CONSUMPTION SMOOTHING AND FAMILY LABOR SUPPLY

(PRELIMINARY AND INCOMPLETE)

Richard Blundell   Luigi Pistaferri   Itay Saporta-Eksten

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INTRODUCTION

- Various recent studies interested in measuring response of consumption to shocks to economic resources (wages, earnings, wealth, etc.)
  - Krueger and Perri (2006, 2010), Blundell, Pistaferri and Preston (2008), Kaufmann and Pistaferri (2010), Heathcote, Storesletten and Violante (2009), Primiceri and van Rens (2009), Attanasio and Pavoni (2010), Kaplan and Violante (2010)
- Find significant evidence of smoothing even of persistent shocks

Research Question

- What are the mechanisms behind such smoothing?
- This paper:
  - Self-insurance (i.e., savings)
  - Labor supply of primary earner
  - Labor supply of secondary earner
  - Other (un-modeled) mechanisms (networks, government, etc.)

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  - Other (un-modeled) mechanisms (networks, government, etc.)
  - ...and tests for "superior information"
- Distinctive features:
  - Allow for non-separability, heterogeneous preferences, correlated shocks
  - Use new data (PSID 1999-2009)
    - ★ Almost comprehensive consumption measure
    - ★ Good quality earnings, hours, asset data

OUR FINDINGS

- Evidence of smoothing of male's and female's permanent shocks to wages
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- Evidence for Frisch substitutability of consumption and hours
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- Female labor supply plays an important role in smoothing permanent shocks to male wages
- Evidence for Frisch substitutability of consumption and hours
  - This facilitates "excess smoothing" of consumption w.r.t. shocks
- Little evidence that external sources of insurance matter

Outline

1. Model
   - Primitives: Joint stochastic wage process
   - Approximation
   - Intuition of "insurance" mechanisms
2. Data
3. Results
   - Additive separability
   - Non-separability
   - Insurance accounting
4. Discussion

Model and Approximation

Wage Process

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

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

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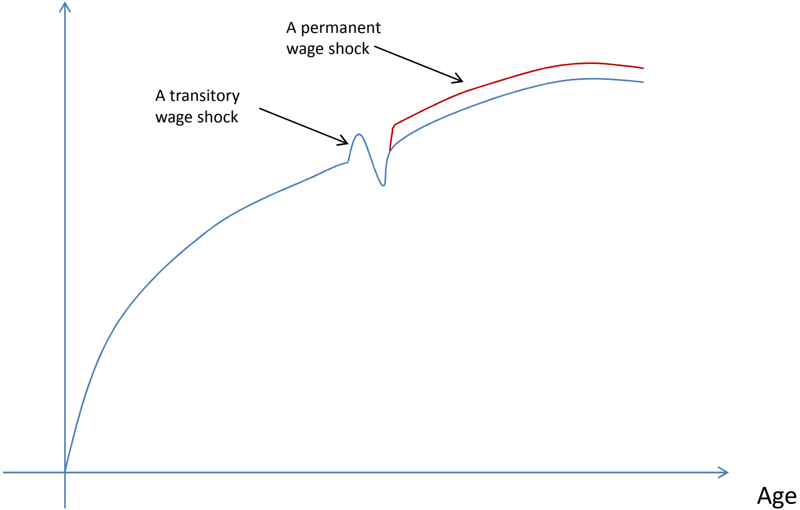
$$\begin{pmatrix} u_{i,1,t} \\ u_{i,2,t} \\ v_{i,1,t} \\ v_{i,2,t} \end{pmatrix} \sim i.i.d. \left(\begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2_{u,1} & \sigma_{u_1,u_2} & 0 & 0 \\ \sigma_{u_1,u_2} & \sigma^2_{u,2} & 0 & 0 \\ 0 & 0 & \sigma^2_{v,1} & \sigma_{v_1,v_2} \\ 0 &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

Transitory vs. Permanent Wage Shock



Household Optimization

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

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

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subject to

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

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- Under additive separability:

$$U\left(C, H_1, H_2\right) = g_0\left(C\right) - g_1\left(H_1\right) - g_2\left(H_2\right)$$

First Order Conditions

$$
\begin{aligned}
U_C &= \lambda_{i,t} \\
U_{H_1} &\leq -\lambda_{i,t} W_{i,1,t} \\
U_{H_2} &\leq -\lambda_{i,t} W_{i,2,t} \\
\lambda_{i,t} &= \frac{1+r}{1+\delta} \mathbb{E}_t \lambda_{i,t+1}
\end{aligned}
$$

- Our goal:
  - Understanding transmission mechanisms from wage shocks to consumption and labor supply decisions of two partners
- No analytical solution with realistic preferences

Solution and Estimation Approaches

- **Our approach**
  - Approximate the Euler equations (interior solution)
  - Approximate the life time budget constraint
  - Write consumption and earnings growth as functions of Frisch elasticities, insurance parameters and wage shocks

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- **Pros**
  - More transparent than full-fledged MSM
  - Unlike Euler equation framework, obtain "consumption function"
- **Cons**
  - Approximation errors
  - Need to specify a wage process
  - Still unable to account for corners, so only crude corrections for non-participation

From Hours to Earnings

- Since (in logs):

$$y = w + h$$

- It follows that:

$$\frac{\partial y}{\partial w} = 1 + \frac{\partial h}{\partial w}$$

- And so the response of earnings to wage shocks is a simple renomination of the response of hours to wage shocks.

