The Role of Correlated Investment-Skill Shocks in Business Cycles

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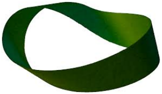

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Introduction

- Conceptual framework is similar to the pervious model:
  - Occupational roles determine the consumption bundles
  - Consumption Bundles $\neq$ Production Activities
- Unlike the previous model
  - occupational choice is based on the comparative advantage
  - agents can switch between the sectors over the business cycle
  - accordingly consumption bundles change as well $\rightarrow$ endogenous variation in the demand composition

This Paper

- studies the contribution of this endogenous variation in the demand composition to the propagation of economic shocks, in addition to the previous mechanisms
- puts the interaction between consumption and production sides of the economy in terms of their factor contents at the heart of the discussion

Householders' Problem

- Continuum of households
- Depending on her occupation a households is either of type L or H
- HH i of type k derives utility from goods (C_{gt}) and services (C_{st})

$$C_{kit} = C_{igt}^{\gamma_k} C_{ist}^{1-\gamma_k}, \qquad k \in \{L, H\}$$

- Households supply labor inelastically and have the following utility function

$$U(C_{igt}, C_{ist}) = \frac{1}{1-\sigma} C_{kit}^{1-\sigma}, \qquad (\sigma > 0)$$

HOUSEHOLDERS' PROBLEM

- Each household $s \in [0, 1]$ is endowed with a vector of efficiency units as a low and high skill worker

$$\left(e_\ell(s), e_h(s)\right)$$

- Agents have the same efficiency units at performing low skill jobs

$$\left(1, e_h(s)\right), \quad \forall s \in [0, 1]$$

- Skills s are distributed according to a density function $f(s)$ across the population

- Each period households supply one unit of labor inelastically to the job offering the highest income level given their endowments

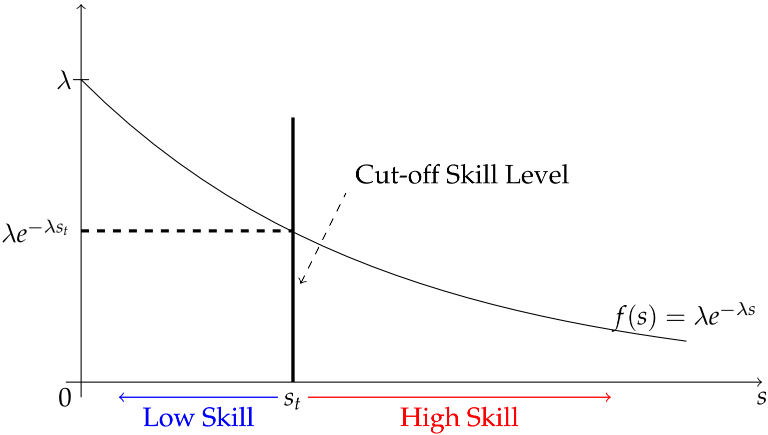
$$w_{kt}e_{kt}(s) = \max\{w_{\ell t}, w_{ht}e_{ht}(s)\}\,, \qquad k \in \{L, H\}$$

- Efficiency units (skills) are distributed exponentially

$$f(s) = \lambda e^{-\lambda s}$$

- These two guarantee that there is a cut-off skill level s_t s.t.
  - Agents with $s \leq s_t$ take Low skill jobs
  - Agents with $s \geq s_t$ take High skill jobs

Skill Distribution



FIRMS' PROBLEM

- **Basic Goods Production.**

$$\max_{\tilde{K}_t, H_t} A_{gt} \tilde{K}_t^{1-\alpha_g} H_t^{\alpha_g} - R_t \tilde{K}_t - w_{ht} H_t \, ,$$

- **Service Goods Production.**

$$\max_{X_{st}, L_t} P_{st} \, A_{st} X_t^{1-\alpha_s} L_t^{\alpha_s} - X_t - w_{\ell t} L_t$$

Equilibrium

Households and firms solve their respective problems as stated in the previous section and market clearing conditions hold in each market:

- Goods and Service sectors

$$Y_{gt} = C_{gt} + I_t + X_t \,,$$
$$Y_{st} = C_{st} \,,$$

where

$$C_{gt} = m_t C_{hgt} + (1 - m_t) C_{\ell gt}$$
$$C_{st} = m_t C_{hst} + (1 - m_t) C_{\ell st} \,,$$

- Labor

$$H_t = \int_{s_t}^{\infty} e_h(s) f(s)\, ds \,, \qquad L_t = \int_0^{s_t} e_\ell(s) f(s)\, ds$$

- The law of motion for capital

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

Planner's Problem

- Given cut-off skill level s_t, the allocation of the total labor between basic goods and services is uniquely determined
- This allows to focus on a simpler problem of a social planner
- The planner determines the cut-off skill level s_t optimally given
  - preference distribution in the population
  - stochastic structure of the economy

Planner's Problem

- a pair of welfare weights $\{\lambda_\ell, \lambda_h\}$
- a sequence of contingency plans: $\{C_{\ell gt}, C_{\ell st}\}$, $\{C_{hgt}, C_{hst}\}$
- aggregate allocations: $\{K_t, X_{st}, u_t\}$

$$\begin{aligned}
\max_{\left\{\{C_{igt}, C_{ist}\}_{i\in\{\ell,h\}}, X_{st}, K_{t+1}, u_t, s_t\right\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \Big\{ & \lambda_\ell m_t U_\ell(\cdot) + \lambda_h (1-m_t) U_h(\cdot) \Big\} \\
& + \mu_{1,t} \left[Y_{gt} - C_{gt} - X_{st} - I_t\right] \\
& + \mu_{2,t} \left[Y_{st} - C_{st}\right] \\
& + \mu_{3,t} \left[C_{gt} - m_t C_{hgt} - (1-m_t) C_{\ell gt}\right] \\
& + \mu_{4,t} \left[C_{st} - m_t C_{hst} - (1-m_t) C_{\ell st}\right] \\
& + \mu_{5,t} \left[K_{t+1} - (1-\delta(u_t)) K_t - I_t q_t^I\right]
\end{aligned}$$

where

$$Y_{gt} = A_{gt} \left[u_t K_t\right]^{1-\alpha_g} \left[H_t\right]^{\alpha_g} \qquad L_t = \int_0^{s_t} f(s)\, ds$$

$$Y_{st} = A_{st} X_{st}^{1-\alpha_s} L_t^{\alpha_s} \qquad H_t = \int_{s_t}^{\infty} e_h(s) f(s)\, ds$$

Quantitative Exercises

Stochastic Structure

- There are two shocks in the system: q_t^I and q_t^λ
- The investment shock q_t^I follows an AR(1) process

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

- The parameter of the skill distribution also follows an AR(1) process

$$\lambda_t = (1-\rho_\lambda)\lambda + \rho_\lambda \lambda_{t-1} - q_t^\lambda \,,$$

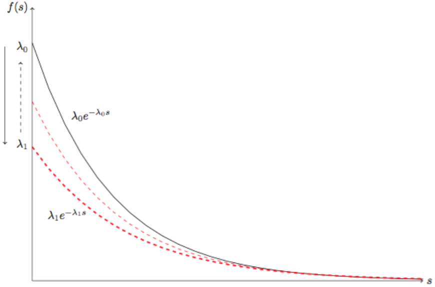
  where λ is the steady state value of the parameter
- (q_t^I, q_t^λ) are jointly driven by the following stoch process

$$\begin{bmatrix} q_t^I \\ q_t^\lambda \end{bmatrix} = \begin{bmatrix} \rho_I & 0 \\ \chi & \rho_\lambda \end{bmatrix} \begin{bmatrix} q_{t-1}^I \\ q_{t-1}^\lambda \end{bmatrix} + \begin{bmatrix} \nu_t^I \\ \nu_t^\lambda \end{bmatrix} \,, \qquad [\nu_t^I \ \nu_t^\lambda]' \text{ w.n.}$$

Evolution of A Positive Skill Shock

- With this specification a positive shock leads to a flatter distribution

  → The mean of the skill distribution ↑



PARAMETERS

Scenario

- Goods production is more capital intensive: $\alpha_g < \alpha_s$
- If an agents works in
  - goods sector $\rightarrow$ High-skill
  - service sector $\rightarrow$ Low-skill

