Lecture 3

Structural change: supply side

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Non-Balanced Growth: The Supply Side

- Baumol's (1967) seminal work: "uneven growth" (non-balanced growth) will be a general feature of growth process because different sectors will grow at different rates owing to different rates of technological progress
- Review some ideas based on Ngai and Pissarides (2007), who formalize Baumol's ideas.
- Rich patterns of structural change during early stages of development and those in more advanced economies today require models that combine supply-side and demand-side factors.
- Isolating these factors is both more tractable and also conceptually more transparent.

Basic idea

- Uneven technological progress $\Longrightarrow$ relative prices must change
- Consumption responds depends on price elasticity
- Want to have tractable preferences to work out implications

Supply side: key ingredients

- Preferences

$$\int_0^\infty \exp(-\rho t)\,\frac{c(t)^{1-\theta}-1}{1-\theta}dt$$

with

$$c(t) = \left(\sum_{i\in\{A,S,M\}} \eta^i c^i(t)^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)}$$

- Technology with **unequal** growth rates

$$\begin{aligned} Y^i(t) &= X^i(t)K^i(t)^\alpha L^i(t)^{1-\alpha}, \\ \dot{X}^i(t)/X^i(t) &= g^i. \end{aligned}$$

- Inelastic labor, M produces all capital

Intuition for preferences

- Intratempotal optimality condition

$$\frac{c^i}{c^j} = \left(\frac{\eta^i}{\eta^j}\right)^{\sigma} \left(\frac{p^i}{p^j}\right)^{-\sigma}$$

- Parameter σ is **price elasticity**, assumed to be same for all goods
- Income elasticity is 1 for all goods
- If p^i/p^j increases then relatively consumption shares $p^i c^i / p^j c^j$
  - decreases if $\sigma < 1$
  - constant if $\sigma = 1$
  - increases if $\sigma > 1$

Production efficiency

- Firm's FOCs

$$\begin{aligned} p^i(t)X^i(t)\,\alpha\left(\frac{K^i(t)}{L^i(t)}\right)^{\alpha-1} &= r(t) \\ p^i(t)X^i(t)\,(1-\alpha)\left(\frac{K^i(t)}{L^i(t)}\right)^{\alpha} &= w(t) \end{aligned}$$

- From firm's optimization, capital-labor ratios are equalizes across sectors

$$\frac{K^i(t)}{L^i(t)} = k(t) \text{ for all } i$$

- Relative prices reflect relative productivities

$$\frac{p^i(t)}{p^j(t)} = \frac{X^j(t)}{X^i(t)} \text{ for } i,j \in \{A,S,M\}$$

- **Relative prices fall in sectors with higher productivity growth**

Consumption side

- Plug these into intratremporal optimality for consumers:

$$\frac{p^i(t)\,c^i(t)}{p^j(t)\,c^j(t)} = \left(\frac{\eta^i}{\eta^j}\right)^{\sigma}\left(\frac{X^j(t)}{X^i(t)}\right)^{1-\sigma}$$

- Consumption share $p^i c^i$ for the more stagnant sector
  - increases if $\sigma < 1$ (empirically relevant case)
  - constant if $\sigma = 1$
  - decreases if $\sigma > 1$

Labor allocation

- For $i, j \neq M$,

$$c^i(t) = X^i(t)\, k(t)^\alpha L^i(t)$$

- Use previous expression

$$\frac{L^i(t)}{L^j(t)} = \left(\frac{\eta^i}{\eta^j}\right)^\sigma \left(\frac{X^j(t)}{X^i(t)}\right)^{1-\sigma}$$

- This gives

$$\frac{\dot{L}_i(t)}{L_i(t)} - \frac{\dot{L}_j(t)}{L_j(t)} = (1-\sigma)\left(g^j - g^i\right) \text{ for } i \in \{A, S\}$$

Discussion

- Suppose demand is inelastic ($\sigma < 1$)
  - prices of faster growing sector fall
  - consumption *share* of that sector falls
  - labor outflows from that sector
- Same logic extends to arbitrary number of sectors
  - asymptotically, everyone works in the most stagnant sector
  - "Baumol's cost disease"

Empirical evidence: Baumol et al (AER, 1985)

TABLE 1—AVERAGE ANNUAL RATE OF PRODUCTIVITY GROWTH BY SECTOR, 1947–76[a]