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- From now on, denote with c, w, y "unexplained" log consumption, wages, earnings.

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

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

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)

Consumption and Earnings Growth

The 'Simple' Separable Case

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

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where

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

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- $\pi_{i,t} \approx \frac{\text{Assets}_{i,t}}{\text{Assets}_{i,t} + \text{Human Wealth}_{i,t}}$ and $s_{i,j,t} \approx \frac{\text{Human Wealth}_{i,j,t}}{\text{Human Wealth}_{i,t}}$
- $\eta_{x,y}$ is the Frisch elasticity of x w.r.t. y

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

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

Interpretation: Consumption response to j's permanent wage shock

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- 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

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

Identification Issues

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Solution: 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).

Data

DATA AND SAMPLE SELECTION

- PSID biennial 1999-2009:
  - PSID consumption went through a major revision in 1999
    - ~70% of consumption expenditures. Very good match with NIPA
    - The sum of food at home, food away from home, gasoline, health, transportation, utilities, etc.
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- Methodology: Use covariance restrictions that theory imposes on $\Delta c_{i,t}$, $\Delta y_{i,1,t}$ and $\Delta y_{i,2,t}$

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- Inference
  - Multi-step procedure
  - Block bootstrap standard errors

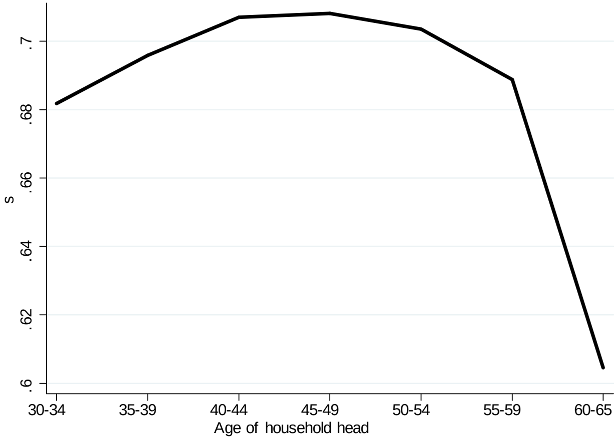
Results: Separable Case

Wage Parameters Estimates

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.	σ_{u_1,u_2}	0.244 (0.22)
	Perm	σ_{v_1,v_2}	0.113 (0.07)
Observations			8,191

Backed Out s by Age

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



Backed Out π by Age

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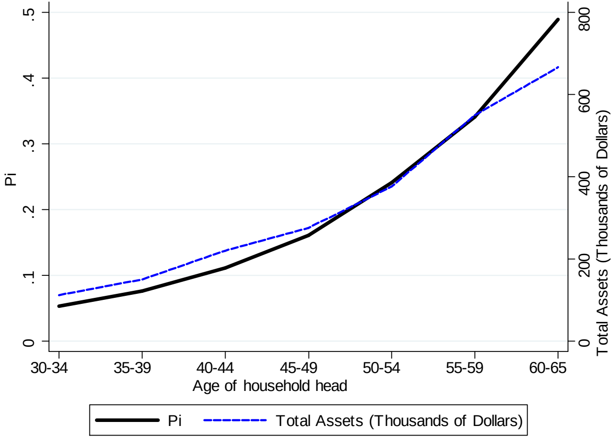

Results for the Separable Case

Insurance from savings	$E(\pi)$	0.181 (0.007)
Insurance over and above savings	β	0.741 (0.311)
EIS of consumption	$\eta_{c,p}$	0.201 (0.087)
Frisch elasticity labor supply (male)	η_{h_1,w_1}	0.431 (0.107)
Frisch elasticity labor supply (female)	η_{h_2,w_2}	0.831 (0.153)

- Benchmarks
  - $\eta_{c,p}$: "The evidence that emerges from micro studies...is that the EIS for consumption...is just below 1" (Attanasio, 1999)
  - η_{h_1,w_1}: Early evidence (MaCurdy, 1981) points to low elasticities (0-0.5); more recent work (Chetty, 2010) suggest larger elasticities (0.3-0.8)
  - η_{h_2,w_2}: Heckman and MaCurdy (1980) find an elasticity of 1.6

