Taxation of Durables, Non-durables, and Earnings with Heterogeneous Preferences

Francesca Parodi
Collegio Carlo Alberto and Institute for Fiscal Studies

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Introduction

Consumption and personal income taxes are key policy instruments:

- major sources of gvt revenues, different mix/design across countries
- redistribution among households
- social insurance against adverse shocks + missing markets
- distortions on households' static and dynamic choices

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- distortions on households' static and dynamic choices

This paper:

- impact of indirect and direct taxation on household life-cycle behavior: consumption, savings, labor supply
- optimal design of taxes on different commodities and labor income
- optimal tax system versus tax practice

Approach and Contributions

1. Household life-cycle model with direct-indirect taxation featuring:
    - multiple consumption goods: necessities, luxuries, durables
    - labor supply decision
    - heterogeneous preferences

   $\rightarrow$ estimated on micro data

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    - under alternative scenarios of preference heterogeneity

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   → estimated on micro data

2. Quantitative normative analysis
    - under alternative scenarios of preference heterogeneity

3. Reconcile tax theory and tax practice
    - allowing for varying degrees of gvt inequality aversion

The model

The model: overview

- Households derive utility from:
  - non-durable necessities and luxuries, consumer durables
  - labor/leisure of second earner
- Face uncertainty in:
  - spouses' earnings and family dynamics
- Self-insure through:
  - buy/sell partially irreversible durables
  - save/borrow in financial assets under borrowing constraints
  - adjust labor supply of second earner
- Gvt provides social insurance through:
  - differentiated consumption taxes
  - progressive labor income taxes

The model: heterogeneity

- Households of 3 education types: $s \in$ (Secondary, High School, College)
  - preferences for intra- and intertemporal consumption, saving and work
  - stochastic earning processes for husband and wife
  - stochastic process for family composition
- Heterogeneous endowments drawn from micro data

The model: household problem

- Households solve the following dynamic optimization problem:

$$\max_{c_{1,t}, c_{2,t}, l_t, d_t, a_t} \mathbb{E}_{t_0} \sum_{t=t_0}^{T} \beta^{t-t_0} U(c_{1,t}, c_{2,t}, d_t, l_t)$$

$s.t.$ durables law of motion, budget constraint, borrowing constraint

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- Approach: intratemporal demand analysis for multiple non-durables integrated with intertemporal life cycle model for durables, savings and family labour supply

The model: household problem

- weak separability between (c_1, c_2) and d, and l, implies:

$$\max_{c_{1,t}, c_{2,t}, l_t, d_t, a_t} \mathbb{E}_{t_0} \sum_{t=t_0}^{T} \beta^{t-t_0} U(u(c_{1,t}, c_{2,t}), d_t, l_t)$$

$$s.t. \qquad \text{constraints}$$

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$$s.t. \qquad \text{constraints}$$

- 2-stage budgeting: intratemporal non-durable problem completely characterized by indirect utility $v(c_t, P_t)$ up to monotonic transformation

$$\max_{c_t, l_t, d_t, a_t} \mathbb{E}_{t_0} \sum_{t=t_0}^{T} \beta^{t-t_0} U(v(c_t, P_t), d_t, l_t)$$

$$s.t. \qquad \text{constraints}$$

The model: preferences

Intertemporal preferences (time separable):

CRRA utility, Stone-Geary preferences

$$U(v(c_t, P_t), d_t, l_t) = \frac{[(v(c_t/n(k_t), P_t))^{\theta}(\delta d_t - \epsilon^d)^{1-\theta}]^{1-\gamma}}{1-\gamma} exp(\Psi(l_t, k_t))$$

- $\epsilon^d < 0$: non-homothetic preferences
- $n(k_t)$: equivalence scale depending on family composition
- service flow of durables proportional to stock of durables
- $\Psi(l_t, k_t) > 0$: disutility from participation

The model: preferences

Intertemporal preferences:

Labor supply changes marginal utility from consumption

$$\Psi(l_t, k_t) = \begin{cases} 0 & \text{if } l_t = NE \\ \psi_0 \times \mathbf{1}(k_t = 0) + \psi_1 \times \mathbf{1}(k_t = 1) + \psi_2 \times \mathbf{1}(k_t = 2) & \text{if } l_t = E \end{cases}$$

- extensive margin choice: employed (E)/not employed (NE)
- disutility from participation depends on family composition: no kids, youngest kid age 0-5, youngest kid age 6+ ($k = 0, 1, 2$)

The model: preferences

Intratemporal preferences:
conditional on total spending on non-durables c

$$\max_{c_1, c_2} u(c_1, c_2) \qquad s.t. \qquad (1+\tau_1^n)\tilde{p}_1 c_1 + (1+\tau_2^n)\tilde{p}_2 c_2 = c$$

- Almost Ideal Demand System model (Deaton and Muellbauer, 1980)
- implies indirect utility function:

$$v(c, P) = exp\left\{ \frac{ln(c) - ln(a(P))}{b(P)} \right\}$$

$$ln(a(P)) = \alpha_0 + \sum_{i=1}^{2} \alpha_i lnp_i + \frac{1}{2} \sum_{i=1}^{2} \sum_{j=1}^{2} \eta_{ij} lnp_i lnp_j$$

$$b(P) = \prod_{i=1}^{2} p_i^{\beta_i}$$

$$P = [p_1, p_2] \qquad p_1 = (1+\tau_1^n)\tilde{p}_1 \qquad p_2 = (1+\tau_2^n)\tilde{p}_2$$

The model: uncertainty

- Earning processes, $g \in (f, m)$:

$$ln y_t^g = f^g(X, t) + \tilde{y}_t^g$$

$$\tilde{y}_t^g = z_t^g + \varepsilon_t^g$$

$$z_t^g = \rho^g z_{t-1}^g + u_t^g$$

$$\varepsilon_t^g \sim N(0, \sigma^2_{\varepsilon^g}), \qquad u_t^g \sim N(0, \sigma^2_{u^g}), \qquad z_0^g \sim N(0, \sigma^2_{z_0^g})$$

