Consumption Smoothing, Assets and Family Labor Supply

Richard Blundell *University College London & IFS*

ECB October 2013

MOTIVATION

- Based on recent work with Luigi Pistaferri and Itay Eksten at Stanford: "Consumption Inequality and Family Labor Supply".

MOTIVATION

- Based on recent work with Luigi Pistaferri and Itay Eksten at Stanford: "Consumption Inequality and Family Labor Supply".
- In this work we note that inequality has many dimensions:
  - Wages→ earnings→ joint earnings→ income→ consumption

Motivation

- Based on recent work with Luigi Pistaferri and Itay Eksten at Stanford: "Consumption Inequality and Family Labor Supply".
- In this work we note that inequality has many dimensions:
  - Wages→ earnings→ joint earnings→ income→ consumption
  - Focus on labor market shocks as the primitive source of uncertainty.

MOTIVATION

- Based on recent work with Luigi Pistaferri and Itay Eksten at Stanford: "Consumption Inequality and Family Labor Supply".
- In this work we note that inequality has many dimensions:
  - Wages→ earnings→ joint earnings→ income→ consumption
  - Focus on labor market shocks as the primitive source of uncertainty.
- The link between the various types of inequality is mediated by multiple 'insurance' mechanisms

Motivation

- Based on recent work with Luigi Pistaferri and Itay Eksten at Stanford: "Consumption Inequality and Family Labor Supply".
- In this work we note that inequality has many dimensions:
  - Wages→ earnings→ joint earnings→ income→ consumption
  - Focus on labor market shocks as the primitive source of uncertainty.
- The link between the various types of inequality is mediated by multiple 'insurance' mechanisms, including:
  - Labor supply: family labor supply (wages→ earnings→ joint earnings)
  - Taxes and welfare: (earnings→ income)
  - Assets: Saving and borrowing (income→ consumption)
  - Informal contracts, gifts, etc.

Motivation

- Based on recent work with Luigi Pistaferri and Itay Eksten at Stanford: "Consumption Inequality and Family Labor Supply".
- In this work we note that inequality has many dimensions:
  - Wages→ earnings→ joint earnings→ income→ consumption
  - Focus on labor market shocks as the primitive source of uncertainty.
- The link between the various types of inequality is mediated by multiple 'insurance' mechanisms, including:
  - Labor supply: family labor supply (wages→ earnings→ joint earnings)
  - Taxes and welfare: (earnings→ income)
  - Assets: Saving and borrowing (income→ consumption)
  - Informal contracts, gifts, etc.
- But how important are each of these mechanisms?

Overview

- Focus on how families deal with labor market shocks.

Overview

- Focus on how families deal with labor market shocks.
- Investigate how assets and labor market shocks combine to impact on consumption.

Overview

- Focus on how families deal with labor market shocks.
- Investigate how assets and labor market shocks combine to impact on consumption.
- Point to the importance of constructing panel/administrative linked data that allow all three measures.

Overview

- Focus on how families deal with labor market shocks.
- Investigate how assets and labor market shocks combine to impact on consumption.
- Point to the importance of constructing panel/administrative linked data that allow all three measures.
- With Luigi and Itay we make use of the new PSID data on consumption, earnings and assets.

OVERVIEW

- Focus on how families deal with labor market shocks.
- Investigate how assets and labor market shocks combine to impact on consumption.
- Point to the importance of constructing panel/administrative linked data that allow all three measures.
- With Luigi and Itay we make use of the new PSID data on consumption, earnings and assets.
- We show that family labor supply, credit market and the tax/welfare system all have key roles to play in the 'insurance' of shocks. Credit and family labor supply act together to insure shocks.

Overview

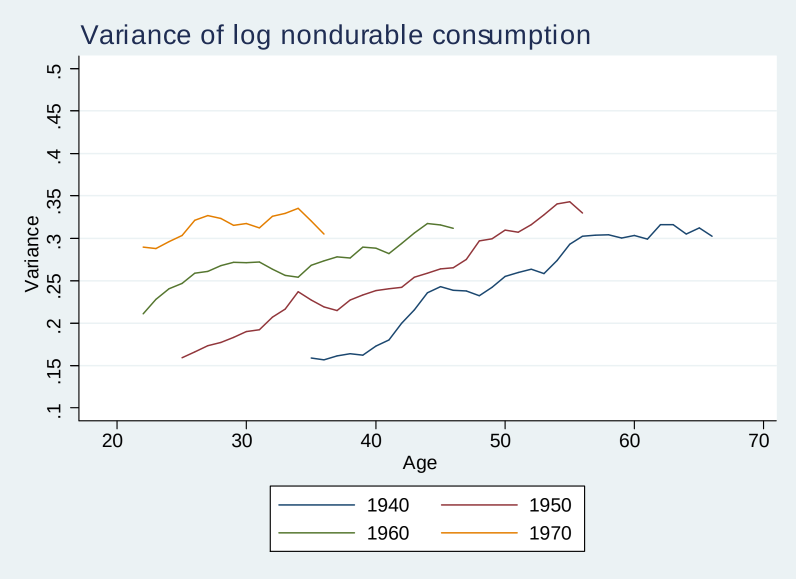
- Focus on how families deal with labor market shocks.
- Investigate how assets and labor market shocks combine to impact on consumption.
- Point to the importance of constructing panel/administrative linked data that allow all three measures.
- With Luigi and Itay we make use of the new PSID data on consumption, earnings and assets.
- We show that family labor supply, credit market and the tax/welfare system all have key roles to play in the 'insurance' of shocks. Credit and family labor supply act together to insure shocks.
- Finding: Once assets, family labor supply and taxes (and welfare) are properly accounted for, we can explain the link between these series and there is less evidence for additional insurance.

Overview

- Focus on how families deal with labor market shocks.
- Investigate how assets and labor market shocks combine to impact on consumption.
- Point to the importance of constructing panel/administrative linked data that allow all three measures.
- With Luigi and Itay we make use of the new PSID data on consumption, earnings and assets.
- We show that family labor supply, credit market and the tax/welfare system all have key roles to play in the 'insurance' of shocks. Credit and family labor supply act together to insure shocks.
- Finding: Once assets, family labor supply and taxes (and welfare) are properly accounted for, we can explain the link between these series and there is less evidence for additional insurance.
- Some consumption inequality descriptives....

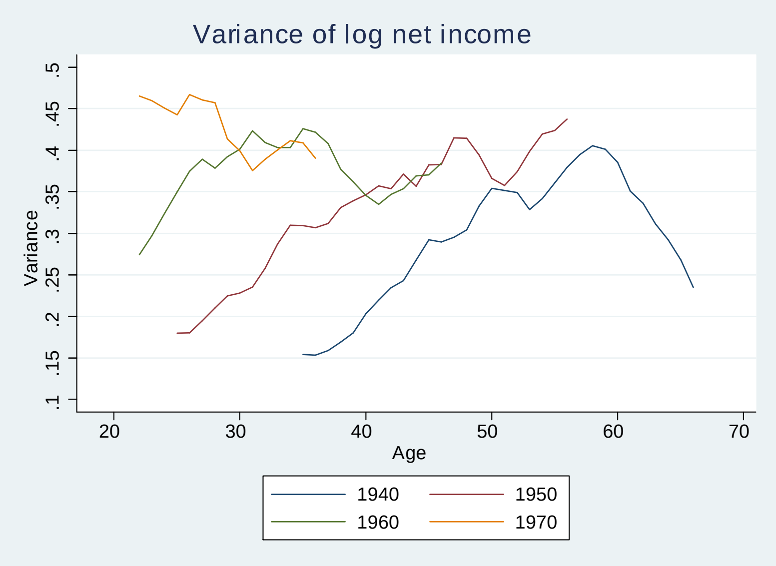
Consumption Inequality in the UK

By age and birth cohort



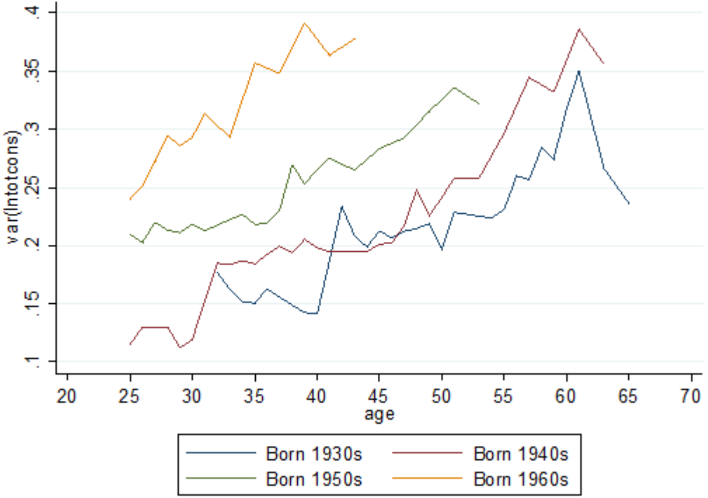
Income Inequality in the UK

By age and birth cohort



Consumption Inequality in the US

By age and birth cohort



- The existing literature (references in paper) usually relates movements in consumption to predictable and unpredictable income changes as well as persistent and non-persistent shocks to economic resources.

- The existing literature (references in paper) usually relates movements in consumption to predictable and unpredictable income changes as well as persistent and non-persistent shocks to economic resources.
- A little background on the empirical strategy for income and consumption dynamics behind these results...

INCOME DYNAMICS

Consider consumer i (of age a) in time period t, has log income $y_{it}(\equiv \ln Y_{i,a,t})$ written

$$y_{it} = Z'_{it}\varphi + f_{0i} + p_t f_{1i} + y^P_{it} + y^T_{it}$$

Income Dynamics

Consider consumer i (of age a) in time period t, has log income $y_{it}(\equiv \ln Y_{i,a,t})$ written

$$y_{it} = Z'_{it}\varphi + f_{0i} + p_t f_{1i} + y^P_{it} + y^T_{it}$$

where y^P_{it} is a persistent process of income shocks, say

$$y^P_{it} = \rho y^P_{it-1} + v_{it}$$

Income Dynamics

Consider consumer i (of age a) in time period t, has log income $y_{it}(\equiv \ln Y_{i,a,t})$ written

$$y_{it} = Z'_{it}\varphi + f_{0i} + p_t f_{1i} + y^P_{it} + y^T_{it}$$

where y^P_{it} is a persistent process of income shocks, say

$$y^P_{it} = \rho y^P_{it-1} + v_{it}$$

which adds to the individual-specific trend $p_t f_i$ and where y^T_{it} is a transitory shock represented by some low order MA process, say

$$y^T_{it} = \varepsilon_{it} + \theta_1 \varepsilon_{i,t-1}$$

Income Dynamics

Consider consumer i (of age a) in time period t, has log income $y_{it}(\equiv \ln Y_{i,a,t})$ written

$$y_{it} = Z_{it}'\varphi + f_{0i} + p_t f_{1i} + y_{it}^P + y_{it}^T$$

where y_{it}^P is a persistent process of income shocks, say

$$y_{it}^P = \rho y_{it-1}^P + v_{it}$$

which adds to the individual-specific trend $p_t f_i$ and where y_{it}^T is a transitory shock represented by some low order MA process, say

$$y_{it}^T = \varepsilon_{it} + \theta_1 \varepsilon_{i,t-1}$$

- A key consideration is to allow variances (or factor loadings) of y^P and y^T to vary with age/time for each birth cohort.

Income Dynamics

Consider consumer i (of age a) in time period t, has log income $y_{it}(\equiv \ln Y_{i,a,t})$ written

$$y_{it} = Z'_{it}\varphi + f_{0i} + p_t f_{1i} + y^P_{it} + y^T_{it}$$

where y^P_{it} is a persistent process of income shocks, say

$$y^P_{it} = \rho y^P_{it-1} + v_{it}$$

which adds to the individual-specific trend $p_t f_i$ and where y^T_{it} is a transitory shock represented by some low order MA process, say

$$y^T_{it} = \varepsilon_{it} + \theta_1 \varepsilon_{i,t-1}$$

• A key consideration is to allow variances (or factor loadings) of y^P and y^T to vary with age/time for each birth cohort.
• Find $p_t f_{1i}$ to be less important and ρ closer to unity, especially in the 30-59 age selection.

