eta_{c,w_j(i)} < 0$) as in BPS, then liquidity constraints mitigate the negative complementarity or even flip its sign. Liquidity constrained households tend to move consumption in the same direction with wages and a varying degree of tightness of such constraints induces heterogeneity in the consumption response. I return to this in section 5.3.

Insurance against permanent shocks. The average pas-through rate of permanent shocks is $\mathbb{E}(\partial \Delta c_{it} / \partial v_{jit}) = \mathbb{E}(\kappa_{c,v_j(i)})$. As per section 3.2.2, this cannot be expressed in closed form in terms of the preference parameters but it can be constructed numerically. I simulate again 10 million households assuming preferences are jointly normal, maintaining $\eta_{c,p} = -0.75$, and drawing initial conditions from their empirical distributions. Panel (b) of figure 2 illustrates the distribution of $\partial \Delta c_{it} / \partial v_{jit}$ under the assumption of joint normality.

The first column of table 9 reports $\mathbb{E}(\partial \Delta c_{it} / \partial v_{jit})$ at 0.453 for male and 0.313 for female permanent shocks. These rates suggest that *on average* 54.7% of male and 68.7% of female

Table 9 – Pass-Through Rates of Permanent Shocks into Consumption

	baseline		no labor supply responses by: men		women		both
	$\mathbb{E}(\frac{\partial \Delta c_{it}}{\partial v_j})$	average hh	$\mathbb{E}(\frac{\partial \Delta c_{it}}{\partial v_j})$	average hh	$\mathbb{E}(\frac{\partial \Delta c_{it}}{\partial v_j})$	average hh	$\mathbb{E}(\frac{\partial \Delta c_{it}}{\partial v_j})$
v_{1it}	0.453	0.457	0.408	0.431	0.515	0.520	0.501
v_{2it}	0.313	0.317	0.364	0.364	0.271	0.266	0.312

Notes: The table presents the average pass-through rates of permanent wage shocks into consumption as well as the pass-through rates for the representative household (the household with average preferences). 'Baseline' refers to the preferred specification of column (6), tables 5-6. The remaining specifications shut down male labor supply, female labor supply, or both.

permanent shocks are insured. There is more insurance against female shocks simply because female earnings are a smaller share in total household earnings ($\mathbb{E}(s_{2it}) = 0.38$). The pass-through rates in the representative household are reported in the second column; at 0.457 and 0.317 respectively, they are similar to the average rates across households.

The pass-through rates are substantially higher (thus less insurance) than BPS who estimate them at 0.34 and 0.20 respectively. There are two reasons for this. First, matching third moments reduces the female labor supply elasticity and limits the ability of family labor supply to provide insurance to wage shocks. Interestingly, Ghosh (2016) reaches a similar conclusion albeit in the extreme: once she targets consumption and earnings third moments she finds no insurance against persistent shocks but full insurance against transitory ones. She abstracts, however, from labor supply and provides no micro-foundations for that result. Moreover, her estimates likely overestimate the pass-through rate precisely because she abstracts from the insurance role of labor supply. Second, an absolute consumption substitution elasticity twice as large as BPS ($\eta_{c,p} = -0.75$ vs. -0.372) implies a smaller coefficient of relative risk aversion, rendering consumption intertemporally more variable and more responsive to shocks.[32]

Away from the average, figure 2 illustrates that the distribution of pass-through rates includes both the full insurance (complete markets; $\partial \Delta c_{it}/\partial v_{jit} \approx 0$) and no insurance (autarky; $\partial \Delta c_{it}/\partial v_{jit} \approx 1$) benchmarks as, at least for male shocks, there is some mass near both extrema.

[32]The pass-through rates of permanent shocks are also higher than in Blundell et al. (2008) at 0.31 at the household level (table 7 therein with earnings the closest variable to wages). They too abstract from higher moments. Alan et al. (2017) find that the central 80% of the distribution of pass-through rates of income shocks falls in the interval 0.05-0.69. This is only slightly narrower than the central 80% of the distribution of pass-through rates in panel (b) of figure 2. However, Alan et al. (2017) use food as a proxy for consumption while I use a comprehensive consumption measure (food may be smoother than other consumption items). Moreover, they do not distinguish between permanent and transitory shocks: bundling both shocks together makes it likelier to find higher consumption insurance because transitory shocks are on average fully insured. Finally, they abstract from labor supply and higher moments of earnings and wages. I estimate a lower labor supply elasticity precisely because of such moments, which then subsequently suppresses partial insurance.

This is consistent with Hryshko and Manovskii (2017) who find that partial insurance in the PSID features two polar modes. While they provide an interpretation on the basis of heterogeneity in the wage process, my paper provides an interpretation on the basis of preferences. I discuss wage heterogeneity in section 5.3 and I show that it is empirically distinguishable from preference heterogeneity.

As the response of consumption to permanent shocks is partly mitigated by labor supply ($\partial\Delta c_{it}/\partial v_{jit}$ depends on labor supply elasticities), table 9 quantifies the role labor supply precisely plays. When *male* labor supply does not respond ($\eta_{h_1,w_1(i)} = 0$), the pass-through rates of *female* shocks increases (0.364) compared to the baseline because women lose their husbands' 'added-worker' insurance (à la Lundberg, 1985). However, the pass-through rates of *male* shocks declines (0.408) because male hours no longer respond positively to own shocks. When *female* labor supply does not respond, the pass-through rates of *male* shocks increases substantially (0.515) as men lose their wives' 'added-worker' insurance. The increase is greater than for female shocks previously because women's endogenous labor supply is a more effective insurance instrument compared to men's ($\mathbb{E}(\eta_{h_2,w_2(i)}) > \mathbb{E}(\eta_{h_1,w_1(i)})$). The pass-through rate of *female* shocks declines for the same reasons like before.[33]

When neither male nor female labor supply respond, the pass-through rate increases to 0.501 for male shocks reflecting the loss of insurance through family labor supply. Overall, out of 54.7 percentage points (*p.p.*) of partial insurance to male shocks in the baseline, 4.8 *p.p.* or 8.8% come from family labor supply; the remaining comes from self-insurance and the mere presence of two earners financing consumption at any given time.[34] Interestingly, the pass-through rate of female shocks remains unchanged because the limited 'added worker' insurance male hours provide is offset by the loss of the amplification effect of female own hours. Compared to BPS, family labor supply plays a relatively smaller role in consumption insurance due to the lower labor supply elasticities I estimate herein.

5.3 Alternative Explanations for Preference Heterogeneity

Misspecification in household preferences or the budget constraint, for example arising from neglected taxes, intra-family inequality, or household-specific consumption prices, may confound preference heterogeneity with the various factors behind the possible misspecification. For example, preference heterogeneity here may be in fact picking up heterogeneity in intra-family bargaining power. In a companion report (Theloudis, 2017) I *reject* the above alternative ex-

[33] Labor supply nonresponse implies $\eta_{c,w_j(i)} = 0$ per case as the complementarity between consumption and hours is defined only when hours are variable.

[34] The baseline degree of partial insurance expressed in *p.p.* is $(1 - \mathbb{E}(\partial\Delta c_{it}/\partial v_{jit})|_{\text{baseline}}) * 100$. The fraction for which family labor supply is responsible is $\mathbb{E}(\partial\Delta c_{it}/\partial v_{jit})|_{\text{no labor supply}} - \mathbb{E}(\partial\Delta c_{it}/\partial v_{jit})|_{\text{baseline}}$. Male shocks still exhibit higher pass-through rates (less insurance) because of the higher share of male earnings in total household earnings. Even with fixed labor supply the presence of a spouse provides consumption insurance to one's own shocks because the spouse's salary also contributes to financing consumption.

planations for preference heterogeneity. The model disciplines how these environments affect the wage elasticities and none of them is consistent with the empirical pattern of heterogeneity: the fact that I find heterogeneity in consumption elasticities but not in elasticities of labor supply allows me to reject these confounding factors (a model without family labor supply would generally not allow me to do this). Below I discuss the implications of two other environments, one where the wage process is heterogeneous and another where households are subject to unobserved liquidity constraints and adjustments costs of work.

Wage process heterogeneity. Suppose that the true wage process is $ARMA(1,1)$ as in Alan et al. (2017) and Hryshko and Manovskii (2017). For each spouse log wage is given by

$$\ln W_{jit} = \mathbf{X}'_{jit}\boldsymbol{\alpha}_{W_j} + \ln W^p_{jit} + u_{jit}$$
$$\ln W^p_{jit} = \rho_{ji} \ln W^p_{jit-1} + v_{jit}$$
$$u_{jit} = \zeta_{jit} + \tau_{ji}\zeta_{jit-1}$$

with ρ_{ji} the $AR(1)$ parameter and τ_{ji} the $MA(1)$ parameter, both heterogeneous across households and spouses. ζ_{jit} is now the serially uncorrelated transitory shock with $\mathbb{E}(\zeta^2_{jit}) \equiv \sigma^2_{\zeta_j(t)}$. This specification implies $\Delta w_{jit} = (\rho_{ji}-1)\ln W^p_{jit-1} + v_{jit} + \Delta\zeta_{jit} + \tau_{ji}\Delta\zeta_{jit-1}$, or more compactly

$$\Delta w_{jit} = \widetilde{\rho}_{jit} + v_{jit} + \Delta\zeta_{jit} + \tau_{ji}\Delta\zeta_{jit-1} \tag{11}$$

where $\widetilde{\rho}_{jit} = (\rho_{ji} - 1)\ln W^p_{jit-1}$ and everything else is defined like before. The permanent-transitory process has $\rho_{ji} = 1$ and $\tau_{ji} = 0$.

To understand the implications of (11) for the identification of preference heterogeneity, it helps momentarily to focus on one earner, say the female, keeping male wages constant. For the sake of illustration I also set $\tau_{2i} = 0$. None of these simplifications are crucial for the main result below. The dynamics of consumption are now given by

$$\Delta c_{it} \approx \eta_{c,w_2(i)}\widetilde{\rho}_{2it} + \eta_{c,w_2(i)}\left(v_{2it} + \Delta\zeta_{2it}\right) + \bar{\eta}_{c(i)}\widetilde{\varepsilon}_2(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i, \rho_{2i})v_{2it} \tag{5'}$$

replacing the baseline expression (5).[35] The first term captures heterogeneity in consumption growth due to heterogeneity in the wage process, the second term captures the intertemporal substitution due to wage shocks and the last term captures income effects from shifts in the lifetime budget constraint (with $\widetilde{\varepsilon}_2(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i, \rho_{2i} = 1) = \varepsilon_2(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i)$; see appendix A).

In the simplest form of identification, $\mathbb{E}(\eta^2_{c,w_2(i)})$ was previously identified by the ratio of the first-order consumption autocovariance over the first-order wage autocovariance. Here, $\mathbb{E}(\Delta c_{it}\Delta c_{it+1}) = -\mathbb{E}(\eta^2_{c,w_2(i)})\left\{\sigma^2_{\zeta_2(t)} - \mathbb{E}(\widetilde{\rho}_{2it}\widetilde{\rho}_{2it+1})\right\}$ while $\mathbb{E}(\Delta w_{2it}\Delta w_{2it+1}) = \mathbb{E}(\widetilde{\rho}_{2it}\widetilde{\rho}_{2it+1}) - \sigma^2_{\zeta_2(t)}$. The ratio $-\mathbb{E}(\Delta c_{it}\Delta c_{it+1})/\mathbb{E}(\Delta w_{2it}\Delta w_{2it+1})$ still identifies preference heterogeneity despite heterogeneity in the wage process. Identification of preference heterogeneity is robust to

[35] To obtain (5'), I plug the new wage process into the log-linearized first-order conditions (4) that are derived independently of the wage process. In addition, I re-approximate the budget constraint in order to map the innovation to λ into shocks to the new wage process. Details of this step appear in appendix A.

the choice of wage process (at least between the two prominent specifications herein) because it relies on ratios of intertemporal correlations that are insensitive to the wage specification. By contrast, if identification relied on contemporaneous moments (e.g. on the transmission of permanent shocks), the correct specification of the wage process would matter. The transmission of permanent shocks in (5') depends on ρ_{ji} and contemporaneous moments generally pick up preference as well as wage heterogeneity.

Unobserved liquidity constraints and adjustment costs of work. Suppose that a proportion ϱ of 'unconstrained' households solves the baseline problem (1) s.t. (2). In addition, a proportion $1-\varrho$ of 'constrained' households solves a different problem with two distinct features: unobserved liquidity constraints and adjustment costs of work. Below I sketch a model that allows (or, better, proxies) for both features while minimizes the changes required to the analytical framework used so far.

