Putting Home Economics into Macroeconomics

Greenwood et al. (1993)

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Seminar: Macroeconomics and International Economics

June 2023

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Motivation I

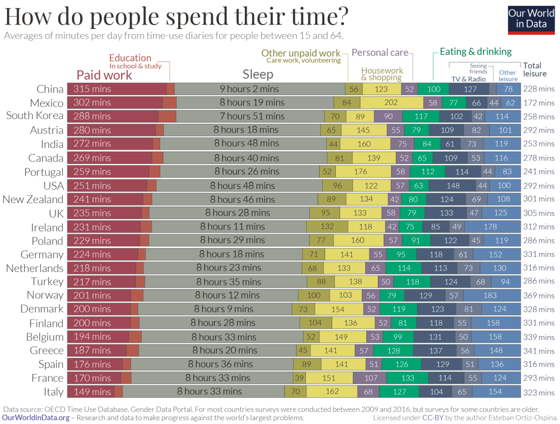

Figure: OECD Countries 2009 - 2016 (Ortiz-Ospina et al., 2020) Extensions

Motivation II

Key Figures U.S. Data

- 25 percent of discretionary time spend on unpaid work
  - e.g. cleaning, cooking, caretaking
- 33 percent of discretionary time spent on paid work
- Household capital spending exceeds market capital spending by 15 percent (Greenwood et al., 1993)
  - e.g. consumer durables or residential structures
- Household sector output between 20-50 percent of measured GDP (Eisner, 1988)

Model

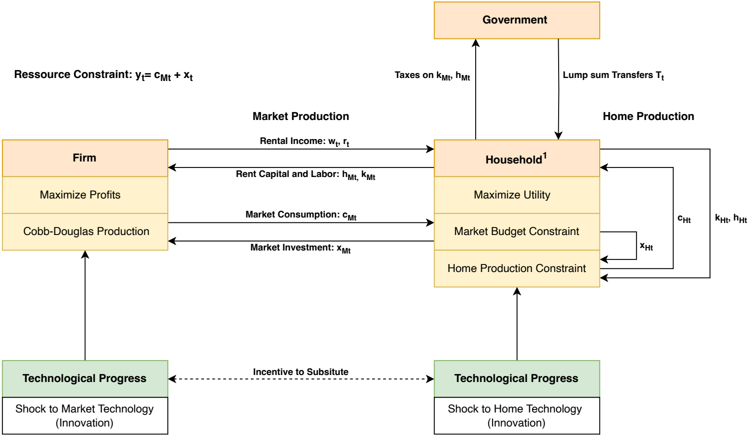

Figure: Constraints of agents: Household, Firm, Government

[1] Increased willingness to substitute

Model Specifications

- **Model 1**: Home production minimized
- **Model 2**: Increased willingness to substitute between home and market
- **Model 3**: Increased incentive to substitute between home and market
  - Note: Model 2 & 3 should deliver similar results
- **Model 4**: More general home production function

Business Cycle Properties I

- Compare the business cycle properties of a specific model with data and other models
- Model 1 is the benchmark model
- Ratios of standard deviations
  - Total investments (x) relative to output
  - Market consumption (c_M) relative to output
  - Market hours (h_M) relative to output
  - Real wages or productivity (w) relative to output
  - Market hours relative to productivity
- Correlations
  - Market hours and productivity (c_M and w)
  - market and home investments (x_M and x_H)

Business Cycle Properties II

- Model 2 & 3 (similar results):
  - Ratios of standard deviations: More accurate than the benchmark
  - Correlations: Bad performance
- Introduce model 2a (increased standard error of home innovation)
  - Adequate performance in terms of correlation between the market hours and productivity
  - Worse performance in other properties compared to the benchmark
- Model 4 (and 4a) captures the correlation between market and home investments
  - Worse performance in other properties compared to the benchmark

Further Results

- Detailed results of the business cycle properties in the appendix Results
- Selected IRFs: appendix
- All Results (Dynare outputs, all IRFs, ...): manuelbieri.ch/Greenwood_1993/

Discussion Results

- Model calibration is crucial
- Better performance in some aspects than the benchmark
- Potential to fine-tune performance w.r.t. correlations

Existing Research Extension (Selection)

- Government spending and taxes
  - Christiano and Eichenbaum (1992)
  - McGrattan et al. (1993)
  - McGrattan et al. (1997)
- International Markets
  - Canova and Ubide (1998)
- Market and home sector as complements
  - Fisher (1997)
- Endogenous Shocks
  - Einarsson and Marquis (1997)

Research Extensions (Selection)