- Family composition:

$$Prob[k_t | k_{t-1}, t, s] \quad \forall t < T_{ret}$$

The model: durables and assets

- Durables (illiquid):
  - δ: depreciation rate
  - π: fraction of durables stock that can be sold on 2nd hand mkt
  - non linear price function for durables:

$$D(x_t) = \begin{cases} (1+\tau^d) & \text{if } x_t \geq 0 \\ \pi & \text{if } x_t < 0 \end{cases}$$

- Financial assets (liquid):
  - χ: fraction of durables stock that can be used as collateral

The model: government

- Differentiated consumption tax rates: $\tau_1^n, \tau_2^n, \tau^d$
- Progressive labor income tax approximated by non-linear tax-transfer function (Benabou, 2002):

$$y^{net} = T(y^{gross}, k) = \lambda_k (y^{gross})^{1-\tau_k}$$

The model: recursive formulation

- Working age:

$$\mathbb{S}_t = \{s, a_{t-1}, d_{t-1}, y_t^f, y_t^m, k_t\}$$

$$V_t(\mathbb{S}_t) = \max_{c_t, l_t, d_t, a_t} \{U(v(c_t, P_t), d_t, l_t) + \beta \int V_{t+1}(\mathbb{S}_{t+1}) dF(y_{t+1}^f, y_{t+1}^m, k_{t+1} | y_t^f, y_t^m, k_t)\}$$

  - durables law of motion

$$d_t = (1-\delta)d_{t-1} + x_t$$

  - budget constraint

$$c_t + D(x_t)x_t + a_t = (1+r)a_{t-1} + T(y_t^m, k_t) + T(y_t^f, k_t) \times \mathbf{1}(l_t = E)$$

  - borrowing constraint

$$a_t \geq -\chi d_t$$

EE Retirement

Institutional background and Data

Institutional background and Data

- Survey of Household Income and Wealth (SHIW):
  - panel component since 1987
  - demographics, income, consumption, hours and wealth
  - breakdown of consumption into non-durables and durables
  - durables stocks and flows rotating panel check attrition durables assets
- Household Budget Survey (HBS):
  - cross-section
  - expenditures diary and interview
  - very disaggregated set of commodities non-durables
- Italian tax regime details

Estimation and Results

Estimation

Two-step estimation strategy:

- **First step**:
  - intratemporal demand system
  - HH head's earning process details
  - family composition transition probabilities details
  - tax function details
- **Second step**:
  - intertemporal preferences
  - durables' dynamics
  - spouse's earning process

First step: intratemporal demand system

- Almost Ideal Demand System estimation equations for two non-durables:

$$w_{it} = \alpha_i + \sum_{j=1}^{2} \eta_{ij} lnp_{jt} + \beta_i ln \left\{ \frac{c_t}{a(P)} \right\} + e_{it} \qquad i, j = 1, 2$$

restrictions: $\sum_{i=1}^{2} \alpha_i = 1$, $\sum_{i=1}^{2} \beta_i = 0$, $\sum_{j=1}^{2} \eta_{ji} = 0$, $\sum_{j=1}^{2} \eta_{ij} = 0$

from which obtain estimated price indices:

$$ln(a(P)) = \alpha_0 + \sum_{i=1}^{2} \alpha_i lnp_i + \frac{1}{2} \sum_{i=1}^{2} \sum_{j=1}^{2} \eta_{ij} lnp_i lnp_j$$

$$b(P) = \prod_{i=1}^{2} p_i^{\beta_i}$$

First step: intratemporal demand system

- Parameters estimation on HBS data
- education specific

	Secondary	High School	College
α_1	0.5774***	0.6156***	0.7918***
	(0.0312)	(0.0314)	(0.0350)
β_1	-0.0269 ***	-0.0319***	-0.0516***
	(0.0036)	(0.0036)	(0.0039)
η_{11}	0.0087	0.0179	0.0564
	(0.0186)	(0.0195)	(0.0279)
N	2,238	2,260	2,110

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

test elasticities

Second step

- Method of simulated moments MSM
- Estimating parameters (education specific):

$$\Theta = \left\{\theta, \gamma, \beta, \epsilon^d, \psi_0, \psi_1, \psi_2, \delta, \pi, \chi, f_0, f_1, f_2, \rho, \sigma_u, \sigma_{z_0}, \sigma_\epsilon, \right\}$$

- Moments targeted in estimation :
  - mean life-cycle profiles (age 30-60) of non-durable consumption, durables, financial assets, female employment rate by education

extra params identification

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  - moments related to durables dynamics

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  - mean deterministic life-cycle profile of female gross earnings and variance-covariance of the stochastic component by education

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- Moments targeted in estimation :
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  - moments related to durables dynamics
  - mean deterministic life-cycle profile of female gross earnings and variance-covariance of the stochastic component by education
- Overidentified model: 383 targeted moments for 45 estimating parameters

extra params identification

Second step: parameter estimates

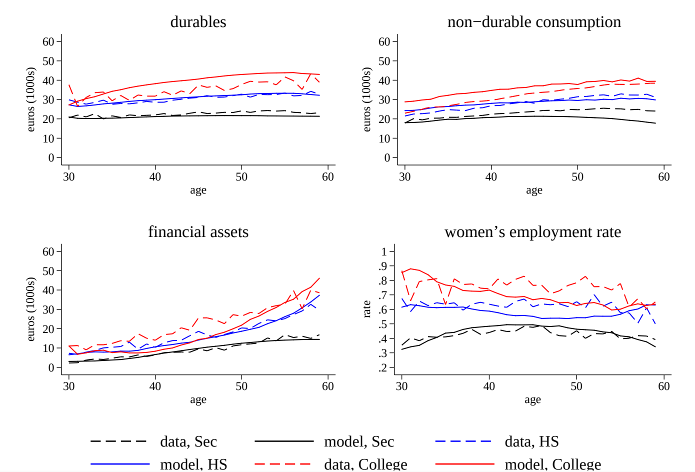
- Preference parameters

	Sec	HS	College	
θ	.7941	.8414	.8217	non-durable consumption share
	(.0024)	(.0023)	(.0031)	
γ	3.56	3.1941	2.7971	coeff. of relative risk aversion
	(.0099)	(.0112)	(.0163)	
β	.9802	.9899	.9955	discount factor
	(.0011)	(.0006)	(.0010)	
ϵ^d	-976	-353	-90	Stone-Geary coeff for durables
	(9.54)	(20.16)	(4.67)	
ψ_0	3.0263	.7741	.4100	female participation: no children
	(14.01)	(.0179)	(.0367)	
ψ_1	.9734	.8226	.6270	female participation: youngest child 0-5
	(.0090)	(.0062)	(.0105)	
ψ_2	.9445	.9426	.6811	female participation: youngest child 6+
	(.0097)	(.0051)	(.0101)	