INCOME DYNAMICS

Consider consumer i (of age a) in time period t, has log income $y_{it}(\equiv \ln Y_{i,a,t})$ written

$$y_{it} = Z'_{it}\varphi + f_{0i} + p_t f_{1i} + y^P_{it} + y^T_{it}$$

where y^P_{it} is a persistent process of income shocks, say

$$y^P_{it} = \rho y^P_{it-1} + v_{it}$$

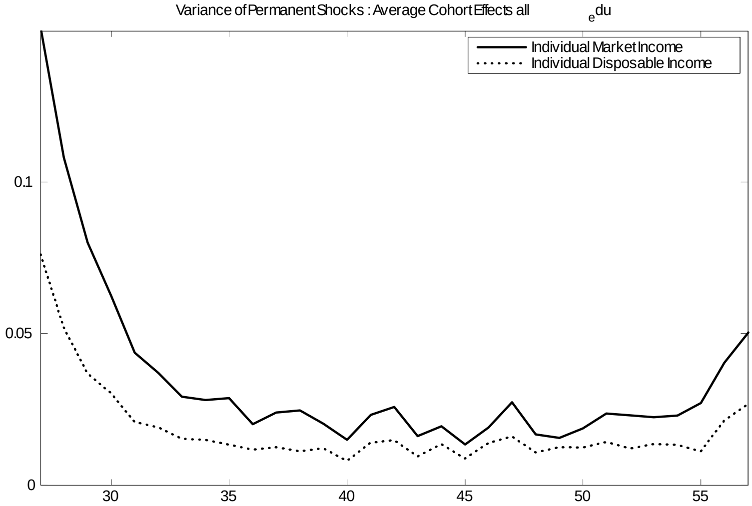
which adds to the individual-specific trend $p_t f_i$ and where y^T_{it} is a transitory shock represented by some low order MA process, say

$$y^T_{it} = \varepsilon_{it} + \theta_1 \varepsilon_{i,t-1}$$

- A key consideration is to allow variances (or factor loadings) of y^P and y^T to vary with age/time for each birth cohort.
- Find $p_t f_{1i}$ to be less important and ρ closer to unity, especially in the 30-59 age selection.
- Detailed work on Norwegian population register panel data....

Life-cycle Income Dynamics

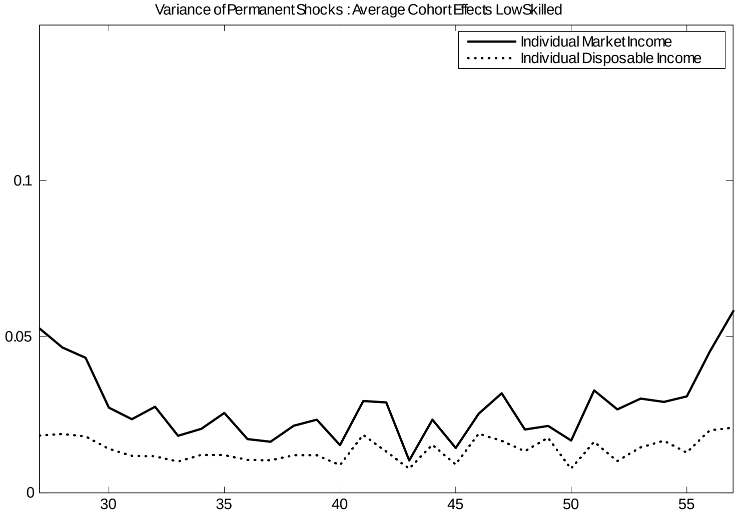
Variance of permanent shocks over the life-cycle



Source: Blundell, Graber and Mogstad (2013), Norwegian Population Panel.

Life-cycle Income Dynamics

Norwegian population panel (low skilled)



Source: Blundell, Graber and Mogstad (2013).

Consumption Growth and Income "Shocks"

To account for the impact of income shocks on consumption we introduce *transmission parameters*: κ_{cvt} and $\kappa_{c\varepsilon t}$, writing consumption growth as:

$$\Delta \ln C_{it} \cong \Gamma_{it} + \Delta Z_{it}' \varphi^c + \kappa_{cvt} v_{it} + \kappa_{c\varepsilon t} \varepsilon_{it} + \xi_{it}$$

Consumption Growth and Income "Shocks"

To account for the impact of income shocks on consumption we introduce *transmission parameters*: κ_{cvt} and $\kappa_{c\varepsilon t}$, writing consumption growth as:

$$\Delta \ln C_{it} \cong \Gamma_{it} + \Delta Z_{it}'\varphi^{c} + \kappa_{cvt} v_{it} + \kappa_{c\varepsilon t}\varepsilon_{it} + \xi_{it}$$

which provides the link between the consumption and income distributions.

Consumption Growth and Income "Shocks"

To account for the impact of income shocks on consumption we introduce *transmission parameters*: κ_{cvt} and $\kappa_{c\varepsilon t}$, writing consumption growth as:

$$\Delta \ln C_{it} \cong \Gamma_{it} + \Delta Z'_{it}\varphi^c + \kappa_{cvt}v_{it} + \kappa_{c\varepsilon t}\varepsilon_{it} + \xi_{it}$$

which provides the link between the consumption and income distributions.

- For example, in Blundell, Low and Preston (QE, 2013) show, for any birth-cohort,

$$\Delta \ln C_{it} \cong \Gamma_{it} + \Delta Z'_{it}\varphi^c + (1-\pi_{it})v_{it} + (1-\pi_{it})\gamma_{Lt}\varepsilon_{it} + \xi_{it}$$

  where

$$\pi_{it} \approx \frac{\text{Assets}_{it}}{\text{Assets}_{it} + \text{Human Wealth}_{it}}$$

  and γ_{Lt} is the annuity value of a transitory shock for an individual aged t retiring at age L.

In this paper we look closer at four key mechanisms:

1. Self-insurance (i.e., savings) through a *direct* measure of π_{it}

In this paper we look closer at four key mechanisms:

1. Self-insurance (i.e., savings) through a *direct* measure of π_{it}
2. Joint labor supply of each earner

In this paper we look closer at four key mechanisms:

1. Self-insurance (i.e., savings) through a *direct* measure of π_{it}
2. Joint labor supply of each earner
3. Non-linear taxes and welfare

In this paper we look closer at four key mechanisms:

1. Self-insurance (i.e., savings) through a *direct* measure of π_{it}
2. Joint labor supply of each earner
3. Non-linear taxes and welfare
4. Other (un-modeled) mechanisms.

IN THIS PAPER WE LOOK CLOSER AT FOUR KEY MECHANISMS:

1. Self-insurance (i.e., savings) through a *direct* measure of π_{it}
2. Joint labor supply of each earner
3. Non-linear taxes and welfare
4. Other (un-modeled) mechanisms. $-$ ► And test for "superior information".

In this paper we look closer at four key mechanisms:

1. Self-insurance (i.e., savings) through a *direct* measure of π_{it}
2. Joint labor supply of each earner
3. Non-linear taxes and welfare
4. Other (un-modeled) mechanisms. – ▶ And test for "superior information".

- **Distinctive features of this paper:**

In this paper we look closer at four key mechanisms:

1. Self-insurance (i.e., savings) through a *direct* measure of π_{it}
2. Joint labor supply of each earner
3. Non-linear taxes and welfare
4. Other (un-modeled) mechanisms. – ► And test for "superior information".

► **Distinctive features of this paper:**

- - Allow for
  - non-separability,
  - heterogeneous assets,
  - correlated shocks to individual wages.

In this paper we look closer at four key mechanisms:

1. Self-insurance (i.e., savings) through a *direct* measure of π_{it}
2. Joint labor supply of each earner
3. Non-linear taxes and welfare
4. Other (un-modeled) mechanisms. – ► And test for "superior information".

► **Distinctive features of this paper:**

- - Allow for
  - non-separability,
  - heterogeneous assets,
  - correlated shocks to individual wages.
- - Use new data from the PSID 1999-2009

In this paper we look closer at four key mechanisms:

1. Self-insurance (i.e., savings) through a *direct* measure of π_{it}
2. Joint labor supply of each earner
3. Non-linear taxes and welfare
4. Other (un-modeled) mechanisms. – ▶ And test for "superior information".

▶ **Distinctive features of this paper:**

- - Allow for
  - non-separability,
  - heterogeneous assets,
  - correlated shocks to individual wages.
- - Use new data from the PSID 1999-2009
  - More comprehensive consumption measure.
  - Asset data collected in every wave.

NIPA-PSID Comparison

	1998	2000	2002	2004	2006	2008
PSID Total	3,276	3,769	4,285	5,058	5,926	5,736
NIPA Total	5,139	5,915	6,447	7,224	8,190	9,021
ratio	0.64	0.64	0.66	0.7	0.72	0.64
PSID Nondurables	746	855	887	1,015	1,188	1,146
NIPA Nondurables	1,330	1,543	1,618	1,831	2,089	2,296
ratio	0.56	0.55	0.55	0.55	0.57	0.5
PSID Services	2,530	2,914	3,398	4,043	4,738	4,590
NIPA Services	3,809	4,371	4,829	5,393	6,101	6,725
ratio	0.66	0.67	0.7	0.75	0.78	0.68

Note: PSID weights are applied for the non-sampled PSID data (47,206 observations for these years). Total consumption is defined as Nondurables + Services. PSID consumption categories include food, gasoline, utilities, health, rent (or rent equivalent), transportation, child care, education and other insurance. NIPA numbers are from NIPA table 2.3.5. All numbers are nonminal

Descriptive Statistics for Consumption

PSID Consumption						
	1998	2000	2002	2004	2006	2008
Consumption	27,290	31,973	35,277	41,555	45,863	44,006
Nondurable Consumption	6,859	7,827	7,827	8,873	9,889	9,246
Food (at home)	5,471	5,785	5,911	6,272	6,588	6,635
Gasoline	1,387	2,041	1,916	2,601	3,301	2,611
Services	21,319	25,150	28,419	33,755	36,949	35,575
Food (out)	2,029	2,279	2,382	2,582	2,693	2,492
Health Insurance	1,056	1,268	1,461	1,750	1,916	2,188
Health Services	902	1,134	1,334	1,447	1,615	1,844
Utilities	2,282	2,651	2,702	4,655	5,038	5,600
Transportation	3,122	3,758	4,474	3,797	3,970	3,759
Education	1,946	2,283	2,390	2,557	2,728	2,584
Child Care	601	653	660	689	648	783
Home Insurance	430	480	552	629	717	729
Rent (or rent equivalent)	8,950	10,645	12,464	15,650	17,623	15,595
Observarions	1,872	1,951	1,984	2,011	2,115	2,221

Notes: PSID data from 1999-2009 PSID waves. PSID means are given for the main sample of estimation: married couples with working males aged 30 to 65. SEO sample excluded. PSID rent is imputed as 6% of reported house value for homeowners. Missing values in consumption and assets sub-categories were treated as zeros.

Descriptive Statistics for Assets and Earnings

PSID Assets, Hours and Earnings						
	1998	2000	2002	2004	2006	2008
Total assets	332,625	352,247	382,600	476,626	555,951	506,823
Housing and RE assets	159,856	187,969	227,224	283,913	327,719	292,910
Financial assets	173,026	164,567	155,605	192,995	228,805	214,441
Total debt	72,718	82,806	98,580	115,873	131,316	137,348
Mortgage	65,876	74,288	89,583	106,423	120,333	123,324
Other debt	7,021	8,687	9,217	9,744	11,584	14,561
First earner (head)						
Earnings	54,220	61,251	63,674	68,500	72,794	75,588
Hours worked	2,357	2,317	2,309	2,309	2,284	2,140
Second earner (wife)						
Participation rate	0.81	0.8	0.81	0.81	0.81	0.8
Earnings (conditional on participation)	26,035	28,611	31,693	33,987	36,185	39,973
Hours worked (conditional on participation)	1,666	1,691	1,697	1,707	1,659	1,648
Observarions	1,872	1,951	1,984	2,011	2,115	2,221

Notes: PSID data from 1999-2009 PSID waves. PSID means are given for the main sample of estimation: married couples with working males aged 30 to 65. SEO sample excluded. PSID rent is imputed as 6% of reported house value for homeowners. Missing values in consumption and assets sub-categories were treated as zeros.