Let the objective function of constrained households be $\mathbb{E}_0 \sum_{t=0}^{T} U_{it}(C_{it}, \bar{H}_{1it}, \bar{H}_{2it}; \mathbf{Z}_{it})$ and their sequential budget constraint $\sum_{j=1}^{2} W_{jit} H_{jit} = C_{it}$, $t = \{0, \ldots, T\}$. There are no assets to fall upon and there is no capacity to save for or borrow from the future as a means to capture (extreme) liquidity constraints in a crude way. Constrained household are 'hand-to-mouth' and consumption equals available income. This is not unrealistic for young or poor households at least for a period of time. Moreover, hours of work $\bar{H}_j$ are fixed in order to capture (extreme) adjustment costs to work. Wages shocks do not shift labor supply due to, for example, institutional or contractual constraints prohibiting adjustments in hours. This is not unrealistic for small shocks or workers without contractual bargaining power.[36]

The solution to this problem is trivial. Hours are fixed ($\Delta h_{jit} = 0$) and earnings growth reflects wage shocks only ($\Delta y_{jit} = \Delta w_{jit}$). A first-order Taylor approximation to the budget constraint yields $\Delta c_{it} \approx q_{1it-1}(v_{1it} + \Delta u_{1it}) + q_{2it-1}(v_{2it} + \Delta u_{2it})$ where q_{jit-1} is spouse j's share of family earnings at $t-1$. All shocks, permanent and transitory, pass through to consumption. A generalization of this is

$$\Delta c_{it} \approx q_{1it-1}(\vartheta_{1it} v_{1it} + \theta_{1it} \Delta u_{1it}) + q_{2it-1}(\vartheta_{2it} v_{2it} + \theta_{2it} \Delta u_{2it})$$

where each shock is associated with a unique loading factor. In the context of liquidity constraints the thetas can be seen as reflecting the tightness of such constraints by household and time. In the extreme case without saving/borrowing, $\vartheta_{jit} = \theta_{jit} = 1$. On the contrary, if liquidity constraints do not bind and saving/borrowing is reinstated then $\theta_{jit} \approx 0$ and $\vartheta_{jit} \approx 1 - \pi_{it} > 0$ corresponding to the case of self-insurance with exogenous labor supply.[37]

[36] A lifecycle model with adjustment costs of work is in principle nonseparable over time. This introduces complications that go beyond the scope of this paper. To retain the advantages of the analytical framework herein, I use fixed labor supply as a crude proxy for extreme adjustment costs of work.

[37] When liquidity constraints do not bind, one obtains $\theta_{jit} \approx 0$ and $\vartheta_{jit} \approx 1 - \pi_{it}$ from the baseline expression (5) when, due to fixed labor supply, all hours and consumption-wage elasticities are zero.

To understand the implications of this environment for preference heterogeneity it helps to focus on the transmission of women's transitory shock u_2 and abstract from male wages as if $q_{2it-1} = 1$. The average transmission parameter of u_2 into consumption (which identifies $\mathbb{E}(\eta_{c,w_2(i)})$ among unconstrained households) now also reflects the degree of liquidity tightness among constrained households. Pooling both types of households together, the average transmission parameter identifies $\varrho\mathbb{E}(\eta_{c,w_2(i)}) + (1-\varrho)\mathbb{E}(\theta_{2it})$, thus biases $\mathbb{E}(\eta_{c,w_2(i)})$ upwards if consumption and hours are Frisch substitutes ($\eta_{c,w_2(i)} < 0$) and the measure of tightness positive (in principle $\theta_{2it} \in [0,1]$ when labor supply is exogenous). The pooled second moment of the transmission parameter is $\varrho\mathbb{E}(\eta^2_{c,w_2(i)}) + (1-\varrho)\mathbb{E}(\theta^2_{2it})$ and picks up heterogeneity in $\eta_{c,w_2(i)}$ *and* variability in liquidity tightness. This likely biases $\text{Var}(\eta_{c,w_2(i)})$ upwards overstating true preference heterogeneity.[38] In a similar spirit, the average transmission parameter of u_2 into female earnings, pooled across constrained and unconstrained households, identifies $\varrho\mathbb{E}(\eta_{h_2,w_2(i)})$ and understates the true average female labor supply elasticity. Its implied pooled variance identifies $\varrho\text{Var}(\eta_{h_2,w_2(i)}) + \varrho(1-\varrho)(\mathbb{E}(\eta_{h_2,w_2(i)}))^2$ and can be smaller *or* larger than $\text{Var}(\eta_{h_2,w_2(i)})$. It is larger if the proportion of unconstrained households or the average labor supply elasticity are relatively large and the elasticity exhibits little heterogeneity across households.

These implications are testable. Among unconstrained households: (1.) average consumption elasticities are smaller (more negative) than the baseline of constrained *and* unconstrained, assuming consumption and hours are Frisch substitutes as in BPS; (2.) the variance of the consumption elasticities are also smaller; (3.) the average male and female labor supply elasticities are larger assuming the characteristics that determine labor market attachment do not differ from the baseline. The difficulty lies in determining which households are unconstrained. As the PSID does not provide consistent information on liquidity constraints, I take wealthy households as the empirical counterpart of the theoretically unconstrained. Wealthy households have sufficient assets to fall upon when adverse conditions arise while their wealth should permit relatively flexible arrangements on the job market.

Table 2 presents descriptive statistics for four subsamples of gradually more stringently defined wealthy households (see footnote 19 for the definition of wealth). Column (W1) describes households whose annual wealth A_t is at least as much as average annual consumption $\overline{C}_t$ in the baseline sample. These are households who can fund at least a year's consumption even with zero labor earnings. Although this condition sounds loose, nearly one third of the baseline sample does not meet it. Column (W2) describes households whose annual wealth is at least twice as much as average annual consumption. Column (W3) is like column (W1) with the additional condition that households hold real debt that does not exceed \$2K in annual terms. Nearly 70% of the baseline sample does not meet this condition. Finally, column (W4) is like column (W3) but with wealth now excluding home equity (i.e. the value of one's home net of

[38] The pooled variance is $\varrho\text{Var}(\eta_{c,w_2(i)}) + (1-\varrho)\text{Var}(\theta_{2it}) + \varrho(1-\varrho)(\mathbb{E}(\eta_{c,w_2(i)}) - \mathbb{E}(\theta_{2it}))^2$ and overstates $\text{Var}(\eta_{c,w_2(i)})$ iff $\text{Var}(\theta_{2it}) + \varrho(\mathbb{E}(\eta_{c,w_2(i)}) - \mathbb{E}(\theta_{2it}))^2 > \text{Var}(\eta_{c,w_2(i)})$. The last condition should generally hold when liquidity tightness varies substantially across households or when preference heterogeneity is limited.

Table 10 – Estimates of Preferences: Wealthy Households

	preferred specification			
	(1)	(2)	(3)	(4)
	$A > \overline{C}$	$A > 2\overline{C}$	$A > \overline{C}$ no debt	$A > \overline{C}$ liquid
Mean consumption elasticities				
$\mathbb{E}(\eta_{c,w_1(i)})$	-0.038	-0.029	-0.056	0.059
	(0.049)	(0.051)	(0.114)	(0.103)
$\mathbb{E}(\eta_{c,w_2(i)})$	0.009	-0.025	0.154	0.044
	(0.066)	(0.055)	(0.118)	(0.093)
Mean labor supply elasticities				
$\mathbb{E}(\eta_{h_1,w_1(i)})$	0.103	0.077	0.188	-0.029
	(0.085)	(0.086)	(0.195)	(0.209)
$\mathbb{E}(\eta_{h_2,w_2(i)})$	0.281	0.185	0.295	-0.156
	(0.177)	(0.160)	(0.354)	(0.224)
Variances [p-values in brackets]				
$\mathrm{V}(\eta_{c,w_1(i)})$	0.253	0.214	0.182	0.082
	[0.000]	[0.003]	[0.043]	[0.062]
$\mathrm{V}(\eta_{c,w_2(i)})$	0.253	0.214	0.182	0.082
	[0.000]	[0.003]	[0.043]	[0.062]
$\mathrm{V}(\eta_{h_1,w_1(i)})$	0.008	0.006	0.035	0.085
	[0.206]	[0.236]	[0.259]	[0.203]
Covariances				
$\mathrm{C}(\eta_{c,w_1(i)}, \eta_{c,w_2(i)})$	0.253	0.214	0.182	0.082
	(0.069)	(0.057)	(0.095)	(0.051)
$\mathrm{C}(\eta_{c,w_1(i)}, \eta_{h_1,w_1(i)})$	0.043	0.034	0.078	0.055
	(0.028)	(0.028)	(0.065)	(0.046)
$\mathrm{C}(\eta_{c,w_2(i)}, \eta_{h_1,w_1(i)})$	0.043	0.034	0.078	0.055
	(0.028)	(0.028)	(0.065)	(0.046)

Notes: The table presents GMM estimates of the first and second moments of wage elasticities from the preferred specification. Column (1) is for households with wealth A_t at least as much as average consumption $\overline{C}_t$ in the baseline sample. Column (2) is for households with wealth at least twice as much as average annual consumption. Column (3) is like column (1) with the additional condition that households hold real debt that does not exceed $2K. Column (4) is like column (3) but the relevant measure of wealth excludes home equity (i.e. the value of one's home net of outstanding mortgages), therefore it better proxies for liquid assets. Standard errors appear in parentheses and, whenever applicable, p-values in square brackets for the one-sided test that the respective parameter equals zero.

outstanding mortgages), therefore better proxying for liquid assets. Nearly 80% of the baseline sample is excluded (which clearly has implications for statistical power).

Average earnings increase moving towards the wealthiest group while hours remain flat with the exception of a small drop in female hours in (W3) and (W4). Age and education also increase reflecting the well known positive correlations among age, education, earnings and wealth. Average wealth nearly doubles while liquid wealth rises by even more. Average consumption does not change much between wealthy and the baseline; it is higher by at most 13% among the wealthy with the biggest part of this increase attributed to housing.

Table 10 re-estimates the preferred specification of the model on the subsamples of wealthy. Three observations emerge. First, the average consumption elasticities do not get smaller (more negative) upon departure from the baseline sample, thus contradicting the first testable implication. These parameters are positive in the last column and larger in absolute value than in the less stringent subsamples. Given that average labor supply elasticities in that sample are negative (probably indicating a strong income effect), the point estimates are consistent with consumption and hours being Frisch substitutes as in BPS. Second, the variances of the consumption elasticities still reveal substantial consumption preference heterogeneity across households. These parameters are always smaller than the baseline and get smaller the more stringent the definition of 'wealthy' is. I deem this pattern consistent with the second testable implication: consumption preference heterogeneity is partly eaten away as one moves towards households who are likelier to be liquidity unconstrained. Third, average labor supply elasticities get smaller the more stringent 'wealthy' is, thus invalidating the third testable implication. This is not entirely unexpected: as spouses in these households are on average more educated, it is likely that they are also more attached to the labor market and less responsive to wage changes. Overall, the evidence is inconclusive about unobserved liquidity constraints and adjustment costs of work.[39]

6 Conclusions

This paper studies the link between wage and consumption inequality using a lifecycle model of family labor supply, consumption and wealth. Although this is not a new topic in itself, the present paper distinctively brings a general preference heterogeneity into the nexus of family labor supply and consumption. By doing so, it formalizes an intuitive idea: inequality is not driven only by wages/incomes and assets but also by individual preferences. It then offers a

[39] Three points stand out on wages of wealthy households (detailed results are available upon request; also see table 3). First, the variances of all types of shocks are remarkably similar between wealthy and the baseline. Second, the correlation between transitory shocks increases as one moves towards the top group. Third, permanent shocks exhibit substantially longer left tail compared to the baseline, consistent with Guvenen et al. (2015)'s finding of longer tails among high earners. The third standardized moments, averaged over the four subsamples, are $\widetilde{\gamma}_{v_1} = -2.11$ (previously $\widetilde{\gamma}_{v_1} = -0.70$) and $\widetilde{\gamma}_{v_2} = -3.09$ (previously $\widetilde{\gamma}_{v_2} = -2.59$).

tractable framework to understand the implications of preference heterogeneity for consumption inequality. I show identification of all moments of the cross-sectional joint distribution of wage elasticities of consumption and labor supply. The main idea behind identification is the conjecture that cross-sectional dispersion in outcomes net of dispersion in prices and observables reflects preference heterogeneity. Importantly, identification does not rely on any specific parametrization of household preferences or their distribution.

The empirical implementation of the model involves fitting second and third moments of the joint distribution of consumption, earnings and wages in the PSID. I find substantial heterogeneity in consumption elasticities across households but limited heterogeneity in intensive margin labor supply elasticities. Consumption in the average household is separable from labor supply, and male and female labor supply elasticities are smaller than average estimates in the literature. The magnitude of these elasticities drop as the model attempts to match third moments of earnings and wages. The usefulness of these results, mean and spread of preferences together, is that they can serve as inputs to welfare and program evaluations (French, 2005) or studies of consumption and wealth inequality (DeNardi et al., 2016) where heterogeneity in the behavioral response may crucially affect the efficacy of policy.

The analytical framework of the paper enables the decomposition of consumption inequality into components pertaining to preference heterogeneity (52% share of inequality), wage inequality (43.8%), and wealth inequality (4.2%). Preference heterogeneity also has implications for consumption partial insurance. On average, there is less insurance against permanent wage shocks than in the homogeneity benchmark of BPS because the insurance role of family labor supply is more limited here and the coefficient of relative risk aversion smaller. The implied distribution of partial insurance includes both the full insurance and autarky benchmarks as in Hryshko and Manovskii (2017).