durables dynamics | female earning process | back

Results: fit of the model

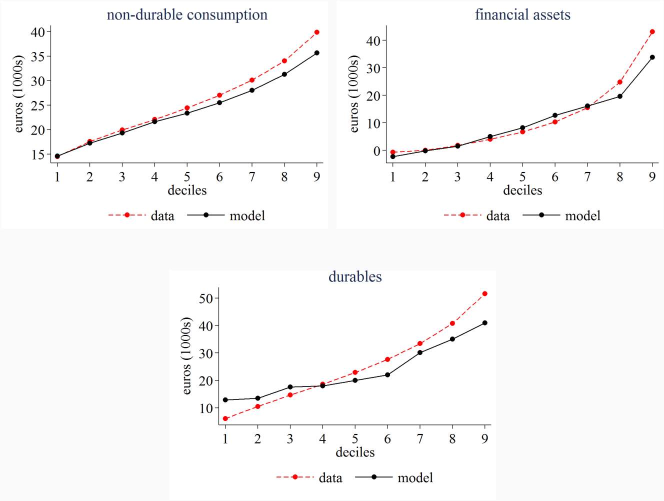
- Mean life-cycle profiles by education



more

Results: validation checks

- Distributions



Results: Life-cycle Marshallian elasticities

	Secondary
1% increase in	employment
female net wage	1.50
male net wage	-1.36
price of necessities	0.02
price of luxuries	-0.07
price of durables	-0.13

	High School
1% increase in	employment
female net wage	1.84
male net wage	-2.04
price of necessities	0.07
price of luxuries	-0.04
price of durables	0.01

	College
1% increase in	employment
female net wage	1.15
male net wage	-1.16
price of necessities	0.02
price of luxuries	-0.04
price of durables	-0.00

Results: Life-cycle Marshallian elasticities

	Secondary	
1% increase in	necessities	luxuries
female net wage	0.43	0.49
male net wage	0.46	0.53
price of necessities	-0.91	-0.03
price of luxuries	-0.01	-1.01
price of durables	-0.03	-0.04

	High School	
1% increase in	necessities	luxuries
female net wage	0.60	0.70
male net wage	0.20	0.23
price of necessities	-0.85	-0.04
price of luxuries	-0.03	-0.99
price of durables	0.05	0.05

	College	
1% increase in	necessities	luxuries
female net wage	0.45	0.60
male net wage	0.32	0.43
price of necessities	-0.63	-0.13
price of luxuries	-0.18	-0.94
price of durables	-0.04	-0.05

Results: Life-cycle Marshallian elasticities

	Secondary		
1% increase in	necessities	luxuries	durables
female net wage	0.43	0.49	0.73
male net wage	0.46	0.53	0.69
price of necessities	-0.91	-0.03	-0.01
price of luxuries	-0.01	-1.01	0.02
price of durables	-0.03	-0.04	-0.98

	High School		
1% increase in	necessities	luxuries	durables
female net wage	0.60	0.70	0.94
male net wage	0.20	0.23	0.29
price of necessities	-0.85	-0.04	0.01
price of luxuries	-0.03	-0.99	0.00
price of durables	0.05	0.05	-1.59

	College		
1% increase in	necessities	luxuries	durables
female net wage	0.45	0.60	0.33
male net wage	0.32	0.43	0.47
price of necessities	-0.63	-0.13	-0.00
price of luxuries	-0.18	-0.94	-0.01
price of durables	-0.04	-0.05	-0.73

Results: Life-cycle Marshallian elasticities

		Secondary		
1% increase in	employment	necessities	luxuries	durables
female net wage	1.50	0.43	0.49	0.73
male net wage	-1.36	0.46	0.53	0.69
price of necessities	0.02	-0.91	-0.03	-0.01
price of luxuries	-0.07	-0.01	-1.01	0.02
price of durables	-0.13	-0.03	-0.04	-0.98
		High School		
1% increase in	employment	necessities	luxuries	durables
female net wage	1.84	0.60	0.70	0.94
male net wage	-2.04	0.20	0.23	0.29
price of necessities	0.07	-0.85	-0.04	0.01
price of luxuries	-0.04	-0.03	-0.99	0.00
price of durables	0.01	0.05	0.05	-1.59
		College		
1% increase in	employment	necessities	luxuries	durables
female net wage	1.15	0.45	0.60	0.33
male net wage	-1.16	0.32	0.43	0.47
price of necessities	0.02	-0.63	-0.13	-0.00
price of luxuries	-0.04	-0.18	-0.94	-0.01
price of durables	-0.00	-0.04	-0.05	-0.73

Quantitative Normative Analysis

Quantitative Normative Analysis

Optimal design of commodities and labour income taxes, **3 scenarios**:

1. homogeneous consumption preferences + utilitarian SWF
    - Utilitarian SWF:

$$\max_{\tau^{n\mathbf{1}},\tau^{n\mathbf{2}},\tau^{d},\lambda} \sum_i EV_0^i(\tau^{n1},\tau^{n2},\tau^{d},\lambda)$$