Household Decisions in a Unitary Framework

Household chooses $\left\{C_{i,t+j}, H_{i,1,t+j}, H_{i,2,t+j}\right\}_{j=0}^{T-t}$ to maximize

$$\mathbb{E}_t \sum_{\tau=0}^{T-t} (1+\delta)^{-\tau} v\left(C_{i,t+\tau}, H_{i,1,t+\tau}, H_{i,2,t+\tau}; Z_{i,t+\tau}\right)$$

subject to

$$C_{i,t} + \frac{A_{i,t+1}}{1+r} = A_{i,t} + H_{i,1,t}W_{i,1,t} + H_{i,1,t}W_{i,2,t}$$

Household Decisions in a Unitary Framework

Household chooses $\left\{C_{i,t+j}, H_{i,1,t+j}, H_{i,2,t+j}\right\}_{j=0}^{T-t}$ to maximize

$$\mathbb{E}_t \sum_{\tau=0}^{T-t} (1+\delta)^{-\tau} v\left(C_{i,t+\tau}, H_{i,1,t+\tau}, H_{i,2,t+\tau}; Z_{i,t+\tau}\right)$$

subject to

$$C_{i,t} + \frac{A_{i,t+1}}{1+r} = A_{i,t} + H_{i,1,t}W_{i,1,t} + H_{i,1,t}W_{i,2,t}$$

Our approach

- Extend previous work and express the distributional dynamics of consumption and earnings growth as functions of Frisch elasticities, 'insurance parameters' and wage shocks

Wage Process

For earner $j = \{1, 2\}$ in household i, period t, wage growth is:

$$\Delta \log W_{i,j,t} = \Delta X'_{i,j,t}\beta_j + \Delta u_{i,j,t} + v_{i,j,t}$$

Wage Process

For earner $j = \{1, 2\}$ in household i, period t, wage growth is:

$$\Delta \log W_{i,j,t} = \Delta X'_{i,j,t}\beta_j + \Delta u_{i,j,t} + v_{i,j,t}$$

$$\begin{pmatrix} u_{i,1,t} \\ u_{i,2,t} \\ v_{i,1,t} \\ v_{i,2,t} \end{pmatrix} \sim i.i.d. \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2_{u,1} & \sigma_{u_1,u_2} & 0 & 0 \\ \sigma_{u_1,u_2} & \sigma^2_{u,2} & 0 & 0 \\ 0 & 0 & \sigma^2_{v,1} & \sigma_{v_1,v_2} \\ 0 & 0 & \sigma_{v_1,v_2} & \sigma^2_{v,2} \end{pmatrix} \right)$$

Wage Process

For earner $j = \{1, 2\}$ in household i, period t, wage growth is:

$$\Delta \log W_{i,j,t} = \Delta X'_{i,j,t}\beta_j + \Delta u_{i,j,t} + v_{i,j,t}$$

$$\begin{pmatrix} u_{i,1,t} \\ u_{i,2,t} \\ v_{i,1,t} \\ v_{i,2,t} \end{pmatrix} \sim i.i.d. \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2_{u,1} & \sigma_{u_1,u_2} & 0 & 0 \\ \sigma_{u_1,u_2} & \sigma^2_{u,2} & 0 & 0 \\ 0 & 0 & \sigma^2_{v,1} & \sigma_{v_1,v_2} \\ 0 & 0 & \sigma_{v_1,v_2} & \sigma^2_{v,2} \end{pmatrix} \right)$$

- Allow the variances to differ by gender and across the life-cycle.

Wage Parameters Estimates

Baseline

Sample			All
Males	Trans.	$\sigma^2_{u_1}$	0.033 (0.007)
	Perm.	$\sigma^2_{v_1}$	0.032 (0.005)
Females	Trans.	$\sigma^2_{u_2}$	0.012 (0.006)
	Perm.	$\sigma^2_{v_2}$	0.043 (0.005)
Correlation of shocks	Trans.	ρ_{u_1,u_2}	0.244 (0.22)
	Perm	ρ_{v_1,v_2}	0.113 (0.07)

The 'Simple' Separable Case

$$\begin{pmatrix} \Delta c_t \\ \Delta y_{1,t} \\ \Delta y_{2,t} \end{pmatrix} \simeq \begin{pmatrix} 0 & 0 & \kappa_{c,v_1} & \kappa_{c,v_2} \\ \kappa_{y_1,u_1} & 0 & \kappa_{y_1,v_1} & \kappa_{y_1,v_2} \\ 0 & \kappa_{y_2,u_2} & \kappa_{y_2,v_1} & \kappa_{y_2,v_2} \end{pmatrix} \begin{pmatrix} \Delta u_{1,t} \\ \Delta u_{2,t} \\ v_{1,t} \\ v_{2,t} \end{pmatrix}$$

Consumption and Earnings Growth

The 'Simple' Separable Case

$$\begin{pmatrix} \Delta c_t \\ \Delta y_{1,t} \\ \Delta y_{2,t} \end{pmatrix} \simeq \begin{pmatrix} 0 & 0 & \kappa_{c,v_1} & \kappa_{c,v_2} \\ \kappa_{y_1,u_1} & 0 & \kappa_{y_1,v_1} & \kappa_{y_1,v_2} \\ 0 & \kappa_{y_2,u_2} & \kappa_{y_2,v_1} & \kappa_{y_2,v_2} \end{pmatrix} \begin{pmatrix} \Delta u_{1,t} \\ \Delta u_{2,t} \\ v_{1,t} \\ v_{2,t} \end{pmatrix}$$

where the key transmission parameters

$$\kappa_{y_j,u_j} = \left(1 + \eta_{h_j,w_j}\right) \rightarrow \text{[Frisch]}$$

Consumption and Earnings Growth

The 'Simple' Separable Case

$$\begin{pmatrix} \Delta c_t \\ \Delta y_{1,t} \\ \Delta y_{2,t} \end{pmatrix} \simeq \begin{pmatrix} 0 & 0 & \kappa_{c,v_1} & \kappa_{c,v_2} \\ \kappa_{y_1,u_1} & 0 & \kappa_{y_1,v_1} & \kappa_{y_1,v_2} \\ 0 & \kappa_{y_2,u_2} & \kappa_{y_2,v_1} & \kappa_{y_2,v_2} \end{pmatrix} \begin{pmatrix} \Delta u_{1,t} \\ \Delta u_{2,t} \\ v_{1,t} \\ v_{2,t} \end{pmatrix}$$

where the key transmission parameters

$$\kappa_{y_j,u_j} = \left(1 + \eta_{h_j,w_j}\right) \rightarrow \text{[Frisch]} \qquad \kappa_{y_j,v_j} \rightarrow \text{[Marshall]}$$

Consumption and Earnings Growth

The 'Simple' Separable Case

$$\begin{pmatrix} \Delta c_t \\ \Delta y_{1,t} \\ \Delta y_{2,t} \end{pmatrix} \simeq \begin{pmatrix} 0 & 0 & \kappa_{c,v_1} & \kappa_{c,v_2} \\ \kappa_{y_1,u_1} & 0 & \kappa_{y_1,v_1} & \kappa_{y_1,v_2} \\ 0 & \kappa_{y_2,u_2} & \kappa_{y_2,v_1} & \kappa_{y_2,v_2} \end{pmatrix} \begin{pmatrix} \Delta u_{1,t} \\ \Delta u_{2,t} \\ v_{1,t} \\ v_{2,t} \end{pmatrix}$$

where the key transmission parameters

$$\kappa_{y_j,u_j} = \left(1 + \eta_{h_j,w_j}\right) \rightarrow \text{[Frisch]} \qquad \kappa_{y_j,v_j} \rightarrow \text{[Marshall]}$$

$$\kappa_{c,v_j} = (1 - \pi_{i,t})\, s_{i,j,t} \frac{\eta_{c,p}\left(1 + \eta_{h_j,w_j}\right)}{\eta_{c,p} + (1 - \pi_{i,t})\, \overline{\eta_{h,w}}}$$

Consumption and Earnings Growth

The 'Simple' Separable Case

$$\begin{pmatrix} \Delta c_t \\ \Delta y_{1,t} \\ \Delta y_{2,t} \end{pmatrix} \simeq \begin{pmatrix} 0 & 0 & \kappa_{c,v_1} & \kappa_{c,v_2} \\ \kappa_{y_1,u_1} & 0 & \kappa_{y_1,v_1} & \kappa_{y_1,v_2} \\ 0 & \kappa_{y_2,u_2} & \kappa_{y_2,v_1} & \kappa_{y_2,v_2} \end{pmatrix} \begin{pmatrix} \Delta u_{1,t} \\ \Delta u_{2,t} \\ v_{1,t} \\ v_{2,t} \end{pmatrix}$$

where the key transmission parameters

$$\kappa_{y_j,u_j} = \left(1 + \eta_{h_j,w_j}\right) \rightarrow \text{[Frisch]} \qquad \kappa_{y_j,v_j} \rightarrow \text{[Marshall]}$$

$$\kappa_{c,v_j} = \left(1 - \pi_{i,t}\right) s_{i,j,t} \frac{\eta_{c,p}\left(1 + \eta_{h_j,w_j}\right)}{\eta_{c,p} + \left(1 - \pi_{i,t}\right)\overline{\eta_{h,w}}}$$

$$\pi_{i,t} \approx \frac{\text{Assets}_{i,t}}{\text{Assets}_{i,t} + \text{Human Wealth}_{i,t}}$$

Consumption and Earnings Growth

The 'Simple' Separable Case

$$\begin{pmatrix} \Delta c_t \\ \Delta y_{1,t} \\ \Delta y_{2,t} \end{pmatrix} \simeq \begin{pmatrix} 0 & 0 & \kappa_{c,v_1} & \kappa_{c,v_2} \\ \kappa_{y_1,u_1} & 0 & \kappa_{y_1,v_1} & \kappa_{y_1,v_2} \\ 0 & \kappa_{y_2,u_2} & \kappa_{y_2,v_1} & \kappa_{y_2,v_2} \end{pmatrix} \begin{pmatrix} \Delta u_{1,t} \\ \Delta u_{2,t} \\ v_{1,t} \\ v_{2,t} \end{pmatrix}$$

where the key transmission parameters

$$\kappa_{y_j,u_j} = \left(1 + \eta_{h_j,w_j}\right) \rightarrow \text{[Frisch]} \qquad \kappa_{y_j,v_j} \rightarrow \text{[Marshall]}$$

$$\kappa_{c,v_j} = (1 - \pi_{i,t})\, s_{i,j,t} \frac{\eta_{c,p}\left(1 + \eta_{h_j,w_j}\right)}{\eta_{c,p} + (1 - \pi_{i,t})\, \overline{\eta_{h,w}}}$$

$$s_{i,j,t} \approx \frac{\text{Human Wealth}_{i,j,t}}{\text{Human Wealth}_{i,t}}$$

Consumption and Earnings Growth

The 'Simple' Separable Case

$$\begin{pmatrix} \Delta c_t \\ \Delta y_{1,t} \\ \Delta y_{2,t} \end{pmatrix} \simeq \begin{pmatrix} 0 & 0 & \kappa_{c,v_1} & \kappa_{c,v_2} \\ \kappa_{y_1,u_1} & 0 & \kappa_{y_1,v_1} & \kappa_{y_1,v_2} \\ 0 & \kappa_{y_2,u_2} & \kappa_{y_2,v_1} & \kappa_{y_2,v_2} \end{pmatrix} \begin{pmatrix} \Delta u_{1,t} \\ \Delta u_{2,t} \\ v_{1,t} \\ v_{2,t} \end{pmatrix}$$

where the key transmission parameters

$$\kappa_{y_j,u_j} = \left(1 + \eta_{h_j,w_j}\right) \rightarrow \text{[Frisch]} \qquad \kappa_{y_j,v_j} \rightarrow \text{[Marshall]}$$

$$\kappa_{c,v_j} = (1 - \pi_{i,t})\, s_{i,j,t} \frac{\eta_{c,p}\left(1 + \eta_{h_j,w_j}\right)}{\eta_{c,p} + (1 - \pi_{i,t})\, \overline{\eta_{h,w}}}$$

$$\overline{\eta_{h,w}} = s_{i,j,t}\eta_{h_j,w_j} + s_{i,-j,t}\eta_{h_{-j},w_{-j}}$$

Consumption and Earnings Growth

The 'Simple' Separable Case

$$\begin{pmatrix} \Delta c_t \\ \Delta y_{1,t} \\ \Delta y_{2,t} \end{pmatrix} \simeq \begin{pmatrix} 0 & 0 & \kappa_{c,v_1} & \kappa_{c,v_2} \\ \kappa_{y_1,u_1} & 0 & \kappa_{y_1,v_1} & \kappa_{y_1,v_2} \\ 0 & \kappa_{y_2,u_2} & \kappa_{y_2,v_1} & \kappa_{y_2,v_2} \end{pmatrix} \begin{pmatrix} \Delta u_{1,t} \\ \Delta u_{2,t} \\ v_{1,t} \\ v_{2,t} \end{pmatrix}$$

- Introduce now β, representing insurance over and above savings, taxes and labour supply $\rightarrow$ networks, etc.
- Key transmission parameter becomes:

$$\kappa_{c,v_j} = (1-\beta)\left(1-\pi_{i,t}\right) s_{i,j,t} \frac{\eta_{c,p}\left(1+\eta_{h_j,w_j}\right)}{\eta_{c,p} + (1-\beta)\left(1-\pi_{i,t}\right)\overline{\eta_{h,w}}}$$

Identification with asset data

- Note that β is not identified separately from π
- Back out π from the data and estimate β

$$\pi_{i,t} \approx \frac{\overbrace{\text{Assets}_{i,t}}^{\textit{Observed in PSID}}}{\underbrace{\text{Human Wealth}_{i,t}}_{\textit{Projected lifetime earnings}} + \text{Assets}_{i,t}}$$

- Human wealth is projected using observables that evolve deterministically (e.g. age).