- Multiple Sectors (Plosser, 1989)
- Introduction of inflation, e.g. by a cash-in-advance constraint suggested by Cooley and Hansen (1989)
- Introduce heterogeneity amongst the consumers
  - Evidence that the importance of the household side changes (Baxter and Jermann, 1999)
- Comparison between countries Chart Time Use
  - Evidence of the relative importance of the household sector in a country (Aguiar and Hurst, 2005)
  - Developed vs. developing countries (Hicks, 2015)

Conclusion

- Including a home production function improves Real Business Cycle (RBC) model's ability to better model the economy
- Fragile model
  - Depends highly on the parameters chosen
  - Little evidence about the true parameters
- Performance of an RBC with home production only valid for post-war U.S. economy
  - Comparison between countries

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Representative Household I

- The household maximizes:

$$U = \sum_{t=0}^{\infty} \beta^t [b \log(C_t) + (1-b) \log(l_t)] \quad (1)$$

- Allocation of time between paid work (h_{Mt}), unpaid work (h_{Ht}) and leisure (l_t)

$$l_t = 1 - h_{Mt} - h_{Ht} \quad (2)$$

- Consumption from the market (c_{Mt}) or from home production (c_{Ht})

$$C_t = [a c_{Mt}^e + (1-a) c_{Ht}^e]^{\frac{1}{e}} \quad (3)$$

Representative Household II

- Allocation of capital between the market and the household

$$c_{Mt} + x_t = w_t(1-\tau_h)h_{Mt} + r_t(1-\tau_k)k_{Mt} + \delta_M \tau_k k_{Mt} + T_t \quad (4)$$

- Home production function
  - Note: Home production can only be consumed

$$c_{Ht} = g(h_{Ht}, k_{Ht}, z_{Ht}) = k_{Ht}^{\eta}(z_{Ht}h_{Ht})^{1-\eta} \quad (5)$$

- More general home production function (model 4)

$$c_{Ht} = g(h_{Ht}, k_{Ht}, z_{Ht}) = [\eta k_{Ht}^{\Psi} + (1-\eta)(z_{Ht}h_{Ht})^{\Psi}]^{\frac{1}{\Psi}} \quad (6)$$

Representative Firm

- Profit maximizing firm with Cobb-Douglas production function
- Maximizes profits by choosing input factors k_{Mt} and h_{Mt}

$$y_t = k_{Mt}^{\theta}(z_{Mt}h_{Mt})^{1-\theta} \tag{7}$$

Government

- Government income is transferred entirely back to the households via a lump-sum transfer T_t

$$G_t = w_t \tau_h h_{Mt} + r_t \tau_k k_{Mt} - \delta_M \tau_k k_{Mt} - T_t = 0 \tag{8}$$

Resource Constraint

- Feasibility implies that market output is allocated across market consumption, total investment, and government spending (=0)

$$y_t = c_{Mt} + x_t \tag{9}$$

Summary Model

- Real Business Cycle model including a home production function
- Agents
  - Representative Household → Utility maximizing
    - Allocation of consumption ($C_t = [ac_{Mt}^e + (1-a)c_{Ht}^e]^{\frac{1}{e}}$)
    - Allocation of time ($l_t = 1 - h_{Mt} - h_{Ht}$)
    - Allocation of investment (x_{Mt}, x_{Ht})
    - Home Production Function: $c_{Ht} = k_{Ht}^{\eta}(z_{Ht}h_{Ht})^{1-\eta}$
  - Representative Firm → Profit maximizing
    - $y_t = k_{Mt}^{\theta}(z_{Mt}h_{Mt})^{1-\theta}$
  - Government → Absent (zero spending)
    - $G_t = w_t\tau_h h_{Mt} + r_t\tau_k k_{Mt} - \delta_M\tau_k k_{Mt} - T_t = 0$
- Exogenous shocks to home and market technology ("innovation")

Business Cycle Properties

Table: Effects of Adding Home Production to RBC Model

	σ_y	$\frac{\sigma_x}{\sigma_y}$	$\frac{\sigma_{c_M}}{\sigma_y}$	$\frac{\sigma_{h_M}}{\sigma_y}$	$\frac{\sigma_w}{\sigma_y}$	$\frac{\sigma_{h_M}}{\sigma_w}$	$\rho_{h_M,w}$	ρ_{x_M,x_H}
Data	1.96	2.61	0.54	0.78	0.73	1.06	-0.12	0.30
1	1.40	2.81	0.40	0.41	0.60	0.69	0.96	-0.13
2	1.56	2.56	0.60	0.50	0.55	0.91	0.84	-0.90
2a	2.36	2.73	1.36	0.94	0.35	2.66	-0.01	-1.00
3	1.47	2.45	0.55	0.48	0.54	0.88	0.94	-0.83
4	1.13	4.09	0.41	0.29	0.74	0.40	0.86	-0.60
4a	1.30	3.10	0.38	0.37	0.64	0.57	0.96	0.26