2. heterogeneous consumption preferences + utilitarian SWF
3. heterogeneous consumption preferences + generalized SWF
    - Generalized SWF (Saez and Stantcheva (2016)):

$$\max_{\tau^{n\mathbf{1}},\tau^{n\mathbf{2}},\tau^{d},\lambda} \sum_i g(EI_0^i(\tau^{n1},\tau^{n2},\tau^{d},\lambda))EV_0^i(\tau^{n1},\tau^{n2},\tau^{d},\lambda)$$

where, weights are: $g(EI_0^i) = (EI_0^i)^{1-\epsilon}$

1. Homogeneous consumption preferences + utilitarian SWF

- consumption tax rates, MTR and ATR at mean gross earnings:

	τ^{n1}	τ^{n2}	τ^{d}	MTR	ATR
status quo	4	10	22	35	26
post	0	0	-7.10	41	33

- shift of tax burden from consumption taxes to labour income taxes
- zero tax rates on non-durables under weak separability + homogeneity (Laroque (2005), Kaplow (2006))
- subsidy on durables under pre-commitment + credit constraints (Cremer and Gahvari (1995))

homogeneous

2. Heterogeneous consumption preferences + utilitarian SWF

- consumption tax rates, MTR and ATR at mean gross earnings:

	τ^{n1}	τ^{n2}	τ^{d}	MTR	ATR
status quo	4	10	22	35	26
post (homogeneous)	0	0	-7.10	41	33
post (heterogeneous)	21.80	18.40	-21.80	28	19

- subsidy on consumer durables, magnified
- shift of tax burden from labour income to non-durable consumption
- differentiated rates of commodity taxation under heterogeneity in consumption preferences (Saez (2002), Diamond and Spinnewijn (2011), Golosov et al. (2013))
  → ranking of social welfare weights along income distribution more

heterogeneous

3. Heterogeneous consumption preferences + generalized SWF

- Optimal tax rates and welfare effects, alternative values of inequality aversion
- Level of labor income tax as revenue neutrality instrument

Inequality Aversion	Optimal tax rates					CEV(%)			
$1-\epsilon$	τ^{n1}	τ^{n2}	τ^{d}	MTR	ATR	All	Sec	HS	College
Homogeneous pref.									
0	0	0	-7.10	41	33	0.76	0.46	1.08	1.19
Heterogeneous pref.									
0	21.76	18.41	-21.75	28	19	0.23	-0.64	0.75	3.23
-2	15.67	4.56	0	36	28	0.07	-0.33	0.34	1.36
-4	4.40	9.82	21.05	35	26	0.02	0.00	0.03	0.07
-20	0	7.66	22.42	37	28	-0.02	0.04	-0.04	-0.22

weights

3. Heterogeneous consumption preferences + generalized SWF

- Optimal tax rates and welfare effects, alternative values of inequality aversion
- Progressivity of labor income tax as revenue neutrality instrument

Inequality Aversion	Optimal tax rates					CEV(%)			
$1-\epsilon$	τ^{n1}	τ^{n2}	τ^{d}	MTR	ATR	All	Sec	HS	College
Homogeneous pref.									
0	0	0	-9.80	41	33	1.07	0.88	1.30	1.20
Heterogeneous pref.									
0	15.70	24.50	-19.08	30	22	0.33	-0.50	0.85	3.21
-2	21.44	11.53	0	32	24	-0.15	-0.64	0.17	1.52
-4	5.23	13.55	22.04	33	25	-0.08	-0.13	-0.04	0.07
-20	0	0	21.75	40	32	0.12	0.28	0.02	-0.40

Conclusions

- Modelling intra- and intertemporal choices in context of uncertainty and preference heterogeneity helps in matching the life-cycle patterns and distributions observed in the micro data
- Taking into account durables dynamics and intertemporal preference heterogeneity is important for conducting optimal taxation analysis in a dynamic stochastic setting
- A generalized social welfare criterion that takes into account society's fairness concerns is needed to reconcile tax theory with tax practice and rationalize current tax systems
- Differentiated consumption taxes - in particular taxes on durables - have redistributive power on top of labour income tax progressivity

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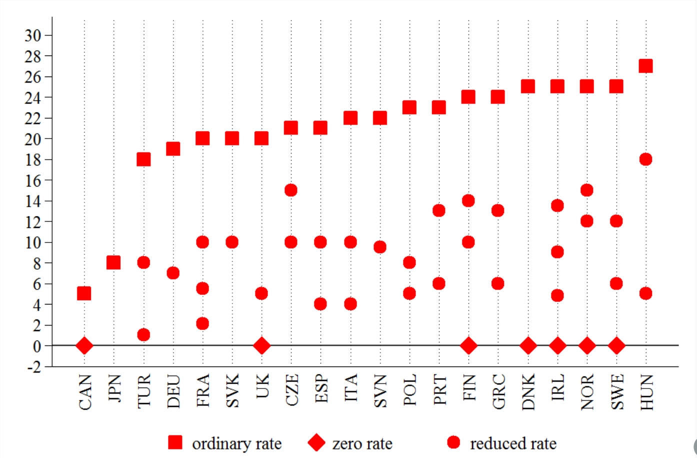
Introduction

- Differentiated rates of consumption tax across countries



back

The model: recursive formulation

- Retirement:

$$\mathbb{S}_t^r = \{s, a_{t-1}, d_{t-1}\}$$

$$V_t^r(\mathbb{S}_t^r) = \max_{c_t, d_t, a_t} \{U(v(c_t, P_t), d_t) + \beta\phi V_{t+1}^r(\mathbb{S}_{t+1}^r)\}$$

  - durables law of motion

$$d_t = (1-\delta)d_{t-1} + x_t$$

  - budget constraint

$$c_t + D(x_t)x_t + a_t = (1+r)a_{t-1} + T(\zeta y^m_{T_{ret}-1}, 0)$$

  - borrowing constraint

$$a_t \geq -\chi d_t$$

back

AIDS model

AIDS is a special case of the general class of PIGLOG preferences

- PIGLOG expenditure fct (min expenditure to attain utility u at prices p):

$$log(c(u,p)) = (1-u)log(a(p)) + (u)log(b(p)) \qquad u \in [0,1]$$

  $a(p)$ cost of subsistence ($u=0$), $b(p)$ cost of bliss ($u=1$)

