Lectures in Growth and Development

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Ec428

Topic 4: Coordination Failure, and Sorting

These notes are not guaranteed to be error free. If you spot one, please let me know.

Also material marked with ^^ means optional material.

Introduction

- So far looked at possibility of convergence vs poverty traps in dynamic models
- Explored different mechanisms that can lead to unique vs multiple stable steady states
- Now explore similar mechanisms in static models
- Even in static models, it is possible to have multiple equilbria

- Standard economic models feature a unique stable equilbrium
- It also have some efficiency properties: Pareto-efficient allocation (first welfare theorem)
- Reason for unique equilibrium: negative feedback mechanism
- In this topic we consider various types of positive feedback mechanisms that are relevant in development economics

Example 1: Increasing Returns

- Consider an industry where price is exogenously given (p) (e.g., it is for export and world prices are given)

- Suppose first the cost function is the standard one reflecting diminishing returns (rising average cost)

$$TC = cq + \gamma q^2$$

- Then a firm will optimize in the following way

$$\begin{aligned} q^* &= \arg\max pq - \left(cq + \gamma q^2\right) \\ &= \frac{p - c}{2\gamma} \end{aligned}$$

- Profits will be

$$\pi = \frac{(p-c)^2}{4\gamma}.$$

- Any similar firm can come in and produce this quantity - starting with low quantity has low average cost ($AC = c + \gamma q$)

- Suppose instead the cost function displays increasing returns (falling average cost):

$$TC = F + cq$$

- Then there is no interior solution: a firm will expand up to its full capacity, say $\overline{q}$

- Then its possible that a new firm will not enter, as for low values of q

$$p < \frac{F}{q} + c$$

- The more you produce, the greater is your cost advantage ($AC = \frac{F}{q} + c$) - example of positive feedback mechanism (PFM)

- Therefore, inefficient incumbent may be able to fend off more efficient entrant (see the Appendix for more details)

- This can trap a sector with an inefficient firm or technology thereby providing a mechanism for under-development

- However, increasing returns are not sufficient for multiple equilbria.

- Two implicit assumptions
  - Customers switch slowly, not instantaneously - or, you could overnight take over the market
  - Credit markets are imperfect & the firm is not very rich - or, you could absorb initial losses and recoup them later

Example 2: Coordination Failure

- Standard example of multiple equilibria - either both buy smart phones, or both stick to non-smart phones

- If you adopt, my marginal returns from adoption goes up (example of PFM)

- The equilbirum with both buying smart phones is more efficient, but may not occur

Player 2 / Player 1	**Buy Smart Phone**	**Stick with Dumb phone**
Buy Smart Phone	(3,3)	(0,1)
Stick with Dumb phone	(1,0)	(1,1)

- Provides an answer to the question why don't developing countries or poorer individuals within a country adopt efficient technologies?

- Returns from adoption of technology may depend on how many others are adopting it
  - Obvious example of network externalities: fax machines, email
  - Less obvious: repair facilties or trained workforce are not going to develop unless a critical threshold of people adopt some technology

- It could be also due to demand complementarities (see Appendix if you are interested)

- Consider a more formal treatment of this mechanism
- Continuum of agents in [0,1]
- Each decides whether to invest or not (say acquire a skill or buy a machine)
- Let π be the fraction of the population that has invested.
- An individual takes this as given when making his decision.
- However, your returns from investing is positively affected by how many others have also invested

$$\begin{aligned} y_s &= H(1+\pi) - c \\ y_u &= L(1+\pi) \end{aligned}$$

- Assumption $H > L$.

- Also, $H > c$.

- Let $H - L \equiv \triangle$

- Note that the model indicates that there are positive externalities (my payoff goes up if you invest) AND complementarities (my marginal return from investing, $y_s - y_u$, goes up if you invest):

$$y_s - y_u \equiv MR(\pi) = \triangle(1 + \pi) - c$$

- Three cases to consider (Figures 1-3)
  - $\triangle - c > 0$: Unique equilbrium, everyone invests
  - $2\triangle - c < 0$: Unique equilbrium, no one invests
  - $2\triangle - c \geq 0 \geq \triangle - c$: Multiple Equilbria. Three equilbria, $\pi^* = 1, \pi^* = \frac{c}{\triangle} - 1$ & $\pi^* = 0$. The interior one unstable.