Frisch vs. Marshallian Elasticities

$$
\begin{aligned}
\Delta c_{i,t} &\simeq \underset{(0.076)}{0.13}\, v_{i,1,t} + \underset{(0.044)}{0.07}\, v_{i,2,t} \\
\Delta y_{i,1,t} &\simeq \underset{(0.107)}{1.43}\, \Delta u_{i,1,t} + \underset{(0.11)}{1.15} v_{i,1,t} - \underset{(0.075)}{0.16}\, v_{i,2,t} \\
\Delta y_{i,2,t} &\simeq \underset{(0.153)}{1.83}\, \Delta u_{i,2,t} - \underset{(0.208)}{0.54}\, v_{i,1,t} + \underset{(0.11)}{1.53} v_{i,2,t}
\end{aligned}
$$

Excess Smoothing

- β appears too high - too much insurance?
- Sensitivity analyses
  - Non-Participation correction
  - Measurement error assumptions
  - Age criteria
  - Average vs. individual assets when constructing $\pi_{i,t}$
  - Different weighting matrices

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- Sensitivity analyses
  - Non-Participation correction
  - Measurement error assumptions
  - Age criteria
  - Average vs. individual assets when constructing $\pi_{i,t}$
  - Different weighting matrices
- Model fit:
  - Excellent for hourly wage moments
  - Variance of consumption growth is understated
  - Covariance of consumption growth and wages is overstated
  - Zero-restriction test on omitted moments rejects the null: $p\text{-}value = 1.4\%$

Removing Additive Separability

Removing Additive Separability: Theory

- Approximating the first order conditions (intensive margin):

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

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- Illustration: A negative transitory wage shock ($\Delta \ln \lambda_{i,t} = 0$)
  - Separability ($\eta_{c,w_j} = 0$): Minimal decrease in consumption (actually, zero in our setup) and hours decrease
  - C and H substitutes: consumption decrease is attenuated (may become increase)

An Illustration

Under separability

W ↓ transitorily

H ↓ (Frisch)

Y= WH ↓

C ↓ a tiny bit due to budget constraint effect

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Under separability

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Under non-separability

W ↓ transitorily

H ↓ (Frisch)

Y= WH ↓

C ↓ a tiny bit due to budget constraint effect, but:

C ↑ if C,H are subst.

Removing Additive Separability: 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 $j = 1, 2$)

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

and:

$$\kappa_{c,v_j} = \eta_{c,w_j} + \frac{\left(\eta_{c,p} - \eta_{c,w_j} - \eta_{c,w_{-j}}\right)\left[\left(1-\pi_t\right)\left(1-\beta\right)\left(s_{jt} + \overline{\eta_{h,w_j}}\right) - \eta_{c,w_j}\right]}{\left(1-\pi_t\right)\left(1-\beta\right)\left(\overline{\eta_{h,w_j}} + \overline{\eta_{h,w_{-j}}} + \overline{\eta_{h,p}}\right) - \eta_{c,w_j} - \eta_{c,w_{-j}} + \eta_{c,p}}$$

Consumption and Earnings Dynamics

- Transmission coefficients (κ) now depends also on "Frisch" cross-elasticities

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- For identification, we impose symmetry of Frisch elasticities

Removing Additive Separability: Results

	(1)	(2)	(3)
	Additive separab.	Non-separab.	Non-separab. w/$\beta = 0$
$E(\pi)$	0.181 (0.007)	0.181 (0.007)	0.181 (0.007)
β	0.741 (0.311)	-0.120 (0.682)	0
$\eta_{c,p}$	0.201 (0.087)	0.437 (0.227)	0.448 (0.165)
η_{h_1,w_1}	0.431 (0.107)	0.514 (0.141)	0.497 (0.143)
η_{h_2,w_2}	0.831 (0.153)	1.032 (0.613)	1.041 (0.480)
η_{c,w_1}	-.-	-0.141 (0.060)	-0.141 (0.061)
$\eta_{h_1,p}$	-.-	0.082 (0.035)	0.082 (0.036)
η_{c,w_2}	-.-	-0.138 (0.218)	-0.158 (0.176)
$\eta_{h_2,p}$	-.-	0.162 (0.256)	0.185 (0.207)
η_{h_1,w_2}	-.-	0.128 (0.060)	0.120 (0.074)
η_{h_2,w_1}	-.-	0.258 (0.121)	0.242 (0.148)

Removing the Separability Assumption

$$\Delta c_{i,t} \simeq \underset{(0.06)}{-0.14}\Delta u_{i,1,t} - \underset{(0.218)}{0.14}\Delta u_{i,2,t} + \underset{(0.08)}{0.38} v_{i,1,t} + \underset{(0.05)}{0.21} v_{i,2,t}$$

$$\Delta y_{i,1,t} \simeq \underset{(0.14)}{1.51}\Delta u_{i,1,t} + \underset{(0.06)}{0.13}\Delta u_{i,2,t} + \underset{(0.142)}{0.98} v_{i,1,t} - \underset{(0.062)}{0.23} v_{i,2,t}$$

$$\Delta y_{i,2,t} \simeq \underset{(0.12)}{0.26}\Delta u_{i,1,t} + \underset{(0.61)}{2.03}\Delta u_{i,2,t} - \underset{(0.19)}{0.81} v_{i,1,t} + \underset{(0.103)}{1.32} v_{i,2,t}$$