A number of important issues are left for future research. The paper only estimates unconditional central moments of preferences; higher than second moments are not estimated at all. While these are constraints ultimately imposed by the data, the ongoing efforts of researchers to obtain joint register income and consumption data should relax much of these constraints. Although the lack of heterogeneity in intensive margin labor supply elasticities is mainly due to the specific sample of stable households and the focus on hours rather participation, this result certainly deserves a deeper investigation perhaps through extending the model to participation decisions too. Finally, work is required to obtain identification results relaxing the independence assumption between preferences and wage shocks.

Appendix

A Taylor Approximations to First-Order Conditions and Lifetime Budget Constraint

Suppose the household utility function takes the form

$$U_{it}(C_{it}, H_{1it}, H_{2it}; \mathbf{Z}_{it}) = \beta_{it}(\mathbf{Z}_i) U_i(C_{it}, H_{1it}, H_{2it}; \mathbf{Z}_{it}) \equiv \widetilde{\beta}_{it} \widetilde{U}_i(\widetilde{C}_{it}, \widetilde{H}_{1it}, \widetilde{H}_{2it})$$

where $\widetilde{\beta}_{it} = \beta_{it}(\mathbf{Z}_i)$, $\widetilde{C}_{it} = C_{it} \exp(-\mathbf{Z}_{it}' \boldsymbol{\alpha}_C)$, $\widetilde{H}_{jit} = H_{jit} \exp(-\mathbf{Z}_{it}' \boldsymbol{\alpha}_{H_j})$ for $j = \{1, 2\}$, and $\mathbf{Z}_i$ is the time invariant portion of $\mathbf{Z}_{it}$. Assuming an internal solution and geometric discounting ($\widetilde{\beta}_{it} = \widetilde{\beta}_i^t$), the first-order conditions of household problem (1) *s.t.* (2) are

$$\begin{aligned}
[C_{it}]: &\qquad \widetilde{U}_{iC}(\widetilde{C}_{it}, \widetilde{H}_{1it}, \widetilde{H}_{2it}) \exp(-\mathbf{Z}_{it}' \boldsymbol{\alpha}_C) = \lambda_{it} \\
[H_{jit}]: &\qquad -\widetilde{U}_{iH_j}(\widetilde{C}_{it}, \widetilde{H}_{1it}, \widetilde{H}_{2it}) \exp(-\mathbf{Z}_{it}' \boldsymbol{\alpha}_{H_j}) = \lambda_{it} W_{jit}, \quad j = \{1, 2\} \\
[A_{it+1}]: &\qquad \widetilde{\beta}_i (1 + r) \mathbb{E}_t \lambda_{it+1} = \lambda_{it}.
\end{aligned}$$

$\widetilde{U}_{iC}$ is the marginal utility of consumption and $\widetilde{U}_{iH_j}$ the marginal utility of hours of spouse j; λ_{it} is the marginal utility of wealth (the Lagrange multiplier on the sequential budget constraint). In the remaining of this appendix I follow steps similar to Blundell et al. (2013) and BPS.

Approximation to intra-temporal first-order conditions. Applying logs to the intra-temporal first-order conditions and taking a first difference in time yields

$$\begin{aligned}
[C_{it}]: &\qquad \Delta \ln \widetilde{U}_{iC}(\widetilde{C}_{it}, \widetilde{H}_{1it}, \widetilde{H}_{2it}) - \Delta \left(\mathbf{Z}_{it}' \boldsymbol{\alpha}_C \right) = \Delta \ln \lambda_{it} \\
[H_{jit}]: &\qquad \Delta \ln \left(-\widetilde{U}_{iH_j}(\widetilde{C}_{it}, \widetilde{H}_{1it}, \widetilde{H}_{2it}) \right) - \Delta \left(\mathbf{Z}_{it}' \boldsymbol{\alpha}_{H_j} \right) = \Delta \ln \lambda_{it} + \Delta \ln W_{jit}.
\end{aligned}$$

A first-order approximation of $\ln \widetilde{U}_{iC}(\widetilde{C}_{it}, \widetilde{H}_{1it}, \widetilde{H}_{2it})$ around $\widetilde{C}_{it-1}$, $\widetilde{H}_{1it-1}$, and $\widetilde{H}_{2it-1}$ yields

$$\begin{aligned}
\Delta \ln \widetilde{U}_{iC}(\widetilde{C}_{it}, \widetilde{H}_{1it}, \widetilde{H}_{2it}) \approx \frac{1}{\widetilde{U}_{iC}(\widetilde{C}_{it-1}, \widetilde{H}_{1it-1}, \widetilde{H}_{2it-1})} \times \Big(&\widetilde{U}_{iCC}(\widetilde{C}_{it-1}, \widetilde{H}_{1it-1}, \widetilde{H}_{2it-1}) \widetilde{C}_{it-1} \Delta \ln C_{it} \\
&+ \widetilde{U}_{iCH_1}(\widetilde{C}_{it-1}, \widetilde{H}_{1it-1}, \widetilde{H}_{2it-1}) \widetilde{H}_{1it-1} \Delta \ln H_{1it} \\
&+ \widetilde{U}_{iCH_2}(\widetilde{C}_{it-1}, \widetilde{H}_{1it-1}, \widetilde{H}_{2it-1}) \widetilde{H}_{2it-1} \Delta \ln H_{2it} \Big)
\end{aligned}$$

where $\widetilde{U}_{iCC}$ denotes the derivative of $\widetilde{U}_{iC}$ with respect to consumption C and so forth. The log-linear approximation of $\Delta \ln \left(-\widetilde{U}_{iH_j}(\widetilde{C}_{it}, \widetilde{H}_{1it}, \widetilde{H}_{2it}) \right)$ follows a similar procedure. Replacing $\Delta \ln \widetilde{U}_{iC}$ and $\Delta \ln \left(-\widetilde{U}_{iH_j} \right)$ with their log-linear approximations yields a system of 3 equations in the growth rates $\Delta \ln C_{it}$, $\Delta \ln H_{1it}$ and $\Delta \ln H_{2it}$ of the 3 outcome variables. Solving the system and rearranging so that all outcome variables and observable taste shifters are on the left results in system (4) in the text (see appendix B for definitions of Frisch elasticities).

Approximation to Euler equation. The approximation to the inter-temporal first-order condition involves future expectations. Suppose $\exp(\Gamma_i) = {}^1\!/\!\widetilde{\beta}_i(1+r)$ for some Γ_i. I apply a second-order approximation to $\exp(\ln\lambda_{it+1})$ around $\ln\lambda_{it} + \Gamma_i$ to get

$$\exp(\ln\lambda_{it+1}) \approx \exp(\ln\lambda_{it} + \Gamma_i)\left(1 + (\Delta\ln\lambda_{it+1} - \Gamma_i) + \frac{1}{2}(\Delta\ln\lambda_{it+1} - \Gamma_i)^2\right).$$

Taking expectations at time t and noting that $\mathbb{E}_t\lambda_{it+1} = \lambda_{it}\exp(\Gamma_i)$ yields

$$\mathbb{E}_t\left(\Delta\ln\lambda_{it+1} - \Gamma_i + \frac{1}{2}(\Delta\ln\lambda_{it+1} - \Gamma_i)^2\right) \approx 0$$

which in turn implies

$$\begin{aligned}\mathbb{E}_t\Delta\ln\lambda_{it+1} &\approx \Gamma_i - \frac{1}{2}\mathbb{E}_t(\Delta\ln\lambda_{it+1} - \Gamma_i)^2 \\ \Delta\ln\lambda_{it+1} &\approx \omega_{it+1} + \varepsilon_{it+1}.\end{aligned} \tag{A.1}$$

The first term $\omega_{it+1} = \Gamma_i - \frac{1}{2}\mathbb{E}_t(\Delta\ln\lambda_{it+1} - \Gamma_i)^2$ captures the impact of interest rate r, impatience $\widetilde{\beta}_i$ and precautionary motives on consumption growth (Blundell et al., 2013). To maintain tractability, I fix $\mathbb{E}_t(\Delta\ln\lambda_{it+1})^2$ (precautionary motive) in the cross-section. ω_{it} is heterogeneous across households due to Γ_i -the anticipated gradient of outcome growth- but non-stochastic. The second term is an expectation error with $\mathbb{E}_t(\varepsilon_{it+1}) = 0$; it captures idiosyncratic revisions to λ upon arrival of new information, namely of wage shocks.

Approximation to lifetime budget constraint (draws on Campbell (1993)'s log-linearization of the intertemporal budget constraint.) The general form of household i's lifetime budget constraint is

$$A_{it} + \mathbb{E}_t\sum_{s=0}^{T-t}\sum_{j=1}^{2}\frac{W_{jit+s}H_{jit+s}}{(1+r)^s} = \mathbb{E}_t\sum_{s=0}^{T-t}\frac{C_{it+s}}{(1+r)^s}.$$

To ease the notation I will temporarily suppress cross-sectional subscript i.

Let $G(\boldsymbol{\xi}) = \ln\sum_{s=0}^{T-t}\exp\xi_s$ for $\boldsymbol{\xi} = (\xi_0, \xi_1, \ldots, \xi_{T-t})'$. Applying a first-order approximation to $G(\boldsymbol{\xi})$ around a deterministic $\boldsymbol{\xi}^0$, and taking expectations conditional on some information set $\mathcal{I}$, yields

$$\mathbb{E}_{\mathcal{I}}G(\boldsymbol{\xi}) \approx G(\boldsymbol{\xi}^0) + \sum_{s=0}^{T-t}\frac{\exp\xi_s^0}{\sum_{\kappa=0}^{T-t}\exp\xi_\kappa^0}\left(\mathbb{E}_{\mathcal{I}}\xi_s - \xi_s^0\right). \tag{A.2}$$

The logarithm of the *right* hand side of the budget constraint, assuming expectations away, is

$$G^{RH}(\boldsymbol{\xi}) = \ln\sum_{s=0}^{T-t}\exp\left(\ln\frac{C_{t+s}}{(1+r)^s}\right)$$

for $\xi_s = \ln C_{t+s} - s\ln(1+r)$. Suppose that $\xi_s^0 = \mathbb{E}_{t-1}\ln C_{t+s} - s\ln(1+r)$. Following (A.2) I write

$$\mathbb{E}_{\mathcal{I}}G^{RH}(\boldsymbol{\xi}) \approx G^{RH}(\boldsymbol{\xi}^0) + \sum_{s=0}^{T-t}\theta_{t+s}\left(\mathbb{E}_{\mathcal{I}}\ln C_{t+s} - \mathbb{E}_{t-1}\ln C_{t+s}\right)$$

where $\theta_{t+s} = \frac{\exp(\mathbb{E}_{t-1} \ln C_{t+s} - s \ln(1+r))}{\sum_{\kappa=0}^{T-t} \exp(\mathbb{E}_{t-1} \ln C_{t+\kappa} - \kappa \ln(1+r))}$ is approximately equal to the expected share of time $t+s$ consumption in total lifetime consumption. θ_{t+s} is known at any $t+s \geq t$ because it pertains to expectations at $t-1$.

Defining the information set to contain information known at time t, that is $\mathcal{I} := t$, and replacing $\ln C_{t+s}$ consecutively by the analytical expression in (4) yields

$$\sum_{s=0}^{T-t} \theta_{t+s} \left(\mathbb{E}_t \ln C_{t+s} - \mathbb{E}_{t-1} \ln C_{t+s} \right) \approx \bar{\eta}_c \varepsilon_t + \sum_{j=1}^{2} \eta_{c,w_j} v_{jt} + \sum_{j=1}^{2} \theta_t \eta_{c,w_j} u_{jt}$$

where $\bar{\eta}_c = \eta_{c,p} + \eta_{c,w_1} + \eta_{c,w_2}$ (ω_{t+s} is non-stochastic and disappears in the first difference). If the share of a period's consumption in total lifetime consumption is negligible, i.e. $\theta_t \approx 0$, then taking a first difference in expectations between t and $t-1$ and reinstating cross-sectional subscript i yields

$$\mathbb{E}_t G^{RH}(\boldsymbol{\xi}) - \mathbb{E}_{t-1} G^{RH}(\boldsymbol{\xi}) \approx \bar{\eta}_{c(i)} \varepsilon_{it} + \sum_{j=1}^{2} \eta_{c,w_j(i)} v_{jit}.$$

Applying similar arguments to the *left* hand side of the budget constraint and using information from (3) and (4) yields

$$\mathbb{E}_t G^{LH}(\boldsymbol{\xi}) - \mathbb{E}_{t-1} G^{LH}(\boldsymbol{\xi}) \approx (1 - \pi_{it}) \sum_{j=1}^{2} \left\{ s_{jit} \bar{\eta}_{h_j(i)} \varepsilon_{it} + \left(s_{jit}(1 + \eta_{h_j,w_j(i)}) + s_{-jit} \eta_{h_{-j},w_j(i)} \right) v_{jit} \right\}$$

where, suppressing cross-sectional i, $\bar{\eta}_{h_j} = \eta_{h_j,p} + \eta_{h_j,w_1} + \eta_{h_j,w_2}$, $-j$ denotes the spouse, and

$$G^{LH}(\boldsymbol{\xi}) = \ln \left(\exp\left(\ln A_t\right) + \sum_{s=1}^{T-t+1} \exp \left(\ln \sum_{j=1}^{2} \frac{W_{jt+s-1} H_{jt+s-1}}{(1+r)^{s-1}} \right) \right)$$

$$\xi_s = \begin{cases} \ln A_{t+s} & \text{for } s = 0 \\ \ln \sum_{j=1}^{2} W_{jt+s-1} H_{jt+s-1} - (s-1) \ln(1+r) & \text{for } s = 1, \ldots, T-t+1 \end{cases}$$

$$\xi_s^0 = \begin{cases} \mathbb{E}_{t-1} \ln A_{t+s} & \text{for } s = 0 \\ \mathbb{E}_{t-1} \ln \sum_{j=1}^{2} W_{jt+s-1} H_{jt+s-1} - (s-1) \ln(1+r) & \text{for } s = 1, \ldots, T-t+1. \end{cases}$$

