

Comments on Openness, Technology Capital, and Development

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Overview

- ▶ Motivation
- ▶ Proposed production function
- ▶ Worked examples
 - ▶ Steady state analysis - gains from scale and integration
 - ▶ Exogenous growth in technology (other than technology capital) and population
 - ▶ Exogenous diffusion of technology other than technology capital

Motivation: "Open countries catch up with productivity leader"

- ▶ EU: Special cases
 - ▶ Post 1990
 - ▶ Adjust LP in France
 - ▶ 1980 joiners - Spain, Portugal
- ▶ Latin America falls behind; Asia catches up
- ▶ Missed connection to literature on convergence clubs
 - ▶ Baumol AER 1986
 - ▶ Ben-David QJE 1993
 - ▶ Quah 1996

Firm Production Function

Locations $n \in \{1, \dots, N\}$

Technologies $m \in \{1, \dots, M\}$

$$F(N, M, Z) = \max_{z_{nm}} \sum_{n,m} g(z_{nm})$$

subject to $\sum_{n,m} z_{nm} \leq Z$

Z (later K and L) rival - must be divided between locations

M nonrival - can be used at an additional location with no reduction in productivity where it is already in use

Firm Production Function

Special case $g(z) = z^\phi$, $Z = K^\alpha L^{1-\alpha}$

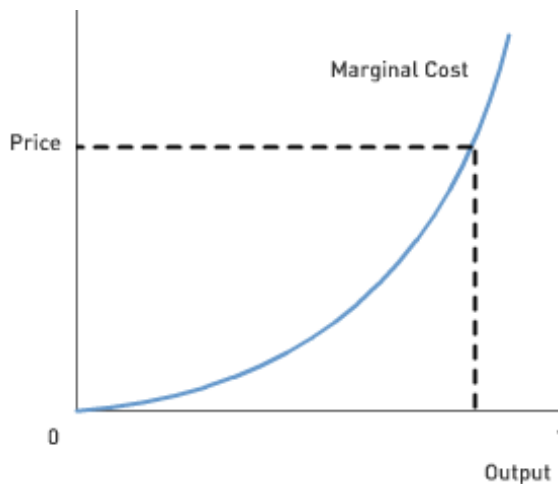
Fix N (function of economy as a whole) and M (under control of firm)

$$F(N, M, K, L) = G(N, M) \left(K^\alpha L^{1-\alpha} \right)^\phi$$

hom(ϕ) in rival inputs with $\phi < 1$

Marshallian Rents

Old idea for financing innovation in competitive equilibrium



Marshallian Rents

- ▶ Conflicts with physical characteristics of replication.
Examples:
 - ▶ Cross docking, ORT
 - ▶ Bloom and Van Reenen - lean manufacturing, using key performance indicators
 - ▶ Comin - Spindles ring or mule, steel open hearth or blast
- ▶ Solow model got hom(1) in rival goods right; so do monopolistic competition models
 - ▶ (as it turns out, Romer 1986 did not)
- ▶ Right approach is GE as formalized by McKenzie: In the restriction to subspace of rival inputs,
 - ▶ all production sets are cones
 - ▶ with price taking, there are no profits, just factor returns

Why Introduce Locations at All?

Suppose M is nonrival, Z is rival, and for firm j

$$Y_j = M^\gamma Z_j^{1-\gamma}$$

No subscript on M as it can be used simultaneously in all firms

With J firms, aggregate output Y becomes

$$\begin{aligned} Y &= JM^\gamma \left(\frac{Z}{J}\right)^{1-\gamma} \\ &= J^\gamma M^\gamma Z^{1-\gamma} \end{aligned}$$

Then $Y \rightarrow \infty$ as $J \rightarrow \infty$

So in this paper, technology capital is non-rival across locations
but not across firms

Locations proportional to people

Firm level production

J symmetrical firms

Aggregate inputs M and K

Population = labor force = L

$$N = \psi L$$

Production for firm j :

$$Y_j = (\psi L)^{1-\phi} M_j^{1-\phi} K_j^{\alpha\phi} L_j^{(1-\alpha)\phi}$$

All output paid as factor returns to M , K , L

First term acts like a spillover benefit from population increase

Locations proportional to people

Aggregate production

J symmetrical firms

Aggregate inputs M and K

Population = labor force = L

$$N = \psi L$$

Aggregate Production

$$\begin{aligned} Y &= (\psi L)^{1-\phi} M^{1-\phi} K^{\alpha\phi} L^{(1-\alpha)\phi} \\ &= \psi^{1-\phi} M^{1-\phi} K^{\alpha\phi} L^{1-\alpha\phi} \end{aligned}$$

Increasing returns - hom($2 - \phi$) in M , K , and L

Hence, scale matters

Locations proportional to people

Decentralization

Marshallian external increasing returns

Market return to L is less than social marginal product

What determines extent of spillovers across boundaries?

- ▶ Excludability of nonrival good M
- ▶ Profit motivated transfers of M across borders via FDI
- ▶ Government restrictions on FDI

In this sense, similar to MC models of trade and growth (T&G)

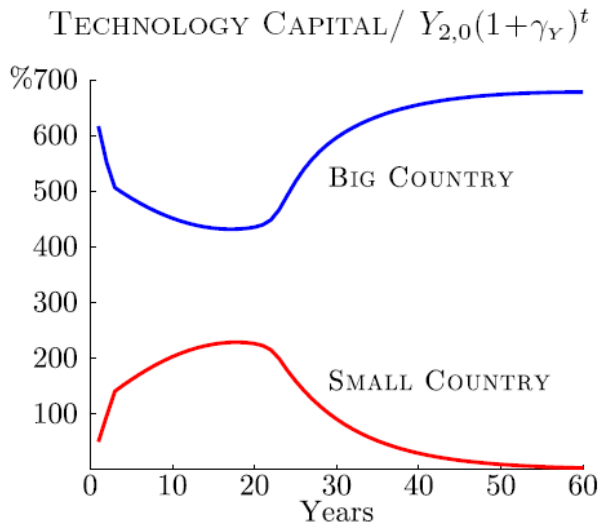
Aside: Harberger Paradox

- ▶ Partial convergence of Parente-Prescott to existing T&G models
- ▶ Current model shares with P-P pareto optimality of no distortion equilibrium
 - ▶ Why? Population/labor participation is exogenous
- ▶ Harberger: Welfare cost second order in distortion

Comparison with existing MC models of T&G

- ▶ PO of no distortion equilibrium vs sub-optimality
- ▶ National income accounting?
 - ▶ Useful part of this and related work by M-P
 - ▶ But, could equally well be done in model of MC
- ▶ Both have increasing returns
- ▶ Price taking vs price setting
- ▶ With or without micro foundations
 - ▶ Issues: IO, patent policy, competition, entry and exit

Connecting to existing literature



Summary

Key strategic choices:

- ▶ Retain price taking
- ▶ Introduce nonrival good
- ▶ Allow for some degree of excludability

To achieve these, gives up on the notion of micro-foundations.

More than just a set of equations

Must have a world that you can describe to reader

Reader could verify if equations are correct

Example: Islands model of unemployment