IDENTIFICATION WITH NON-SEPARABILITY

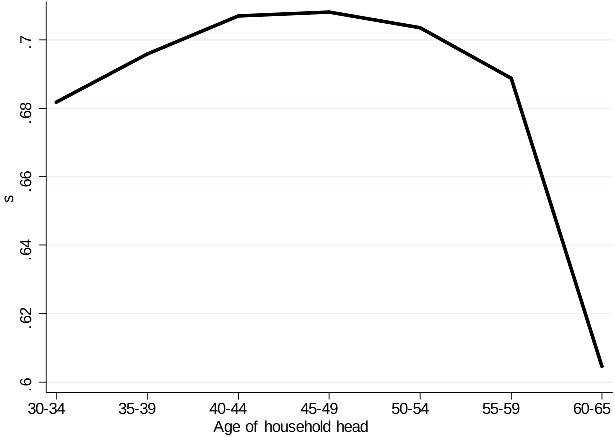
- When preferences are non-separable, we have:

$$\begin{pmatrix} \Delta c_t \\ \Delta y_{1,t} \\ \Delta y_{2,t} \end{pmatrix} \simeq \begin{pmatrix} \kappa_{c,u_1} & \kappa_{c,u_2} & \kappa_{c,v_1} & \kappa_{c,v_2} \\ \kappa_{y_1,u_1} & \kappa_{y_1,u_2} & \kappa_{y_1,v_1} & \kappa_{y_1,v_2} \\ \kappa_{y_2,u_1} & \kappa_{y_2,u_2} & \kappa_{y_2,v_1} & \kappa_{y_2,v_2} \end{pmatrix} \begin{pmatrix} \Delta u_{1,t} \\ \Delta u_{2,t} \\ v_{1,t} \\ v_{2,t} \end{pmatrix}$$

- $\kappa_{c,u_j} \rightarrow$ non-separability between consumption and leisure j
  $\kappa_{y_j,u_k} \rightarrow$ non-separability between spouses' leisures

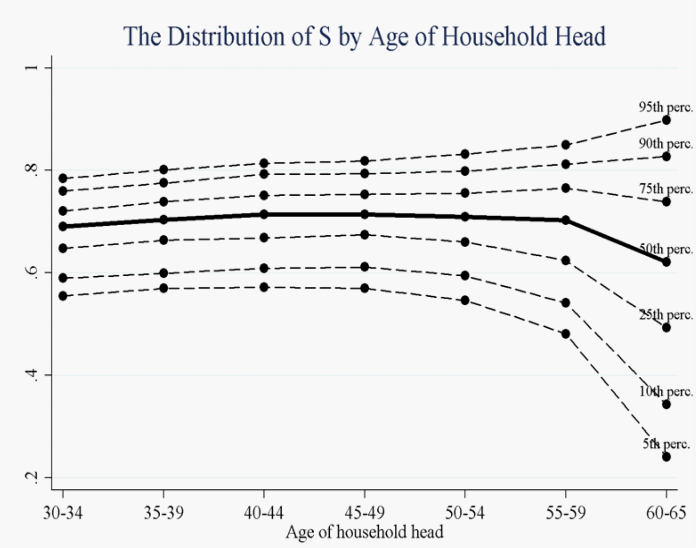
DISTRIBUTION OF s BY AGE

$$s_{i,t} \approx \frac{\text{Human Wealth}_{male,i,t}}{\text{Human Wealth}_{i,t}}:$$



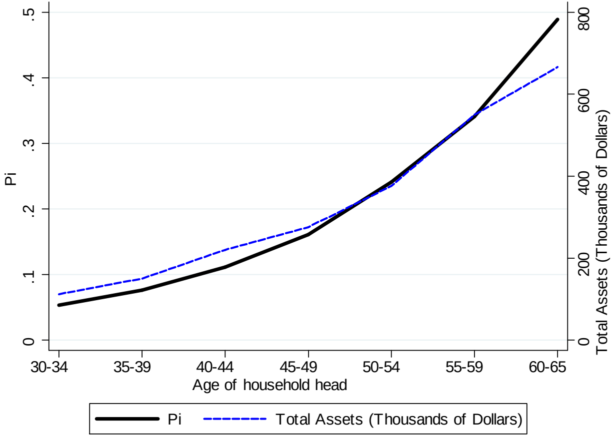
Distribution of s by Age

$$s_{i,t} \approx \frac{\text{Human Wealth}_{male,i,t}}{\text{Human Wealth}_{i,t}}:$$



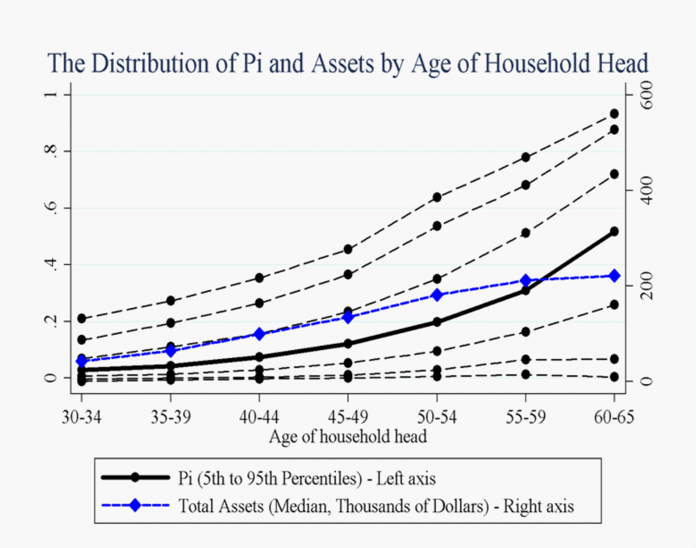
Distribution of π by Age

$$\pi_{i,t} \approx \frac{\text{Assets}_{i,t}}{\text{Assets}_{i,t}+\text{Human Wealth}_{i,t}}:$$



Distribution of π by Age

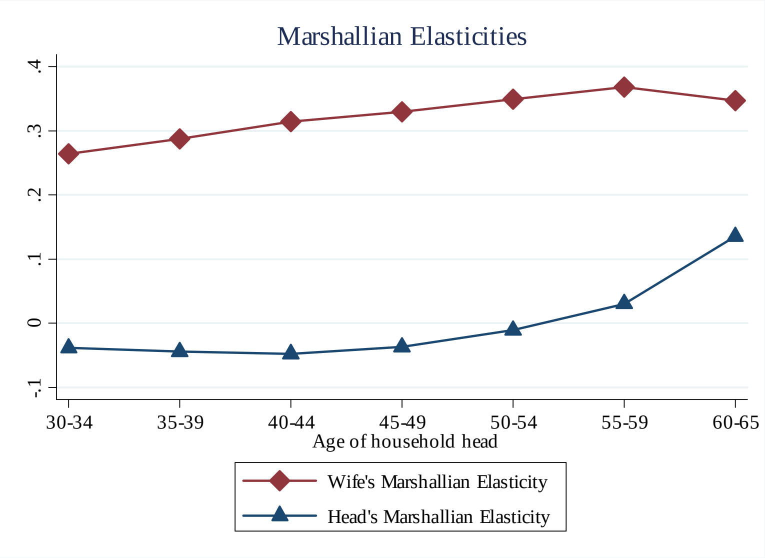
$$\pi_{i,t} \approx \frac{\text{Assets}_{i,t}}{\text{Assets}_{i,t}+\text{Human Wealth}_{i,t}}:$$



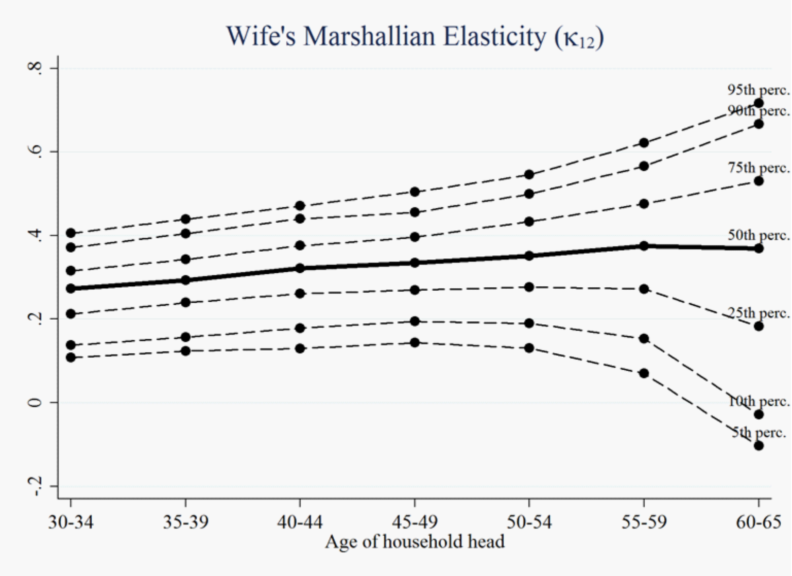
RESULTS: WITH AND WITHOUT SEPARABILITY

	(1) Additive separ.	(2) Non-separab.	(3) Non-separab.
$E(\pi)$	0.181 (0.008)	0.181 (0.008)	0.181 (0.008)
β	0.741 (0.085)	-0.120 (0.098)	0
$\eta_{c,p}$	0.201 (0.077)	0.437 (0.124)	0.448 (0.126)
η_{h_1,w_1}	0.431 (0.097)	0.514 (0.150)	0.497 (0.150)
η_{h_2,w_2}	0.831 (0.133)	1.032 (0.265)	1.041 (0.275)
η_{c,w_1}	-.-	-0.141 (0.051)	-0.141 (0.053)
$\eta_{h_1,p}$	-.-	0.082 (0.030)	0.082 (0.031)
η_{c,w_2}	-.-	-0.138 (0.139)	-0.158 (0.121)
$\eta_{h_2,p}$	-.-	0.162 (0.166)	0.185 (0.145)
η_{h_1,w_2}	-.-	0.128 (0.052)	0.120 (0.064)
η_{h_2,w_1}	-.-	0.258 (0.103)	0.242 (0.119)

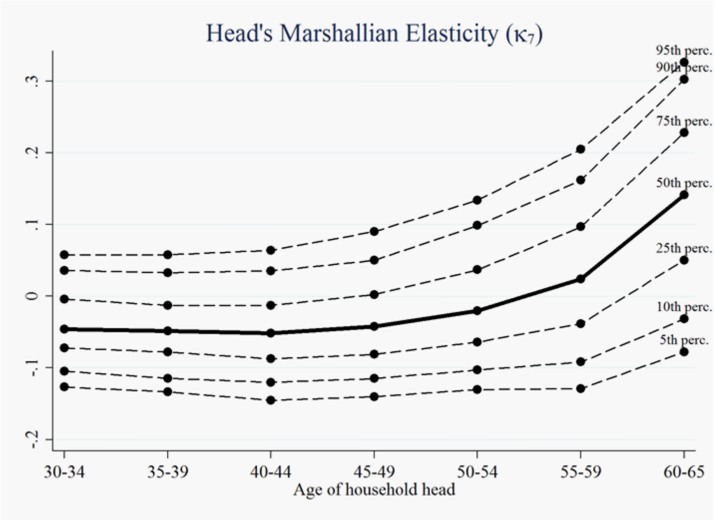
Marshallian Elasticities: By Age



Marshallian Elasticities: By Age



Marshallian Elasticities: By Age



Interpretation: Insurance Via Labor Supply (Shock to Male Wages)