- specific functional form for $log(a(p))$ and $log(b(p)) \rightarrow$ AIDS expenditure fct:

$$log(c(u,p)) = \alpha_0 + \sum_k \alpha_k logp_k + \frac{1}{2}\sum_k \sum_j \gamma^*_{k,j} logp_k logp_j + u\beta_0 \prod_k p_k^{\beta_k}$$

- Shephard's lemma: $\frac{\partial log(c(u,p))}{\partial logp_i} = \frac{p_i q_i}{c(u,p)} = w_i$
- log differentiation and $x = c(u,p) \rightarrow v = u(x,p)$ imply:

$$w_i = \alpha_i + \sum_j \gamma_{i,j} logp_j + \beta_i u\beta_0 \prod_k p_k^{\beta_k} \rightarrow w_i = \alpha_i + \sum_j \gamma_{i,j} logp_j + \beta_i log\left\{\frac{x}{P}\right\}$$

back

Tax regime

- Consumption tax (VAT):
  - 4% on non-durable necessities (e.g. food, medications)
  - 10% on non-durable luxuries (e.g. food away from home)
  - 22% on durables (e.g. motor vehicles, jewellery and furniture)
- labour income tax:
  - levied at the individual level
  - primary instrument for achieving progressivity

Income brackets (annual gross income)	tax rates (%)
$\leq$ 15,000	23
15,000-28,000	27
28,000-55,000	38
55,000-75,000	41
$\geq$ 75,000	43

back

First step: men's earning process

- Model for the log of earnings of husband in household i of age t for three education levels (secondary, high school, college)

$$lny_{i,t} = D_t + \beta_1 age_{i,t} + \beta_2 age^2_{i,t} + \beta_4 reg_i + \tilde{y}_{i,t}$$

$$\tilde{y}_{i,t} = z_{i,t} + \varepsilon_{i,t}$$

$$z_{i,t} = \rho z_{i,t-1} + u_{i,t}$$

$$\varepsilon_{i,t} \sim N(0, \sigma^2_\varepsilon), \qquad u_{i,t} \sim N(0, \sigma^2_u), \qquad z_{i,0} \sim N(0, \sigma^2_{\mathbf{z_0}})$$

back

First step: men's earning process

- Parameters of the stochastic component estimated by MDM (diagonal weighting matrix) by education level

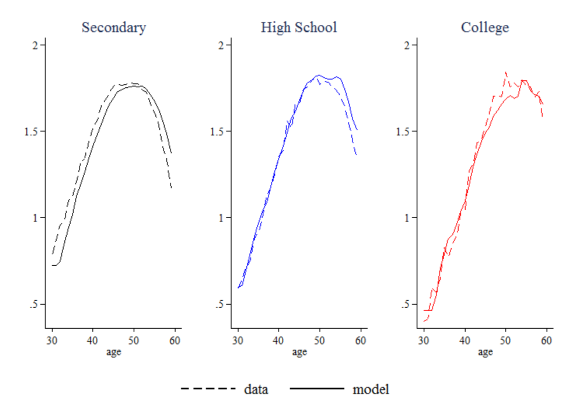
	Education level		
	Secondary	High School	College
ρ	0.9351	0.9483	0.9667
	(0.0310)	(0.0385)	(0.1008)
σ_u^2	0.0128	0.0119	0.0092
	(0.0068)	(0.0101)	(0.0126)
$\sigma_{z_0}^2$	0.0379	0.0488	0.1464
	(0.0167)	(0.0278)	(0.0885)
σ_ε^2	0.0980	0.0653	0.0799
	(0.0152)	(0.0184)	(0.0271)
N	2,156	1,254	410

Bootstrapped standard errors in parentheses

identification back

First step: family composition transitions

- family composition: 0 for no kids in hh, 1 for youngest kid in hh aged 0-5, 2 for youngest kid in hh aged 6+
- estimate education specific transition probabilities

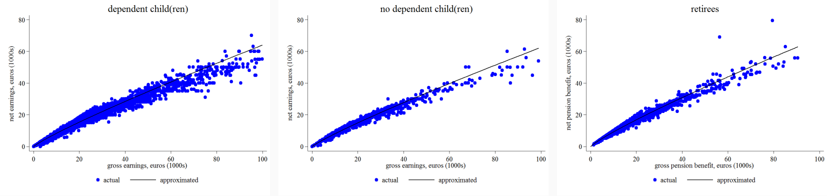


back

First step: tax function

- estimated by family composition and separately for retirees

parameters back



First step: tax function

- logarithmic transformation of tax function:

$$ln(y^{net}) = ln(\lambda) + (1-\tau)ln(y^{gross})$$

estimated by family composition and separately for retirees

	dependent child(ren)	no dependent child(ren)	retirees
λ	2.39	2.23	2.98
$1-\tau$	0.88	0.89	0.87

back

First step: intratemporal demand system

- predicted expenditure shares, budget and compensated own- and cross-price elasticities

	shares	budget elasticity	p_1 elasticity
Secondary			
share c_1	0.344 ***	0.922***	-0.613 ***
	(0.001)	(0.010)	(0.053)
share c_2	0.656***	1.041***	0.321***
	(0.001)	(0.005)	(0.028)
High School			
share c_1	0.332 ***	0.904***	-0.587 ***
	(0.001)	(0.011)	(0.058)
share c_2	0.668***	1.048***	0.292***
	(0.001)	(0.005)	(0.029)
College			
share c_1	0.326 ***	0.842***	-0.428 ***
	(0.001)	(0.012)	(0.084)
share c_2	0.674***	1.077***	0.207***
	(0.001)	(0.006)	(0.041)

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Second step: parameterisation

Parameters	Value (annual)	Definition	Source
r	0.02	Interest rate	literature
τ_1^n	0.04	VAT rate on non-durable necessity	see text
τ_2^n	0.10	VAT rate on non-durable luxury	see text
τ^d	0.22	VAT rate on durables	see text

back

Second step

- Estimation via MSM:

$$\hat{\Theta} = \arg\min_{\Theta} \left\{ \sum_{k=1}^{K} \left[(m_k^d - m_k^s(\Theta))^2 / Var(m_k^d) \right] \right\} = \arg\min_{\Theta} \{ g(\Theta)' W g(\Theta) \}$$

