Putting Home Economics into Macroeconomics

Greenwood et al. (1993)

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Motivation

- Paper focuses on the home sector by introducing a home production function into a standard RBC model
  - Households can produce goods and services at home (substitute to market production)
- Why should you focus on the home sector?
  - 25 percent of discretionary time spent on unpaid work at home, in contrast to 33 percent spent on paid work
    - e.g. cooking, cleaning, caretaking
  - Investment in household capital exceeds investment in business capital by about 15 percent
    - e.g. consumer durables, housing
  - Value of household production between 20 and 50 percent of the value of GDP (Eisner, 1988)

Model

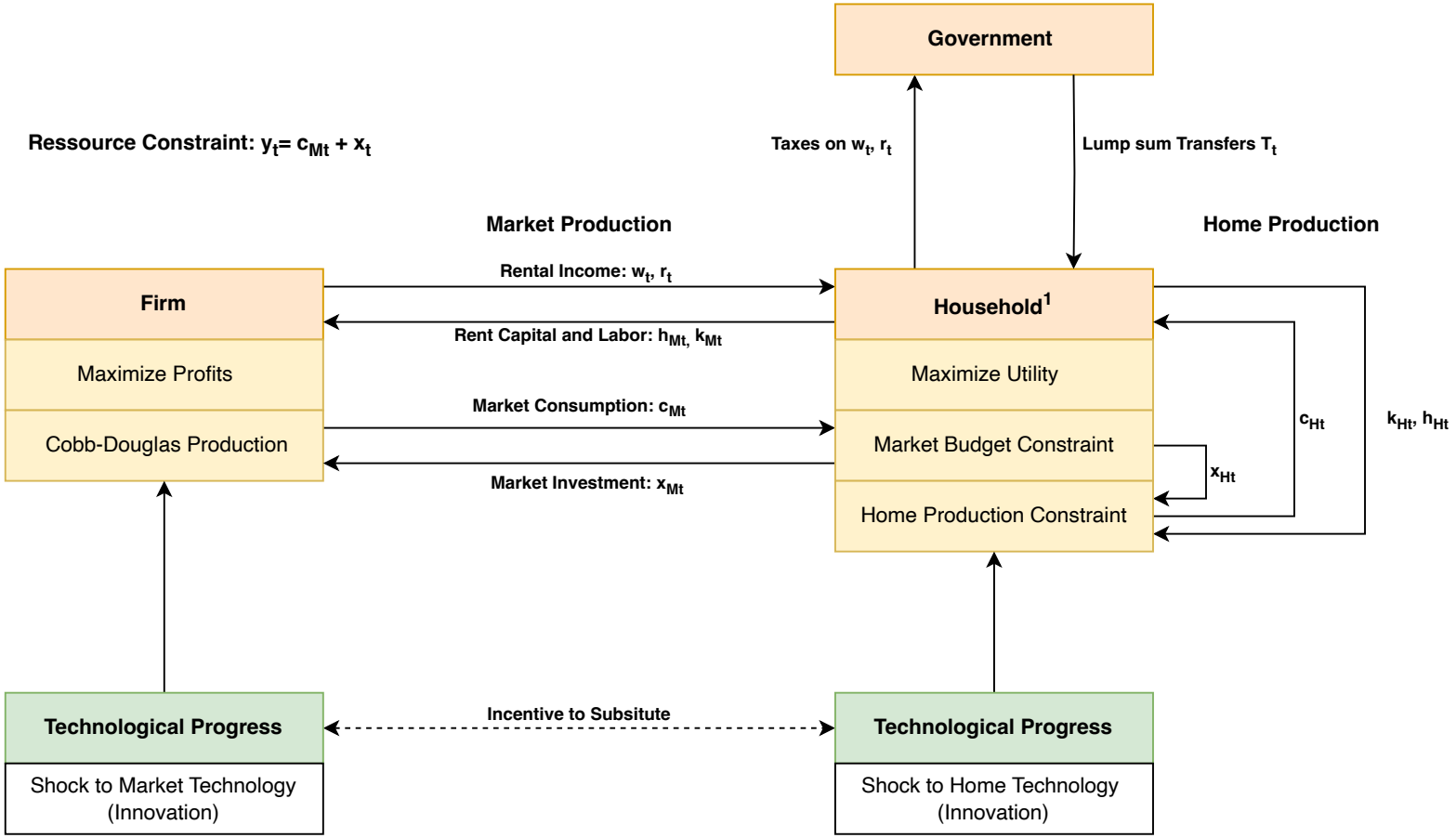

Figure: Constraints of agents: Household, Firm, Government

[1] Willingness to substitute

Model Specifications

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

Business Cycle Properties I

- Compare the business cycle properties of simulated models with U.S. data from 1947 to 1987
- 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 yield similar results
  - Ratios of standard deviations: More accurate than the benchmark
  - Correlations: Bad performance (comovement problem)
- Model 2a
  - Increasing standard deviation of home technology shock
  - More accurate correlation between the market hours and productivity
  - Worse performance in most other properties compared to the benchmark
- Model 4 and 4a
  - Setting elasticity of substitution in home production
  - More accurate correlation between the market and home investments
  - Worse performance in other properties compared to the benchmark

Discussion Results

- Better performance in terms of volatility than the benchmark
- Potential to improve the accuracy of comovement of variables
- Model calibration is important
  - Lacking evidence for some parameter values
  - E.g., the elasticity of substitution in home production
- Further results:
  - Detailed results of the business cycle properties and explanations to the comovement problem → Appendix
  - All Results (Dynare outputs, impulse response functions, ...): manuelbieri.ch/Greenwood_1993/

Existing 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 growth arising from human capital accumulation
  - Einarsson and Marquis (1997)

Suggested Extensions (Selection)