The rest of the notation is as follows: $\pi_t = \frac{Q_{1t}}{Q_{1t}+Q_{2t}}$, with $Q_{1t} = \exp\left(\mathbb{E}_{t-1} \ln A_t\right)$ and $Q_{2t} = \sum_{\kappa=0}^{T-t} \exp\left(\mathbb{E}_{t-1} \ln \sum_j W_{jt+\kappa} H_{jt+\kappa} - \kappa \ln(1+r) \right)$, is the 'partial insurance' coefficient: it is approximately equal to the share of financial wealth in the household's total financial and human wealth at t. $s_{jt} = \sum_{s=0}^{T-t} \vartheta_{t+s} \widetilde{q}_{jt+s}$, with $\vartheta_{t+s} = \exp\left(\mathbb{E}_{t-1} \ln \sum_{j=1}^{2} W_{jt+s} H_{jt+s} - s \ln(1+r) \right) / Q_{2t}$ and $\widetilde{q}_{jt+s} = \frac{\mathbb{E}_{t-1} W_{jt+s} H_{jt+s}}{\sum_{\iota=1}^{2} \mathbb{E}_{t-1} W_{\iota t+s} H_{\iota t+s}}$, is approximately equal to the share of spouse j's human wealth (expected lifetime earnings) in the household's total human wealth at t. ϑ_{t+s} and $\widetilde{q}_{jt+s}$ are known at any $t+s \geq t$ (they pertain to expectations at $t-1$) and $\vartheta_{t+s} \approx 0$ if the share of a period's earnings in the household's total lifetime earnings is negligible.

I bring the two sides together following Blundell et al. (2013, p. 34) who point out that "the realized budget must balance" and, therefore, the objects on the two sides of the log-linearized budget constraint "have the same distribution". I solve for ε_{it} to get

$$\varepsilon_{it} \approx \varepsilon_1(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i) v_{1it} + \varepsilon_2(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i) v_{2it} \tag{A.3}$$

where

$$\begin{aligned}
\varepsilon_1(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i) &= \frac{(1-\pi_{it})\left(s_{1it}(1+\eta_{h_1,w_1(i)}) + s_{2it}\eta_{h_2,w_1(i)}\right) - \eta_{c,w_1(i)}}{\bar{\eta}_{c(i)} - (1-\pi_{it})\left(s_{1it}\bar{\eta}_{h_1(i)} + s_{2it}\bar{\eta}_{h_2(i)}\right)} \\
\varepsilon_2(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i) &= \frac{(1-\pi_{it})\left(s_{1it}\eta_{h_1,w_2(i)} + s_{2it}(1+\eta_{h_2,w_2(i)})\right) - \eta_{c,w_2(i)}}{\bar{\eta}_{c(i)} - (1-\pi_{it})\left(s_{1it}\bar{\eta}_{h_1(i)} + s_{2it}\bar{\eta}_{h_2(i)}\right)}
\end{aligned}$$

and $\mathbf{s}_{it} = (s_{1it}, s_{2it})'$ with $s_{1it} + s_{2it} = 1$ by construction. $\boldsymbol{\eta}_i$ is the 9×1 vector of household-specific Frisch elasticities presented in table 1 and defined in appendix B.

Combining the approximations to the intra-temporal first-order conditions in (4), the Euler equation in (A.1) and the intertemporal budget constraint in (A.3), I obtain

$$\begin{aligned}
\Delta c_{it} &\approx \bar{\eta}_{c(i)}\omega_{it} + \eta_{c,w_1(i)}\Delta u_{1it} + \eta_{c,w_2(i)}\Delta u_{2it} \\
&\quad + \left(\eta_{c,w_1(i)} + \bar{\eta}_{c(i)}\varepsilon_1(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i)\right) v_{1it} + \left(\eta_{c,w_2(i)} + \bar{\eta}_{c(i)}\varepsilon_2(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i)\right) v_{2it} \\
\Delta h_{jit} &\approx \bar{\eta}_{h_j(i)}\omega_{it} + \eta_{h_j,w_1(i)}\Delta u_{1it} + \eta_{h_j,w_2(i)}\Delta u_{2it} \\
&\quad + \left(\eta_{h_j,w_1(i)} + \bar{\eta}_{h_j(i)}\varepsilon_1(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i)\right) v_{1it} + \left(\eta_{h_j,w_2(i)} + \bar{\eta}_{h_j(i)}\varepsilon_2(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i)\right) v_{2it}.
\end{aligned}$$

The intercepts $\bar{\eta}_{c(i)}\omega_{it}$ and $\bar{\eta}_{h_j(i)}\omega_{it}$ reflect the gradient of outcome growth in the absence of shocks. As shown above, this is a function of the interest rate, the discount factor and precautionary motives. Identification of moments of the intercepts is straightforward. However, this does not imply identification of moments of the discount factor $\widetilde{\beta}_i$ because two consecutive moments of $\widetilde{\beta}_i$ appear additively in any moment of ω_{it}. Separating them is impossible. Therefore I absorb $\bar{\eta}_{c(i)}\omega_{it}$ and $\bar{\eta}_{h_j(i)}\omega_{it}$ into random intercepts of a first-stage regression of consumption and hours on observables, resulting in the main system of estimating equations (5)-(7).

Approximation with heterogeneous wage process. Following the same steps as above but replacing the permanent-transitory wage process (3) with the $ARMA(1,1)$ process (11) yields for the right hand side (resp. left hand side) of the budget constraint

$$\mathbb{E}_t G^{RH}(\boldsymbol{\xi}) - \mathbb{E}_{t-1} G^{RH}(\boldsymbol{\xi}) \approx \bar{\eta}_{c(i)}\varepsilon_{it} + \sum_{j=1}^{2} \eta_{c,w_j(i)} f_c(\rho_{ji}) v_{jit}$$

$$\begin{aligned}
\mathbb{E}_t G^{LH}(\boldsymbol{\xi}) - \mathbb{E}_{t-1} G^{LH}(\boldsymbol{\xi}) &\approx (1-\pi_{it})\left(s_{1it}\bar{\eta}_{h_1(i)} + s_{2it}\bar{\eta}_{h_2(i)}\right)\varepsilon_{it} \\
&\quad + (1-\pi_{it})\sum_{j=1}^{2}\left(f_{h_j}(s_{jit}, \rho_{ji})(1+\eta_{h_j,w_j(i)}) + f_{h_{-j}}(s_{-jit}, \rho_{ji})\eta_{h_{-j},w_j(i)}\right) v_{jit}
\end{aligned}$$

where $f_c(\rho_{ji}) = 1 + \sum_{s=1}^{T-t} \theta_{it+s}(\rho_{ji}^s - 1)$, $f_{h_{j'}}(s_{j'it}, \rho_{ji}) = s_{j'it} + \sum_{s=1}^{T-t} \vartheta_{it+s}\widetilde{q}_{j'it+s}(\rho_{ji}^s - 1)$ with $f_c(\rho_{ji} = 1) = 1$, $f_{h_{j'}}(s_{j'it}, \rho_{ji} = 1) = s_{j'it}$ and $j, j' = \{1, 2\}$. Bringing the two sides together yields

$$\varepsilon_{it} \approx \widetilde{\varepsilon}_1(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i, \rho_{1i}) v_{1it} + \widetilde{\varepsilon}_2(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i, \rho_{2i}) v_{2it}$$

where

$$\widetilde{\varepsilon}_j(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i, \rho_{ji}) = \frac{(1-\pi_{it})\left(f_{h_j}(s_{jit}, \rho_{ji})(1+\eta_{h_j,w_j(i)}) + f_{h_{-j}}(s_{-jit}, \rho_{ji})\eta_{h_{-j},w_j(i)}\right) - f_c(\rho_{ji})\eta_{c,w_j(i)}}{\bar{\eta}_{c(i)} - (1-\pi_{it})\left(s_{1it}\bar{\eta}_{h_1(i)} + s_{2it}\bar{\eta}_{h_2(i)}\right)}$$

and $\widetilde{\varepsilon}_j(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i, \rho_{ji} = 1) = \varepsilon_j(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i)$. Combining this with previous results yields equation (5') for consumption growth in the presence of a heterogeneous wage process.

B Frisch Elasticities

Period preferences $U_i(C_{it}, H_{1it}, H_{2it})$ are described ordinally by 9 Frisch elasticities. There are 9 elasticities because there are 3 goods (C, H_1, H_2) and 3 prices (P, W_1, W_2); consequently there are 3 own-price and 6 cross-price elasticities. Their analytical expressions are

$$\begin{aligned}
\eta_{c,w_j(i)} &= \left.\frac{\partial C}{\partial W_j}\frac{W_j}{C}\right|^{i}_{\lambda\text{-const.}} &= Det^{-1}\frac{U_{H_j}}{C}(U_{CH_{-j}}U_{H_1H_2} - U_{CH_j}U_{H_{-j}H_{-j}}), \quad j = \{1,2\} \\
\eta_{c,p(i)} &= \left.\frac{\partial C}{\partial P}\frac{P}{C}\right|^{i}_{\lambda\text{-const.}} &= Det^{-1}\frac{U_C}{C}(U_{H_1H_1}U_{H_2H_2} - U^2_{H_1H_2}) \\
\eta_{h_j,w_j(i)} &= \left.\frac{\partial H_j}{\partial W_j}\frac{W_j}{H_j}\right|^{i}_{\lambda\text{-const.}} &= Det^{-1}\frac{U_{H_j}}{H_j}(U_{CC}U_{H_{-j}H_{-j}} - U^2_{CH_{-j}}), \quad j = \{1,2\} \\
\eta_{h_j,w_{-j}(i)} &= \left.\frac{\partial H_j}{\partial W_{-j}}\frac{W_{-j}}{H_j}\right|^{i}_{\lambda\text{-const.}} &= Det^{-1}\frac{U_{H_{-j}}}{H_j}(U_{CH_1}U_{CH_2} - U_{CC}U_{H_1H_2}), \quad j = \{1,2\} \\
\eta_{h_j,p(i)} &= \left.\frac{\partial H_j}{\partial P}\frac{P}{H_j}\right|^{i}_{\lambda\text{-const.}} &= Det^{-1}\frac{U_C}{H_j}(U_{CH_{-j}}U_{H_1H_2} - U_{CH_j}U_{H_{-j}H_{-j}}), \quad j = \{1,2\}
\end{aligned}$$

where $-j$ denotes the spouse, U_x the marginal utility with respect to outcome variable $x = \{C, H_1, H_2\}$ and $U_{x\chi}$ the derivative of U_x with respect to $\chi = \{C, H_1, H_2\}$. Det is the determinant of the Hessian matrix of preferences given by $Det = U_{CC}U_{H_1H_1}U_{H_2H_2} + 2U_{CH_1}U_{CH_2}U_{H_1H_2} - U_{CC}U^2_{H_1H_2} - U_{H_1H_1}U^2_{CH_2} - U_{H_2H_2}U^2_{CH_1}$. All partial derivatives as well as outcome variables and the determinant Det are i-specific but I suppress this subscript to ease the notation. The partial effects are calculated at the household level holding λ constant in expectation.

From Phlips (1974, section 2.4) the matrix of substitution effects after a marginal-utility-of-wealth-compensated price change is

$$\begin{pmatrix} \frac{dC}{dP} & -\frac{dC}{dW_1} & -\frac{dC}{dW_2} \\ \frac{dH_1}{dP} & -\frac{dH_1}{dW_1} & -\frac{dH_1}{dW_2} \\ \frac{dH_2}{dP} & -\frac{dH_2}{dW_1} & -\frac{dH_2}{dW_2} \end{pmatrix} = \lambda_i \mathbf{H}_i^{-1}\mathbf{I}_3 \tag{B.1}$$

where $\mathbf{H}_i$ is the Hessian of U_i and $\mathbf{I}_3$ is a 3×3 identity matrix. I obtain (B.1) by totally differentiating the intra-temporal first-order conditions of the household problem with respect to prices and noting that $\Delta\lambda_{it} = 0$ in expectation. As the right hand side of (B.1) is a symmetric matrix (the Hessian is symmetric by Young's theorem and standard regularity conditions on U_i), it follows that $\frac{dH_j}{dP} = -\frac{dC}{dW_j}$ and $\frac{dH_1}{dW_2} = \frac{dH_2}{dW_1}$. Simple manipulations of these restrictions translate into restrictions on the corresponding cross-price Frisch elasticities.