The average response of total earnings ($y = y_1 + y_2$) to a permanent shock to the male's wages:

$$\frac{\partial \Delta y}{\partial v_1} = \underbrace{s}_{\widehat{s}=0.69} * \underbrace{\frac{\partial \Delta y_1}{\partial v_1}}_{\widehat{\kappa}_{y_1,v_1}=0.98} + \underbrace{(1-s)}_{1-\widehat{s}=0.31} * \underbrace{\frac{\partial \Delta y_2}{\partial v_1}}_{\widehat{\kappa}_{y_2,v_1}=-0.81} = 0.44$$

Interpretation: Insurance via Labor Supply (Shock to Male Wages)

The average response of total earnings ($y = y_1 + y_2$) to a permanent shock to the male's wages:

$$\frac{\partial \Delta y}{\partial v_1} = \underbrace{s}_{\widehat{s}=0.69} * \underbrace{\frac{\partial \Delta y_1}{\partial v_1}}_{\widehat{\kappa}_{y_1,v_1}=0.98} + \underbrace{(1-s)}_{1-\widehat{s}=0.31} * \underbrace{\frac{\partial \Delta y_2}{\partial v_1}}_{\widehat{\kappa}_{y_2,v_1}=-0.81} = 0.44$$

Response of consumption to a 10% permanent decrease in the male's wage rate ($v_1 = -0.1$):

one earner, fixed labor supply and no insurance	-10%

Interpretation: Insurance Via Labor Supply (Shock to Male Wages)

The average response of total earnings ($y = y_1 + y_2$) to a permanent shock to the male's wages:

$$\frac{\partial \Delta y}{\partial v_1} = \underbrace{s}_{\widehat{s}=0.69} * \underbrace{\frac{\partial \Delta y_1}{\partial v_1}}_{\widehat{\kappa}_{y_1,v_1}=0.98} + \underbrace{(1-s)}_{1-\widehat{s}=0.31} * \underbrace{\frac{\partial \Delta y_2}{\partial v_1}}_{\widehat{\kappa}_{y_2,v_1}=-0.81} = 0.44$$

Response of consumption to a 10% permanent decrease in the male's wage rate ($v_1 = -0.1$):

one earner, fixed labor supply and no insurance	-10%
two earners, fixed labor supply and no insurance	-6.9%

Interpretation: Insurance Via Labor Supply (Shock to Male Wages)

The average response of total earnings ($y = y_1 + y_2$) to a permanent shock to the male's wages:

$$\frac{\partial \Delta y}{\partial v_1} = \underbrace{s}_{\widehat{s}=0.69} * \underbrace{\frac{\partial \Delta y_1}{\partial v_1}}_{\widehat{\kappa}_{y_1,v_1}=0.98} + \underbrace{(1-s)}_{1-\widehat{s}=0.31} * \underbrace{\frac{\partial \Delta y_2}{\partial v_1}}_{\widehat{\kappa}_{y_2,v_1}=-0.81} = 0.44$$

Response of consumption to a 10% permanent decrease in the male's wage rate ($v_1 = -0.1$):

one earner, fixed labor supply and no insurance	-10%
two earners, fixed labor supply and no insurance	-6.9%
with husband labor supply adjustment	-6.8%

Interpretation: Insurance via Labor Supply (Shock to Male Wages)

The average response of total earnings ($y = y_1 + y_2$) to a permanent shock to the male's wages:

$$\frac{\partial \Delta y}{\partial v_1} = \underbrace{s}_{\widehat{s}=0.69} * \underbrace{\frac{\partial \Delta y_1}{\partial v_1}}_{\widehat{\kappa}_{y_1,v_1}=0.98} + \underbrace{(1-s)}_{1-\widehat{s}=0.31} * \underbrace{\frac{\partial \Delta y_2}{\partial v_1}}_{\widehat{\kappa}_{y_2,v_1}=-0.81} = 0.44$$

Response of consumption to a 10% permanent decrease in the male's wage rate ($v_1 = -0.1$):

one earner, fixed labor supply and no insurance	-10%
two earners, fixed labor supply and no insurance	-6.9%
with husband labor supply adjustment	-6.8%
with family labor supply adjustment	-4.4%

Interpretation: Insurance Via Labor Supply (Shock to Male Wages)

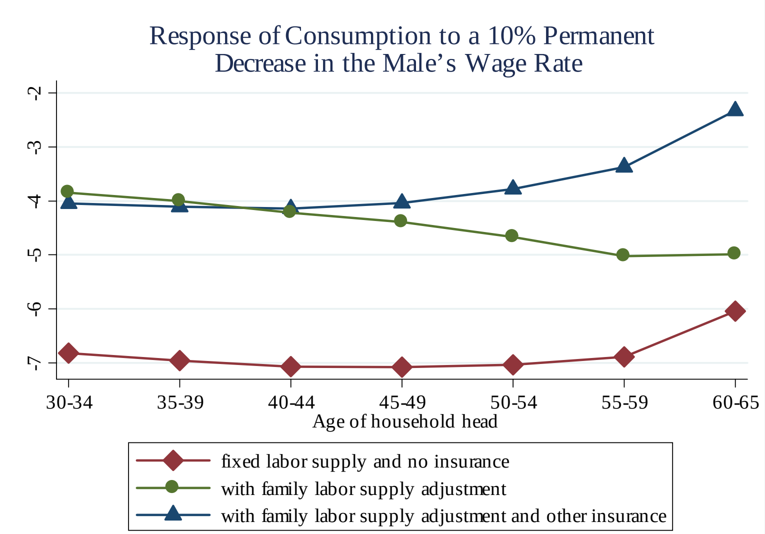
The average response of total earnings ($y = y_1 + y_2$) to a permanent shock to the male's wages:

$$\frac{\partial \Delta y}{\partial v_1} = \underbrace{s}_{\widehat{s}=0.69} * \underbrace{\frac{\partial \Delta y_1}{\partial v_1}}_{\widehat{\kappa}_{y_1,v_1}=0.98} + \underbrace{(1-s)}_{1-\widehat{s}=0.31} * \underbrace{\frac{\partial \Delta y_2}{\partial v_1}}_{\widehat{\kappa}_{y_2,v_1}=-0.81} = 0.44$$

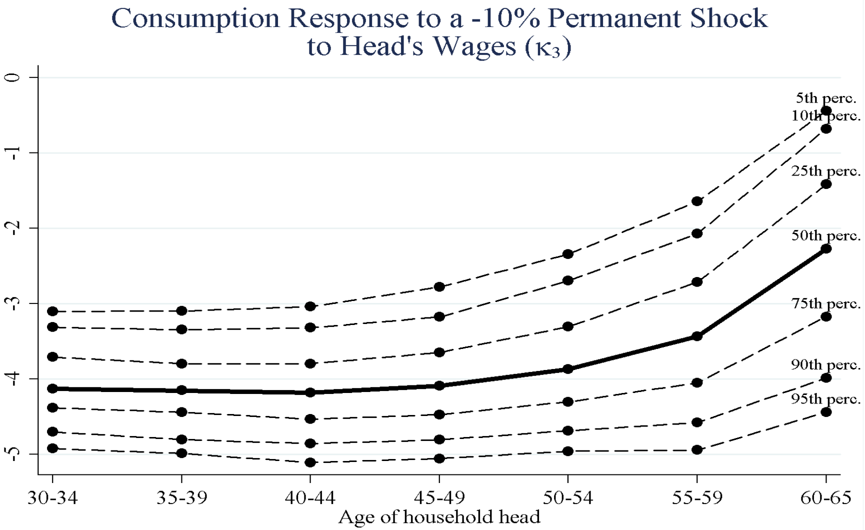
Response of consumption to a 10% permanent decrease in the male's wage rate ($v_1 = -0.1$):

one earner, fixed labor supply and no insurance	-10%
two earners, fixed labor supply and no insurance	-6.9%
with husband labor supply adjustment	-6.8%
with family labor supply adjustment	-4.4%
with family labor supply adjustment and other insurance	-3.8%

Insurance via Labor Supply (Shock to Male Wages): By Age



Insurance via Labor Supply (Shock to Male Wages): By Age



Interpretation: Insurance via Labor Supply (Shock to Female Wages)

The average response of total earnings to a permanent shock to the female's wages:

$$\frac{\partial \Delta y}{\partial v_2} = \underbrace{s}_{0.69} * \underbrace{\frac{\partial \Delta y_1}{\partial v_2}}_{\kappa_{y_1,v_2}=-0.23} + \underbrace{(1-s)}_{0.31} * \underbrace{\frac{\partial \Delta y_2}{\partial v_2}}_{\kappa_{y_2,v_2}=1.32} = 0.25$$

Response of consumption to a 10% permanent decrease in the female's wage rate ($v_2 = -0.1$):

two earners, fixed labor supply and no insurance	-3.1%

Interpretation: Insurance Via Labor Supply (Shock to Female Wages)

The average response of total earnings to a permanent shock to the female's wages:

$$\frac{\partial \Delta y}{\partial v_2} = \underbrace{s}_{0.69} * \underbrace{\frac{\partial \Delta y_1}{\partial v_2}}_{\kappa_{y_1,v_2}=-0.23} + \underbrace{(1-s)}_{0.31} * \underbrace{\frac{\partial \Delta y_2}{\partial v_2}}_{\kappa_{y_2,v_2}=1.32} = 0.25$$

Response of consumption to a 10% permanent decrease in the female's wage rate ($v_2 = -0.1$):

two earners, fixed labor supply and no insurance	-3.1%
with family labor supply adjustment	-2.5%

Interpretation: Insurance Via Labor Supply (Shock to Female Wages)

The average response of total earnings to a permanent shock to the female's wages:

$$\frac{\partial \Delta y}{\partial v_2} = \underbrace{s}_{0.69} * \underbrace{\frac{\partial \Delta y_1}{\partial v_2}}_{\kappa_{y_1,v_2}=-0.23} + \underbrace{(1-s)}_{0.31} * \underbrace{\frac{\partial \Delta y_2}{\partial v_2}}_{\kappa_{y_2,v_2}=1.32} = 0.25$$

Response of consumption to a 10% permanent decrease in the female's wage rate ($v_2 = -0.1$):

two earners, fixed labor supply and no insurance	-3.1%
with family labor supply adjustment	-2.5%
with family labor supply adjustment and other insurance	-2.1%

Summary and conclusions...

- Focus on understanding the transmission of inequality over the working life.

SUMMARY AND CONCLUSIONS...

- Focus on understanding the transmission of inequality over the working life.
- Found that family labor supply is a key mechanism for smoothing consumption

Summary and conclusions...

- Focus on understanding the transmission of inequality over the working life.
- Found that family labor supply is a key mechanism for smoothing consumption
  - especially for those with limited access to assets,
  - and non-separability between consumption and labour supply is essential.

Summary and conclusions...

- Focus on understanding the transmission of inequality over the working life.
- Found that family labor supply is a key mechanism for smoothing consumption
  - especially for those with limited access to assets,
  - and non-separability between consumption and labour supply is essential.
- Once family labor supply, assets and taxes (and benefits) are properly accounted for, there is less evidence for additional insurance

SUMMARY AND CONCLUSIONS...

- Focus on understanding the transmission of inequality over the working life.
- Found that family labor supply is a key mechanism for smoothing consumption
  - especially for those with limited access to assets,
  - and non-separability between consumption and labour supply is essential.
- Once family labor supply, assets and taxes (and benefits) are properly accounted for, there is less evidence for additional insurance
  - lots to be done to dig deeper into these, and other, mechanisms.
  - consider detailed consumption components and form of non-separability.