  $\rightarrow$ Higher skill agents work in more capital intensive (sophisticated) jobs
- Their consumption baskets contain more of these goods: $\gamma_h > \gamma_\ell$
- As agents switch from the service sector to goods sector, their consumption baskets changes as well

  $\rightarrow$ They simply imitate high skill agents' consumption behavior

PARAMETERS

σ	2.00	σ_I	0.02	C/Y	0.80
β	0.96	σ_X	0.009	I/Y	0.20
γ_ℓ	0.30	σ_ν	0.00	K/Y	1.98
γ_h	0.80	ρ_I	0.00	X_s/Y	0.08
α_g	0.60	ρ_X	0.00	Y_g/Y	0.70
α_s	0.80	ρ_λ	0.60	P_sY_s/Y	0.38
τ	1.42	a_X	0.00	U_h/U_ℓ	1.18
λ	0.30	χ	0.50	m	0.50
λ_h	0.50	A_s	1.80		

Table: Paramater Values and Ratios

Results

- As in the previous model, first match the persistence and the standard deviation of output
- Compare moments of other variables with the US data and GHH

	USA			GHH			Model		
	Std	AR	Corr	Std	AR	Corr	Std	AR	Corr
Y	3.50	0.66	1.00	3.50	0.66	1.00	3.50	0.66	1.00
C	2.20	0.72	0.74	2.20	0.94	0.79	2.34	0.79	0.50
I	10.5	0.25	0.68	11.6	0.50	0.90	15.5	0.38	0.85
L	2.10	0.39	0.81	2.20	0.66	1.00	3.61	0.60	0.95
Y/L	2.20	0.77	0.82	1.30	0.66	1.00	1.13	0.84	0.07

Results Cont'd

- The model captures the persistence of consumption in the data much better than GHH

	USA			GHH			Model		
	Std	AR	Corr	Std	AR	Corr	Std	AR	Corr
Y	3.50	0.66	1.00	3.50	0.66	1.00	3.50	0.66	1.00
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Y/L	2.20	0.77	0.82	1.30	0.66	1.00	1.13	0.84	0.07

Results Cont'd

- Persistencies of other variables are very comparable to GHH

	USA			GHH			Model		
	Std	AR	Corr	Std	AR	Corr	Std	AR	Corr
Y	3.50	0.66	1.00	3.50	0.66	1.00	3.50	0.66	1.00
C	2.20	0.72	0.74	2.20	0.94	0.79	2.34	0.79	0.50
I	10.5	0.25	0.68	11.6	0.50	0.90	15.5	0.38	0.85
L	2.10	0.39	0.81	2.20	0.66	1.00	3.61	0.60	0.95
Y/L	2.20	0.77	0.82	1.30	0.66	1.00	1.13	0.84	0.07

Results Cont'd

- Measure of amplification: σ_ν/σ_Y
  - GHH: $5.15/3.5 = 1.47$
  - Model: $2.0/3.5 = 0.57$
- Model seems to generate significant amplification compare to GHH
- Recall the stochastic process

$$\begin{bmatrix} q_t^I \\ q_t^\lambda \end{bmatrix} = \begin{bmatrix} \rho_I & 0 \\ \chi & \rho_\lambda \end{bmatrix} \begin{bmatrix} q_{t-1}^I \\ q_{t-1}^\lambda \end{bmatrix} + \begin{bmatrix} \nu_t^I \\ \nu_t^\lambda \end{bmatrix}$$

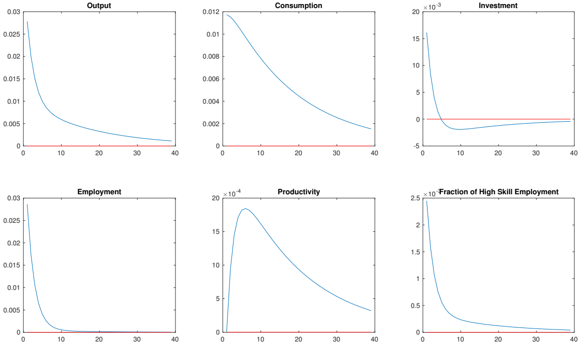
  $\rightarrow \nu_t^I$ effects both q^I and q^λ through χ

