Economic growth in an emerging economy

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This paper is in an old tradition

- One-good economy, of which Solow, 1956 is the paradigm: with a friendly production function amenable to manipulation and precise results. The big story is TFP.
- Endogenous growth models didn't go much beyond the neoclassical workhorse: separate the goods-producing sector from an ideas-producing sector (R&D) or a knowledge-producing sector (universities), derivatives of Lucas, 1988.

Basic ideas

- Try to advance beyond the single-sector model in goods to capture some of the basic features and challenges of underdeveloped economies
- What are these?
  - Knowledge of production functions is limited to very few goods
  - Growth occurs by incorporating production functions that exist elsewhere, not by endogenous efforts to improve productivity
  - This process is constrained by informational externalities and coordination problems
  - Solving the coordination problem requires the existence of a planner that can build “infrastructure”
  - Also, allow for “subsidies” to overcome informational externalities that hamper private investment in “new” sectors
  - Planner’s budget constraint is important: she has to tax some agents in order to invest and to subsidize older sectors

Features of the model

- One traditional sector with unlimited supplies of labor (Lewis, 1954); nxm modern sectors, which may or may not exist (they require importing and mastering technology: self-discovery and information externalities)
- There are n possible infrastructure projects that are necessary for the introduction of m sectors supported by each infrastructure project, allowing the emergence of a "family of sectors" using the same infrastructure
- The emergence of any of these sectors in a given family is a function of information investment by individual firms
- I do away with the problem of domestic demand by assuming we are dealing with a small economy where all production is for world markets and all consumption consists of importables
- There is no domestic production of importables because domestic markets are too small and production is subject to economies of scale

Features of the model

- Traditional sector uses land and labor; modern sectors, labor and human capital
- Human capital is on-the-job trading
- Government taxes traditional and modern sectors and spends its revenue on “infrastructure” (and, in some runs, subsidizing investment in information): balanced budget
- Growth takes place by incorporating technologies existing outside the national economy (“advantages of backwardness”) and elsewhere in the world
- Without the infrastructure that a family of sectors needs, there is no investment in sectors belonging to that family (coordination problem)
- For simplicity, we assume that each project has the same cost, there is no depreciation, and that it lasts forever
- We also assume that all firms are small and use similar, fixed-coefficient-technology, which is unknown to firms; the planner has an advantage in that it knows the expected value of the input coefficients in each sector, but not their distribution (this can be relaxed without altering the results)
- Firms are more risk-averse than government

The formal model

$$(1)\quad \mathrm{Y} = F(T, L) + \sum_{i,j} \left[p_{ij} G_{ik}(L_{ij}, H_{ij})\right] A_{ij} B_j$$

$$A_{ij} = 0,1$$

$$i = 1,2, \dots, n; j = 1,2, \dots m$$

$$(2)\quad H_t = (1+\mu) H_{t-1}, \qquad H_0 = \bar{H}$$

$$(3)\quad H^D = J\left[\left(\sum_{i,j\neq 0} G_{i,j}\right), s\right], \qquad \frac{\partial H}{\partial G} > 0, \qquad \frac{\partial H}{\partial s} < 0$$

$$(4)\quad \lambda \dot{B} + \delta\left(\sum_{ij\neq 0} C_{ij}\right) = \tau_T * \pi_T + \tau_p * \sum_{i,j\neq 0} \pi_{ij}^{p} + \tau_c * \sum_{i,j\neq 0} \pi_{ij}^{c}$$

Glossary

Y = aggregate output
F = output of traditional sector (price assumed numeraire)
T = land input
L = unskilled labor
G_{ij} = output of non-traditional sector i in family of sectors j
p_{ij} = price of G_{ij}
H_{ij} = human capital input of G_{ij}
A_{ij} = binary variable indicating existence in the economy of G_{ij}
B_j = binary public input j that allows the existence of family of sectors j
π_{ij} = profits in producing G_{ij}
τ = rate of profit taxation
λ = cost/price of each public input B_j (assumed to be equal for all inputs)
δ = proportion of information costs that are subsidized
C_{ij} = investment in information in sector i, family of sectors j

Microeconomics

Assume that there is an initial investment in information that only the pioneer makes; in the second period, production and sales take place.