- Multiple Sectors (Plosser, 1989)
- Introduce heterogeneity amongst the consumers
  - Evidence that the relative importance of the household production changes (Baxter and Jermann, 1999)
- Application of the home production model in other countries
  - Evidence for differences in the relative importance of the household sector between countries (Aguiar and Hurst, 2005)
  - Developed vs. developing countries (Hicks, 2015) Chart Time Use

Conclusion

- Adding a home production function to a standard RBC improves the model's ability to account for business cycle properties
- Fragile model
  - Depends highly on the parameters chosen
  - Little evidence for the parameter values
- Performance of the home production model only valid for U.S. post-war economy data

References I

Aguiar, Mark and Erik Hurst, "Consumption versus Expenditure," *Journal of Political Economy*, 2005, *113* (5), 919–948.

Baxter, Marianne, "Are Consumer Durables Important for Business Cycles?," *The Review of Economics and Statistics*, 1996, *78* (1), 147–155.

_ **and Urban J. Jermann**, "Household Production and the Excess Sensitivity of Consumption to Current Income," *American Economic Review*, September 1999, *89* (4), 902–920.

Benhabib, Jess, Richard Rogerson, and Randall Wright, "Homework in Macroeconomics: Household Production and Aggregate Fluctuations," *Journal of Political Economy*, 1991, *99* (6), 1166–1187.

References II

Canova, Fabio and Angel J. Ubide, "International business cycles, financial markets and household production," *Journal of Economic Dynamics and Control*, 1998, *22* (4), 545–572.

Christiano, Lawrence J. and Martin Eichenbaum, "Current Real-Business-Cycle Theories and Aggregate Labor-Market Fluctuations," *The American Economic Review*, 1992, *82* (3), 430–450.

Davis, Morris A. and Jonathan Heathcote, "Housing and the Business Cycle," *International Economic Review*, 2005, *46* (3), 751–784.

Einarsson, Tor and Milton H. Marquis, "Home production with endogenous growth," *Journal of Monetary Economics*, 1997, *39* (3), 551–569.

References III

Eisner, Robert, "Extended Accounts for National Income and Product," *Journal of Economic Literature*, 1988, *26* (4), 1611–1684.

Fisher, Jonas D. M., "Relative prices, complementarities and comovement among components of aggregate expenditures," *Journal of Monetary Economics*, 1997, *39* (3), 449–474.