Industry	*GPO/L* (1)	*GDO/L* (2)	ρ (3)	λ (4)
1. Agriculture	3.59	4.47	1.56	3.95
2. Mining	2.70	2.76	0.08	1.38
3. Construction	1.66	1.19	−0.34	1.49
4. Manufacturing-Durables	2.52	2.80	0.58	3.08
5. Manufacturing-Nondurables	3.21	3.23	0.41	2.56
6. Transportation and Warehousing	1.74	2.74	0.68	2.42
7. Communication and Broadcasting	5.42	5.50	3.99	5.21
8. Utilities	4.96	4.77	1.53	2.96
9. Trade		2.17	1.09	2.19
a. Wholesale Trade	2.37			
b. Retail Trade	1.99			
10. Finance and Insurance	0.50	0.31	−0.27	0.57
11. Real Estate	2.72	3.10	1.21	4.86
12. General Services	0.93			
a. Hotels, Personal and Repair (except auto)		1.37	−0.31	1.35
b. Business and Professional Services		1.70	0.83	2.30
c. Auto Repair and Services		1.45	−0.84	1.04
d. Movies and Amusements		0.99	−0.56	0.64
e. Medical, Educational and Nonprofit		−0.46	−1.14	−0.19
f. Household Workers		−0.21	−0.21	−0.21
13. Government Enterprises	−0.51	1.10	−0.52	0.99
14. Government Industry	0.31	−0.18	0.08	−0.18
Overall: *GDP*	2.16			
GNP		2.18	1.17	2.18

Empirical evidence: Baumol et al (AER, 1985)

14. Government Industry	..	..	..	..
B. Annual Prod. Growth Rate, 1947–76:				
a. Progressive Sectors (all)	2.94	3.04	1.09	2.92
b. Stagnant Sectors	0.64	0.56	−0.84	0.73
c. Progressive Service Sectors	2.71	2.79	1.63	2.79
d. Overall	2.16	2.18	1.17	2.18
C. Percent of Employed Persons in Stagnant Sectors:				
a. 1947	27.6	30.7	32.4	32.4
b. 1976	41.2	42.0	43.0	43.0
D. Stagnant Sector Share of Final Output (1958 $):				
a. 1947	21.4	31.2	31.5	31.5
b. 1976	21.2	29.2	28.9	28.9
E. Stagnant Sector Share of Final Output (Current $):				
a. 1947	17.9	26.8	27.0	27.0
b. 1976	29.9	38.6	38.1	38.1
F. Stagnant Sector Share of *GDO* (1958 $):				
a. 1947	16.8	21.9	24.2	24.2
b. 1976	16.8	19.8	21.3	21.3
G. Stagnant Sector Share of *GDO* (Current $):				
a. 1947	13.7	18.3	20.4	20.4
b. 1976	22.9	24.5	26.7	26.7
H. Percent of Employed Persons in Progressive Services:[b]				
a. 1947	21.3	23.5	23.5	23.5
b. 1976	22.5	26.7	26.7	26.7

Uneven growth and balanced growth path

- This model produces uneven growth
- Is it consistent with Kaldor facts?
- Can we converge to a "Constant Growth Path"?

Feasibility

- Feasibility constraint

$$\begin{aligned} c^M + \dot{K} &= X^M \left(K^M\right)^\alpha \left(L^M\right)^{1-\alpha} - \delta K \\ c^A &= X^A \left(K^A\right)^\alpha \left(L^A\right)^{1-\alpha} \\ c^S &= X^S \left(K^S\right)^\alpha \left(L^S\right)^{1-\alpha} \end{aligned}$$

- Multiply by p^i and sum to get

$$C + \dot{K} = X^M (K)^\alpha (\bar{L})^{1-\alpha} - \delta K$$

where

$$C \equiv \sum_{i \in \{A,M,S\}} p^i c^i$$

- To make progress, lets express dynamic conditions in terms of C

Intertemporal optimality condition

Excercise

Let λ be multiplier on the consumer's budget constraint and

$$C(t) \equiv \sum_{i \in \{A,M,S\}} p^i(t)\, c^i(t)$$

be total consumption expenditures. Show that optimality requres

$$\frac{\dot{\lambda}}{\lambda} + \frac{\dot{C}}{C} = (1-\theta)\,\frac{\dot{c}}{c}$$

and

$$\frac{\dot{\lambda}}{\lambda} = -\left(\alpha X^M K^{\alpha-1} \bar{L}^{1-\alpha} - \delta - \rho\right)$$

Euler equation

- So we have two conditions

$$C + \dot{K} = X^M K^\alpha \bar{L}^{1-\alpha} - \delta K$$

$$\frac{\dot{C}}{C} - (1-\theta)\frac{\dot{c}}{c} = \left(\alpha X^M K^{\alpha-1} \bar{L}^{1-\alpha} - \delta - \rho\right)$$

- Note that if $\theta = 1$, these are the optimality conditions of the neoclassical growth model
  - therefore, $\theta = 1$ is a sufficient condition to deliver Kaldor facts
  - it also turns out to be a necessary condition