Fit of model with non-separability

- Wage fit unchanged
- Doing better with $E\left[(\Delta c_t)^2\right]$ and $\Delta y_{1,t}, \Delta y_{2,t}$ moments but not with $\Delta c_t, \Delta w_{j,t}$
- Removing zero restrictions:
  - Better match: $E\left[\Delta w_{1,t} \Delta c_{t-2}\right]$ and $E\left[\Delta w_{2,t} \Delta c_{t-2}\right]$
  - Worse match for others...
  - Model implies symmetries which are not rejected (p-value 0.06 for male and 0.31 for female)

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

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

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

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

fixed labor supply and no insurance	-6.9%

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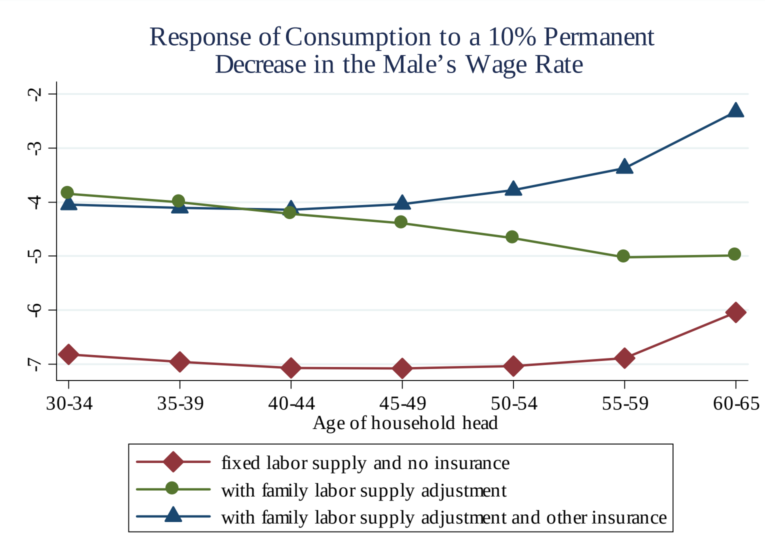
Response of consumption to a 10% permanent decrease in the male's wage rate ($v_1 = -0.1$):

fixed labor supply and no insurance	-6.9%
with family labor supply adjustment	-4.4%
with family labor supply adjustment and other insurance	-3.8%

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



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

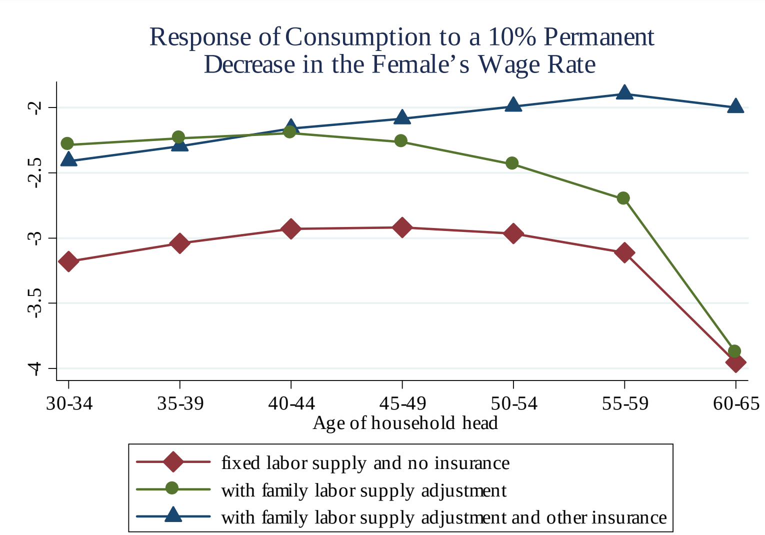
The average response of total earnings to a permanent shock to the female's wages:

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

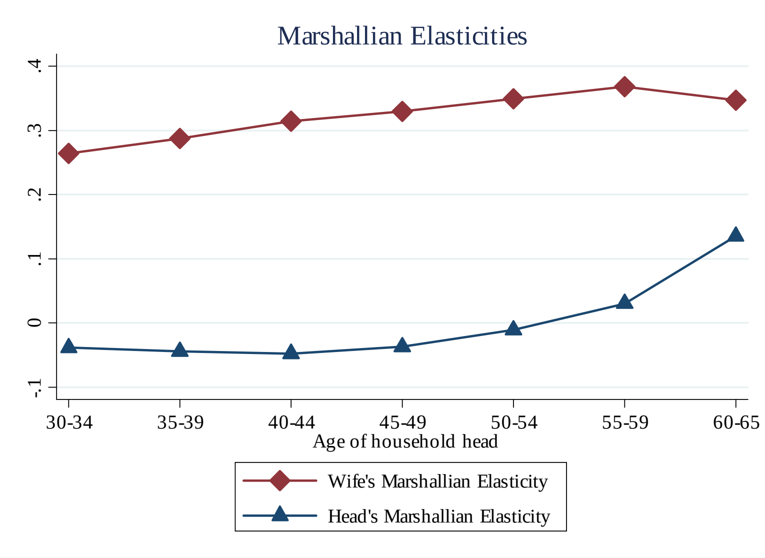
Response of consumption to a 10% permanent decrease in the female's wage rate ($v_2 = -0.1$):