- Variance of the estimator:

$$\hat{V} = (1 + \frac{1}{ns})(\hat{G}' W \hat{G})^{-1}$$

where

$$\hat{G} = \left. \frac{\partial g(\Theta)}{\partial \Theta} \right|_{\Theta = \hat{\Theta}}$$

back

Second step: identification of δ and π

$d_t = (1-\delta)d_{t-1} + x_t$

- For net sellers, $\tilde{d} = \pi d$ and $\tilde{x} = \pi x$ observed

$$\pi d_t = (1-\delta)\pi d_{t-1} + \pi x_t \rightarrow \tilde{d}_t = (1-\delta)\tilde{d}_{t-1} + \tilde{x}_t$$

$$1-\delta = \frac{\tilde{d}_t - \tilde{x}_t}{\tilde{d}_{t-1}}$$

- For net buyers, $\tilde{d} = \pi d$ and $\tilde{x} = (1+\tau^d)x$ observed

$$(1+\tau^d)\pi d_t = (1-\delta)(1+\tau^d)\pi d_{t-1} + (1+\tau^d)\pi x_t \rightarrow$$
$$(1+\tau^d)\tilde{d}_t = (1-\delta)(1+\tau^d)\tilde{d}_{t-1} + \pi\tilde{x}_t$$

$$1-\delta = \frac{\tilde{d}_t - \frac{\pi}{1+\tau^d}\tilde{x}_t}{\tilde{d}_{t-1}}$$

$$\pi = (1+\tau^d)\frac{\tilde{d}_t - (1-\delta)\tilde{d}_{t-1}}{\tilde{x}_t}$$

back

Second step: parameter estimates

- Durable dynamics parameters

	All education levels	
δ	.0344	durables depreciation rate
	(.0007)	
π	.4532	fraction of reversible durables
	(.0030)	
χ	.0917	fraction of collateralizable durables
	(.0048)	

back

Second step: parameter estimates

- Female earning process parameters

	Sec	HS	College	
f_0	8.5953	9.1434	8.9207	deterministic component: intercept
	(.0239)	(.0070)	(.0121)	
f_1	0.04	0.022	0.04	deterministic component: age
	(.0003)	(.0004)	(.0008)	
f_2	-0.0005	-0.00015	-0.00035	deterministic component: age squared
	(.000007)	(.00002)	(.00002)	
ρ	0.9801	0.9426	0.8817	AR(1) persistency
	(.0046)	(.0028)	(.0106)	
σ_u	0.1057	0.1180	0.1710	std dev of AR(1) innovation
	(.0068)	(.0018)	(.0100)	
σ_{z0}	0.3684	0.4244	0.40	std dev of initial realization
	(.0128)	(.0092)	(.0272)	
σ_ϵ	0.35	0.26	0.2363	std dev of transitoty shock
	(.0177)	(.0174)	(.0341)	

back

First step: men earning process

Identification of the parameters of the stochastic component

- ρ identified from the slope of the covariance at lags greater than zero:

$$\frac{cov(\tilde{y}_{i,t}, \tilde{y}_{i,t-4})}{cov(\tilde{y}_{i,t-2}, \tilde{y}_{i,t-4})} = \frac{\rho^4 var(z_{i,t-4})}{\rho^2 var(z_{i,t-4})}$$

- σ_ε^2 identified from difference between variance and covariance at first lag:

$$var(\tilde{y}_{i,t-2}) - \frac{1}{\rho^2} cov(\tilde{y}_{i,t}, \tilde{y}_{i,t-2}) = var(z_{i,t-2}) + \sigma_\varepsilon^2 - \frac{1}{\rho^2}\rho^2 var(z_{i,t-2})$$

- $\sigma_{z_0}^2$ identified residually from variance at age zero:

$$var(\tilde{y}_{i,0}) - \sigma_\varepsilon^2$$

- σ_u^2 identified from difference between variance and covariance at second lag :

$$var(\tilde{y}_{i,t-2}) - cov(\tilde{y}_{i,t}, \tilde{y}_{i,t-4}) - \sigma_\varepsilon^2 = \rho^4 var(z_{i,t-4}) + \sigma_u^2 + \sigma_\varepsilon^2 - \rho^4 var(z_{i,t-4}) - \sigma_\varepsilon^2$$

Hence, at least 3 subsequent waves are needed back

Estimation: homogeneous consumption preferences

- AIDS estimates and elasticities

	α_1	β_1	η_{11}
share c_1	0.8513 ***	-0.0587***	-0.0101
	(0.0125)	(0.0014)	(0.0127)

$N = 13,989$

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

	shares	budget elasticity	p_1 elasticity	p_2 elasticity
share c_1	0.337 ***	0.826***	-0.603 ***	0.603***
	(0.001)	(0.004)	(0.037)	(0.037)
share c_2	0.663***	1.088***	0.307***	-0.307***
	(0.001)	(0.002)	(0.019)	(0.019)

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

back

Estimation: homogeneous consumption preferences

- Preference parameters

	All education levels			
θ		.85		non-durable consumption share
		(.0018)		
γ		3.36		coeff. of relative risk aversion
		(.0071)		
β		.99		discount factor
		(.0006)		
ϵ^d		-300		Stone-Geary coeff. for durables
		(3.4852)		
	Sec	HS	College	
ψ_0	3.0494	.7946	.4610	female participation: no children
	(14.7319)	(.0299)	(.0391)	
ψ_1	.9761	.9528	.9128	female participation: youngest child 0-5
	(.0072)	(.0099)	(.0132)	
ψ_2	.9410	.99	.80	female participation: youngest child 6+
	(.0047)	(.0086)	(.0163)	