C Identification Details

Wage process. There are 6 parameters for the cross-sectional dispersion of shocks (marginal and joint) at time t: $\sigma^2_{v_j(t)}$, $\sigma^2_{u_j(t)}$, $\sigma_{v_1v_2(t)}$, $\sigma_{u_1u_2(t)}$ ($j = \{1, 2\}$). Identification follows Meghir and Pistaferri (2004) and earlier studies and requires second moments of the joint distribution of spouses' wages across households; namely

$$\begin{aligned}
\sigma^2_{v_j(t)} &= \mathbb{E}\left(\Delta w_{jit}(\Delta w_{jit-1} + \Delta w_{jit} + \Delta w_{jit+1})\right) \\
\sigma^2_{u_j(t)} &= -\mathbb{E}\left(\Delta w_{jit}\Delta w_{jit+1}\right) \\
\sigma_{v_1v_2(t)} &= \mathbb{E}\left(\Delta w_{1it}(\Delta w_{2it-1} + \Delta w_{2it} + \Delta w_{2it+1})\right) \\
\sigma_{u_1u_2(t)} &= -\mathbb{E}\left(\Delta w_{1it}\Delta w_{2it+1}\right)
\end{aligned}$$

with Δw_{jit} given by (3). There are 8 parameters for the cross-sectional skewness of shocks (marginal and joint) at t: $\gamma_{v_j(t)}$, $\gamma_{u_j(t)}$, $\gamma_{v_1v_2^2(t)}$, $\gamma_{v_1^2v_2(t)}$, $\gamma_{u_1u_2^2(t)}$, $\gamma_{u_1^2u_2(t)}$. Identification requires third moments of the joint distribution of spouses' wages across households; namely

$$\begin{aligned}
\gamma_{v_j(t)} &= \mathbb{E}\left((\Delta w_{jit})^2(\Delta w_{jit-1} + \Delta w_{jit} + \Delta w_{jit+1})\right) \\
\gamma_{u_j(t)} &= -\mathbb{E}\left((\Delta w_{jit})^2\Delta w_{jit+1}\right) \\
\gamma_{v_1v_2^2(t)} &= \mathbb{E}\left((\Delta w_{2it})^2(\Delta w_{1it-1} + \Delta w_{1it} + \Delta w_{1it+1})\right) \\
\gamma_{v_1^2v_2(t)} &= \mathbb{E}\left((\Delta w_{1it})^2(\Delta w_{2it-1} + \Delta w_{2it} + \Delta w_{2it+1})\right) \\
\gamma_{u_1u_2^2(t)} &= -\mathbb{E}\left((\Delta w_{2it})^2\Delta w_{1it+1}\right) \\
\gamma_{u_1^2u_2(t)} &= -\mathbb{E}\left((\Delta w_{1it})^2\Delta w_{2it+1}\right).
\end{aligned}$$

Generalization to the n^{th} moment ($n > 1$) is straightforward. The n^{th} moment of permanent shocks is identified through $\mathbb{E}\left((\Delta w_{jit})^{n-1}(\Delta w_{jit-1} + \Delta w_{jit} + \Delta w_{jit+1})\right)$ (own moments) and $\mathbb{E}\left((\Delta w_{2it})^{n-\nu}\left(\Delta w_{1it-1} + \Delta w_{1it} + \Delta w_{1it+1}\right)^{\nu}\right)$ (cross-moments) with $\nu = \{1, \ldots, n-1\}$. These moments carry information on $\mathbb{E}(v^n_{jit})$ and $\mathbb{E}(v^{\nu}_{1it}v^{n-\nu}_{2it})$ respectively *plus* a sum of products of lower-order moments (up to $n-2 \geq 2$) of the spouses' permanent and transitory shocks between $t-2$ and $t+1$. Such lower-order moments are identified sequentially relying on results for the variance and skewness and then moving up, if required, until reaching moments of order $n-2$.

The n^{th} moment of transitory shocks is identified through the n^{th} autocovariance of wages; namely $\mathbb{E}\left((\Delta w_{jit})^{n-1}\Delta w_{jit+1}\right)$ (own moments) and $\mathbb{E}\left((\Delta w_{2it})^{n-\nu}(\Delta w_{1it+1})^{\nu}\right)$ (cross-moments). The autocovariances carry information on $\mathbb{E}(u^n_{jit})$ and $\mathbb{E}(u^{\nu}_{1it}u^{n-\nu}_{2it})$ respectively *plus*, like previously, a sum of products of lower-order moments (order up to $n-2 \geq 2$) of the spouses' permanent and transitory wage shocks between $t-1$ and $t+1$.

Four remarks are in order. First, unlike the variance and skewness, it is not possible to identify higher than third moments without previously identifying lower-order moments. Second, no generic formulas exist for $\mathbb{E}(v^n_{jit})$, $\mathbb{E}(u^n_{jit})$ etc. *for every* n. The reason is the accompanying sum of products of lower-order moments in each case. Such term depends on (and increases with) n; lower-order sums are not nested within higher-order sums thus ruling

Table C.1 – Second Moments of Preference Distribution $F_{\boldsymbol{\eta}}$

	Consumption elasticities			*Male labor supply elasticities*			*Female labor supply elasticities*		
	$\eta_{c,w_1(i)}$	$\eta_{c,w_2(i)}$	$\eta_{c,p(i)}$	$\eta_{h_1,w_1(i)}$	$\eta_{h_1,w_2(i)}$	$\eta_{h_1,p(i)}$	$\eta_{h_2,w_1(i)}$	$\eta_{h_2,w_2(i)}$	$\eta_{h_2,p(i)}$
$\eta_{c,w_1(i)}$	$\mathrm{V}(\eta_{c,w_1(i)})$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_1(i)}\\ \eta_{c,w_2(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_1(i)}\\ \eta_{c,p(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_1(i)}\\ \eta_{h_1,w_1(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_1(i)}\\ \eta_{h_1,w_2(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_1(i)}\\ \eta_{h_1,p(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_1(i)}\\ \eta_{h_2,w_1(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_1(i)}\\ \eta_{h_2,w_2(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_1(i)}\\ \eta_{h_2,p(i)}\end{pmatrix}$
$\eta_{c,w_2(i)}$		$\mathrm{V}(\eta_{c,w_2(i)})$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_2(i)}\\ \eta_{c,p(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_2(i)}\\ \eta_{h_1,w_1(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_2(i)}\\ \eta_{h_1,w_2(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_2(i)}\\ \eta_{h_1,p(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_2(i)}\\ \eta_{h_2,w_1(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_2(i)}\\ \eta_{h_2,w_2(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,w_2(i)}\\ \eta_{h_2,p(i)}\end{pmatrix}$
$\eta_{c,p(i)}$			$\mathrm{V}(\eta_{c,p(i)})$	$\mathrm{C}\begin{pmatrix}\eta_{c,p(i)}\\ \eta_{h_1,w_1(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,p(i)}\\ \eta_{h_1,w_2(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,p(i)}\\ \eta_{h_1,p(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,p(i)}\\ \eta_{h_2,w_1(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,p(i)}\\ \eta_{h_2,w_2(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{c,p(i)}\\ \eta_{h_2,p(i)}\end{pmatrix}$
$\eta_{h_1,w_1(i)}$				$\mathrm{V}(\eta_{h_1,w_1(i)})$	$\mathrm{C}\begin{pmatrix}\eta_{h_1,w_1(i)}\\ \eta_{h_1,w_2(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{h_1,w_1(i)}\\ \eta_{h_1,p(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{h_1,w_1(i)}\\ \eta_{h_2,w_1(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{h_1,w_1(i)}\\ \eta_{h_2,w_2(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{h_1,w_1(i)}\\ \eta_{h_2,p(i)}\end{pmatrix}$
$\eta_{h_1,w_2(i)}$					$\mathrm{V}(\eta_{h_1,w_2(i)})$	$\mathrm{C}\begin{pmatrix}\eta_{h_1,w_2(i)}\\ \eta_{h_1,p(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{h_1,w_2(i)}\\ \eta_{h_2,w_1(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{h_1,w_2(i)}\\ \eta_{h_2,w_2(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{h_1,w_2(i)}\\ \eta_{h_2,p(i)}\end{pmatrix}$
$\eta_{h_1,p(i)}$						$\mathrm{V}(\eta_{h_1,p(i)})$	$\mathrm{C}\begin{pmatrix}\eta_{h_1,p(i)}\\ \eta_{h_2,w_1(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{h_1,p(i)}\\ \eta_{h_2,w_2(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{h_1,p(i)}\\ \eta_{h_2,p(i)}\end{pmatrix}$
$\eta_{h_2,w_1(i)}$							$\mathrm{V}(\eta_{h_2,w_1(i)})$	$\mathrm{C}\begin{pmatrix}\eta_{h_2,w_1(i)}\\ \eta_{h_2,w_2(i)}\end{pmatrix}$	$\mathrm{C}\begin{pmatrix}\eta_{h_2,w_1(i)}\\ \eta_{h_2,p(i)}\end{pmatrix}$
$\eta_{h_2,w_2(i)}$								$\mathrm{V}(\eta_{h_2,w_2(i)})$	$\mathrm{C}\begin{pmatrix}\eta_{h_2,w_2(i)}\\ \eta_{h_2,p(i)}\end{pmatrix}$
$\eta_{h_2,p(i)}$									$\mathrm{V}(\eta_{h_2,p(i)})$

Notes: The table lists the 45 parameters that characterize the unconditional second moment of the distribution of preferences $F_{\boldsymbol{\eta}}$. Parameters that refer exclusively to wage elasticities appear without shade. These are all identified from panel data on consumption, earnings, and wages. Parameters that involve moments of the labor supply elasticities *with respect to the price of consumption* (own moments and cross-moments with wage elasticities) appear in light gray. These are linear transformations of the previous moments, thus identified. Moments of the consumption substitution elasticity appear in dark gray; these are not identified. V denotes the cross-sectional variance and C denotes the covariance.

out a generic formula *for every* n. Third, over-identifying restrictions exist for all own- and cross-moments of order higher than 2. Fourth, identification so far assumes measurement error away. If the data are contaminated with error, then identification requires moments of the error up to order n. While information on the variance of measurement error in survey data is often available through validation studies (Bound et al., 1994, for the PSID), information on its distributional aspects is usually missing necessitating additional assumptions (for example, Gaussian distribution as in proposition 1 of section 3.2). The variance of wage measurement error can easily be accounted for in the above identifying equations (e.g. BPS and section 4).

Preferences. There are 9 parameters for the unconditional first moment of the joint distribution $F_{\boldsymbol{\eta}}$ of Frisch elasticities across households: $\mathbb{E}(\eta_{c,w_j(i)})$, $\mathbb{E}(\eta_{c,p(i)})$, $\mathbb{E}(\eta_{h_{j'},w_j(i)})$, and $\mathbb{E}(\eta_{h_{j'},p(i)})$ for $j, j' = \{1,2\}$. There are 45 parameters for the unconditional second moment; table C.1 lists these parameters. In general, there are $\prod_{i=1}^{8}(n+i)/8!$ parameters for the unconditional $n^{\text{th}} = \{1,2,3,\dots\}$ moment, assuming that such moment exists and is finite.

I group these parameters (moments) into three categories. The first involves exclusively moments of *wage elasticities*. The second involves moments of the labor supply elasticities *with respect to the price of consumption* $\eta_{h_j,p}$, including their cross-moments with wage elasticities. The third includes all other parameters, namely moments that involve the *consumption substitution elasticity* $\eta_{c,p}$. In table C.1, parameters belonging to the first category appear without shade, those in the second appear in light gray, and those in the third appear in dark gray.