EXTRA SLIDES

Results by age, education and asset selections

	Baseline	Age 30-55	Some college+	Top 2 asset terc.
$E(\pi)$	0.181	0.142	0.202	0.245
β	-0.120	-0.177	0.117	-0.046
	(0.098)	(0.089)	(0.072)	(0.084)
$\eta_{c,p}$	0.437	0.465	0.368	0.343
	(0.124)	(0.044)	(0.05)	(0.04)
η_{h_1,w_1}	0.514	0.467	0.542	0.388
	(0.150)	(0.036)	(0.045)	(0.037)
η_{h_2,w_2}	1.032	1.039	0.858	0.986
	(0.265)	(0.099)	(0.097)	(0.105)
η_{c,w_1}	-0.141	-0.113	-0.162	-0.127
	(0.051)	(0.018)	(0.022)	(0.016)
$\eta_{h_1,p}$	0.082	0.065	0.087	0.07
	(0.030)	(0.01)	(0.012)	(0.009)
η_{c,w_2}	-0.138	-0.083	-0.142	-0.129
	(0.139)	(0.029)	(0.032)	(0.154)
$\eta_{h_2,p}$	0.162	0.097	0.169	0.154
	(0.166)	(0.034)	(0.038)	(0.038)
η_{h_1,w_2}	0.128	0.101	0.115	0.079
	(0.052)	(0.011)	(0.012)	(0.01)
η_{h_2,w_1}	0.258	0.205	0.255	0.172
	(0.103)	(0.022)	(0.027)	(0.021)

Note: Specifications (2) to (4) - Non-bootstrap s.e.'s

Concavity and Advance Information

- **Concavity of preferences**. Use the fact that:

$$\begin{pmatrix} \eta_{cp}\frac{c}{p} & \eta_{cw_1}\frac{c}{w_1} & \eta_{cw_2}\frac{c}{w_2} \\ -\eta_{h_1p}\frac{h_1}{p} & -\eta_{h_1w_1}\frac{h_1}{w_1} & -\eta_{h_1w_2}\frac{h_1}{w_2} \\ -\eta_{h_2p}\frac{h_2}{p} & -\eta_{h_2w_1}\frac{h_2}{w_1} & -\eta_{h_2w_2}\frac{h_2}{w_2} \end{pmatrix} = \lambda \begin{pmatrix} \frac{d^2u}{dc^2} & \frac{d^2u}{dcdl_1} & \frac{d^2u}{dcdl_2} \\ \frac{d^2u}{dl_1dc} & \frac{d^2u}{dl_1^2} & \frac{d^2u}{dl_1dl_2} \\ \frac{d^2u}{dl_2dc} & \frac{d^2u}{dl_2dl_1} & \frac{d^2u}{dl_2^2} \end{pmatrix}^{-1}$$

-
  - Appendix shows concavity cannot rejected, and is numerically satisfied at average values of wages, hours, consumption.

Concavity and Advance Information

- **Concavity of preferences**. Use the fact that:

$$\begin{pmatrix} \eta_{cp}\frac{c}{p} & \eta_{cw_1}\frac{c}{w_1} & \eta_{cw_2}\frac{c}{w_2} \\ -\eta_{h_1p}\frac{h_1}{p} & -\eta_{h_1w_1}\frac{h_1}{w_1} & -\eta_{h_1w_2}\frac{h_1}{w_2} \\ -\eta_{h_2p}\frac{h_2}{p} & -\eta_{h_2w_1}\frac{h_2}{w_1} & -\eta_{h_2w_2}\frac{h_2}{w_2} \end{pmatrix} = \lambda \begin{pmatrix} \frac{d^2u}{dc^2} & \frac{d^2u}{dcdl_1} & \frac{d^2u}{dcdl_2} \\ \frac{d^2u}{dl_1dc} & \frac{d^2u}{dl_1^2} & \frac{d^2u}{dl_1dl_2} \\ \frac{d^2u}{dl_2dc} & \frac{d^2u}{dl_2dl_1} & \frac{d^2u}{dl_2^2} \end{pmatrix}^{-1}$$

-
  - Appendix shows concavity cannot rejected, and is numerically satisfied at average values of wages, hours, consumption.
- **Advance Information**. Consumption growth should be correlated with future wage growth (Cunha et al., 2008, and BPP 2008).
  - Test has p-value 13%

RESULTS: EXTENSIVE MARGIN

- Estimate a "conditional" Euler equation, controlling for changes in hours (intensive margin) and changes in participation (extensive margin)

Results: Extensive Margin

- Estimate a "conditional" Euler equation, controlling for changes in hours (intensive margin) and changes in participation (extensive margin)

	Regression results		First stage F-stats	
	(1)	(2)	(1)	(2)
$\Delta EMP_t(Male)$	0.144 (0.269)		23.4	
$\Delta h_t(Male)$	−0.073 (0.075)	−0.013 (0.021)	26.3	135.5
$\Delta EMP_t(Female)$	0.356 (0.169)	0.362 (0.176)	98.4	91.2
$\Delta h_t(Female)$	−0.220 (0.100)	−0.171 (0.094)	86.5	77.7
Sample	All	EMP_t(Male)=1		
Instruments	2^{nd},4^{th} lags	2^{nd},4^{th} lags		

Note: Δx_t is defined as $(x_t - x_{t-1})$ / $[0.5\,(x_t + x_{t-1})]$

Wage Parameters by Assets and Age

			(1)	(2)	(3)	(4)	(5)
Sample			All	1st asset tercile	2nd, 3rd asset terciles	age<40	age>=40
Males	Trans.	σ^2_{u1}	0.033	0.03	0.042	0.042	0.028
			(0.007)	(0.009)	(0.009)	(0.013)	(0.008)
	Perm.	σ^2_{v1}	0.035	0.027	0.039	0.025	0.039
			(0.005)	(0.006)	(0.007)	(0.009)	(0.007)
Females	Trans.	σ^2_{u2}	0.012	0.023	0.011	0.02	0.01
			(0.005)	(0.009)	(0.007)	(0.015)	(0.005)
	Perm.	σ^2_{v2}	0.046	0.036	0.05	0.053	0.042
			(0.004)	(0.007)	(0.006)	(0.013)	(0.005)
Correlations of Shocks	Trans.	$\sigma_{u1,u2}$	0.202	-0.264	0.39	0.459	0.115
			(0.159)	(0.181)	(0.197)	(0.28)	(0.201)
	Perm.	$\sigma_{v1,v2}$	0.153	0.366	0.096	0.041	0.162
			(0.06)	(0.142)	(0.066)	(0.174)	(0.063)
Observations			8,191	2,626	5,565	2,172	6,019

Transmission Parameters:

Consumption response to *j*'s permanent wage shock:

$$\kappa_{c,v_j} = (1-\beta)(1-\pi_{i,t})\, s_{i,j,t} \frac{\eta_{c,p}\left(1+\eta_{h_j,w_j}\right)}{\eta_{c,p} + (1-\beta)(1-\pi_{i,t})\,\overline{\eta_{h,w}}}$$

TRANSMISSION PARAMETERS:

Consumption response to j's permanent wage shock:

$$\kappa_{c,v_j} = (1-\beta)(1-\pi_{i,t})\, s_{i,j,t} \frac{\eta_{c,p}\left(1+\eta_{h_j,w_j}\right)}{\eta_{c,p} + (1-\beta)(1-\pi_{i,t})\,\overline{\eta_{h,w}}}$$

- declines with $\pi_{i,t}$ (accumulated assets allow better insurance of shocks)

TRANSMISSION PARAMETERS:

Consumption response to j's permanent wage shock:

$$\kappa_{c,v_j} = (1-\beta)(1-\pi_{i,t})\, s_{i,j,t} \frac{\eta_{c,p}\left(1+\eta_{h_j,w_j}\right)}{\eta_{c,p} + (1-\beta)(1-\pi_{i,t})\,\overline{\eta_{h,w}}}$$

- declines with $\pi_{i,t}$ (accumulated assets allow better insurance of shocks)
- declines with β (outside insurance allows more smoothing)

Transmission Parameters:

Consumption response to j's permanent wage shock:

$$\kappa_{c,v_j} = (1-\beta)(1-\pi_{i,t})\, s_{i,j,t} \frac{\eta_{c,p}\left(1+\eta_{h_j,w_j}\right)}{\eta_{c,p} + (1-\beta)(1-\pi_{i,t})\,\overline{\eta_{h,w}}}$$

- declines with $\pi_{i,t}$ (accumulated assets allow better insurance of shocks)
- declines with β (outside insurance allows more smoothing)
- increases with $s_{i,j,t}$ (j's earnings play heavier weight)

Transmission Parameters:

Consumption response to j's permanent wage shock:

$$\kappa_{c,v_j} = (1-\beta)(1-\pi_{i,t})\, s_{i,j,t} \frac{\eta_{c,p}\left(1+\eta_{h_j,w_j}\right)}{\eta_{c,p} + (1-\beta)(1-\pi_{i,t})\,\overline{\eta_{h,w}}}$$

- declines with $\pi_{i,t}$ (accumulated assets allow better insurance of shocks)
- declines with β (outside insurance allows more smoothing)
- increases with $s_{i,j,t}$ (j's earnings play heavier weight)
- increases with $\eta_{c,p}$ (consumers more tolerant of intertemporal fluctuations in consumption)

Transmission Parameters:

Consumption response to *j*'s permanent wage shock:

$$\kappa_{c,v_j} = (1-\beta)\left(1-\pi_{i,t}\right) s_{i,j,t} \frac{\eta_{c,p}\left(1+\eta_{h_j,w_j}\right)}{\eta_{c,p} + \left(1-\beta\right)\left(1-\pi_{i,t}\right)\overline{\eta_{h,w}}}$$

- declines with $\pi_{i,t}$ (accumulated assets allow better insurance of shocks)
- declines with β (outside insurance allows more smoothing)
- increases with $s_{i,j,t}$ (*j*'s earnings play heavier weight)
- increases with $\eta_{c,p}$ (consumers more tolerant of intertemporal fluctuations in consumption)
- declines with $\eta_{h_{-j},w_{-j}}$ ("added worker" effect)

TRANSMISSION PARAMETERS:

Consumption response to j's permanent wage shock:

$$\kappa_{c,v_j} = (1-\beta)(1-\pi_{i,t})\, s_{i,j,t} \frac{\eta_{c,p}\left(1+\eta_{h_j,w_j}\right)}{\eta_{c,p} + \ (1-\beta)(1-\pi_{i,t})\,\overline{\eta_{h,w}}}$$

- declines with $\pi_{i,t}$ (accumulated assets allow better insurance of shocks)
- declines with β (outside insurance allows more smoothing)
- increases with $s_{i,j,t}$ (j's earnings play heavier weight)
- increases with $\eta_{c,p}$ (consumers more tolerant of intertemporal fluctuations in consumption)
- declines with $\eta_{h_{-j},w_{-j}}$ ("added worker" effect)
- declines with η_{h_j,w_j} only if j's labor supply responds negatively to own permanent shock. In one-earner case, true if

$$(1-\beta)(1-\pi_{i,t}) - \eta_{c,p} > 0$$

Data and Sample Selection

- PSID biennial 1999-2009:
  - PSID consumption went through a major revision in 1999
    - ~70% of consumption expenditures. Good match with NIPA
    - The sum of food at home, food away from home, gasoline, health, transportation, utilities, etc.
    - Main items that are missing: clothing (now included), recreation, alcohol and tobacco
  - Earning and hours for each earner
  - Assets data available for each wave

Data and Sample Selection

- PSID biennial 1999-2009:
  - PSID consumption went through a major revision in 1999
    - ~70% of consumption expenditures. Good match with NIPA
    - The sum of food at home, food away from home, gasoline, health, transportation, utilities, etc.
    - Main items that are missing: clothing (now included), recreation, alcohol and tobacco
  - Earning and hours for each earner
  - Assets data available for each wave
- To begin with focus on:
  - Married couples, male aged 30-60 (with robustness on 30-55 group)
  - Working males (93% in this age group)
  - Stable household composition

Data and Sample Selection

- PSID biennial 1999-2009:
  - PSID consumption went through a major revision in 1999
    - ~70% of consumption expenditures. Good match with NIPA
    - The sum of food at home, food away from home, gasoline, health, transportation, utilities, etc.
    - Main items that are missing: clothing (now included), recreation, alcohol and tobacco
  - Earning and hours for each earner
  - Assets data available for each wave
- To begin with focus on:
  - Married couples, male aged 30-60 (with robustness on 30-55 group)
  - Working males (93% in this age group)
  - Stable household composition
- Methodology: Use structural restrictions that 'theory' imposes on the variance covariance structure of $\Delta c_{i,t}$, $\Delta y_{i,1,t}$ and $\Delta y_{i,2,t}$

SOME ECONOMETRICS ISSUES

- Measurement error
  - For consumption, use martingale assumption and mean-reversion
  - For wages, use external estimates from Bound et al. (1994)

Some Econometrics Issues

- Measurement error
  - For consumption, use martingale assumption and mean-reversion
  - For wages, use external estimates from Bound et al. (1994)
- Non-Participation
  - ~20% of women in our sample work 0 hours in a given year
  - Selection adjusted second moments

SOME ECONOMETRICS ISSUES

- Measurement error
  - For consumption, use martingale assumption and mean-reversion
  - For wages, use external estimates from Bound et al. (1994)
- Non-Participation
  - ~20% of women in our sample work 0 hours in a given year
  - Selection adjusted second moments
- Inference
  - Multi-step procedure
  - Block bootstrap standard errors

Inference

- Multi-step estimation procedure:
  - Regress $c_{i,t}, y_{i,j,t}, w_{i,j,t}$ on observable characteristics, and construct the residuals $\Delta c_{i,t}, \Delta y_{i,j,t}$ and $\Delta w_{i,j,t}$
  - Estimate the wage parameters using the conditional second order moments for $\Delta w_{i,1,t}$ and $\Delta w_{i,2,t}$
  - Estimate $\pi_{i,t}$ and $s_{i,t}$ using asset and (current and projected) earnings data
  - Estimate preference parameters using restrictions on the joint behavior of $\Delta c_{i,t}, \Delta y_{i,j,t}$ and $\Delta w_{i,j,t}$
- GMM with standard errors corrected by the block bootstrap.