Fisher, Jonas D. M., "Why Does Household Investment Lead Business Investment over the Business Cycle?," *Journal of Political Economy*, 2007, *115* (1), 141–168.

Greenwood, Jeremy, *Evolving Households: The Imprint of Technology on Life* January 2019.

_ **and Zvi Hercowitz**, "The allocation of capital and time over the business cycle," *Journal of political Economy*, 1991, *99* (6), 1188–1214.

References IV

_ , **Richard Rogerson, and Randall Wright**, "Putting home economics into macroeconomics," *Federal Reserve Bank of Minneapolis Quarterly Review*, 1993, *17* (3).

_ , _ , **and** _ , "6. Household Production in Real Business Cycle Theory," in "frontiers of Business cycle research," Princeton University Press, 2020, pp. 157–174.

Hansen, Gary D. and Randall Wright, "The Labor Market in Real Business Cycle Theory," *Quarterly Review*, 1992, *16* (2).

Hicks, Daniel L., "Consumption Volatility, Marketization, and Expenditure in an Emerging Market Economy," *American Economic Journal: Macroeconomics*, 2015, *7* (2), 95–123.

McGrattan, Ellen R., Richard Rogerson, and Randall Wright, "Household Production and Taxation in the Stochastic Growth Model," *Federal Reserve Bank of Minneapolis*, 1993.

References V

_ , _ , **and** _ , "An Equilibrium Model of the Business Cycle with Household Production and Fiscal Policy," *International Economic Review*, 1997, *38* (2), 267–290.

Ortiz-Ospina, Esteban, Charlie Giattino, and Max Roser, "Time Use," *Our World in Data*, 2020.

Plosser, Charles I., "Understanding Real Business Cycles," *Journal of Economic Perspectives*, 1989, *3* (3), 51–77.

Representative Household I

- Household maximizes:

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

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

$$l_t = 1 - h_{Mt} - h_{Ht} \tag{2}$$

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

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

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 $\rightarrow$ 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 $\rightarrow$ profit maximizing
    - $y_t = k_{Mt}^{\theta}(z_{Mt}h_{Mt})^{1-\theta}$
  - Government $\rightarrow$ 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 in the first column correspond to the model specifications

Comovement Problem I

Productivity vs. Market Hours

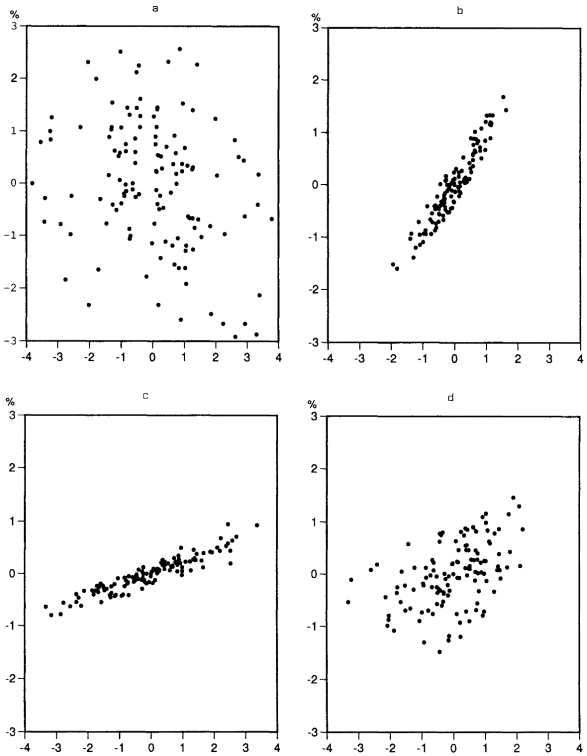

Figure: Market Hours vs. Productivity (Benhabib et al., 1991)