Under the conditions of proposition 1 and abstracting from measurement error for now, I define the following intertemporal moments of consumption, earnings and wages:

$$
\begin{aligned}
m_{cw_j} &= \mathbb{E}(\Delta c_{it}\Delta w_{jit+1}) &&= -\mathbb{E}(\eta_{c,w_j(i)})\sigma^2_{u_j(t)} - \mathbb{E}(\eta_{c,w_{j'}(i)})\sigma_{u_1u_2(t)} \\
m_{cc} &= \mathbb{E}(\Delta c_{it}\Delta c_{it+1}) &&= -\mathbb{E}(\eta^2_{c,w_1(i)})\sigma^2_{u_1(t)} - \mathbb{E}(\eta^2_{c,w_2(i)})\sigma^2_{u_2(t)} - 2\mathbb{E}(\eta_{c,w_1(i)}\eta_{c,w_2(i)})\sigma_{u_1u_2(t)} \\
m_{c^2w_j} &= \mathbb{E}((\Delta c_{it})^2\Delta w_{jit+1}) &&= -\mathbb{E}(\eta^2_{c,w_j(i)})\gamma_{u_j(t)} - \mathbb{E}(\eta^2_{c,w_{j'}(i)})\gamma_{u_ju^2_{j'}(t)} - 2\mathbb{E}(\eta_{c,w_1(i)}\eta_{c,w_2(i)})\gamma_{u^2_ju_{j'}(t)} \\
m_{y_jw_j} &= \mathbb{E}(\Delta y_{jit}\Delta w_{jit+1}) &&= -\mathbb{E}(1+\eta_{h_j,w_j(i)})\sigma^2_{u_j(t)} - \mathbb{E}(\eta_{h_j,w_{j'}(i)})\sigma_{u_1u_2(t)} \\
m_{y_jw_{j'}} &= \mathbb{E}(\Delta y_{jit}\Delta w_{j'it+1}) &&= -\mathbb{E}(1+\eta_{h_j,w_j(i)})\sigma_{u_1u_2(t)} - \mathbb{E}(\eta_{h_j,w_{j'}(i)})\sigma^2_{u_{j'}(t)} \\
m_{y_jy_j} &= \mathbb{E}(\Delta y_{jit}\Delta y_{jit+1}) &&= -\mathbb{E}((1+\eta_{h_j,w_j(i)})^2)\sigma^2_{u_j(t)} - \mathbb{E}(\eta^2_{h_j,w_{j'}(i)})\sigma^2_{u_{j'}(t)} \\
& && \quad - 2\mathbb{E}((1+\eta_{h_j,w_j(i)})\eta_{h_j,w_{j'}(i)})\sigma_{u_1u_2(t)} \\
m_{y^2_jw_j} &= \mathbb{E}((\Delta y_{jit})^2\Delta w_{jit+1}) &&= -\mathbb{E}((1+\eta_{h_j,w_j(i)})^2)\gamma_{u_j(t)} - \mathbb{E}(\eta^2_{h_j,w_{j'}(i)})\gamma_{u_ju^2_{j'}(t)} \\
& && \quad - 2\mathbb{E}((1+\eta_{h_j,w_j(i)})\eta_{h_j,w_{j'}(i)})\gamma_{u^2_ju_{j'}(t)} \\
m_{y^2_jw_{j'}} &= \mathbb{E}((\Delta y_{jit})^2\Delta w_{j'it+1}) &&= -\mathbb{E}((1+\eta_{h_j,w_j(i)})^2)\gamma_{u^2_ju_{j'}(t)} - \mathbb{E}(\eta^2_{h_j,w_{j'}(i)})\gamma_{u_{j'}(t)} \\
& && \quad - 2\mathbb{E}((1+\eta_{h_j,w_j(i)})\eta_{h_j,w_{j'}(i)})\gamma_{u_ju^2_{j'}(t)} \\
m_{cy_j} &= \mathbb{E}(\Delta c_{it}\Delta y_{jit+1}) &&= -\mathbb{E}(\eta_{c,w_j(i)}(1+\eta_{h_j,w_j(i)}))\sigma^2_{u_j(t)} - \mathbb{E}(\eta_{c,w_{j'}(i)}\eta_{h_j,w_{j'}(i)})\sigma^2_{u_{j'}(t)} \\
& && \quad - \Big(\mathbb{E}(\eta_{c,w_j(i)}\eta_{h_j,w_{j'}(i)}) + \mathbb{E}(\eta_{c,w_{j'}(i)}(1+\eta_{h_j,w_j(i)}))\Big)\sigma_{u_1u_2(t)} \\
m_{cy_jw_j} &= \mathbb{E}(\Delta c_{it}\Delta y_{jit}\Delta w_{jit+1}) &&= -\mathbb{E}(\eta_{c,w_j(i)}(1+\eta_{h_j,w_j(i)}))\gamma_{u_j(t)} - \mathbb{E}(\eta_{c,w_{j'}(i)}\eta_{h_j,w_{j'}(i)})\gamma_{u_ju^2_{j'}(t)} \\
& && \quad - \Big(\mathbb{E}(\eta_{c,w_j(i)}\eta_{h_j,w_{j'}(i)}) + \mathbb{E}(\eta_{c,w_{j'}(i)}(1+\eta_{h_j,w_j(i)}))\Big)\gamma_{u^2_ju_{j'}(t)} \\
m_{cy_jw_{j'}} &= \mathbb{E}(\Delta c_{it}\Delta y_{jit}\Delta w_{j'it+1}) &&= -\mathbb{E}(\eta_{c,w_j(i)}(1+\eta_{h_j,w_j(i)}))\gamma_{u^2_ju_{j'}(t)} - \mathbb{E}(\eta_{c,w_{j'}(i)}\eta_{h_j,w_{j'}(i)})\gamma_{u_{j'}(t)} \\
& && \quad - \Big(\mathbb{E}(\eta_{c,w_j(i)}\eta_{h_j,w_{j'}(i)}) + \mathbb{E}(\eta_{c,w_{j'}(i)}(1+\eta_{h_j,w_j(i)}))\Big)\gamma_{u_ju^2_{j'}(t)}
\end{aligned}
$$

where $j, j' = \{1, 2\}$ and $j \neq j'$. To obtain these expressions I rely on results from Bohrnstedt and Goldberger (1969) for the covariance of products of random variables. All moments may vary with t but I have removed such subscript to ease the notation.

The mean wage elasticities are identified through a combination of wage moments and joint consumption-wage and earnings-wage moments; namely

$$
\begin{aligned}
\mathbb{E}(\eta_{c,w_j(i)}) &= \Big(m_{cw_{j'}}\sigma_{u_1u_2} - m_{cw_j}\sigma^2_{u_{j'}}\Big) \,/\, \big(\sigma^2_{u_1}\sigma^2_{u_2} - (\sigma_{u_1u_2})^2\big) \\
\mathbb{E}(\eta_{h_j,w_j(i)}) &= \Big(m_{y_jw_{j'}}\sigma_{u_1u_2} - m_{y_jw_j}\sigma^2_{u_{j'}}\Big) \,/\, \big(\sigma^2_{u_1}\sigma^2_{u_2} - (\sigma_{u_1u_2})^2\big) - 1 \\
\mathbb{E}(\eta_{h_j,w_{j'}(i)}) &= \Big(m_{y_jw_j}\sigma_{u_1u_2} - m_{y_jw_{j'}}\sigma^2_{u_j}\Big) \,/\, \big(\sigma^2_{u_1}\sigma^2_{u_2} - (\sigma_{u_1u_2})^2\big)\,.
\end{aligned}
$$

These parameters are heavily over-identified by many additional moments. In addition, symmetry of the matrix of Frisch substitution effects implies linear restrictions between reciprocal cross-elasticities (see appendix B). As a result the following relation must hold: $\mathbb{E}(\eta_{h_2,w_1(i)}) = \mathbb{E}(\eta_{h_1,w_2(i)})\mathbb{E}(Y_{1it}/Y_{2it})$ where Y_{jit} is earnings of spouse j.

The second moments of the consumption-wage elasticities (upper left triangle of table C.1) are identified from wage, consumption, and joint consumption-wage moments; namely

$$\begin{pmatrix} \sigma^2_{u_1(t)} & \sigma^2_{u_2(t)} & 2\sigma_{u_1u_2(t)} \\ \gamma_{u_1(t)} & \gamma_{u_1u_2^2(t)} & 2\gamma_{u_1^2u_2(t)} \\ \gamma_{u_1^2u_2(t)} & \gamma_{u_2(t)} & 2\gamma_{u_1u_2^2(t)} \end{pmatrix} \begin{pmatrix} \mathbb{E}(\eta^2_{c,w_1(i)}) \\ \mathbb{E}(\eta^2_{c,w_2(i)}) \\ \mathbb{E}(\eta_{c,w_1(i)}\eta_{c,w_2(i)}) \end{pmatrix} = - \begin{pmatrix} m_{cc} \\ m_{c^2w_1} \\ m_{c^2w_2} \end{pmatrix}.$$

The system is linear in the parameters. The matrix of coefficients is nonsingular if the distribution of shocks is asymmetric about the mean, that is, if shocks are skewed. The matrix is nonsingular also if $\sigma_{u_1u_2} = 0$ *or* $\gamma_{u_1^2u_2} = \gamma_{u_1u_2^2} = 0$. If all cross-moments of shocks are zero, the matrix *is* singular and the covariance of elasticities is not identified but the variances are.

The second moments of the male and female labor supply elasticities (bottom middle and right triangles respectively) are identified in a similar way from wage, earnings, and joint earnings-wage moments; namely

$$\begin{pmatrix} \sigma^2_{u_j(t)} & \sigma^2_{u_{j'}(t)} & 2\sigma_{u_1u_2(t)} \\ \gamma_{u_j(t)} & \gamma_{u_ju_{j'}^2(t)} & 2\gamma_{u_j^2u_{j'}(t)} \\ \gamma_{u_j^2u_{j'}(t)} & \gamma_{u_{j'}(t)} & 2\gamma_{u_ju_{j'}^2(t)} \end{pmatrix} \begin{pmatrix} \mathbb{E}((1+\eta_{h_j,w_j(i)})^2) \\ \mathbb{E}(\eta^2_{h_j,w_{j'}(i)}) \\ \mathbb{E}((1+\eta_{h_j,w_j(i)})\eta_{h_j,w_{j'}(i)}) \end{pmatrix} = - \begin{pmatrix} m_{y_jy_j} \\ m_{y_j^2w_j} \\ m_{y_j^2w_{j'}} \end{pmatrix}.$$

Frisch symmetry implies a restriction between $\text{Var}(\eta_{h_1,w_2(i)})$ and $\text{Var}(\eta_{h_2,w_1(i)})$.

The second cross-moments of consumption and hours elasticities (upper middle and right rectangles respectively) are identified as follows. Consider the linear system

$$\begin{pmatrix} \sigma^2_{u_j(t)} & \sigma^2_{u_{j'}(t)} & \sigma_{u_1u_2(t)} & \sigma_{u_1u_2(t)} \\ \gamma_{u_j(t)} & \gamma_{u_ju_{j'}^2(t)} & \gamma_{u_j^2u_{j'}(t)} & \gamma_{u_j^2u_{j'}(t)} \\ \gamma_{u_j^2u_{j'}(t)} & \gamma_{u_{j'}(t)} & \gamma_{u_ju_{j'}^2(t)} & \gamma_{u_ju_{j'}^2(t)} \end{pmatrix} \begin{pmatrix} \mathbb{E}(\eta_{c,w_j(i)}(1+\eta_{h_j,w_j(i)})) \\ \mathbb{E}(\eta_{c,w_{j'}(i)}\eta_{h_j,w_{j'}(i)}) \\ \mathbb{E}(\eta_{c,w_j(i)}\eta_{h_j,w_{j'}(i)}) \\ \mathbb{E}(\eta_{c,w_{j'}(i)}(1+\eta_{h_j,w_j(i)})) \end{pmatrix} = - \begin{pmatrix} m_{cy_j} \\ m_{cy_jw_j} \\ m_{cy_jw_{j'}} \end{pmatrix}$$

repeated twice for $j = \{1,2\}$ while $j' = \{1,2\} \neq j$. This yields 6 equations in 8 parameters. In addition, symmetry of the matrix of Frisch substitution effects provides two linear restrictions $\mathbb{E}(\eta_{c,w_j(i)}\eta_{h_2,w_1(i)}) = \mathbb{E}(\eta_{c,w_j(i)}\eta_{h_1,w_2(i)})\mathbb{E}(Y_{1it}/Y_{2it})$; taken together these 8 equations just identify the parameters of interest. In practice the parameters are over-identified by at least as many additional equations. Finally, the second cross-moments of male and female labor supply elasticities (middle right rectangle) are identified in a similar manner.

Identification so far assumes measurement error away. If the data are contaminated with error, then the variance of consumption error enters m_{cc} additively. The structure is then under-identified and an additional restriction, for example $\mathbb{E}(\eta^2_{c,w_1(i)}) = \mathbb{E}(\eta^2_{c,w_2(i)})$, suffices for identification of all parameters including the variance of the error. The variance of earnings error enters $m_{y_jy_j}$ additively while the covariance between the error in earnings and the error in wages enters $m_{y_jw_j}$ (this is because wages are constructed as earnings over hours; see section 4.1). The latter two moments of the error are available from the validation study of Bound et al. (1994), thus necessitate no additional restrictions.

Identification of higher moments obeys a similar idea: consumption skewness reflects skewness in wage shocks as well as skewness in consumption preferences; earnings kurtosis reflects kurtosis in the distribution of shocks as well as in labor supply preferences, etc. Practically, however, identification is less parsimonious due to the ever-increasing number of parameters involved. As an illustration, the four parameters for (co-)skewness in the $\eta_{c,w_j(i)}$'s are over-identified by $\mathbb{E}((\Delta c_{it})^2 \Delta c_{it+1})$, $\mathbb{E}(\Delta w_{jit-1}(\Delta c_{it})^2 \Delta c_{it+1})$ and $\mathbb{E}((\Delta w_{jit-1})^2(\Delta c_{it})^2 \Delta c_{it+1})$, $j = \{1, 2\}$. Third and fourth moments alone do not suffice to identify all four parameters unless one restricts co-skewness in the $\eta_{c,w_j(i)}$'s. To avoid such restrictions, the fifth moment above provides the additional identifying equation that completes identification. All other third moments of wage elasticities are identified in a similar way.

The discussion extends to the n^{th} moment of wage elasticities. This involves an ever-longer intertemporal product of consumption or earnings (for consumption: $\prod_{\tau=0}^{n-3} \Delta c_{it-\tau} \Delta c_{it} \Delta c_{it+1}$, $n \geq 3$) as well as empirical moments of order at least $n+2$. The data requirements quickly become tedious and restrictions on higher cross-moments only partly alleviate such requirements. This is the reason why in this paper I focus on first and second moments only.