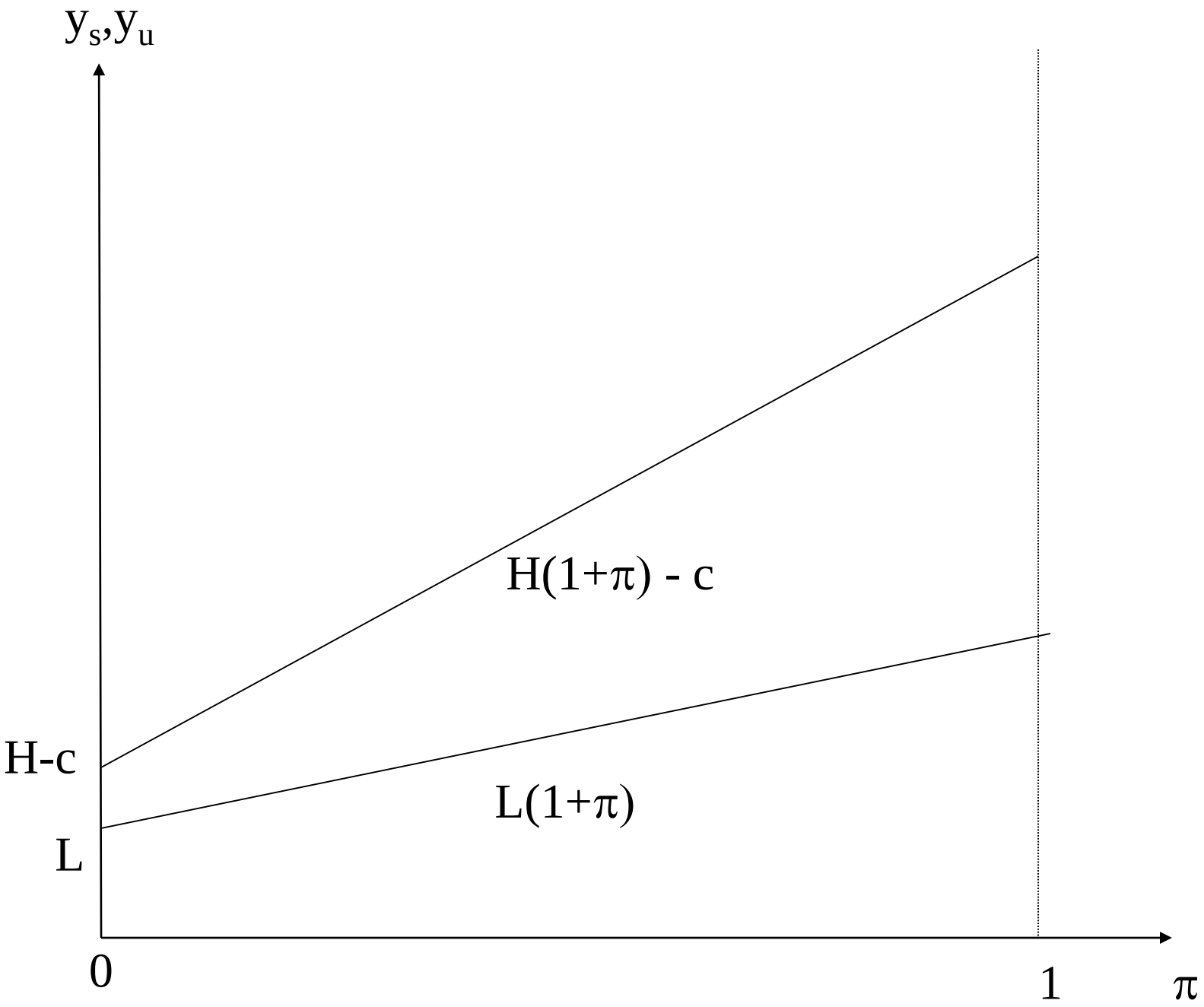

Figure 1: Case 1 (H-L>c), Unique Equilibrium, π=1