$(5)\ \left(1-\tau_p\right)E(\pi) \geq C(1+r)$ (profitability condition for pioneer)

$(6)\ (1-\tau_c)\pi \geq 0$ (profitability condition for copycat)

$(5a)\ \left(1-\tau_p\right)\left(p-\overline{w}E(l)-sE(h)\right)G \geq C(1+r)$

$(6a)\ (1-\tau_c)(p-\overline{w}l-sh)G \geq 0$

In order to discover the set of feasible combinations of l,h that are profitable, we set (5a) to equality

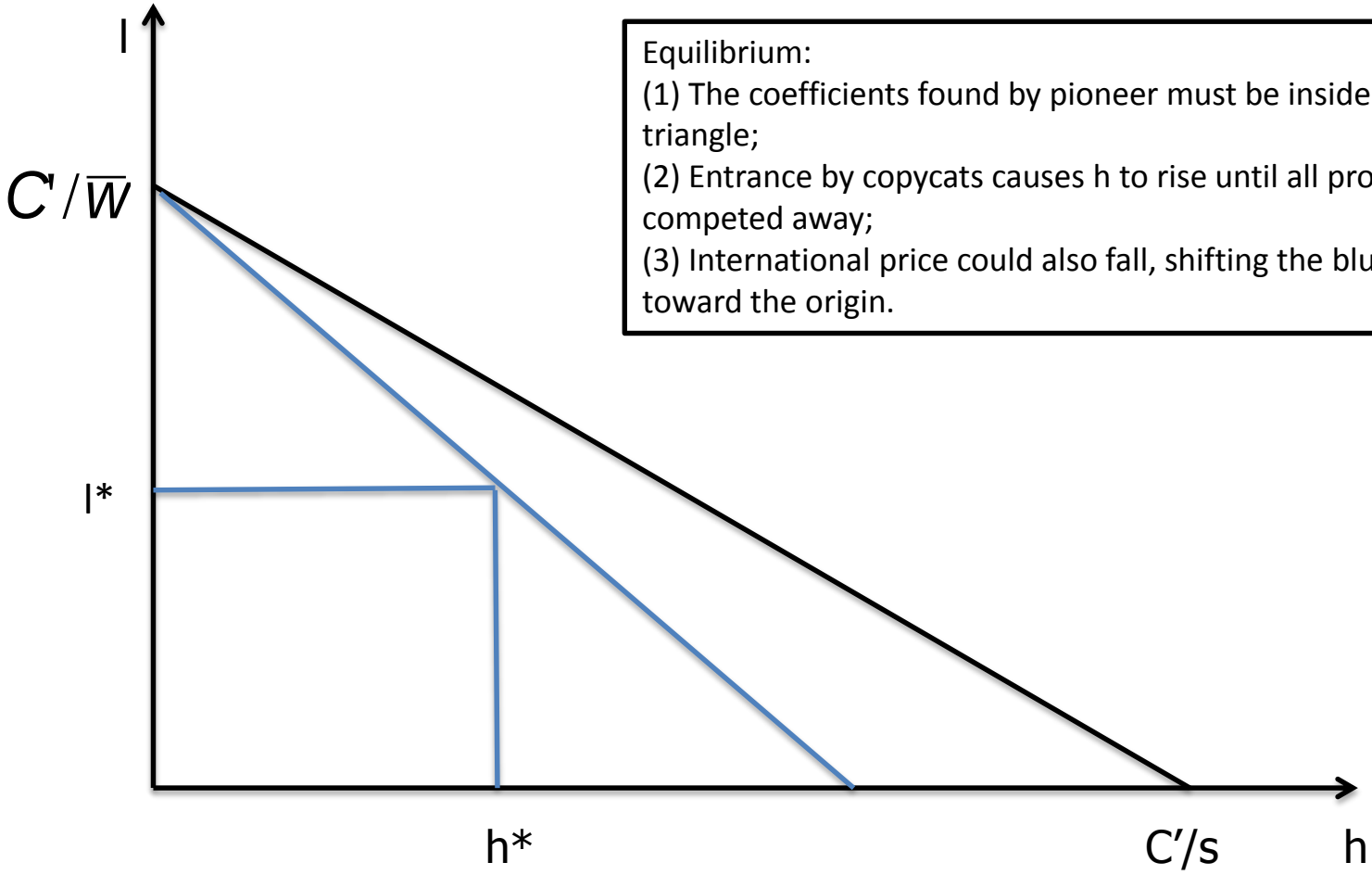
$(7)\ l = -\frac{s}{\overline{w}} * h + C'/\overline{w}$