D Consumption, Earnings, and Hours Inequality

To simplify the illustration of the derivation of consumption inequality, I write consumption growth as $\Delta c_{it} \approx \psi_{1i} \Delta u_{1it} + \psi_{2i} \Delta u_{2it} + \phi_{1it} v_{1it} + \phi_{2it} v_{2it}$. This mimics expression (5) in the main text with $\psi_{ji} = \psi_j(\boldsymbol{\eta}_i)$ and $\phi_{jit} = \phi_j(\boldsymbol{\eta}_i, \pi_{it}, \mathbf{s}_{it})$ for appropriate functions $\psi_j(\cdot)$ and $\phi_j(\cdot)$.

From the properties of the variance operator it follows that

$$\begin{aligned}
\mathrm{Var}\left(\Delta c_{it}\right) \approx\ & \mathrm{Var}\left(\psi_{1i} \Delta u_{1it}\right) + \mathrm{Var}\left(\psi_{2i} \Delta u_{2it}\right) + \mathrm{Var}\left(\phi_{1it} v_{1it}\right) + \mathrm{Var}\left(\phi_{2it} v_{2it}\right) \\
&+ 2\mathrm{Cov}\left(\psi_{1i} \Delta u_{1it}, \psi_{2i} \Delta u_{2it}\right) + 2\mathrm{Cov}\left(\psi_{1i} \Delta u_{1it}, \phi_{1it} v_{1it}\right) \\
&+ 2\mathrm{Cov}\left(\psi_{1i} \Delta u_{1it}, \phi_{2it} v_{2it}\right) + 2\mathrm{Cov}\left(\psi_{2i} \Delta u_{2it}, \phi_{1it} v_{1it}\right) \\
&+ 2\mathrm{Cov}\left(\psi_{2i} \Delta u_{2it}, \phi_{2it} v_{2it}\right) + 2\mathrm{Cov}\left(\phi_{1it} v_{1it}, \phi_{2it} v_{2it}\right).
\end{aligned}$$

Using results from Goodman (1960) and noting that (i) shocks have zero means and (ii) wage shocks are independent of preferences, π_{it}, and $\mathbf{s}_{it}$, hence also independent of ψ_{ji} and ϕ_{jit}, $\mathrm{Var}\left(\psi_{1i} \Delta u_{1it}\right)$ becomes equal to $\mathbb{E}\left(\psi_{1i}^2\right) \mathrm{Var}\left(\Delta u_{1it}\right)$ and similarly for the other variances too. Using results from Bohrnstedt and Goldberger (1969) it can be shown that most covariances are zero except those involving exclusively transitory shocks only or permanent shocks only. Most covariances are zero because of (i) and (ii), and (iii) permanent and transitory shocks are independent. The non-zero covariances are $\mathrm{Cov}\left(\psi_{1i} \Delta u_{1it}, \psi_{2i} \Delta u_{2it}\right) = \mathbb{E}\left(\psi_{1i}\psi_{2i}\right) \mathrm{Cov}\left(\Delta u_{1it}, \Delta u_{2it}\right)$ and similarly for $\mathrm{Cov}\left(\phi_{1it} v_{1it}, \phi_{2it} v_{2it}\right)$.

Relying on these results, the analytical expression for hours inequality is given by

$$\begin{aligned}
\mathrm{Var}\left(\Delta h_{jit}\right) \approx\ & \mathbb{E}(\eta_{h_j,w_1(i)}^2) \times \left(\sigma_{u_1(t)}^2 + \sigma_{u_1(t-1)}^2\right) + \mathbb{E}(\eta_{h_j,w_2(i)}^2) \times \left(\sigma_{u_2(t)}^2 + \sigma_{u_2(t-1)}^2\right) \\
&+ 2\mathbb{E}(\eta_{h_j,w_1(i)} \eta_{h_j,w_2(i)}) \times \left(\sigma_{u_1 u_2(t)} + \sigma_{u_1 u_2(t-1)}\right) \\
&+ \mathbb{E}\left(\left(\eta_{h_j,w_1(i)} + \bar{\eta}_{h_j(i)} \varepsilon_1(\pi_{it}, \mathbf{s}_{it}; \boldsymbol{\eta}_i)\right)^2\right) \times \sigma_{v_1(t)}^2
\end{aligned}$$

$$+\,\mathbb{E}\left(\left(\eta_{h_j,w_2(i)}+\bar{\eta}_{h_j(i)}\varepsilon_2(\pi_{it},\mathbf{s}_{it};\boldsymbol{\eta}_i)\right)^2\right)\times\sigma^2_{v_2(t)}$$

$$+\,2\mathbb{E}\left(\left(\eta_{h_j,w_1(i)}+\bar{\eta}_{h_j(i)}\varepsilon_1(\pi_{it},\mathbf{s}_{it};\boldsymbol{\eta}_i)\right)\left(\eta_{h_j,w_2(i)}+\bar{\eta}_{h_j(i)}\varepsilon_2(\pi_{it},\mathbf{s}_{it};\boldsymbol{\eta}_i)\right)\right)\times\sigma_{v_1v_2(t)},$$

for $j=\{1,2\}$. The expression for $\text{Var}\left(\Delta y_{jit}\right)$ follows from the identity $\Delta y_{jit}=\Delta h_{jit}+\Delta w_{jit}$.

E Estimation Details and Additional Results

This appendix details the estimation of the spousal shares of human wealth s_{jit} and the 'partial insurance' coefficient π_{it}. In addition, it reports the empirical and fitted values of all moments targeted in the structural estimation, a number of robustness checks, as well as a comparison of my results with those of BPS.

Estimation of $\mathbf{s}_{it}$ and π_{it}. Parameters $\mathbf{s}_{it}=(s_{1it},s_{2it})'$ and π_{it} are used in the simulations of consumption growth *after* the moments of wage elasticities are estimated. The simulations of Δc_{it} are required in the estimation of $\eta_{c,p}$ and the discussion of consumption inequality in section 5.1 and partial insurance in section 5.2. From appendix A, $s_{jit}\approx\overline{\overline{Y}}_{jit}/\overline{\overline{Y}}_{it}$ and $\pi_{it}\approx\text{Assets}_{it}/(\text{Assets}_{it}+\overline{\overline{Y}}_{it})$, where $\overline{\overline{Y}}_{jit}=Y_{jit}+\mathbb{E}_t\sum_{\varsigma=1}^{T}\frac{Y_{jit+\varsigma}}{(1+r)^\varsigma}$ is spouse j's human wealth at the beginning of time t, namely the expected discounted stream of lifetime earnings between t and the end of working life. Y_{jit} is spouse j's labor earnings at t. $\overline{\overline{Y}}_{it}=\sum_j\overline{\overline{Y}}_{jit}$ is the sum of human wealth in the household.

The main difficulty in estimating s_{jit} is that human wealth conforms to expectations through $\mathbb{E}_tY_{jit+\varsigma}$. I follow BPS and estimate this as follows. I pool earnings across all periods and I regress them on a set of predictable characteristics including a cubic polynomial in age, year of birth, race and education dummies, as well as interactions of the polynomial with the race and education dummies. I summarize this regression as $Y_{jit}=\mathbf{Q}'_{jit}\boldsymbol{\delta}_j+\epsilon_{jit}$. I then obtain $\mathbb{E}_tY_{jit+\varsigma}$ as the appropriate fitted value from this regression, i.e. $\mathbb{E}_tY_{jit+\varsigma}=\mathbf{Q}'_{jit+\varsigma}\hat{\boldsymbol{\delta}}_j$. I set the discount rate at 2% annually and the end of working life at 65. This allows me to construct s_{jit}, $j=\{1,2\}$, and π_{it} as assets/wealth are directly observed in the PSID. Table E.1 presents summary statistics. I estimate $\mathbb{E}(s_{1it})=0.616$ and $\mathbb{E}(\pi_{it})=0.187$. The averages as well as the patterns of s_{1it} and π_{it} with age are similar to BPS.

Table E.1 – Summary Statistics for s and π

s_{1it}					π_{it}				
mean	med.	st.d.	min	max	mean	med.	st.d.	min	max
0.616	0.621	0.091	0.125	0.996	0.187	0.129	0.179	0.000	0.959

Notes: The table presents summary statistics for men's share of human wealth (s_{1it}) and for the partial insurance coefficient (π_{it}) in the baseline sample. Women's share of human wealth is $s_{2it}=1-s_{1it}$.

Targeted moments. The estimation of the model (stages 2 & 3) targets 80 moments of the joint distribution of wages, earnings, and consumption. The number of targeted moments increases to more than 400 if the distribution can vary with time. Tables E.2-E.4 list the targeted moments alongside their empirical and fitted values. Block bootstrap standard errors for the empirical moments are in parentheses based on 1,000 bootstrap replications.

The reported t-statistics are for the null hypothesis that the respective theoretical moment equals its empirical counterpart. More than 90% of targeted moments are associated with an absolute t-statistic lower than the rule of thumb of 1.96. The magnitude and standard error of most of the 7 moments for which $|t\text{-stat}| > 1.96$ are very small making small and economically unimportant departures from the target value easier to generate large t-statistics.

Robustness. Table E.5 presents estimates of the first and second moments of wage elasticities removing extreme observations of wages, earnings and consumption. Column (3) trims the bottom 0.5% and top 0.5% of the distribution of wages. This drops 3.46% of the baseline sample of table 2 because the condition applies separately to male and female wages and results additionally in dropping households that now appear in the sample only once. Column (4) trims the bottom 2% and top 2% of the distribution of wages (drops 12.33% of the baseline sample) and column (5) trims the bottom 0.5% and top 0.5% of the distribution of wages, earnings and consumption (drops 5.12% of the baseline sample). Column (1) duplicates the baseline results of tables 5-6. The parameters, particularly the variance of the consumption-wage elasticities, are remarkably robust. The largest differences from the baseline appear in the sample of column (4) where the magnitude of $\text{Var}(\eta_{c,w_j(i)})$ and $\mathbb{E}(\eta_{h_2,w_2(i)})$ increase substantially.

Comparison with BPS. Column (2) presents the benchmark results of BPS who find weak evidence of Frisch substitution between consumption and male hours ($\eta_{c,w_1} = -0.15$, $s.e. = 0.06$) and larger labor supply elasticities. BPS estimate the elasticities from the joint response of consumption and hours to transitory *and* permanent shocks while I only use the former.[40] The latter response is the sum of two forces: a compensated response to wages (substitution effect) and an uncompensated response through the lifetime budget constraint (income effect). Despite strong positive (negative) income effects on consumption (labor supply), BPS find an overall excess smoothness of consumption and hours to permanent shocks. This is reconciled by large substitution effects of opposite sign, namely negative consumption elasticities and large positive labor supply elasticities. A companion report (Theloudis, 2017) details the role of the income effect for the estimation of each parameter.

[40] I only use the response to transitory shocks in order to keep the empirical information consistent across specifications in tables 5-6. With unobserved preference heterogeneity I cannot target moments of the consumption and hours response to permanent shocks unless I impose strong parametric form assumptions.

Table E.2 – Targeted Wage Moments

	data	model	t-stat. diff.		data	model	t-stat. diff.
$\mathbb{E}((\Delta w_{1t})^2)$	0.132	0.132	0.000	$\mathbb{E}((\Delta w_{1t})^2 \Delta w_{2t})$	0.007	0.007	0.000
	(0.010)				(0.004)		
$\mathbb{E}(\Delta w_{1t} \Delta w_{1t'})$	-0.029	-0.029	-0.000	$\mathbb{E}((\Delta w_{1t})^2 \Delta w_{2t'})$	-0.012	-0.000	0.843
	(0.005)				(0.014)		
$\mathbb{E}((\Delta w_{2t})^2)$	0.098	0.098	0.000	$\mathbb{E}((\Delta w_{1t'})^2 \Delta w_{2t})$	-0.005	0.000	1.578
	(0.008)				(0.004)		
$\mathbb{E}(\Delta w_{2t} \Delta w_{2t'})$	-0.013	-0.013	-0.002	$\mathbb{E}(\Delta w_{1t} (\Delta w_{2t})^2)$	0.001	0.001	0.000
	(0.004)				(0.003)		
$\mathbb{E}(\Delta w_{1t} \Delta w_{2t})$	0.017	0.017	-0.000	$\mathbb{E}(\Delta w_{1t} (\Delta w_{2t'})^2)$	0.001	-0.000	-0.722
	(0.003)				(0.003)		
$\mathbb{E}(\Delta w_{1t} \Delta w_{2t'})$	-0.005	-0.004	0.253	$\mathbb{E}(\Delta w_{1t'} (\Delta w_{2t})^2)$	0.002	0.000	-0.466
	(0.003)				(0.003)		
$\mathbb{E}(\Delta w_{1t'} \Delta w_{2t})$	-0.003	-0.004	-0.270	$\mathbb{E}(\Delta w_{1t} \Delta w_{1t'} \Delta w_{2t})$	0.003	-0.000	-1.407
	(0.003)				(0.002)		
$\mathbb{E}((\Delta w_{1t})^3)$	-0.010	-0.010	0.000	$\mathbb{E}(\Delta w_{1t} \Delta w_{1t'} \Delta w_{2t'})$	-0.003	0.000	1.398
	(0.016)				(0.002)		
$\mathbb{E}(\Delta w_{1t} (\Delta w_{1t'})^2)$	-0.006	-0.017	-1.423	$\mathbb{E}(\Delta w_{1t} \Delta w_{2t} \Delta w_{2t'})$	0.001	0.000	-0.226
	(0.007)				(0.002)		
$\mathbb{E}(\Delta w_{1t'} (\Delta w_{1t})^2)$	0.027	0.017	-1.017	$\mathbb{E}(\Delta w_{1t'} \Delta w_{2t} \Delta w_{2t'})$	-0.001	-0.000	0.137
	(0.011)				(0.002)		
$\mathbb{E}((\Delta w_{2t})^3)$	-0.035	-0.035	0.000				
	(0.011)						
$\mathbb{E}(\Delta w_{2t} (\Delta w_{2t'})^2)$	-0.003	-0.008	-0.983				
	(0.005)						
$\mathbb{E}(\Delta w_{2t'} (\Delta w_{2t})^2)$	0.013	0.008	-0.836				
	(0.006)						

Notes: The table presents the list of targeted wage moments alongside their empirical and theoretical values. Empirical moments are net of measurement error. Block bootstrap standard errors for the empirical moments are in parentheses based on 1,000 bootstrap replications. The reported t-statistic is for the null hypothesis that $\textit{theoretical moment} - \textit{empirical moment} = 0$. $t' \equiv t + 1$.