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%

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



Marshallian Elasticities: By Age



Discussion

Discussion (1)

- Evidence for consumption and leisure Frisch complementarity
- Large changes in hours
  - Fall of consumption at retirement or unemployment
  - Appears consistent with substitutability, not complementarity

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How to Reconcile?

- Possible theoretical explanations: Extensive vs. Intensive margin
  - Fixed costs paid at employment (extensive margin): Buy a suit
  - Other goods substitute with hours (intensive margin): Utilities
  - Blundell and Laroque (2011) derive a model with both margins

Discussion (2)

- We estimated "conditional" Euler equations, controlling for changes in hours (intensive margin) and changes in participation (extensive margin)
- Use lags as IVs

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- Use lags as IVs

(Noisy) results, but consistent with this idea:

	Regression results			First Stage F-stats		
	(1)	(2)	(3)	(1)	(2)	(3)
ΔEMP_t(male)	0.144			23.4		
	(0.369)					
Δh_t(male)	-0.0728	-0.0127	-0.0138	26.3	135.5	6.0
	(0.175)	(0.0207)	(0.0635)			
ΔEMP_t(female)	0.456**	0.362*	0.232	98.4	91.2	12.6
	(0.199)	(0.186)	(0.892)			
Δh_t(female)	-0.220**	-0.171*	-0.128	86.5	77.7	18.5
	(0.0999)	(0.0939)	(0.314)			
Sample	All	EMP_t(male)=1	EMP_t(male)=1			
Instruments	2, 4 lags	2, 4 lags	4 lag			
Observations	7,247	6,678	6,678			

Δx_t is defined as $(x_t - x_{t-1})/[0.5(x_t + x_{t-1})]$.

DISCUSSION (3)

- Concavity of preferences. Use the fact that:

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

  Does not reject concavity at average values of wages, hours, consumption.

- Information. Consumption growth should be correlated with future wage growth if individuals have more information than the econometrician (Cunha et al., 2008).
  - Test has p-value 13%

Conclusions

- We estimate a life cycle model with two earners and labor supply decisions and find:
  - Smoothing: The average household can smooth at least 62% of male and 79% of female permanent wage shocks
  - Added worker effects: Female labor supply plays an important role in consumption smoothing
  - Non-separability: Evidence for Frisch substitutability of consumption and hours (intensive margin), and Frisch complementarity of spouses' leisures
  - No *outside* insurance: Once family labor supply, assets and taxes are properly accounted for their is little evidence of additional insurance

Extensions

- How large are approximation errors?
- Liquidity constraints
- Nonseparability of consumption and hours vs. fixed cost of labor
- Adjustment cost in hours
- Intra-family allocation issues

APPENDIX: 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.

APPENDIX: 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.

APPENDIX: 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

Appendix: Separable Case by Assets and Age

		(1)	(2)	(3)	(4)	(5)
Sample		All	1st asset tercile	2nd, 3rd asset terciles	age<40	age>=40
Insurance from savings	$E(\pi)$	0.181	0.043	0.245	0.068	0.222
Insurance over and above savings	β	0.781	0.814	0.792	-0.077	0.861
		(0.033)	(0.04)	(0.046)	(0.194)	(0.033)
Elasticity of intertemporal substitution of consumption	$\eta_{c,p}$	0.284	1.154	0.171	0.349	0.22
		(0.047)	(0.6)	(0.04)	(0.057)	(0.055)
Frisch elasticity of labor supply (male)	$\eta_{h1,w1}$	0.471	0.407	0.4	0.385	0.521
		(0.042)	(0.065)	(0.045)	(0.053)	(0.052)
Frisch elasticity of labor supply (female)	$\eta_{h2,w2}$	1.115	1.044	1.024	1.519	1.018
		(0.07)	(0.103)	(0.084)	(0.147)	(0.075)
	Observations	8,191	2,626	5,565	2,172	6,019

Variable Definitions

- **Variable Definitions**
  - Consumption measure
    - ★ The sum of food at home, food away from home, gasoline, health, transportation, utilities, etc.
    - ★ Main items that are missing: clothing, recreation, alcohol and tobacco

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    - ★ The ratio of annual earnings and annual hours