$where\ C' = \left[p - \frac{C(1+r)}{G(1-\tau_p)}\right]$

Glossary

π = profits
r = interest rate
C = information costs
w = wages of unskilled labor
s = wages of skilled labor
l = coefficient of unskilled labor per unit of output
h = coefficient of skilled labor per unit of output

The set of feasible input-output coefficients is represented by the area below the straight line …



Equilibrium:
(1) The coefficients found by pioneer must be inside the triangle;
(2) Entrance by copycats causes h to rise until all profits are competed away;
(3) International price could also fall, shifting the blue line toward the origin.

What's the nature of the problem?

- It's better to wait until the discovery is made by someone else, because the pioneer incurs the costs of discovery while the copycat doesn't
- If coefficients l and h fall within the triangle, the product will turn out to be profitable, and even more so for the copycat
- The copycat may cause the wage of skilled labor to increase (Δs), which may render the investment unprofitable by reducing the space of profitable technologies
- She may also cause the price of the product to decline, by displacing the straight line toward the origin
- The analysis is formally the same for demand discoveries: what is unknown is the size of the triangle, although its slope is known (it is determined by the known values of the input coefficients l,h)

Possible choices of infrastructure

1. Random choice of projects
2. Choose sectors with highest E(l) (comparative advantage)
3. Choose sectors with highest E(h) (externalities in human capital formation)
4. Choose sectors with lowest E(l) – discard because it doesn't make much sense
5. Choose sectors with lowest E(h) – again, comparative advantage argument

Sequencing

1. Remember that the planner has the following choices:
   a. set taxes on traditional sector, on pioneers, on copycats;
   b. subsidize or not subsidize C
2. Start with initial values of output in traditional sector, C, and a set of tax rates
3. Government collects tax revenues and builds infrastructure
4. This generates H for the next period
5. Determine which sectors will emerge during the next period
6. Do this for every choice of tax rates and subsidy (binary) and run for 50 periods