Table E.3 – Targeted Earnings Moments

	data	model	t-stat. diff.		data	model	t-stat. diff.
$\mathbb{E}(\Delta w_{1t}\Delta y_{1t'})$	-0.036	-0.036	-0.021	$\mathbb{E}((\Delta w_{1t})^2\Delta y_{2t'})$	0.001	-0.000	-0.201
	(0.005)				(0.005)		
$\mathbb{E}(\Delta w_{1t'}\Delta y_{1t})$	-0.033	-0.036	-0.494	$\mathbb{E}((\Delta w_{1t'})^2\Delta y_{2t})$	0.002	0.000	-0.277
	(0.005)				(0.004)		
$\mathbb{E}(\Delta w_{2t}\Delta y_{1t'})$	-0.004	-0.005	-0.270	$\mathbb{E}((\Delta w_{2t})^2\Delta y_{2t'})$	0.017	0.011	-1.184
	(0.003)				(0.006)		
$\mathbb{E}(\Delta w_{2t'}\Delta y_{1t})$	-0.003	-0.005	-0.755	$\mathbb{E}((\Delta w_{2t'})^2\Delta y_{2t})$	-0.004	-0.011	-0.890
	(0.003)				(0.007)		
$\mathbb{E}(\Delta w_{1t}\Delta y_{2t'})$	-0.004	-0.006	-0.449	$\mathbb{E}(\Delta w_{1t}(\Delta y_{1t'})^2)$	-0.021	-0.027	-0.804
	(0.003)				(0.007)		
$\mathbb{E}(\Delta w_{1t'}\Delta y_{2t})$	0.000	-0.006	-1.741	$\mathbb{E}(\Delta w_{1t'}(\Delta y_{1t})^2)$	0.035	0.027	-0.798
	(0.003)				(0.010)		
$\mathbb{E}(\Delta w_{2t}\Delta y_{2t'})$	-0.035	-0.018	3.179	$\mathbb{E}(\Delta w_{2t}(\Delta y_{1t'})^2)$	-0.004	0.001	1.258
	(0.005)				(0.003)		
$\mathbb{E}(\Delta w_{2t'}\Delta y_{2t})$	-0.033	-0.018	2.610	$\mathbb{E}(\Delta w_{2t'}(\Delta y_{1t})^2)$	-0.009	-0.001	0.726
	(0.006)				(0.012)		
$\mathbb{E}(\Delta y_{1t}\Delta y_{1t'})$	-0.045	-0.047	-0.296	$\mathbb{E}(\Delta w_{1t}(\Delta y_{2t'})^2)$	0.005	-0.001	-1.512
	(0.005)				(0.004)		
$\mathbb{E}(\Delta y_{1t}\Delta y_{2t'})$	-0.007	-0.007	0.040	$\mathbb{E}(\Delta w_{1t'}(\Delta y_{2t})^2)$	0.000	0.001	0.058
	(0.003)				(0.005)		
$\mathbb{E}(\Delta y_{1t'}\Delta y_{2t})$	-0.002	-0.007	-1.236	$\mathbb{E}(\Delta w_{2t}(\Delta y_{2t'})^2)$	-0.005	-0.014	-1.355
	(0.004)				(0.007)		
$\mathbb{E}(\Delta y_{2t}\Delta y_{2t'})$	-0.024	-0.025	-0.101	$\mathbb{E}(\Delta w_{2t'}(\Delta y_{2t})^2)$	0.007	0.014	1.046
	(0.006)				(0.007)		
$\mathbb{E}((\Delta w_{1t})^2\Delta y_{1t'})$	0.033	0.021	-1.056	$\mathbb{E}(\Delta w_{1t}\Delta y_{1t'}\Delta y_{2t'})$	-0.005	0.001	2.473
	(0.012)				(0.002)		
$\mathbb{E}((\Delta w_{1t'})^2\Delta y_{1t})$	-0.016	-0.021	-0.643	$\mathbb{E}(\Delta w_{1t'}\Delta y_{1t}\Delta y_{2t})$	-0.001	-0.001	0.052
	(0.007)				(0.003)		
$\mathbb{E}((\Delta w_{2t})^2\Delta y_{1t'})$	-0.001	0.001	0.723	$\mathbb{E}(\Delta w_{2t}\Delta y_{1t'}\Delta y_{2t'})$	-0.002	-0.001	0.878
	(0.003)				(0.002)		
$\mathbb{E}((\Delta w_{2t'})^2\Delta y_{1t})$	0.002	-0.001	-1.063	$\mathbb{E}(\Delta w_{2t'}\Delta y_{1t}\Delta y_{2t})$	-0.003	0.001	1.243
	(0.002)				(0.003)		

Notes: The table presents the list of targeted earnings moments alongside their empirical and theoretical values. Empirical moments are net of measurement error. Block bootstrap standard errors for the empirical moments are in parentheses based on 1,000 bootstrap replications. The reported t-statistic is for the null hypothesis that $\textit{theoretical moment} - \textit{empirical moment} = 0$. $t' \equiv t + 1$.

Table E.4 – Targeted Consumption Moments

	data	model	t-stat. diff.		data	model	t-stat. diff.
$\mathbb{E}(\Delta w_{1t}\Delta c_{t'})$	-0.001	0.002	1.240	$\mathbb{E}(\Delta w_{1t}(\Delta c_{t'})^2)$	-0.000	-0.006	-6.648
	(0.002)				(0.001)		
$\mathbb{E}(\Delta w_{1t'}\Delta c_{t})$	0.000	0.002	0.631	$\mathbb{E}(\Delta w_{1t'}(\Delta c_{t})^2)$	-0.001	0.006	7.172
	(0.002)				(0.001)		
$\mathbb{E}(\Delta w_{2t}\Delta c_{t'})$	-0.000	0.001	0.587	$\mathbb{E}(\Delta w_{2t}(\Delta c_{t'})^2)$	0.001	-0.003	-7.947
	(0.002)				(0.001)		
$\mathbb{E}(\Delta w_{2t'}\Delta c_{t})$	0.002	0.001	-0.836	$\mathbb{E}(\Delta w_{2t'}(\Delta c_{t})^2)$	-0.000	0.003	4.849
	(0.002)				(0.001)		
$\mathbb{E}(\Delta y_{1t}\Delta c_{t'})$	-0.005	-0.002	1.171	$\mathbb{E}(\Delta w_{1t}\Delta y_{1t'}\Delta c_{t'})$	-0.002	-0.001	0.757
	(0.002)				(0.002)		
$\mathbb{E}(\Delta y_{1t'}\Delta c_{t})$	0.001	-0.002	-1.448	$\mathbb{E}(\Delta w_{1t'}\Delta y_{1t}\Delta c_{t})$	0.000	0.001	0.525
	(0.002)				(0.002)		
$\mathbb{E}(\Delta y_{2t}\Delta c_{t'})$	0.001	0.001	0.032	$\mathbb{E}(\Delta w_{2t}\Delta y_{1t'}\Delta c_{t'})$	0.001	0.000	-1.213
	(0.002)				(0.001)		
$\mathbb{E}(\Delta y_{2t'}\Delta c_{t})$	0.002	0.001	-0.818	$\mathbb{E}(\Delta w_{2t'}\Delta y_{1t}\Delta c_{t})$	-0.001	0.000	0.983
	(0.002)				(0.001)		
$\mathbb{E}(\Delta c_{t}\Delta c_{t'})$	-0.018	-0.018	0.000	$\mathbb{E}(\Delta w_{1t}\Delta y_{2t'}\Delta c_{t'})$	0.001	0.000	-1.012
	(0.001)				(0.001)		
$\mathbb{E}((\Delta w_{1t})^2\Delta c_{t'})$	-0.005	-0.001	0.617	$\mathbb{E}(\Delta w_{1t'}\Delta y_{2t}\Delta c_{t})$	0.002	0.000	-1.790
	(0.007)				(0.001)		
$\mathbb{E}((\Delta w_{1t'})^2\Delta c_{t})$	0.004	0.001	-0.890	$\mathbb{E}(\Delta w_{2t}\Delta y_{2t'}\Delta c_{t'})$	0.000	0.000	0.017
	(0.003)				(0.001)		
$\mathbb{E}((\Delta w_{2t})^2\Delta c_{t'})$	0.000	-0.000	-0.383	$\mathbb{E}(\Delta w_{2t'}\Delta y_{2t}\Delta c_{t})$	0.000	-0.000	-0.292
	(0.002)				(0.001)		
$\mathbb{E}((\Delta w_{2t'})^2\Delta c_{t})$	-0.001	0.000	0.489				
	(0.002)						

Notes: The table presents the list of targeted consumption moments alongside their empirical and theoretical values. Empirical moments are net of measurement error. Block bootstrap standard errors for the empirical moments are in parentheses based on 1,000 bootstrap replications. The reported t-statistic is for the null hypothesis that $\textit{theoretical moment} - \textit{empirical moment} = 0$. $t' \equiv t+1$.

Table E.5 – Robustness

	(1) Baseline	(2) BPS	(3) Central 99% of distribution of wages	(4) Central 96% of distribution of wages	(5) Central 99% of distribution of W_j, Y_j, C
Mean consumption elasticities					
$\mathbb{E}(\eta_{c,w_1(i)})$	-0.056	-0.148	-0.011	-0.021	-0.045
	(0.070)	(0.060)	(0.058)	(0.060)	(0.070)
$\mathbb{E}(\eta_{c,w_2(i)})$	-0.024	-0.030	-0.021	0.008	0.016
	(0.074)	(0.059)	(0.072)	(0.108)	(0.071)
Mean labor supply elasticities					
$\mathbb{E}(\eta_{h_1,w_1(i)})$	0.239	0.594	0.097	0.204	0.110
	(0.095)	(0.155)	(0.097)	(0.103)	(0.102)
$\mathbb{E}(\eta_{h_2,w_2(i)})$	0.366	0.871	0.329	0.543	0.340
	(0.194)	(0.221)	(0.170)	(0.212)	(0.170)
Variances [p-values in brackets]					
$\mathrm{V}(\eta_{c,w_1(i)})$	0.346		0.324	0.538	0.324
	[0.003]		[0.001]	[0.008]	[0.002]
$\mathrm{V}(\eta_{c,w_2(i)})$	0.346		0.324	0.538	0.324
	[0.003]		[0.001]	[0.008]	[0.002]
$\mathrm{V}(\eta_{h_1,w_1(i)})$	0.076		0.180	0.003	0.167
	[0.249]		[0.100]	[0.223]	[0.142]
Covariances					
$\mathrm{C}(\eta_{c,w_1(i)}, \eta_{c,w_2(i)})$	0.346		0.324	0.538	0.324
	(0.092)		(0.085)	(0.156)	(0.088)
$\mathrm{C}(\eta_{c,w_1(i)}, \eta_{h_1,w_1(i)})$	0.136		0.039	0.025	0.094
	(0.071)		(0.040)	(0.047)	(0.064)
$\mathrm{C}(\eta_{c,w_2(i)}, \eta_{h_1,w_1(i)})$	0.136		0.039	0.025	0.094
	(0.071)		(0.040)	(0.047)	(0.064)

Notes: The table presents GMM estimates of the first and second moments of wage elasticities. Column (1) duplicates the baseline results of tables 5-6. Column (2) reports estimates from table 4 column 2 in BPS. BPS estimate the parameters from the joint response of consumption and family labor supply to permanent and transitory shocks whereas I exploit the response to transitory shocks only. Column (3) removes extreme observations of male and female wages trimming the bottom 0.5% and top 0.5% of the respective distributions. Column (4) extends this by trimming the bottom 2.0% and top 2.0% of the wage distributions. Column (5) removes extreme observations of wages, earnings, and consumption trimming the bottom 0.5% and top 0.5% of the respective distributions. Standard errors appear in parentheses and, whenever applicable, p-values in square brackets for the one-sided test that the respective parameter equals zero.

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