- a: U.S. Data; b: Standard Model; c and d: Home Production

Comovement Problem II

- Data: Small negative correlation ($\rho_{h_M,w}$) $\rightarrow$ less hours required to earn same income
- Standard model: Only shock to labor demand $\rightarrow$ positive correlation
- Model with home production: Additional shock to labor supply through home technology shocks
  - Increase standard deviation of home technology shocks to further shift labor supply $\rightarrow$ decreases the correlation
- Problem: Most papers use very similar standard deviation for the home technology shock (e.g., Benhabib et al., 1991; Hansen and Wright, 1992; Fisher, 2007)
- No evidence for a much higher standard deviation

Comovement Problem III

Market Investment vs. Home Investment

- Data: Positive correlation (ρ_{x_M,x_H})
- Standard model with home production (Fisher, 2007)
  - Market capital produces market consumption and investment goods
  - Household capital produces only home consumption goods
  - Incentive to substitute away from household capital toward business capital after a market technology shock $\rightarrow$ negative correlation

Comovement Problem IV

- Model with general home production function:
  - Highly correlated shocks $\rightarrow$ shock to market and home at the same time
  - Move hours to the market but hours in the home are more effective
  - Degree of substitution in home production can imply the desire to increase capital in the home during market upswing $\rightarrow$ positive correlation
- Lacking evidence for the elasticity of substitution in home production
- Other Solutions:
  - Add home capital to market production (Fisher, 2007)
  - Introduction of durable and non-durable goods (Baxter, 1996)