- My computations suggests that the contribution of the skill shock q^λ is much more important than q^I

  $\rightarrow$ Labor productivity shocks can be the main drivers of business cycles rather than the investment shocks

Results Cont'd

- One of the main challenges for RBC models:
  they cannot match the very low co-movement (even slightly negative) between productivity and output in data
- But this model can generate very low (almost zero) co-movement between productivity and output: 0.07
- IRFs give a better picture for the evolution of the labor productivity



- Low (almost zero) co-movement between productivity and output:

  Reason: over the expansion workers with increasingly fewer efficiency units in goods production start working in the goods production sector → low productivity

Economies with Different Skill Distributions

- The model also allows some other interesting numerical exercises
- We can compare two economies that are different only in terms of their skill distributions
- Consider two economies parameterized by λ

	Model ($\lambda_1 = 0.25$)			Model ($\lambda_2 = 0.30$)		
	Std	AR	Corr	Std	AR	Corr
Output	4.14	0.69	1.00	3.52	0.68	1.00
Consumption	2.67	0.83	0.55	2.34	0.79	0.50
Investment	17.10	0.41	0.86	15.54	0.38	0.85
Hours	4.50	0.60	0.95	3.61	0.60	0.95
Productivity	1.37	0.79	−0.10	1.13	0.84	0.07
Capital	6.27	0.98	0.68	5.46	0.98	0.68
Utilization	5.68	0.46	0.42	5.04	0.42	0.42

- An economy with a flatter skill distribution ($\lambda_1 = 0.25$) exhibits more volatility and persistence overall

Economies with Different Preference Gaps

- Another exercise: how does the gap between preference parameters affect the results?

  Economy 1: $\gamma_\ell = 0.4$ and $\gamma_h = 0.6$

  Economy 2: $\gamma_\ell = 0.3$ and $\gamma_h = 0.8$
- In both economies factor intensities: $\alpha_g = 0.8$ and $\alpha_s = 0.6$

	Model ($\gamma_\ell = 0.4,\ \gamma_h = 0.6$)			Model ($\gamma_\ell = 0.3,\ \gamma_h = 0.8$)		
	Std	AR	Corr	Std	AR	Corr
Output	3.90	0.65	1.00	4.05	0.66	1.00
Consumption	2.47	0.84	0.65	2.54	0.38	0.83
Investment	27.1	0.37	0.83	29.54	0.38	0.83
Hours	3.47	0.58	0.98	3.63	0.58	0.98
Productivity	0.84	0.96	0.59	0.86	0.97	0.67
Capital	6.27	0.97	0.67	9.43	0.97	0.67
Utilization	6.69	0.65	0.13	5.99	0.64	0.15

- The economy with a wider preference gap fluctuates slightly more in response to a technology shock

Conclusions

- Main Mechanism:
  - $m_t \uparrow$
    (the fraction of agents working in the goods sector increases)
  - $C_{gt}^{\gamma_\ell} C_{st}^{1-\gamma_\ell} \rightarrow C_{gt}^{\gamma_h} C_{st}^{1-\gamma_h}, \qquad (\gamma_h > \gamma_\ell)$
    (these agents replace their service intensive consumption baskets with goods intensive consumption baskets)
  - $Y_g \uparrow$
    (demand for goods increases even more)
  - m_t stays high
- This endogenous mechanism alone can generate sizable amplification and persistence, even without labor-leisure choice
  - In standard models, what stops an agent working more is the foregoing utility from leisure
  - But here this mechanism does not exist. Instead, the position of an agent in the skill distribution together with the demand for the basic goods determines whether he can work *more*

Conclusions Cont'd

- The model is better equipped and more flexible to study consumption and labor market dynamics
- Further thoughts:
  - The model can be extended to include a multi-dimensional skill distribution
  - It can be interpreted as a firm-entry model: entering the goods market requires one unit of high-skill labor and as soon as an individual starts working as a high-skill worker his consumption basket changes as well
  - The results are just suggestive since I have not followed a rigorous calibration procedure