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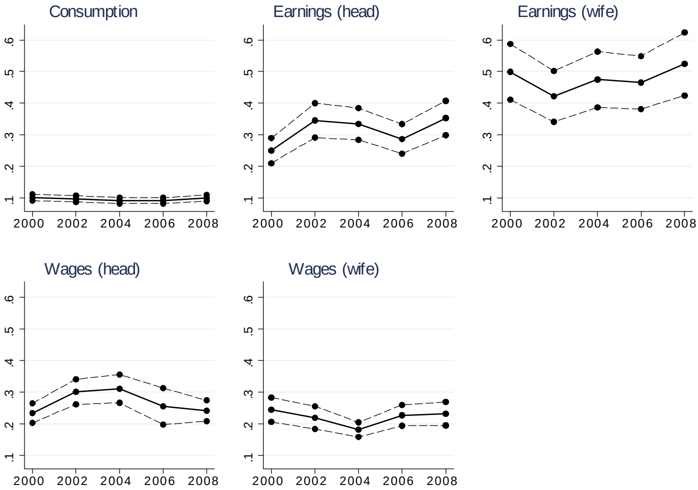
NIPA-PSID Comparison

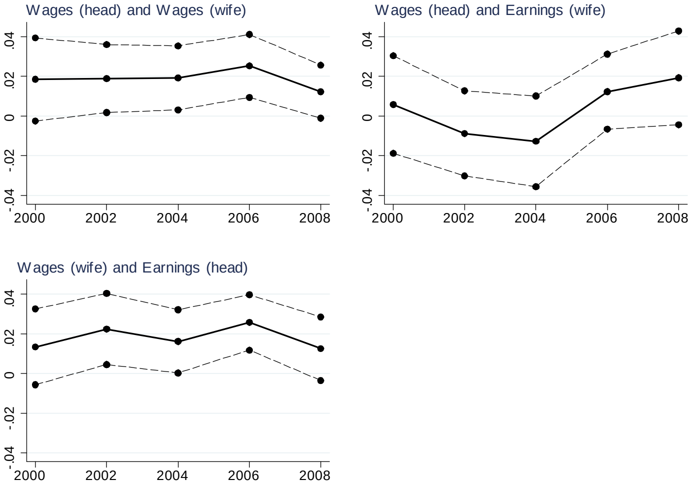
	1998	2000	2002	2004	2006	2008
PSID Total	3,276	3,769	4,285	5,058	5,926	5,736
NIPA Total	5,139	5,915	6,447	7,224	8,190	9,021
ratio	0.64	0.64	0.66	0.7	0.72	0.64
PSID Nondurables	746	855	887	1,015	1,188	1,146
NIPA Nondurables	1,330	1,543	1,618	1,831	2,089	2,296
ratio	0.56	0.55	0.55	0.55	0.57	0.5
PSID Services	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

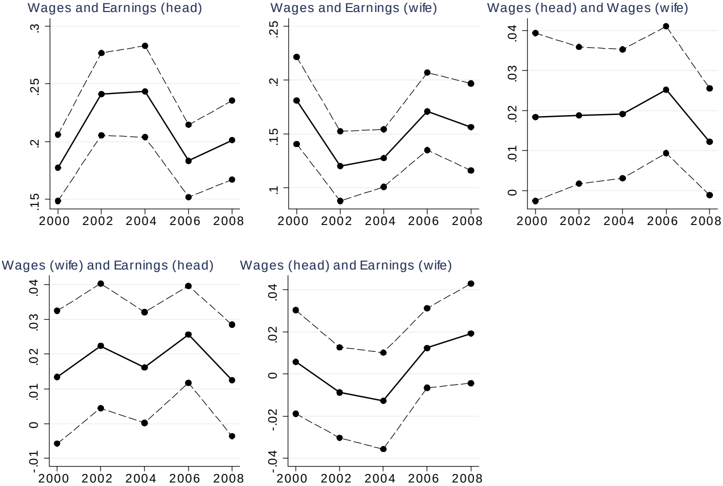
Variance of Residual Consumption, Earnings and Wages Growth



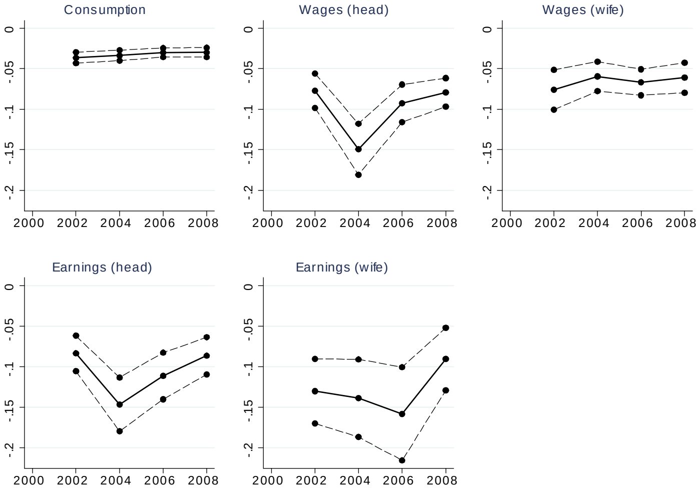
Covariance of Earnings and Wages between Spouses