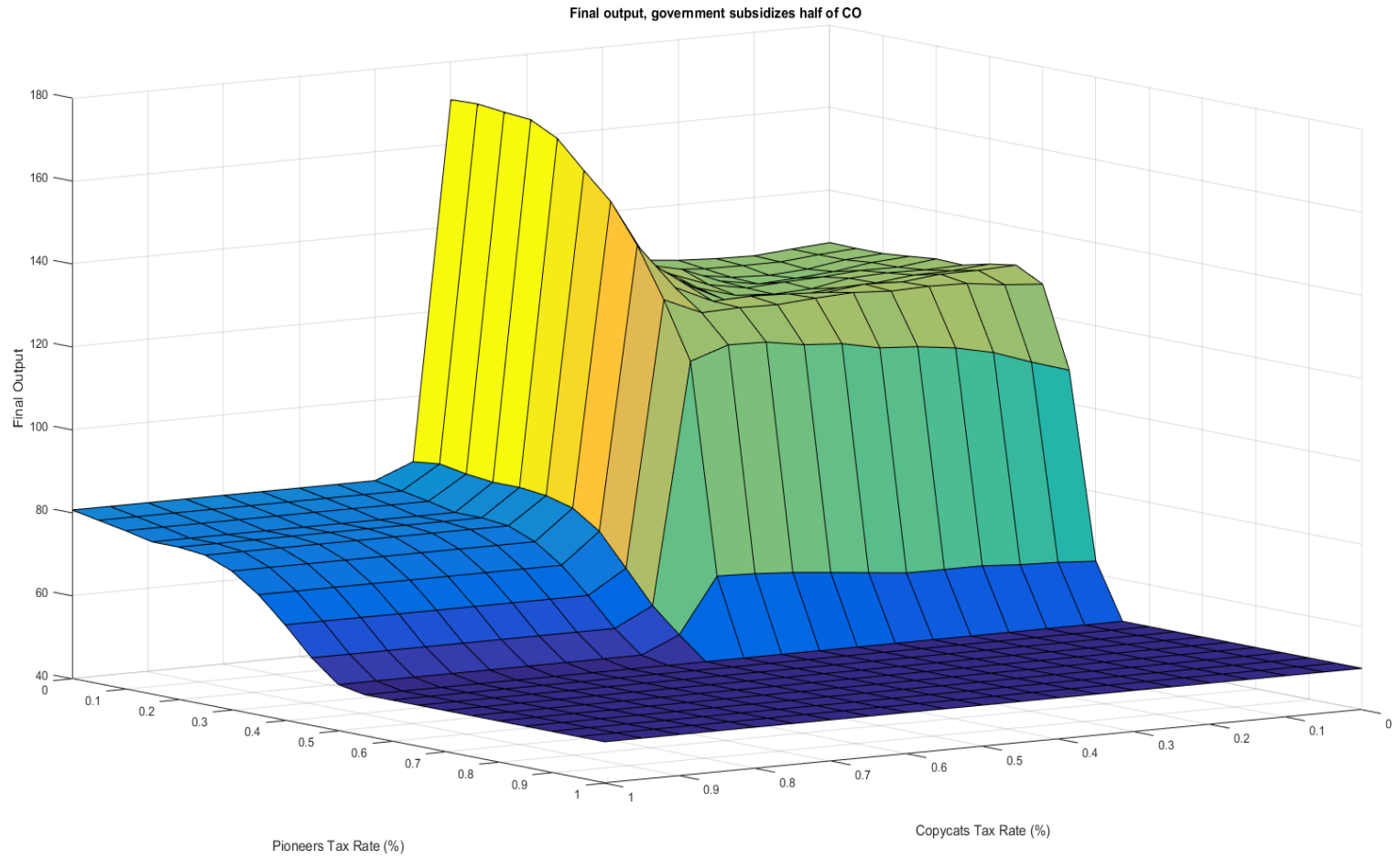
Results with three levels of information investment subsidy: 0, 50%, and 100%

C subsidy	Strategy	Growth rate of output	Growth rate of skilled labor	Tax on pioneers (%)	Tax on copycats (%)
0%	Random	1.5	1.6	0	50
	Highest E(I)	1.0	1.4	0	25
	Highest E(h), lowest E(I)	1.6	1.6	0	50
	Lowest E(I)	1.7	2.7	0	50
50%	Random	2.2	2.6	0	50
	Highest E(I)	1.9	1.9	0	25
	Highest E(h), lowest E(I)	2.5	3.0	5	50
	Lowest E(I)	2.3	2.6	0	50
100%	Random	2.1	2.6	0	50
	Highest E(L)	2.1	2.2	0	40
	Highest E(h), lowest E(I)	2.5	3.0	0	50
	Lowest E(I)	2.3	1.2	0	50