Impulse Response Functions I

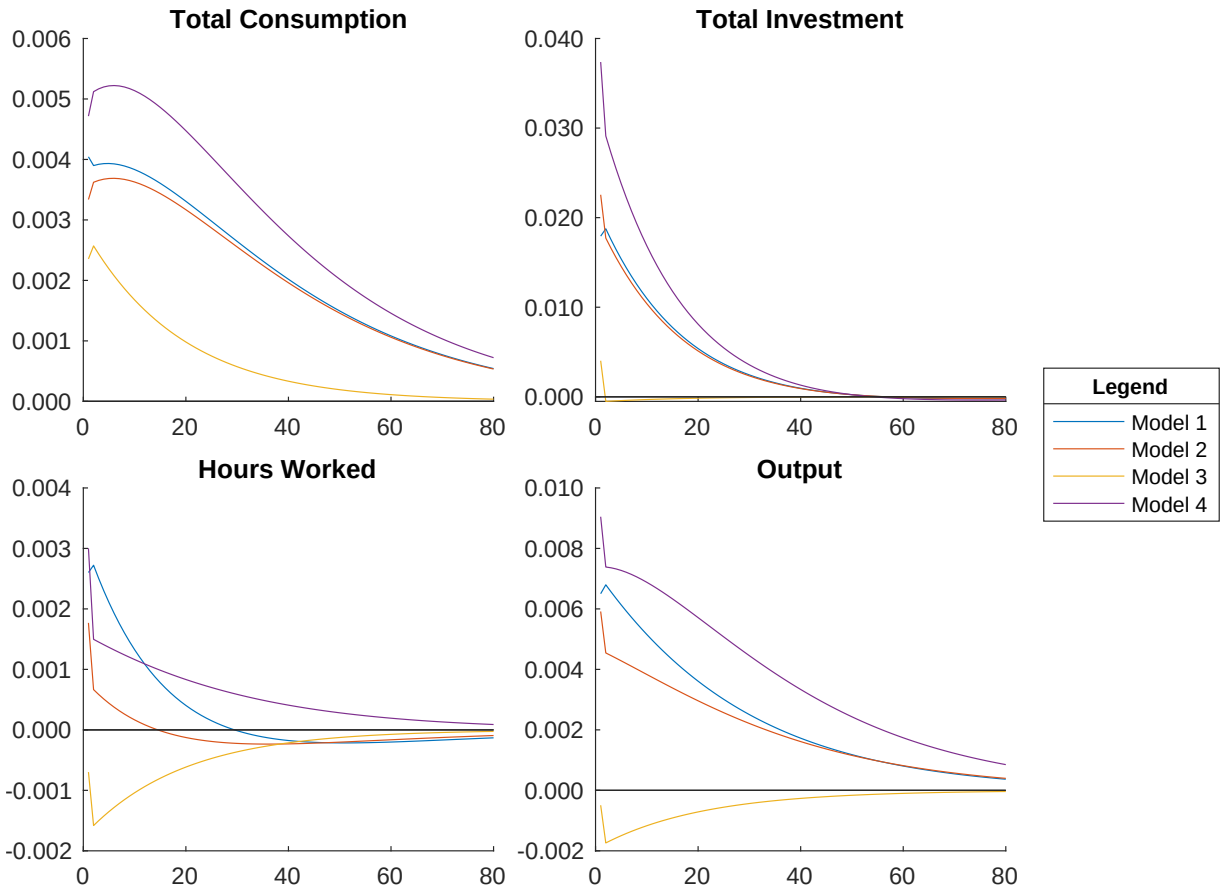

Figure: Impulse Response Functions for Home Technology Shock

Impulse Response Functions II

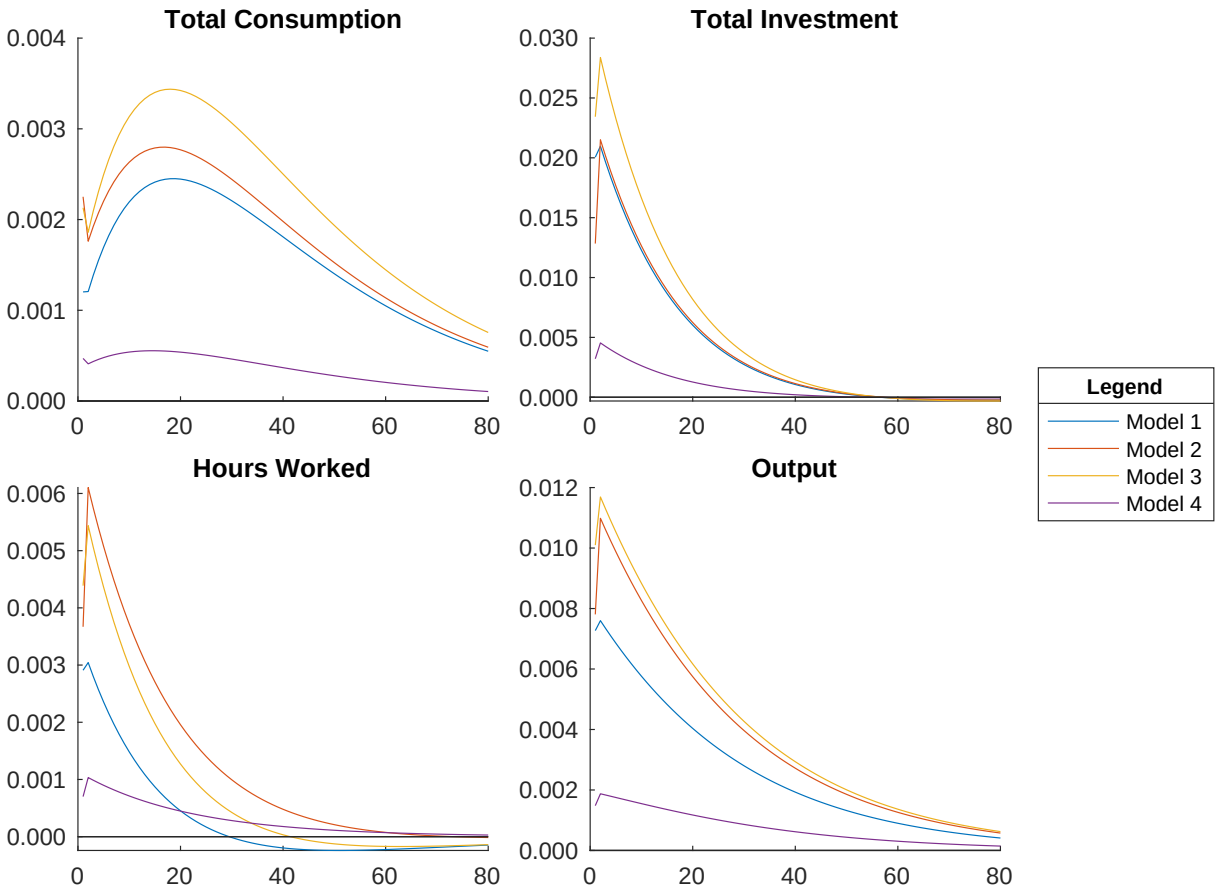

Figure: Impulse Response Functions for Market Technology Shock

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