Covariances of Consumption with Earnings and Wages



Covariances with Lagged Growth



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 $\Delta w_{i,j,t}$
- Will correct standard errors by the block bootstrap (disregarded for the time being)
- GMM strategy - identity matrix

Fit of Model

- Fit of hourly wage moments is excellent

Moment	Data	Model (Separable)	Model (NS)
$E[\Delta w_{1,t}\Delta w_{1,t-2}]$	-0.0991	-0.0991	-0.0991
$E[(\Delta w_{1,t})^2]$	0.2679	0.2679	0.2679
$E[\Delta w_{2,t}\Delta w_{2,t-2}]$	-0.064	-0.064	-0.064
$E[(\Delta w_{2,t})^2]$	0.2191	0.2191	0.2191
$E[\Delta w_{1,t}\Delta w_{2,t}]$	0.02	0.02	0.02
$E[\Delta w_{1,t}\Delta w_{2,t-2}]$	-0.002	-0.0039	-0.0039
$E[\Delta w_{2,t}\Delta w_{1,t-2}]$	-0.0059	-0.0039	-0.0039

Fit of Model (2)

Fit of other moments slightly more problematic:

Moment	Data	Model (Separable)	Model (NS)
$E[(\Delta c_t)^2]$	0.0963	0.0671	0.0791
$E[\Delta c_t \Delta c_{t-2}]$	-0.0325	-0.0325	-0.0332
$E[\Delta c_t \Delta w_{1,t}]$	0.0021	0.0098	0.0186
$E[\Delta c_t \Delta w_{2,t}]$	0.0021	0.0089	0.0158
$E[\Delta c_t \Delta y_{1,t}]$	0.0115	0.011	0.0093
$E[\Delta c_t \Delta y_{2,t}]$	0.0039	0.0105	-0.0094
$E[(\Delta y_{1,t})^2]$	0.3148	0.3006	0.3001
$E[(\Delta y_{2,t})^2]$	0.4777	0.4615	0.4656
$E[\Delta w_{1,t} \Delta y_{1,t}]$	0.2089	0.2385	0.2325
$E[\Delta w_{2,t} \Delta y_{2,t}]$	0.1514	0.1956	0.1732
$E[\Delta w_{1,t} \Delta y_{2,t}]$	0.0037	0.0036	-0.0162
$E[\Delta w_{2,t} \Delta y_{1,t}]$	0.018	0.0147	0.0114

Moment	Data	Model (Separable)	Model (NS)
$E[\Delta y_{1,t} \Delta y_{2,t}]$	0.0092	-0.0121	0.0115
$E[\Delta y_{1,t} \Delta y_{1,t-2}]$	-0.1067	-0.0962	-0.1102
$E[\Delta y_{2,t} \Delta y_{2,t-2}]$	-0.1289	-0.0847	-0.1229
$E[\Delta w_{1,t} \Delta y_{1,t-2}]$	-0.0681	-0.0763	-0.0808
$E[\Delta w_{2,t} \Delta y_{2,t-2}]$	-0.0395	-0.019	-0.0265
$E[\Delta y_{1,t} \Delta w_{1,t-2}]$	-0.0774	-0.0763	-0.0808
$E[\Delta y_{2,t} \Delta w_{2,t-2}]$	-0.0332	-0.019	-0.0265
$E[\Delta w_{1,t} \Delta y_{2,t-2}]$	0.0131	-0.0083	-0.0204
$E[\Delta w_{2,t} \Delta y_{1,t-2}]$	-0.0084	-0.0058	-0.0097
$E[\Delta y_{1,t} \Delta w_{2,t-2}]$	-0.004	-0.0058	-0.0097
$E[\Delta y_{2,t} \Delta w_{1,t-2}]$	-0.0084	-0.0083	-0.0204

FIT OF MODEL (3)

- Moreover, we impose that certain moments are zero:

Moment	Data	Model (Separable)	Model (NS)
$E[\Delta c_t \Delta w_{1,t-2}]$	-0.0005	0	0.0016
$E[\Delta c_t \Delta w_{2,t-2}]$	0.0018	0	0.0027
$E[\Delta c_t \Delta y_{1,t-2}]$	-0.0065	0	0.0057
$E[\Delta c_t \Delta y_{2,t-2}]$	0.0034	0	0.0082
$E[\Delta w_{1,t} \Delta c_{t-2}]$	0.0046	0	0.0016
$E[\Delta w_{2,t} \Delta c_{t-2}]$	0.0026	0	0.0027
$E[\Delta y_{1,t} \Delta c_{t-2}]$	0.0005	0	0.0057
$E[\Delta y_{2,t} \Delta c_{t-2}]$	0.0006	0	0.0082