Non-Separability and Measurement Errors

$$\begin{pmatrix} \Delta w_{i,1,t} \\ \Delta w_{i,2,t} \\ \Delta c_{i,t} \\ \Delta y_{i,1,t} \\ \Delta y_{i,2,t} \end{pmatrix} \simeq \begin{pmatrix} 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 \\ \kappa_{c,u_1} & \kappa_{c,u_2} & \kappa_{c,v_1} & \kappa_{c,v_2} \\ \kappa_{y_1,u_1} & \kappa_{y_1,u_2} & \kappa_{y_1,v_1} & \kappa_{y_1,v_2} \\ \kappa_{y_2,u_1} & \kappa_{y_2,u_2} & \kappa_{y_2,v_1} & \kappa_{y_2,v_2} \end{pmatrix} \begin{pmatrix} \Delta u_{i,1,t} \\ \Delta u_{i,2,t} \\ v_{i,1,t} \\ v_{i,2,t} \end{pmatrix} + \begin{matrix} \Delta\xi^w_{i,1,t} \\ \Delta\xi^w_{i,2,t} \\ \Delta\xi^c_{i,t} \\ \Delta\xi^y_{i,1,t} \\ \Delta\xi^y_{i,2,t} \end{matrix}$$

- where $\zeta^w_{i,j,t}$, $\zeta^c_{i,t}$ and $\zeta^y_{i,j,t}$ are measurement errors in log wages of earner j, log consumption, and log earnings of earner j.

Income dynamics - more details

- Our focus here is on non-stationarity, heterogenous profiles, and shocks of varying persistence.

INCOME DYNAMICS - MORE DETAILS

- Our focus here is on non-stationarity, heterogenous profiles, and shocks of varying persistence.
- Individual i of age a in time period t, has log income $y_{i,a} (\equiv \ln Y_{i,a,t})$

$$y_{i,a} = \mathbf{Z}_{i,a}^T \varphi_a + f_{0i} + f_{1i} p_a + y_{i,a}^P + \varepsilon_{i,a}$$

where $\beta_i p_a$ is an individual-specific trend, allow non-zero covariance between f_0 and f_1.

Income dynamics - more details

- Our focus here is on non-stationarity, heterogenous profiles, and shocks of varying persistence.
- Individual i of age a in time period t, has log income $y_{i,a}(\equiv \ln Y_{i,a,t})$

$$y_{i,a} = \mathbf{Z}_{i,a}^T \varphi_a + f_{0i} + f_{1i} p_a + y_{i,a}^P + \varepsilon_{i,a}$$

  where $\beta_i p_a$ is an individual-specific trend, allow non-zero covariance between f_0 and f_1.

- $y_{i,a}^T$ is the persistent process with variance σ_a^2

$$y_{i,a}^T = \rho y_{i,a-1}^T + v_{i,a}$$

  and $\varepsilon_{i,a}$ is a transitory process (can be low order MA) with variance ω_a^2 (can be low order MA).

Income dynamics - more details

- Our focus here is on non-stationarity, heterogenous profiles, and shocks of varying persistence.
- Individual i of age a in time period t, has log income $y_{i,a}(\equiv \ln Y_{i,a,t})$

$$y_{i,a} = \mathbf{Z}_{i,a}^{T}\varphi_a + f_{0i} + f_{1i}p_a + y_{i,a}^{P} + \varepsilon_{i,a}$$

where $\beta_i p_a$ is an individual-specific trend, allow non-zero covariance between f_0 and f_1.

- $y_{i,a}^{T}$ is the persistent process with variance σ_a^2

$$y_{i,a}^{T} = \rho y_{i,a-1}^{T} + v_{i,a}$$

and $\varepsilon_{i,a}$ is a transitory process (can be low order MA) with variance ω_a^2 (can be low order MA).

- Allow variances (or factor loadings) of $v_{i,a}$ and $\varepsilon_{i,a}$ to vary with age/time for each birth cohort and education group.

Idiosyncratic Trends

- The idiosyncratic trend term $p_t f_{1i}$ could take a number of forms. Two alternatives are worth highlighting:
  - (a) deterministic idiosyncratic trend:

    $$p_t f_{1i} = r(t) f_{1i}$$

    where r is a known function of t, e.g. $r(t) = t$,

Idiosyncratic Trends

- The idiosyncratic trend term $p_t f_{1i}$ could take a number of forms. Two alternatives are worth highlighting:
  - (a) deterministic idiosyncratic trend:

    $$p_t f_{1i} = r(t) f_{1i}$$

    where r is a known function of t, e.g. $r(t) = t$, and
  - (b) stochastic trend in 'ability prices':

    $$p_t = p_{t-1} + \xi_t$$

    with $E_{t-1}\xi_t = 0$.

Idiosyncratic Trends

- The idiosyncratic trend term $p_t f_{1i}$ could take a number of forms. Two alternatives are worth highlighting:
  - (a) deterministic idiosyncratic trend:

    $$p_t f_{1i} = r(t) f_{1i}$$

    where r is a known function of t, e.g. $r(t) = t$, and
  - (b) stochastic trend in 'ability prices':

    $$p_t = p_{t-1} + \xi_t$$

    with $E_{t-1}\xi_t = 0$.
- Evidence points to some periods of time where each of these is of key importance. Deterministic trends as in (a), appear most prominently early in the working life. Formally, this is a life-cycle effect.

Idiosyncratic Trends

- The idiosyncratic trend term $p_t f_{1i}$ could take a number of forms. Two alternatives are worth highlighting:
  - (a) deterministic idiosyncratic trend:

    $$p_t f_{1i} = r(t) f_{1i}$$

    where r is a known function of t, e.g. $r(t) = t$, and
  - (b) stochastic trend in 'ability prices':

    $$p_t = p_{t-1} + \xi_t$$

    with $E_{t-1}\xi_t = 0$.
- Evidence points to some periods of time where each of these is of key importance. Deterministic trends as in (a), appear most prominently early in the working life. Formally, this is a life-cycle effect.
- Alternatively, stochastic trends (b) are most likely to occur during periods of technical change when skill prices are changing across the unobserved ability distribution. Formally, this is a calender time effect.

Idiosyncratic Trends

- For each cohort we consider several alternative models for the heterogenous profile $\beta_i p_a$:

Idiosyncratic Trends

- For each cohort we consider several alternative models for the heterogenous profile $\beta_i p_a$:

1. Baseline Specification: $f_{1i} = 0$

Idiosyncratic Trends

- For each cohort we consider several alternative models for the heterogenous profile $\beta_i p_a$:

1. Baseline Specification: $f_{1i} = 0$
2. Linear Specification: $p_a = \gamma_1 a + \gamma_0$, so that

$$\Delta^{\rho} \boldsymbol{p}_a = (1 - \rho)\, \gamma_0 \boldsymbol{\iota} + \gamma_1 \boldsymbol{\xi}_0$$

where $\boldsymbol{\xi}_0 \equiv [\boldsymbol{a} - \rho\, (\boldsymbol{a} - 1)]$.

IDIOSYNCRATIC TRENDS

- For each cohort we consider several alternative models for the heterogenous profile $\beta_i p_a$:

1. Baseline Specification: $f_{1i} = 0$
2. Linear Specification: $p_a = \gamma_1 a + \gamma_0$, so that

$$\Delta^{\rho} \boldsymbol{p}_a = (1-\rho)\,\gamma_0 \boldsymbol{\iota} + \gamma_1 \boldsymbol{\xi}_0$$

   where $\boldsymbol{\xi}_0 \equiv [\boldsymbol{a} - \rho\,(\boldsymbol{a} - 1)]$.
3. Quadratic Specification: $p_a = \gamma_0 + \gamma_1 a + \gamma_2 a^2$

Idiosyncratic Trends

- For each cohort we consider several alternative models for the heterogenous profile $\beta_i p_a$:

1. Baseline Specification: $f_{1i} = 0$
2. Linear Specification: $p_a = \gamma_1 a + \gamma_0$, so that

$$\Delta^{\rho} \boldsymbol{p}_a = (1 - \rho)\, \gamma_0 \boldsymbol{\iota} + \gamma_1 \boldsymbol{\xi}_0$$

   where $\boldsymbol{\xi}_0 \equiv [\boldsymbol{a} - \rho\,(\boldsymbol{a} - 1)]$.
3. Quadratic Specification: $p_a = \gamma_0 + \gamma_1 a + \gamma_2 a^2$
4. Piecewise-Linear Specification:

$$\boldsymbol{p}_a = \begin{cases} \kappa_1 a + 35\,(1 - \kappa_1) & \text{if } a \leq 35 \\ a & \text{otherwise} \\ \kappa_2 a + 52\,(1 - \kappa_2) & \text{if } a \geq 52 \end{cases}$$

   with knots at age 35 and age 52.

Idiosyncratic Trends

- For each cohort we consider several alternative models for the heterogenous profile $\beta_i p_a$:

1. Baseline Specification: $f_{1i} = 0$
2. Linear Specification: $p_a = \gamma_1 a + \gamma_0$, so that

$$\Delta^{\rho} \boldsymbol{p}_a = (1-\rho)\,\gamma_0 \boldsymbol{\iota} + \gamma_1 \boldsymbol{\xi}_0$$

   where $\boldsymbol{\xi}_0 \equiv [\boldsymbol{a} - \rho(\boldsymbol{a}-1)]$.
3. Quadratic Specification: $p_a = \gamma_0 + \gamma_1 a + \gamma_2 a^2$
4. Piecewise-Linear Specification:

$$\boldsymbol{p}_a = \begin{cases} \kappa_1 a + 35\,(1-\kappa_1) & \text{if } a \leq 35 \\ a & \text{otherwise} \\ \kappa_2 a + 52\,(1-\kappa_2) & \text{if } a \geq 52 \end{cases}$$

   with knots at age 35 and age 52.
5. Polynomials up to degree 4.

Covariance structure

- Suppose we observe individual i at age $a = 1, ..., T$, we then have $T - 1$ equations $\Delta^\rho y_{ia}$ ($\equiv y_{i,a} - \rho y_{i,a-1}$). In vector form

$$\Delta^\rho \boldsymbol{y}_i = \left((1-\rho)\, \boldsymbol{\iota}, \Delta^\rho \boldsymbol{p}_a \right) \begin{pmatrix} f_{0i} \\ f_{1i} \end{pmatrix} + \boldsymbol{v}_i + \Delta^\rho \boldsymbol{\varepsilon}_i.$$

Covariance structure

- Suppose we observe individual i at age $a = 1, ..., T$, we then have $T - 1$ equations $\Delta^\rho y_{ia}$ $(\equiv y_{i,a} - \rho y_{i,a-1})$. In vector form

$$\Delta^\rho \boldsymbol{y}_i = \left((1-\rho)\,\boldsymbol{\iota}, \Delta^\rho \boldsymbol{p}_a \right) \begin{pmatrix} f_{0i} \\ f_{1i} \end{pmatrix} + \boldsymbol{v}_i + \Delta^\rho \boldsymbol{\varepsilon}_i.$$

- The Variance-Covariance matrix in general has the form: $\text{Var}(\Delta^\rho \boldsymbol{y}_i) = \boldsymbol{\Omega} + \boldsymbol{W}$ where $\mathbf{W} =$

$$\begin{pmatrix} \sigma_2^2 + \omega_2^2 + \rho^2\omega_1^2 & -\rho\omega_2^2 & 0 & 0 \\ -\rho\omega_2^2 & \sigma_3^2 + \omega_3^2 + \rho^2\omega_2^2 & -\rho\omega_3^2 & 0 \\ 0 & -\rho\omega_3^2 & \ddots & -\rho\omega_{T-1}^2 \\ 0 & 0 & -\rho\omega_{T-1}^2 & \sigma_T^2 + \omega_T^2 + \rho^2\omega_{T-1}^2 \end{pmatrix}$$