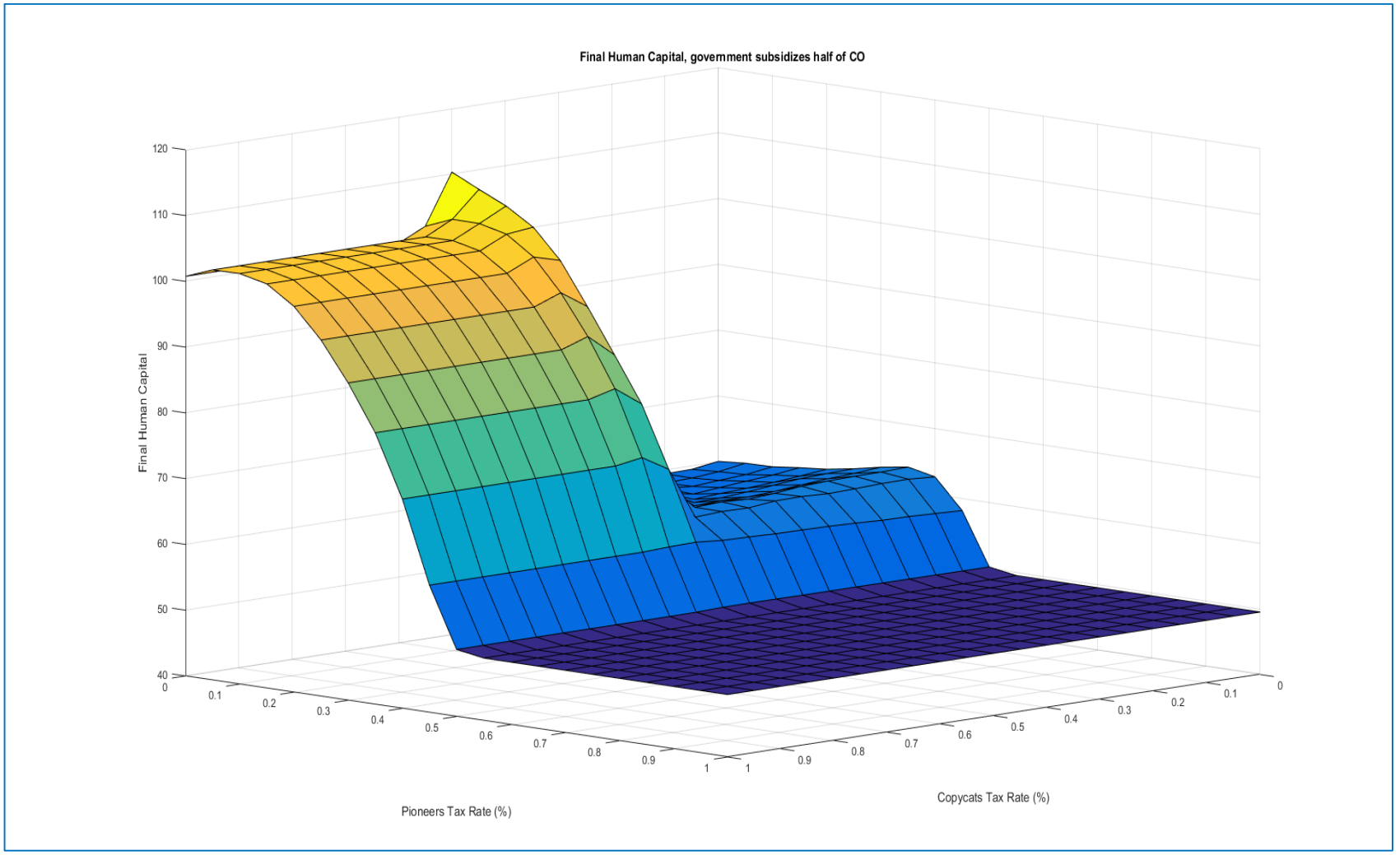
Results

- Paying C is a dominant strategy
- So is taxing pioneers at a low rate and copycats at a high rate
- In fact, if government isn't able or doesn't want to choose sectors it can just choose a random strategy and subsidize C
- This leads to slightly lower growth, but doesn't alter the best strategies with respect to subsidies and tax rates