back

Life-cycle Marshallian elasticities: homogeneous consumption preferences

	All			
1% increase in	employment	necessities	luxuries	durables
female net wage	1.38	0.42	0.58	0.80
male net wage	-1.59	0.34	0.45	0.25
price of necessities	0.08	-0.84	-0.03	0.00
price of luxuries	-0.07	0.05	-1.03	0.01
price of durables	-0.04	0.03	0.05	-1.65
	Secondary			
1% increase in	employment	necessities	luxuries	durables
female net wage	1.46	0.37	0.51	0.61
male net wage	-1.68	0.40	0.53	0.31
price of necessities	0.07	-0.85	-0.04	0.00
price of luxuries	-0.05	0.06	-1.02	0.02
price of durables	-0.02	0.02	0.03	-1.44
	High School			
1% increase in	employment	necessities	luxuries	durables
female net wage	1.43	0.48	0.66	0.98
male net wage	-1.70	0.26	0.36	0.18
price of necessities	0.11	-0.82	-0.02	0.01
price of luxuries	-0.11	0.05	-1.04	0.01
price of durables	-0.06	0.07	0.10	-2.08
	College			
1% increase in	employment	necessities	luxuries	durables
female net wage	0.93	0.40	0.57	0.68
male net wage	-0.87	0.36	0.51	0.33
price of necessities	0.01	-0.83	-0.05	-0.01
price of luxuries	-0.00	0.07	-1.02	-0.03
price of durables	-0.01	-0.03	-0.05	-0.76

back

Non-separability test

$$w_i = \alpha_{0i} + \alpha_{1i} df + \sum_{j=1}^{k} \eta_{ij} lnp_j + (\beta_{0i} + \beta_{1i} df) ln \left\{ \frac{c}{a(p)} \right\} + e_i$$

$$ln(a(P)) = \sum_{i=1}^{n} (\alpha_{0i} + \alpha_{1i} df) lnp_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \eta_{ij} lnp_i lnp_j$$

	Secondary	High School	College
α_0	0.4573***	0.7003***	0.8786***
	(0.0333)	(0.0348)	(0.0390)
α_1	0.0429	-0.2107**	-0.0501
	(0.0612)	(0.0665)	(0.0666)
β_0	-0.0108 ***	-0.0381***	-0.0581***
	(0.0039)	(0.0039)	(0.0043)
β_1	-0.0112	0.0162*	-0.0003
	(0.0071)	(0.0075)	(0.0074)
η_{11}	- 0.0136	0.0047	0.0870
	(0.0113)	(0.0115)	(0.0183)
N	2,193	2,185	1,999

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

back

Euler equations

$$u'_{c_t} = \beta \left(1 + r\right) E u'_{c_{t+1}}$$

$$\begin{aligned} u'_{x_t} = {} & \beta D\left(x_t\right)\left(1 + r\right) E_t u'_{c_{t+1}} \\ & - \beta E_t \underbrace{\left[\beta\left(1 - \delta\right) D\left(x_{t+1}\right)\left(1 + r\right) E_{t+1} u'_{c_{t+2}} - \left(1 - \delta\right) u'_{x_{t+1}}\right]}_{\text{store in t+1}} \end{aligned}$$

model

Rotating panel

Year first interview	Year of survey 1987	1989	1991	1993	1995	1998	2000	2002	2004	2006	2008	2010	2012	2014
1987	8027	1206	350	173	126	85	61	44	33	30	28	23	21	13
1989		7068	1837	877	701	459	343	263	197	159	146	123	102	64
1991			6001	2420	1752	1169	832	613	464	393	347	293	244	166
1993				4619	1066	583	399	270	199	157	141	124	106	78
1995					4490	373	245	177	117	101	84	75	62	46
1998						4478	1993	1224	845	636	538	450	380	267
2000							4128	1014	667	475	398	330	256	170
2002								4406	1082	672	525	416	340	221
2004									4408	1334	995	786	631	395
2006										3811	1143	856	648	414
2008											3632	1145	806	481
2010												3330	1015	579
2012													3540	1565
2014														3697
sample size	8027	8274	8188	8089	8135	7147	8001	8011	8012	7768	7977	7951	8151	8156
% panel hhs		14.6	26.7	42.9	44.8	37.3	48.4	45.0	45.0	50.9	54.4	58.1	56.6	54.7

back

Check for absence of non random attrition

Variable	hhs in 2010 sample only	hhs in 2010 and 2012 samples	hhs in 2012 sample only
consumption	25299.21	26381.97	24180.87
	(16200.07)	(15376.81)	(14579.85)
durable consumption	1627.81	1233.78	952.76
	(5086.05)	(4300.55)	(3596.78)
non durable consumption	23671.40	25148.18	23228.106
	(14515.29)	(14069.37)	(13409.34)
disposable income	33146.58	31788.48	29289.21
	(25129.62)	(22629.14)	(22604.65)
gender of head of hh	1.46	1.45	1.46
	(0.5)	(0.5)	(0.5)
age of head of hh	55.10	53.09	55.81
	(17.18)	(15.37)	(17.21)
education of head of hh	3.25	3.43	3.19
	(1.07)	(1.04)	(1.07)
family size	2.49	2.60	2.43
	(1.28)	(1.32)	(1.31)
geographic area	1.81	1.85	1.80
	(0.85)	(0.88)	(0.87)
observations	2315	1015	3540

back

Liquid assets measure

- Assets measure in data is adjusted so that it is net of imputed down- payment for non-homeowners with non-negative assets who are assumed to become homeowners at some point in the future, according to the formula:
  - if $Y_a(1 - X_a) > (0.75 - X_a)$

$$\tilde{A}_a = X_a A_a^H + (1 - Y_a)(1 - X_a) A_a^{NH-} + Y_a(1 - X_a)\left(1 - \frac{0.75 - X_a}{Y_a(1 - X_a)} \frac{Dp}{A + Dp}\right) A_a^{NH+}$$