Covariance structure

- Suppose we observe individual i at age $a = 1, ..., T$, we then have $T - 1$ equations $\Delta^\rho y_{ia}$ $(\equiv y_{i,a} - \rho y_{i,a-1})$. In vector form

$$\Delta^\rho \boldsymbol{y}_i = \left((1-\rho)\, \boldsymbol{\iota}, \Delta^\rho \boldsymbol{p}_a \right) \begin{pmatrix} f_{0i} \\ f_{1i} \end{pmatrix} + \boldsymbol{v}_i + \Delta^\rho \boldsymbol{\varepsilon}_i .$$

- The Variance-Covariance matrix in general has the form: $\mathrm{Var}(\Delta^\rho \boldsymbol{y}_i) = \boldsymbol{\Omega} + \boldsymbol{W}$ where $\mathbf{W} =$

$$\begin{pmatrix} \sigma_2^2 + \omega_2^2 + \rho^2\omega_1^2 & -\rho\omega_2^2 & 0 & 0 \\ -\rho\omega_2^2 & \sigma_3^2 + \omega_3^2 + \rho^2\omega_2^2 & -\rho\omega_3^2 & 0 \\ 0 & -\rho\omega_3^2 & \ddots & -\rho\omega_{T-1}^2 \\ 0 & 0 & -\rho\omega_{T-1}^2 & \sigma_T^2 + \omega_T^2 + \rho^2\omega_{T-1}^2 \end{pmatrix}$$

- For the linear heterogeneous profiles case:

$$\boldsymbol{\Omega} = \left[(1-\rho)\, \boldsymbol{\iota}, \boldsymbol{\xi}_0 \right] \begin{pmatrix} \sigma_0^2 & \rho_{01}\sigma_0\sigma_1 \\ \rho_{01}\sigma_0\sigma_1 & \sigma_1^2 \end{pmatrix} \left[(1-\rho)\, \boldsymbol{\iota}, \boldsymbol{\xi}_0 \right]^T .$$

Removing Additive Separability: Theory

- Approximating the first order conditions (intensive margin):

$$\begin{aligned}\Delta c_{i,t} &\simeq \left(\eta_{c,w_1} + \eta_{c,w_2} - \eta_{c,p}\right) \Delta \ln \lambda_{i,t} \\ &\quad + \eta_{c,w_1} \Delta w_{i,1t+1} + \eta_{c,w_2} \Delta w_{i,2t+1}\end{aligned}$$

Removing Additive Separability: Theory

- Approximating the first order conditions (intensive margin):

$$\begin{aligned}\Delta c_{i,t} &\simeq \left(\eta_{c,w_1} + \eta_{c,w_2} - \eta_{c,p}\right) \Delta \ln \lambda_{i,t} \\ &\quad + \eta_{c,w_1} \Delta w_{i,1t+1} + \eta_{c,w_2} \Delta w_{i,2t+1}\end{aligned}$$

- Interpretation:
  - C and H substitutes ($\eta_{c,w_j} < 0$) $\Rightarrow$ Excess smoothing
  - C and H complements ($\eta_{c,w_j} > 0$) $\Rightarrow$ Excess sensitivity

Removing Additive Separability: Theory

- Approximating the first order conditions (intensive margin):

$$\begin{aligned}\Delta c_{i,t} &\simeq \left(\eta_{c,w_1} + \eta_{c,w_2} - \eta_{c,p}\right)\Delta \ln \lambda_{i,t} \\ &\quad + \eta_{c,w_1}\Delta w_{i,1t+1} + \eta_{c,w_2}\Delta w_{i,2t+1}\end{aligned}$$

- Interpretation:
  - C and H substitutes ($\eta_{c,w_j} < 0$) $\Rightarrow$ Excess smoothing
  - C and H complements ($\eta_{c,w_j} > 0$) $\Rightarrow$ Excess sensitivity
- Moments

$$\begin{pmatrix} \Delta c_{i,t} \\ \Delta y_{i,1,t} \\ \Delta y_{i,2,t} \end{pmatrix} \simeq \begin{pmatrix} \kappa_{i,c,u_1} & \kappa_{i,c,u_2} & \kappa_{i,c,v_1} & \kappa_{i,c,v_2} \\ \kappa_{i,y_1,u_1} & \kappa_{i,y_1,u_2} & \kappa_{i,y_1,v_1} & \kappa_{i,y_1,v_2} \\ \kappa_{i,y_2,u_1} & \kappa_{i,y_2,u_2} & \kappa_{i,y_2,v_1} & \kappa_{i,y_2,v_2} \end{pmatrix} \begin{pmatrix} \Delta u_{i,1,t} \\ \Delta u_{i,2,t} \\ v_{i,1,t} \\ v_{i,2,t} \end{pmatrix}$$

where (for $j = 1, 2$)

$$\kappa_{i,c,u_j} = \eta_{c,w_j};\ \ \kappa_{i,y_j,u_j} = 1 + \eta_{h_j,w_j};\ \ \kappa_{i,y_j,u_{-j}} = \eta_{h_j,w_{-j}}$$

Non-linear Taxes

$$\widetilde{Y}_{it} = (1 - \chi_t)\left(H_{1,t}W_{1,t} + H_{2,t}W_{2,t}\right)^{1-\mu_t}$$

Non-linear Taxes

$$\widetilde{Y}_{it} = (1 - \chi_t)\left(H_{1,t}W_{1,t} + H_{2,t}W_{2,t}\right)^{1-\mu_t}$$

- Implications for underlying structural preference parameters, e.g.

$$\widetilde{\eta}_{h_j,w_j} = \frac{\eta_{h_j,w_j}(1-\mu)}{1+\mu\eta_{h_j,w_j}} (\text{with } \widetilde{\eta}_{h_j,w_j} \leq \eta_{h_j,w_j} \text{ for } 0 \leq \mu \leq 1)$$

Non-linear Taxes

$$\widetilde{Y}_{it} = (1 - \chi_t)\left(H_{1,t}W_{1,t} + H_{2,t}W_{2,t}\right)^{1-\mu_t}$$

- Implications for underlying structural preference parameters, e.g.

$$\widetilde{\eta}_{h_j,w_j} = \frac{\eta_{h_j,w_j}(1-\mu)}{1+\mu\eta_{h_j,w_j}} (\text{with } \widetilde{\eta}_{h_j,w_j} \leq \eta_{h_j,w_j} \text{ for } 0 \leq \mu \leq 1)$$

- Labor supply elasticities (w.r.t. *W*) are dampened: Return to work decreases as people cross tax brackets

LOADING FACTOR MATRIX: ESTIMATES

Response to	Separable case			Non-separable case		
	Consump.	Husband's earnings	Wife's earnings	Consump.	Husband's earnings	Wife's earnings
	(1)	(2)	(3)	(4)	(5)	(6)
v_1	0.13 (0.060)	1.15 (0.067)	−0.54 (0.206)	0.38 (0.057)	0.98 (0.131)	−0.81 (0.180)
v_2	0.07 (0.040)	−0.16 (0.057)	1.53 (0.101)	0.21 (0.037)	−0.23 (0.048)	1.32 (0.087)
Δu_1	0	1.43 (0.097)	0	−0.14 (0.051)	1.51 (0.150)	0.26 (0.103)
Δu_2	0	0	1.83 (0.133)	−0.14 (0.139)	0.13 (0.051)	2.03 (0.265)

- Heterogeneity:

	(1) Baseline	(2) Age 30-55	(3) Some college+	(4) Top 2 asset terc.	(5) Age variance	(6) Sel.correct.
$E(\pi)$	0.181	0.142	0.202	0.245	0.181	0.176
β	-0.120	-0.177	0.117	-0.046	-0.109	-0.129
	(0.198)	(0.089)	(0.072)	(0.084)	(0.077)	(0.076)
$\eta_{c,p}$	0.437	0.465	0.368	0.343	0.42	0.473
	(0.124)	(0.044)	(0.05)	(0.04)	(0.037)	(0.041)
η_{h_1,w_1}	0.514	0.467	0.542	0.388	0.575	0.509
	(0.150)	(0.036)	(0.045)	(0.037)	(0.04)	(0.038)
η_{h_2,w_2}	1.032	1.039	0.858	0.986	1.005	1.095
	(0.265)	(0.099)	(0.097)	(0.105)	(0.086)	(0.092)
η_{c,w_1}	-0.141	-0.113	-0.162	-0.127	-0.15	-0.150
	(0.051)	(0.018)	(0.022)	(0.016)	(0.018)	(0.017)
$\eta_{h_1,p}$	0.082	0.065	0.087	0.07	0.087	0.088
	(0.030)	(0.01)	(0.012)	(0.009)	(0.01)	(0.01)
η_{c,w_2}	-0.138	-0.083	-0.142	-0.129	-0.11	-0.122
	(0.139)	(0.029)	(0.032)	(0.154)	(0.026)	(0.028)
$\eta_{h_2,p}$	0.162	0.097	0.169	0.154	0.129	0.143
	(0.166)	(0.034)	(0.038)	(0.038)	(0.038)	(0.033)
η_{h_1,w_2}	0.128	0.101	0.115	0.079	0.141	0.125
	(0.052)	(0.011)	(0.012)	(0.01)	(0.011)	(0.01)
η_{h_2,w_1}	0.258	0.205	0.255	0.172	0.285	0.253
	(0.103)	(0.022)	(0.027)	(0.021)	(0.022)	(0.021)

Note: Specifications (2) to (6) - Non-bootstrap s.e.'s

Approximation of the Euler equation (1)

- From $\lambda_{i,t} = \frac{1+\delta}{1+r}\mathbb{E}_t\lambda_{i,t+1}$, use a second order Taylor approximation (with $r = \delta$) to yield:

$$\Delta \ln \lambda_{i,t+1} \approx \omega_t + \varepsilon_{i,t+1}$$

- where

$$\begin{aligned} \omega_t &= -\frac{1}{2}\mathbb{E}_t \left(\Delta \ln \lambda_{i,t+1}\right)^2 \\ \varepsilon_{i,t+1} &= \Delta \ln \lambda_{i,t+1} - \mathbb{E}_t \left(\Delta \ln \lambda_{i,t+1}\right) \end{aligned}$$

- Then use the fact that

$$\begin{aligned} \Delta \ln U_{C_{i,t+1}} &= \Delta \ln \lambda_{i,t+1} \\ \Delta \ln U_{H_{i,j,t+1}} &= -\Delta \ln \lambda_{i,t+1} - \Delta \ln W_{i,j,t+1} \end{aligned}$$

Approximation of the Euler equation (2)

- Consider now Taylor expansion of $U_{C_{i,t+1}} (= \lambda_{i,t+1})$:

$$
\begin{aligned}
U_{C_{i,t+1}} &\approx U_{C_{i,t}} + (C_{i,t+1} - C_{i,t})\, U_{C_{i,t}C_{i,t}} \\
\frac{U_{C_{i,t+1}} - U_{C_{i,t}}}{U_{C_{i,t}}} &\approx \left(\frac{C_{i,t+1} - C_{i,t}}{C_{i,t}}\right) \frac{U_{C_{i,t}C_{i,t}} C_{i,t}}{U_{C_{i,t}}} \\
\Delta \ln U_{C_{i,t+1}} &\approx -\frac{1}{\eta_{c,p}} \Delta \ln C_{i,t+1}
\end{aligned}
$$

- and therefore, from

$$\Delta \ln \lambda_{i,t+1} \approx \omega_{t+1} + \varepsilon_{i,t+1}$$

- get

$$\Delta \ln C_{i,t+1} = -\eta_{c,p} \left(\omega_{t+1} + \varepsilon_{i,t+1}\right)$$

Approximation of the life time budget constraint

- Use the fact that

$$\mathbb{E}_I\left[\ln\sum_{i=0}^{T-t}X_{t+i}\right] = \ln\sum_{i=0}^{T-t}\exp\mathbb{E}_{t-1}\ln X_{t+i} + \sum_{i=0}^{T-t}\frac{\exp\mathbb{E}_{t-1}\ln X_{t+i}}{\sum_{j=0}^{T-t}\exp\mathbb{E}_{t-1}\ln X_{t+j}}\left(\mathbb{E}_I-\mathbb{E}_{t-1}\right)\ln X_{t+i} + O\left(\mathbb{E}_I\left\|\xi_t^T\right\|^2\right)$$

for $X = C, WH$ and appropriate choice of $\mathbb{E}_I$.

- Goal: obtain a mapping from wage innovations to innovations in consumption (marginal utility of wealth)