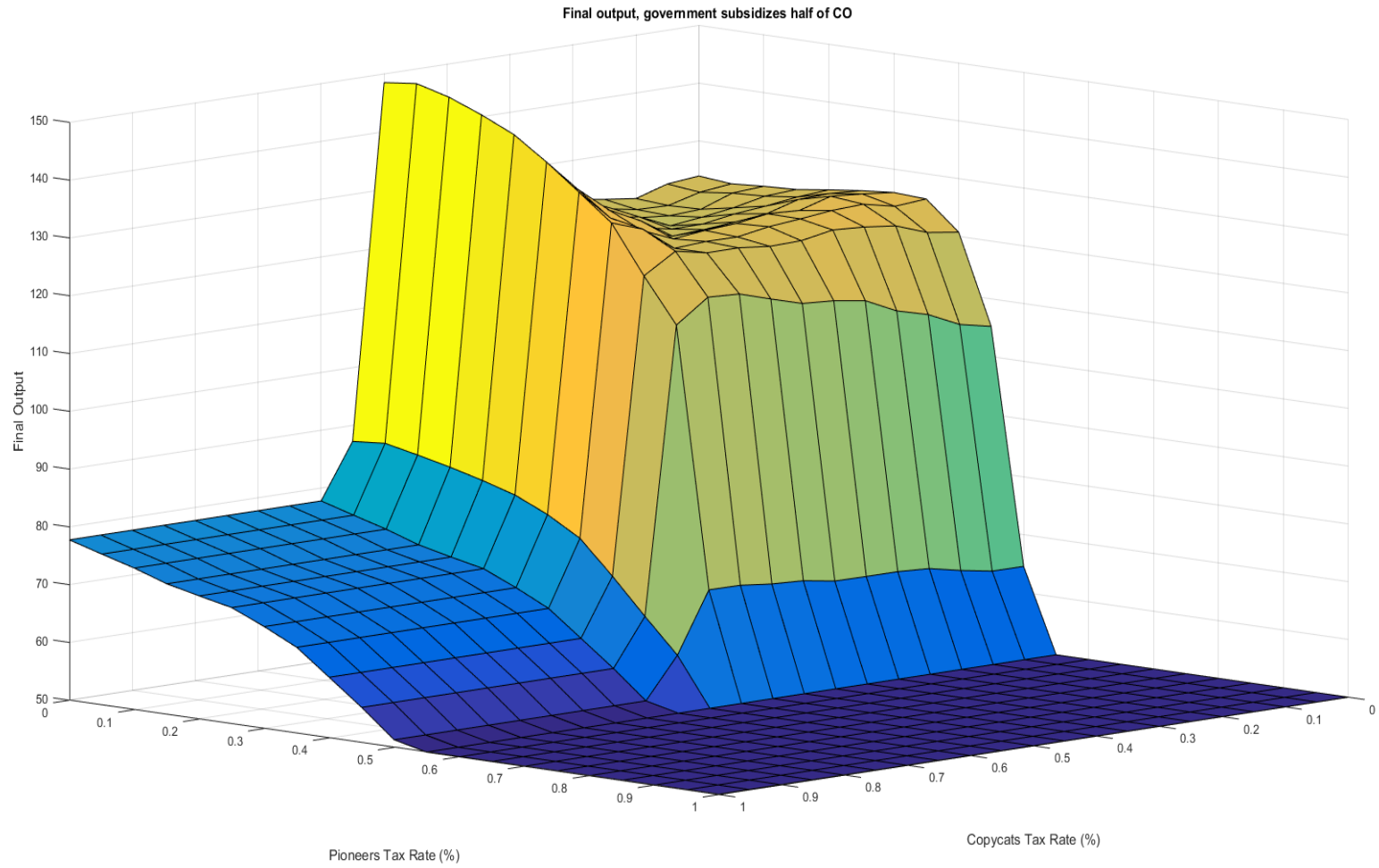
Final output: planner subsidizes 50% of C and chooses infrastructure with highest E(h)/lowest E(l)