  - otherwise

$$\tilde{A}_a = X_a A_a^H + (1 - Y_a)(1 - X_a) A_a^{NH-} + Y_a(1 - X_a)\left(1 - \frac{Dp}{A + Dp}\right) A_a^{NH+}$$

where,

- Dp: observed or imputed downpayment for buying house
- X_a : proportion of homeowners aged a; $(1 - X_a)$:proportion of non-homeowners; $(0.75 - X_a)$ proportion of non-homeowners who are saving towards buying a house (by age 60 around 0.75 of HHs are homeowners in data)
- $Y_a(1 - X_a)$: proportion of non-homeowners with positive assets
- A_a^H: average assets of homeowners at age a
- A_a^{NH+},A_a^{NH-}: average (positive/negative) assets of non-homeowners at age a

back

Durables descriptives

- Descriptives of durables components in SHIW selected sample

	Value of stock	Value of purchase	Value of sale
Vehicles	10,669.80	1,894.62	221.67
	(11,984.44)	(5,961.74)	(1,498.30)
Furniture	14,289.48	827.86	
	(16,767.61)	(2,816.99)	
Jewellery	4,884.12	168.31	16.02
	(17,537.89)	(1,999.85)	(560.71)

$N = 45,337$

Sample means and standard deviations in parentheses

back

Durables net flow in data

- Net buyers

	1%	5%	10 %	25%	50%	75%	90%	95%	99%
% purchases	62.2	82.8	100	100	100	100	100	100	100
% sales	0	0	0	0	0	0	0	17.2	34.8

$N = 19,957$

- Net sellers

	1%	5%	10 %	25%	50%	75%	90%	95%	99%
% purchases	0	0	0	0	0	12.1	37.5	44	47.4
% sales	52.63	56	62.5	87.9	100	100	100	100	100

$N = 462$

back

Non-durables in HBS

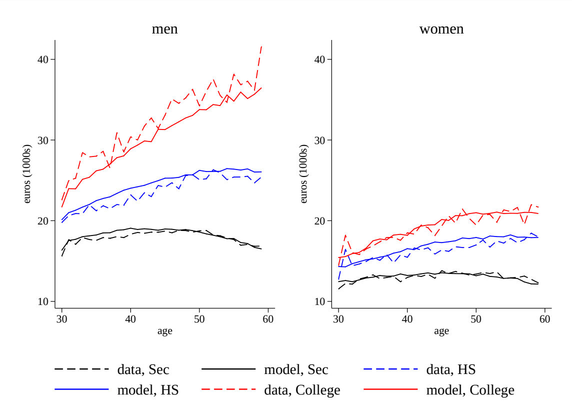
- Average expenditure shares (%) in main non-durables categories, HBS

necessities		luxuries	
1. Food at home	90.04	1. Food away from home	63.28
2. Books and newspapers	8.62	2. Housing repairs	21.11
3. Medical expenses	1.34	3. Personal care	8.65
		4. Holiday and travel	4.61
		5. Entertainment	2.36
total	34.40	total	65.60

back

Results: fit of the model

- Mean net wage profiles by education



back

1. Optimal tax policy experiments

- changes (%) in hh choices and lifetime welfare wrt pre reform scenario

	All	Sec	HS	College
financial assets	-28.45	-30.08	-25.66	-31.95
durables stock	17.30	20.09	14.44	18.95
non-durable consumption	-2.09	-2.29	-1.77	-2.50
non-durable consumption, necessities	-5.07	-5.21	-4.83	-5.34
non-durable consumption, luxuries	-0.86	-0.99	-0.54	-1.45
durables flow	32.03	33.06	29.73	37.12
female participation	1.05	1.06	1.20	0.51
Expected lifetime income	-8.82	-8.86	-8.74	-8.90
CEV	0.76	0.46	1.08	1.19
Expected lifetime utility	1.50	0.91	2.14	2.35
Gini on expected lifetime income	0.18	1.00	0.05	0.00

back

2. Optimal tax policy experiments

- changes (%) in hh choices and lifetime welfare wrt pre reform scenario

	All	Sec	HS	College
financial assets	-39.26	-29.78	-44.88	-46.74
durables stock	57.53	52.60	59.29	67.85
non-durable consumption	-8.20	-8.09	-8.05	-9.08
non-durable consumption, necessities	-11.83	-12.16	-11.79	-10.61
non-durable consumption, luxuries	-6.50	-6.04	-6.34	-8.49
durables flow	123.27	112.68	131.72	126.34
female participation	4.49	4.09	5.11	3.80
Expected lifetime income	4.87	4.68	5.14	4.82
CEV	0.23	-0.64	0.75	3.23
Expected lifetime utility	0.20	-1.33	1.36	4.56
Gini on expected lifetime income	0.87	1.81	1.37	0.89

- consumption preference heterogeneity lowers optimal redistribution

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2. Optimal tax policy experiments

- consumption tax rates, MTR and ATR at mean gross earnings:

	τ^{n1}	τ^{n2}	τ^{d}	MTR	ATR
fully homog.	0	0	-7.10	41	33
heterog. AIDS	0	3.83	-5.17	40	32
heterog. AIDS, γ	12.35	8.11	-9.48	36	28
heterog. AIDS, γ, ϵ^d	18.81	12.65	-17.10	34	25
heterog. AIDS, γ, ϵ^d, β	24.21	16.73	-17.72	31	22
fully heterog.	21.80	18.40	-21.80	28	19

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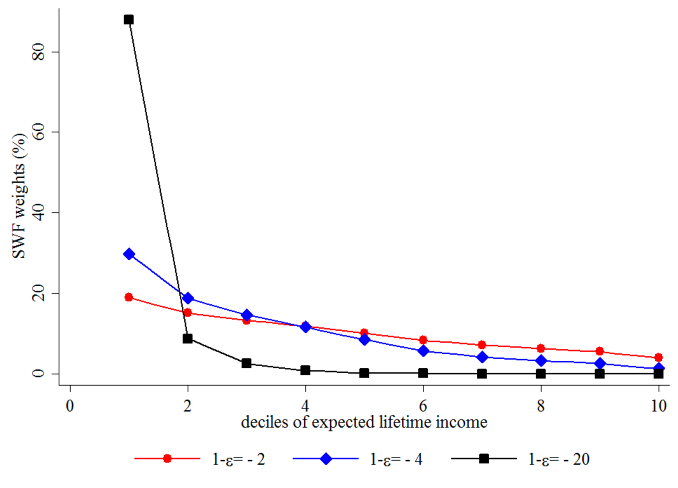
3. generalized SWF weights



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