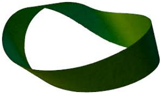
The Composition of Aggregate Demand, Division of Labor and the Busines Cycle

Ercan Karadas
NYU & UNCC



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MOTIVATION

- A baseline RBC model has two propagation mechanisms:
  - The capital accumulation mechanism
  - Intertemporal substitution in labor supply
- However,

> *... many RBC models have weak internal propagation mechanisms and do not generate interesting dynamics via their internal structure (Cogley and Nason (1995)).*

- How about multi-sector models?

This Paper

- A new internal propagation mechanism into a multi-sector RBC model
- Two main ingredients
  (i) Division of labor between two types of agents
  (ii) Type-dependent consumption behavior
- How does the type of labor that individuals supply and their consumption behavior interact in propagating the economic shocks?

(I) DIVISION OF LABOR

- Consumption Bundles $\neq$ Production Activities
- Circular interaction: I can consume the good you produce only if you demand the good I produce
- This is in addition to one that already present in GE models with homogeneous agents.
- Arises because of the *functional roles* assumed through the division of labor

(II) TYPE-DEPENDENT CONSUMPTION

- Different consumption bundles contain different capital contents
- As the consumption patterns change the average capital intensity of the goods consumed changes as well
- Since the capital stock is the main driver and the only stock variable in the model, this has first order effects on the statistical properties of economic shocks

Model Overview

- Two types of agents: H, L
- Two sectors: goods and services
- Each agent specialize in one good:
  - H produces capital-intensive good
  - L produces labor-intensive good
- Each type has a stronger desire to consume the good that the other type produces

Main Mechanism

- Investment shock
- As high-skill agents are employed in a more capital intensive sector, their productivities, and so their incomes, increase relatively more initially
- They spend their additional income mostly on service goods in which low-skill agents are specialized, so the demand for the low-skill labor increases as well
- As their income rises, low-skill agents start consuming relatively more basic goods, which in turn generates additional demand for high-skill labor that is not related to the original technology shock
- A circular interaction between the two types of agents emerges

Related Studies

- Homework models in macroeconomics Benhabib et. al (1991).
- Models with occupational choice based on comparative advantage Chang (2000)
- Business cycle models of investment specific shocks: Greenwood et.al (1988), Greenwood et.al (2000)
- Business cycles models with quality choice Jaimovic et. al (2015)
- Benhabib et. al (2006) discusses in detail how compositional effects may play a significant role in the dynamic properties of aggregate variables in the two, especially in the three-sector real business cycle models provided that the factor intensities among the sectors are different enough.
- Finally this paper addresses some of the issues, most notably raised by Cogley and Naso (1995) related to performance of the real business cycle models.

Model Overview

- A continuum of identical families
  → measure m of High-skill agents and $1-m$ of Low-skill agents
- Three consumption goods:
  - Basic goods

$$C_{gt} = A_{gt} K_{gt}^{1-\alpha_g} H_t^{\alpha_g}$$

  - Market produced services

$$C_{mt} = A_{mt} K_{mt}^{1-\alpha_m} L_t^{\alpha_m}$$

  - Home produced services

$$C_{ht} = \eta C_{gt}$$

- An Investment good

$$I_t = A_{It} \left(\omega_g^{\frac{1}{\epsilon}} M_{gt}^{\frac{\epsilon-1}{\epsilon}} + \omega_m^{\frac{1}{\epsilon}} M_{mt}^{\frac{\epsilon-1}{\epsilon}} \right)^{\frac{\epsilon}{1-\epsilon}}$$

Model Overview

- Preferences

$$U(C_{gt}, C_{ht}, C_{mt}, N_{ht}) = \frac{\Phi_1}{1-\gamma}\left(C_t - \Phi_2 \frac{N_t^{1+\theta}}{1+\theta}\right)^{1-\gamma}$$

where C_t is implicitly defined by the following relationships

$$C_t = \min\left\{C_{st},\ \xi C_{gt}^{\nu}\right\}$$
$$1 = \sum_{j\in\{h,m\}}^{I} \Omega_j^{\frac{1}{\sigma}} C_{st}^{\frac{\epsilon_j-\sigma}{\sigma}} C_{jt}^{\frac{\sigma-1}{\sigma}}$$