- The data corresponds to the U.S. time series between 1947 and 1987
- Numbers correspond to the model specifications

Impulse Response Function I

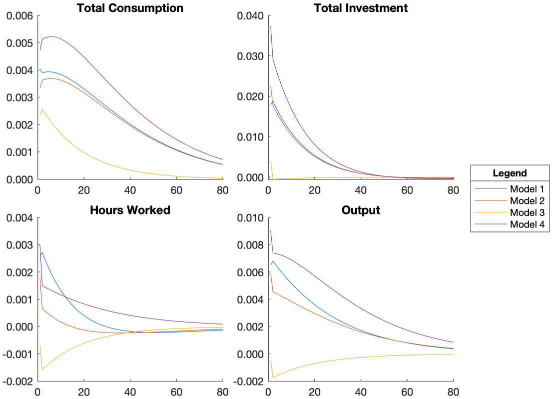

Figure: Impulse Response Functions for Home Technology Shock

Impulse Response Function II

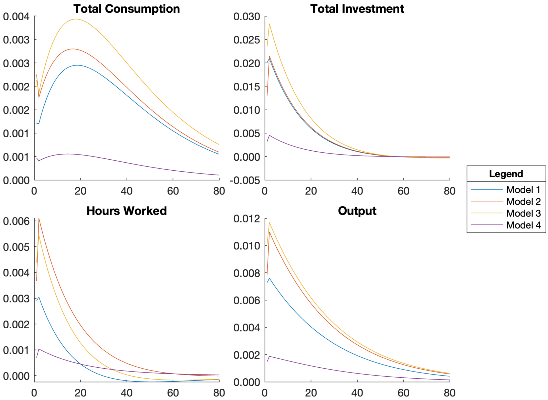

Figure: Impulse Response Functions for Market Technology Shock

Endogenous Variables I

Table: Endogenous Variables

	Meaning
[a] C	Total consumption
[a] c_H	Goods and services produced in the home
[a] c_M	Goods and services purchased in the market
[b] h_H	Labour hours spent working in the household
[b] h_M	Labour hours spent working in the market
[b] l	Leisure time $(1 - h_H - h_M)$
[c] k	Total capital
[c] k_H	Household capital
[c] k_M	Market capital
[a] r	Price at which business capital can be rented to firms
[b] T	Lump-sum transfer payment from the government

Endogenous Variables II

	Meaning
^{b}w	Real wage rate in the market
^{b}x	Total investment
$^{b}x_H$	Investment in household capital
$^{b}x_M$	Investment in business capital
^{b}y	Market output
$^{c}z_H$	Technology level in the home
$^{c}z_M$	Technology level in the market
$^{c}\tilde{z}_H$	Shock resulting from technological changes in the home
$^{c}\tilde{z}_M$	Shock resulting from technological changes in the market

- ^{a} denotes forward-looking variables (jumpers)
- ^{b} denotes static variables
- ^{c} denotes state variables

Exogenous Variables

Table: Exogenous Variables

	Meaning	Standard deviation
ϵ_H	Innovations in the home	σ_H
ϵ_M	Innovations in the market	σ_M

Parameters I

Table: Parameters

	Meaning
a	Share of c_{Mt} of total consumption
b	Weight factor of consumption vis-a-vis leisure
e	Willingness of a household to substitute between market consumption c_{Mt} and home consumption c_{Ht}
β	Discount factor
δ_H	Depreciation rate on household capital
δ_M	Depreciation rate on business capital (tax-deductible)
η	Capital share in the home production function
γ	Measures the household's incentive, to move economic activity between the home and the market

Parameters II

	Meaning
ρ_H	Persistence of market technology shock
ρ_M	Persistence of home technology shock
σ_H	Standard deviation of innovations in the household
σ_M	Standard deviation of innovations in the market
τ_k	Tax rate on capital income
τ_h	Tax rate on labour income
θ	Capital share in the market production function
λ	Growth rate of **all** endogenous variables besides h_{Mt}, h_{Ht}, l_t and r_t
Ψ	Willingness of a household to substitute between capital k_{Ht} and time h_{Ht} in the home production

Further Reading

- Greenwood and Hercowitz (1991)
- Greenwood (2019)
- Greenwood et al. (2020)