Macroeconomic Theory: Lecture 9

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Last time: SFC models

- So far you've see Classical/Neoclassical growth and distribution models
- Then OLG, RBC, and New Keynesian models, with a nod towards DSGE type models.
- Then models looking at effective demand/uncertainty/accounting
- Now a model of endogenous technical change. See GD Cht 16.
- Websummit: all about increasing investment to increase technical change.

Technical change

- Classical model: historical tendency, biased change.
- Neoclassical model: exogenous technical change.
- Need for models of endogenous technical change.
- Question of bias arises.

Quick refreshers

- Harrod neutral technical change: labour augmenting
- Hicks neutral technical change: if a change in technology does not change the ratio of capital's marginal product to labour's marginal product for a given capital to labour ratio.
- Solow neutral: capital augmenting

Manna from Heaven, or not?

- Technical change is endogenous when it occurs as a direct result of deliberate economic activity.
- R&D vs luck
- Rate of technical change linked to rate of capital accumulation
- Increase in amount of new capital per worker is the embodiment hypothesis.

Transmission mechanisms and embodiment

- Tech. change usually transmitted through a capital good, thus embodied.
- Denison. Embodied tech. change transmitted through gross investment, eg. transistor.
- Ideas are unembodied, for example Fordism/Taylorism/Buddhism.

Illustrating technical progress

- Imagine a tech. progress function like $\gamma = a + bg_k$ where γ is capital output ratio, g_k is growth rate of capital.
- 1 growth rate consistent with with steady stage growth where $\gamma = a/1 - b$
- Problem 1: it's independent of economic behaviour.
- Problem 2: equivalent to Cobb/Douglas function.
- See Solow, Technical Progress, Capital Formation, and Economic Growth, AER, 1967.
- Harold Lydall, On Measuring Technical Progress, Australian Economic Papers, 1969.

Vintage models

- Different models of machines with different ages.
- In Harrod-Neutral terms and assuming a constrant prodit share, productivity improves machines constantly $x_v = (1+\gamma)x_{v-1}$.
- Obsolesence$x_v - xN_v < 0$
- Really important: what is service life of machine, T? $T \leq -\ln(1\pi_t)/\ln(1+\gamma)$
- Equilibrium output $X = \sum_{v=0}^{T} X_0(1+g)^v = X_0/g * (1+g^{1+T} - 1)$
- Develop into $K_{T+1} = s\pi K$, equivalent to $g = s_p\pi$.
- This is the Cambridge equation.

Yeh wha?

- When there is an ordering of machines by vintage, the wage determines the productivity of the last machine. Link here to Ricardo's extensive margin/rent theory.
- So, could increases in the saving rate improve productivity growth by reducing average age of capital stock?

Induced Technical Change

- Marx: by making labour more more expensive in 19th Century Factory Acts stimulated discovery of labor saving machinery.
- Barbara Solow on the triangular trade. Capitalism and Slavery in the Exceedingly Long Run, 1987.
- Invention Possibility Frontier, $\gamma = f(x)$, assume a menu of technical changes available.
- Planner $\max(1-\pi)\gamma + \pi x$ subject to $\gamma = f(x)$ for a given π.
- Solution after some linear programming is $f'(x) = -\pi/(1-\pi)$.s