  - Preferences are type-dependent (suppressed)

$$\Phi_{1i}, \Phi_{2i}, \theta_i, \xi_i, \nu_i, \sigma_i, \epsilon_i, \Omega_i \qquad i \in \{h, \ell\}$$

  - The consumption aggregate is composed of two layers

Model Overview

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- The first tier is between consumption of goods and services

Model Overview

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- The second tier is between services C_{ht} and C_{mt}
  - Non-homothetic generalizations of CES preferences.
  - Originally proposed by Sato (1975) and Hanoch (1975)
  - Recently been used in the structural change literature (Comin et. all, 2015; Matsuyama, 2017)
  - Interpretation of the parameters
    - σ: measures the elasticity of substitution between C_{ht} and C_{mt}
    - ϵ_j measures the income sensitivity of the share of expenditures on the good C_{jt}, $j \in \{h, m\}$

Cross-sectional Consumption Patterns 1

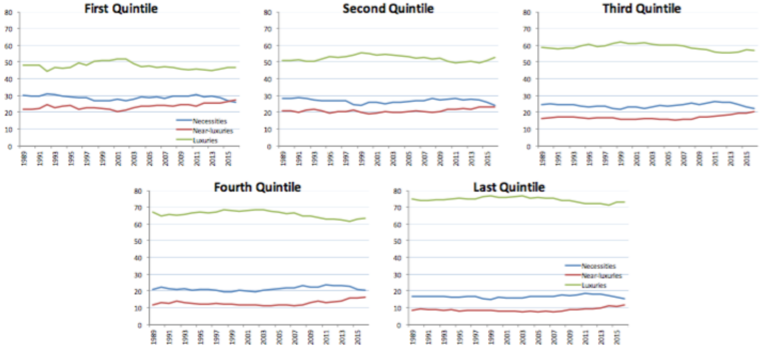

Figure: The Shares of Necessities, Near-Luxuries and Luxuries by Income Quintiles, 1989-2016. Source: Bureau of Labor Statistics, CES.

Cross-sectional Consumption Patterns 2

Survey paper Chai et.all. 2015 list three *stylized* facts on the consumption behavior of different income groups:

Stylized Fact 1: At low income levels, spending diversity is low as food expenditure dominates spending,

Stylized Fact 2: As household income grows, spending diversity increases via reductions in the budget share of food spending and increases in non-food expenditure,

Stylized Fact 3: Individual household spending becomes more diversified as income rises.

How Do Paramaters Map to the Evidence?

$$U(C_{gt}, C_{ht}, C_{mt}, N_{ht}) = \frac{\Phi_1}{1-\gamma}\left(C_t - \Phi_2 \frac{N_t^{1+\theta}}{1+\theta}\right)^{1-\gamma}$$

$$C_t = \min\left\{C_{st},\ \xi C_{gt}^{\nu}\right\}$$

$$1 = \sum_{j\in\{h,m\}}^{I} \Omega_j^{\frac{1}{\sigma}} C_{st}^{\frac{\epsilon_j-\sigma}{\sigma}} C_{jt}^{\frac{\sigma-1}{\sigma}}$$

- ξ: the share of expenditures on goods
- ν: how fast the share of services increases as the income rises
- Ω_h: the share of home produced services in steady state
- $\epsilon_h(\epsilon_m)$: how fast home (market) produced services expand as the income rises