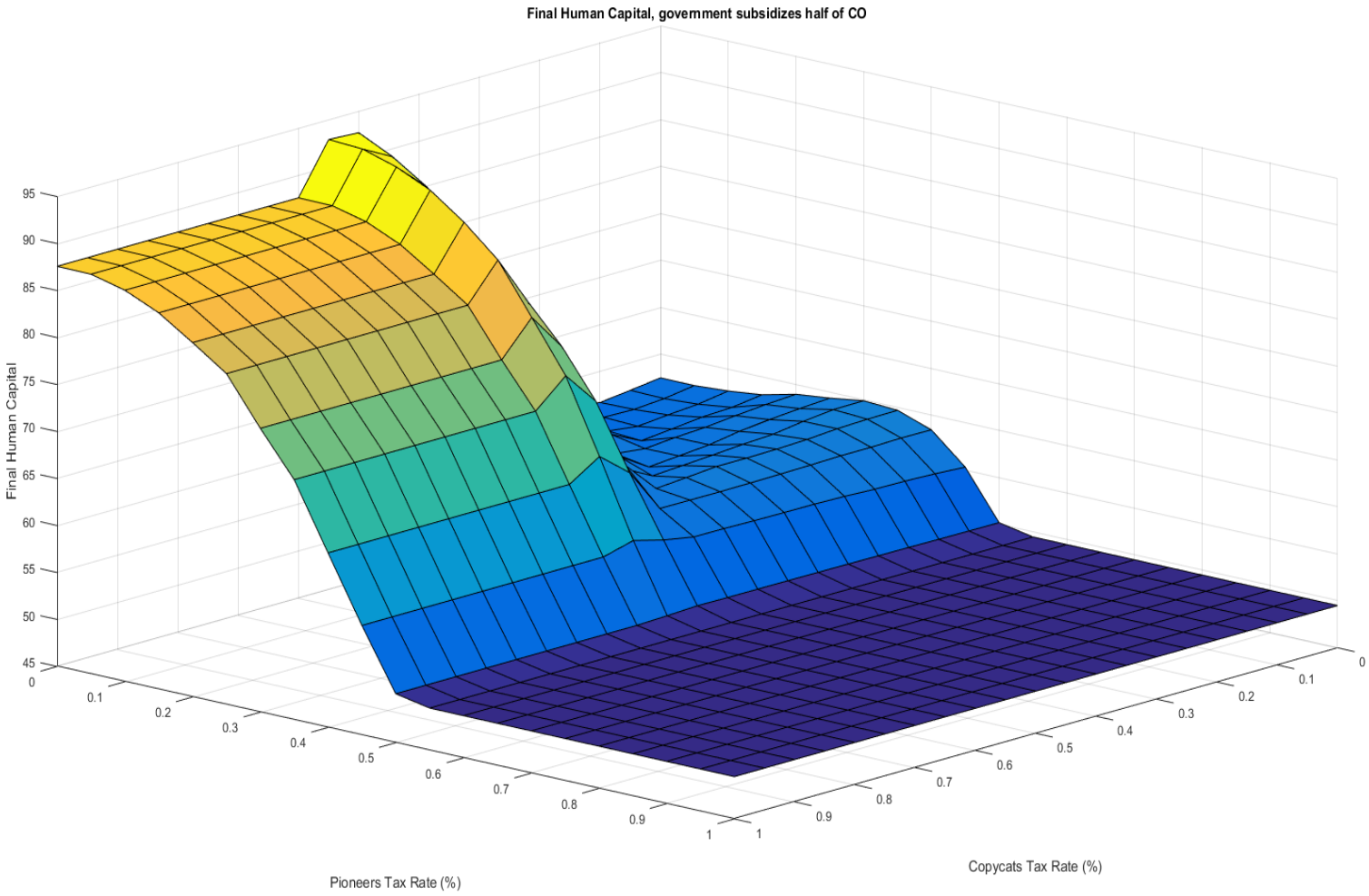
Final human capital: planner subsidizes C and chooses infrastructure with highest E(h)/lowest E(l)



Final output: planner subsidizes C and chooses infrastructure at random



Final human capital: random choice of infrastructure



What happens when the cost of information investment rises by 50%?

C subsidy	Strategy	Growth rate of output	Growth rate of skilled labor	Tax on pioneers (%)	Tax on copycats (%)
0%	Random	1.5	0.4	0	50
	Highest E(h), lowest E(l)	1.6	0.4	0	50
50%	Random	2.2	1.5	0	50
	Highest E(h), lowest E(l)	2.5	1.8	0	50
100%	Random	2.1	1.4	0	50
	Highest E(h), lowest E(l)	2.4	1.8	0	50

Results don’t vary much..

- Maximum growth rate falls, as expected: one of the constraints on growth is the lack of knowledge of production functions
  - Corollary: The larger are information costs, the lower is the growth rate, even if the planner subsidizes costs
- Growth still tends to be about the same whether the subsidy is 50 or 100%
- Accumulation of human capital is somewhat higher with a smaller subsidy to information discovery
- This latter result is due to the planner’s budget constraint: a lower subsidy rate allows the planner to build more infrastructure

Conclusions

- The basic problem of development is the densification of production and knowledge
- Developing countries have very concentrated production structures and little knowledge of how to produce the goods that are produced in developed countries
- Concentration on TFP, R&D or more investment in universities is wrong-headed: the challenge is to diversify, with which a country imports knowledge on how to produce increasingly complex goods
- What countries need is adaptation capacities, not knowledge-creation capacities
- Solving the coordination problem and internalizing information externalities: subsidies to information investment, “infrastructure” investment, and use of differentiated taxation for pioneers and copycats
- Caveat: This implies a governance that most developing countries may not have