- Joint test that they are zero: $p - value = 0.024$

Fit of model with non-separability (1)

Moment	Data	Model (Separable)	Model (NS)
$E[(\Delta c_t)^2]$	0.0963	0.0671	0.0791
$E[\Delta c_t \Delta c_{t-2}]$	-0.0325	-0.0325	-0.0332
$E[\Delta c_t \Delta w_{1,t}]$	0.0021	0.0098	0.0186
$E[\Delta c_t \Delta w_{2,t}]$	0.0021	0.0089	0.0158
$E[\Delta c_t \Delta y_{1,t}]$	0.0115	0.011	0.0093
$E[\Delta c_t \Delta y_{2,t}]$	0.0039	0.0105	-0.0094
$E[(\Delta y_{1,t})^2]$	0.3148	0.3006	0.3001
$E[(\Delta y_{2,t})^2]$	0.4777	0.4615	0.4656
$E[\Delta w_{1,t} \Delta y_{1,t}]$	0.2089	0.2385	0.2325
$E[\Delta w_{2,t} \Delta y_{2,t}]$	0.1514	0.1956	0.1732
$E[\Delta w_{1,t} \Delta y_{2,t}]$	0.0037	0.0036	-0.0162
$E[\Delta w_{2,t} \Delta y_{1,t}]$	0.018	0.0147	0.0114

Moment	Data	Model (Separable)	Model (NS)
$E[\Delta y_{1,t} \Delta y_{2,t}]$	0.0092	-0.0121	0.0115
$E[\Delta y_{1,t} \Delta y_{1,t-2}]$	-0.1067	-0.0962	-0.1102
$E[\Delta y_{2,t} \Delta y_{2,t-2}]$	-0.1289	-0.0847	-0.1229
$E[\Delta w_{1,t} \Delta y_{1,t-2}]$	-0.0681	-0.0763	-0.0808
$E[\Delta w_{2,t} \Delta y_{2,t-2}]$	-0.0395	-0.019	-0.0265
$E[\Delta y_{1,t} \Delta w_{1,t-2}]$	-0.0774	-0.0763	-0.0808
$E[\Delta y_{2,t} \Delta w_{2,t-2}]$	-0.0332	-0.019	-0.0265
$E[\Delta w_{1,t} \Delta y_{2,t-2}]$	0.0131	-0.0083	-0.0204
$E[\Delta w_{2,t} \Delta y_{1,t-2}]$	-0.0084	-0.0058	-0.0097
$E[\Delta y_{1,t} \Delta w_{2,t-2}]$	-0.004	-0.0058	-0.0097
$E[\Delta y_{2,t} \Delta w_{1,t-2}]$	-0.0084	-0.0083	-0.0204

- Doing better with $E\left[(\Delta c_t)^2\right]$ and $\Delta y_{1,t}, \Delta y_{2,t}$ moments but not with $\Delta c_t, \Delta w_{j,t}$.

FIT OF MODEL WITH NON-SEPARABILITY (2)

Moment	Data	Model (Separable)	Model (NS)
$E[\Delta c_t \Delta w_{1,t-2}]$	-0.0005	0	0.0016
$E[\Delta c_t \Delta w_{2,t-2}]$	0.0018	0	0.0027
$E[\Delta c_t \Delta y_{1,t-2}]$	-0.0065	0	0.0057
$E[\Delta c_t \Delta y_{2,t-2}]$	0.0034	0	0.0082
$E[\Delta w_{1,t} \Delta c_{t-2}]$	0.0046	0	0.0016
$E[\Delta w_{2,t} \Delta c_{t-2}]$	0.0026	0	0.0027
$E[\Delta y_{1,t} \Delta c_{t-2}]$	0.0005	0	0.0057
$E[\Delta y_{2,t} \Delta c_{t-2}]$	0.0006	0	0.0082

- Better match: $E\left[\Delta w_{1,t} \Delta c_{t-2}\right]$ and $E\left[\Delta w_{2,t} \Delta c_{t-2}\right]$
- Model implies symmetries which are rejected for male (p-value 0.02) but not for female (p-value 0.35)

Literature Review

- **Consumption smoothing**
  - Incomplete markets model: Hall and Mishkin (1982), Kaplan and Violante (2010), Hryshko (2011)
  - Partial Insurance: Blundell, Pistaferri and Preston (2008), Heathcote, Storesletten and Violante (2009)
    - Private information and Limited commitment: Attanasio and Pavoni (2010), Krueger and Perri (2011)
  - Superior information: Primiceri and van Rens (2009), Kaufmann and Pistaferri (2010), Guvenen and Smith (2011)
- **Added worker effect**: Lundberg (1985), Hyslop (2001), Stephens (2002), Juhn and Potter (2007)
- **Non-separability between consumption and leisure**: Heckman (1974), Browning, Deaton and Irish (1985), Browning and Meghir (1991), Hall (2009)