HOUSHOLDS' PROBLEM

$$V(K_t, q_t) = \max_{\{C_{gt}, C_{ht}, C_{mt}, N_{\ell t}, N_{ht}, I_t, u_t\}} \left\{ U(\cdot) + \beta \mathbb{E} V(K_{t+1}, q_{t+1}) \right\}$$

subject to

$$(i) \sum_{j \in \{g,h,m\}} P_{jt} C_{jt} + I_t = R_t u_t K_t + w_{\ell t} N_{\ell t} + w_{ht} N_{ht}$$

$$(ii)\ K_{t+1} = (1 - \delta(u_t)) K_t + I_t q_t \,,$$

$$(iii)\ C_{jt} = C_{hjt} + C_{\ell jt},\ j \in \{g, h, m\},$$

$$(iv)\ C_{hgt}, C_{hst}, C_{\ell gt}, C_{\ell st} \geq 0 \,,$$

$$(v)\ \text{given } K_0 \,.$$

Quantitative Experiments

- Reference: Greenwood, Hercowitz and Huffman (1988)
- The investment shock q_t follows an AR(1) process

$$q_t = \rho q_{t-1} + \nu_t \,, \qquad \nu_t \backsim N(0, \sigma_I^2) \,.$$

- $\sigma_I = 0.045$ and $\rho = 0.52$
- τ, θ_h, σ and β are also from GHH
- $m = 1/2$
- $\omega = 0.7$ and $\epsilon = 0.1$
- Remaining parameters:
  - Non-homotheticity: $\sigma_i, \epsilon_{ih}, \epsilon_{im}, \xi_i, \nu_i \qquad i \in \{h, \ell\}$
  - Capital intensity: α_g, α_m

Reference Scenario: GHH

γ	2.00	θ_h	0.60	θ_ℓ	0.60	C/Y	0.80
β	0.96	Φ_{h1}	1.00	$\Phi_{\ell 1}$	1.00	I/Y	0.20
A_g	2.50	Φ_{h2}	1.00	$\Phi_{\ell 2}$	1.00	K/Y	2.06
A_s	2.50	Ω_h	0.50	Ω_ℓ	0.50	K_g/uK	0.76
α_g	0.71	σ_h	1.40	σ_ℓ	1.40	Y_g/Y	0.76
α_m	0.71	ϵ_{hh}	1.00	$\epsilon_{\ell h}$	1.00	$P_m Y_m/Y$	0.24
τ	1.42	ϵ_{hm}	1.00	$\epsilon_{\ell m}$	1.00	$\mathcal{U}_h/\mathcal{U}_\ell$	1.00
ω	0.70	ξ_h	1.00	ξ_ℓ	1.00	ρ	0.51
ϵ	0.10	ν_h	1.00	ν_ℓ	1.00	σ	0.045

Table: Paramater Values and Ratios

Reference Scenario: GHH

	USA			GHH			GHH Scenario		
	Std	AR	Corr	Std	AR	Corr	Std	AR	Corr
Output	3.50	0.66	1.00	3.50	0.66	1.00	3.50	0.66	1.00
Consumption	2.20	0.72	0.74	2.20	0.94	0.79	2.17	0.95	0.80
Investment	10.5	0.25	0.68	11.6	0.50	0.90	11.6	0.50	0.90
Hours	2.10	0.39	0.81	2.20	0.66	1.00	2.21	0.66	1.00
Productivity	2.20	0.77	0.82	1.30	0.66	1.00	1.32	0.66	1.00
Capital	-	-	-	5.60	0.99	0.52	5.72	0.99	0.65
Utilization	-	-	-	6.00	0.52	0.61	6.17	0.53	0.61

Table: Moments

Main Scenario

γ	2.00	θ_h	0.60	θ_ℓ	0.30	C/Y	0.80
β	0.96	Φ_{h1}	1.00	$\Phi_{\ell 1}$	1.00	I/Y	0.20
A_g	2.50	Φ_{h2}	1.00	$\Phi_{\ell 2}$	1.00	K/Y	2.06
A_s	2.50	Ω_h	0.40	Ω_ℓ	0.70	K_g/uK	0.62
α_g	0.66	σ_h	1.40	σ_ℓ	1.40	Y_g/Y	0.62
α_m	0.80	ϵ_{hh}	0.90	$\epsilon_{\ell h}$	1.00	$P_m Y_m/Y$	0.38
τ	1.42	ϵ_{hm}	1.20	$\epsilon_{\ell m}$	1.00	$\mathcal{U}_h/\mathcal{U}_\ell$	1.81
ω	0.70	ξ_h	0.70	ξ_ℓ	1.00	ρ	0.51
ϵ	0.10	ν_h	2.00	ν_ℓ	1.00	σ	0.045