Technical progress

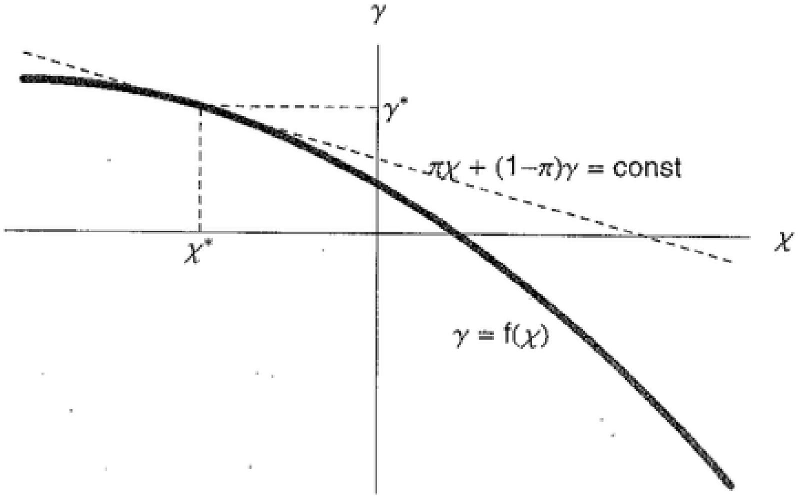

Figure 1: Technical progress and profit-maximising entrepreneurs

Specialisation

- Returns to scale & imperfect competition (Krugman JPE 1990)
- Increasing specialisation drives increasing returns.
- Imagine a production function like $X = N^{1-\alpha} \sum_{t=1}^{A} K_i^{\alpha}$.
- A here is a measure of a number of designs and plans available.
- KISS. Constant labour force, no unemployment. Everone hired in final goods sector. Competition exists so wages equal marginal product.
- Capital goods used up in 1 period (circulating capital)
- Firms pay for everything at the end of the period. Interest is not a cost of production. Capital goods produced by monopolies.
- Use good where marginal product equals price P_i.
- Diff. wrt K, set equal to P_i to get demand curve for capital good: $K_i^d = N(\alpha/P_i^(1/1-\alpha))$.
- You've seen a version of this before. Remember where?

Monopolistic competition and growth

- Setup another linear program. This time it yields $P_i^* = 1/\alpha c$
- Or, since $\alpha < 1$, monopolist will always charge a markup over marginal cost.
- Since introduction of new good doesn't affect demand for existing goods, monopolist produces here forever.
- Increases in wages lead to increases in productivity in long run here.

Learning by doing

- Only 1 of Kenneth Arrow's seminal contributions. Idea is that learning causes positive spillovers. - Learning is an external economy of scale.
- Firm and economy level production.
- Have $X_i = \min(AK_i, X(K^{\alpha})N_i)$ at firm level which leads to
- $\mathrm{X} = \min[AK, K^{\alpha}N]$.
- Here firms will growth at a constant rate of profit equal to the constant profit share times capital productivity, $r = \pi A$. Rate of accumulation is
- $1 + g_K = \beta(1 + r) = \beta(1 + \pi A)$. The rate of labour saving tech. change depends on the rate of accumualtion.
- Also true $1 + \gamma = (1 + g_K)^{\alpha}$.
- The rate of technical change depends on the rate of capital accumulation because knowledge grows as an unintended consequence of investment.
- Increases in real wage actually slow this process down in this formulation.

Learning by doing: evidence

See Peter Thompson's Learning by Doing chapter here:
`http://economics.fiu.edu/research/working-papers/2008/08-06/08-06.pdf`

From Thompson:

> *"Dunne, Roberts and Samuelson (1989) re- port that among 208,000 US manufacturing plants that survived any given five-year period of observation, annual employment growth rates averaged 7.6 percent for plants under five years of age, 3.7 percent for plants aged six to ten years, and 2.9 percent for plants eleven to fifteen years of age."*

Learning by doing: evidence

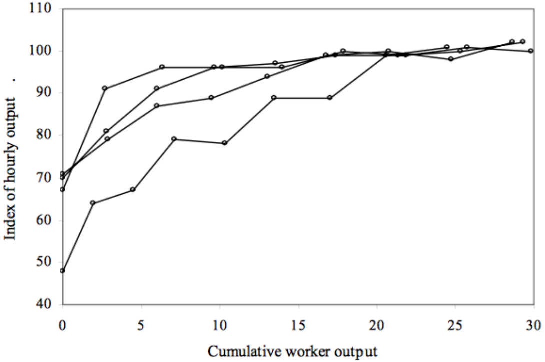

Figure 3-5. Average worker productivity (index) of new workers on four tasks at a munitions factory, plotted against average cumulative output per worker. Observations are recorded weekly, at the points indicated by circles. Source data: Jovanovic and Nyarko (1995, table A-4).

Figure 2: Technolgical change

Next time

- The Keynesian approach.