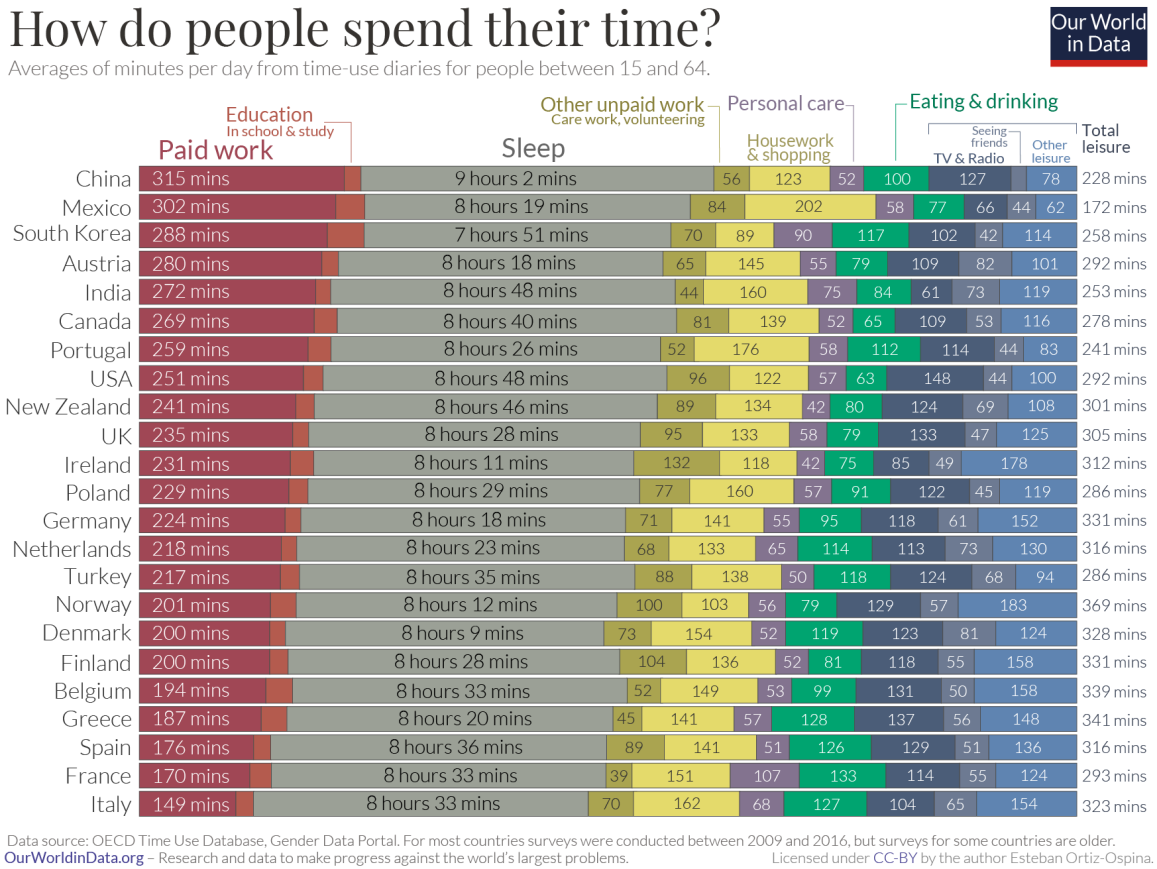

Figure: OECD Countries 2009 - 2016 (Ortiz-Ospina et al., 2020) Extensions

Further Reading

- Standard home production model:
  - Greenwood and Hercowitz (1991)
  - Greenwood (2019)
  - Greenwood et al. (2020)
- More modern models with home production:
  - Davis and Heathcote (2005)
  - Fisher (2007)