Table: Paramater Values and Ratios

Moments

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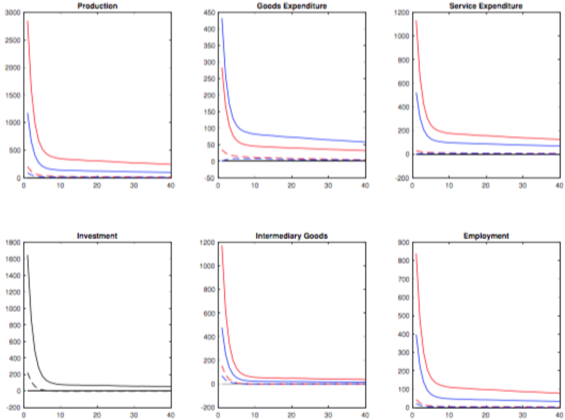
	Std	AR	Corr	Std	AR	Corr	Std	AR	Corr
Output	3.50	0.66	1.00	3.50	0.66	1.00	7.16	0.72	1.00
Consumption	2.20	0.72	0.74	2.20	0.94	0.79	6.14	0.80	0.99
Investment	10.5	0.25	0.68	11.6	0.50	0.90	12.21	0.57	0.94
Hours	2.10	0.39	0.81	2.20	0.66	1.00	6.32	0.74	0.99
Productivity	2.20	0.77	0.82	1.30	0.66	1.00	0.89	0.61	0.97
Capital	-	-	-	5.60	0.99	0.52	6.95	1.00	0.69
Utilization	-	-	-	6.00	0.52	0.61	7.71	0.51	0.64

Table: Moments

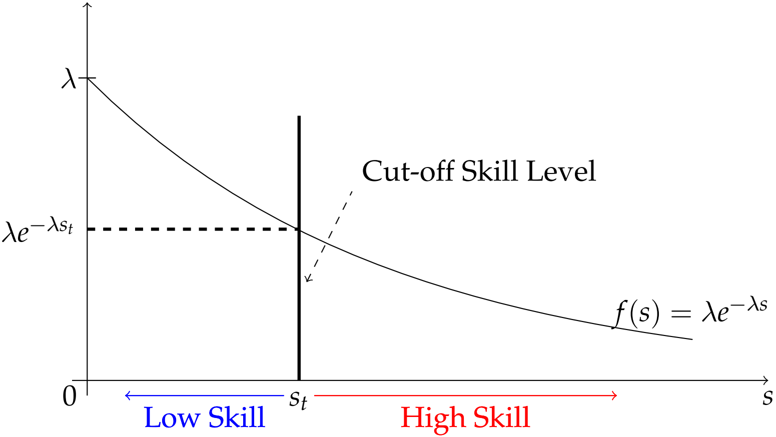
IRFs


Production
Goods Expenditure
Service Expenditure
Investment
Intermediary Goods
Employment

Extension: Incomplete Specialization

- Allow incomplete specialization
- Each household $s \in [0, 1]$ is endowed with a vector of efficiency units: $e_\ell(s)$ and $e_h(s)$
  - The same efficiency units at performing low skill jobs: $e_\ell(s) = 1, \forall s$.
  - Heterogeneous skills in performing high skill jobs.
- The distribution of efficiency units (skills): $f(s) = \lambda e^{-\lambda s}$

Optimal Labor Allocation



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- Investment shock
- As high-skill agents are employed in a more capital intensive sector, their productivities, and so their incomes, increase relatively more initially
- They spend their additional income mostly on service goods in which low-skill agents are specialized, so the demand for the low-skill labor increases as well
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- A circular interaction between the two types of agents emerges

CONCLUSIONS

- The imposed preference structure and the division of labor generates significant amplification in the model
- Does not need to rely on intertemporal substitution of labor-leisure
- Investment is not too volatile in comparison to other GHH type of models
- Co-movement puzzle does not arise in the model
- On theoretical side main contribution of this paper: imposing an empirically plausible restrictions on the consumers' behavior improves performance of multi-sector models