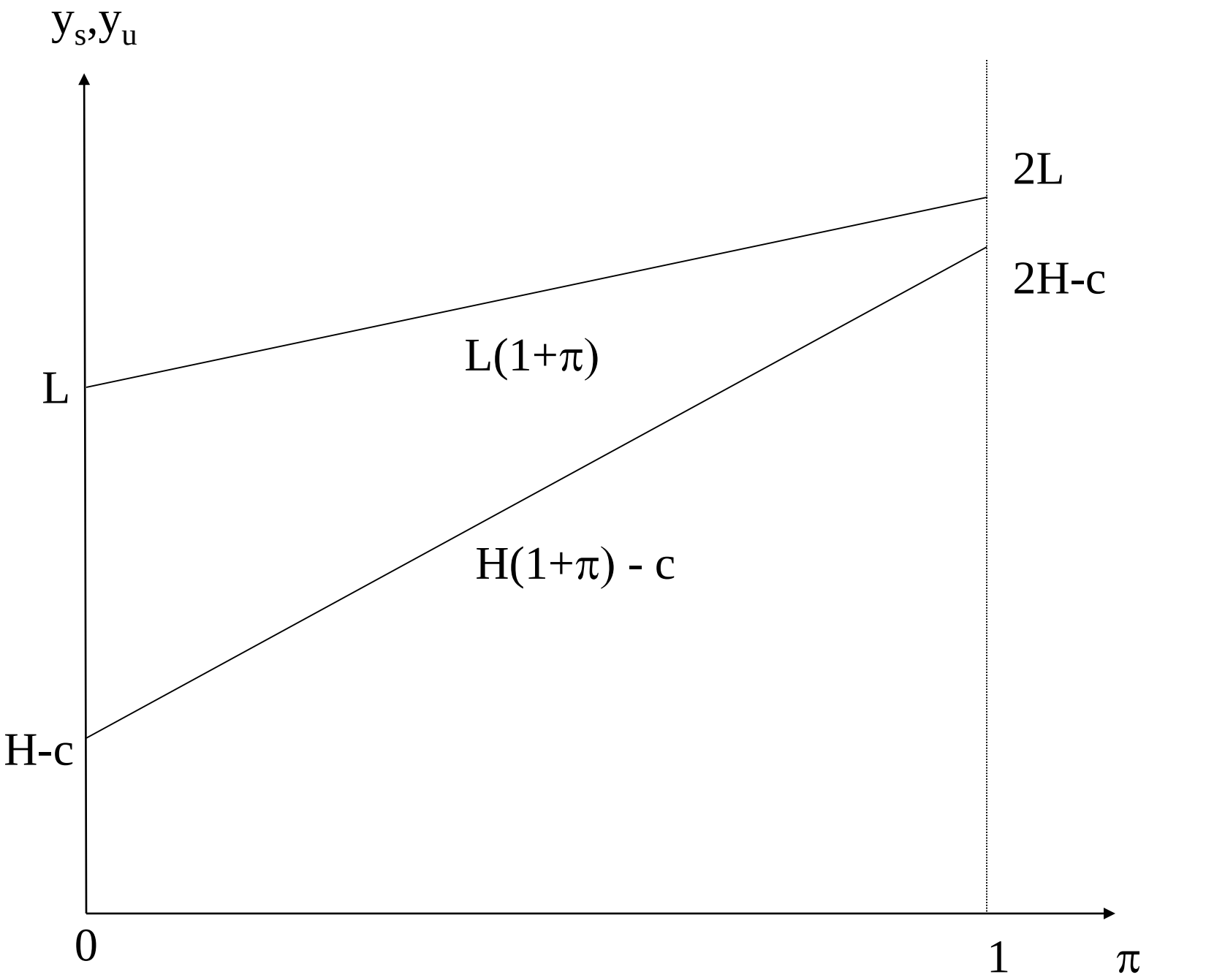

Figure 2: Case 2 (2(H-L)<c), Unique Equilibrium $\pi=0$

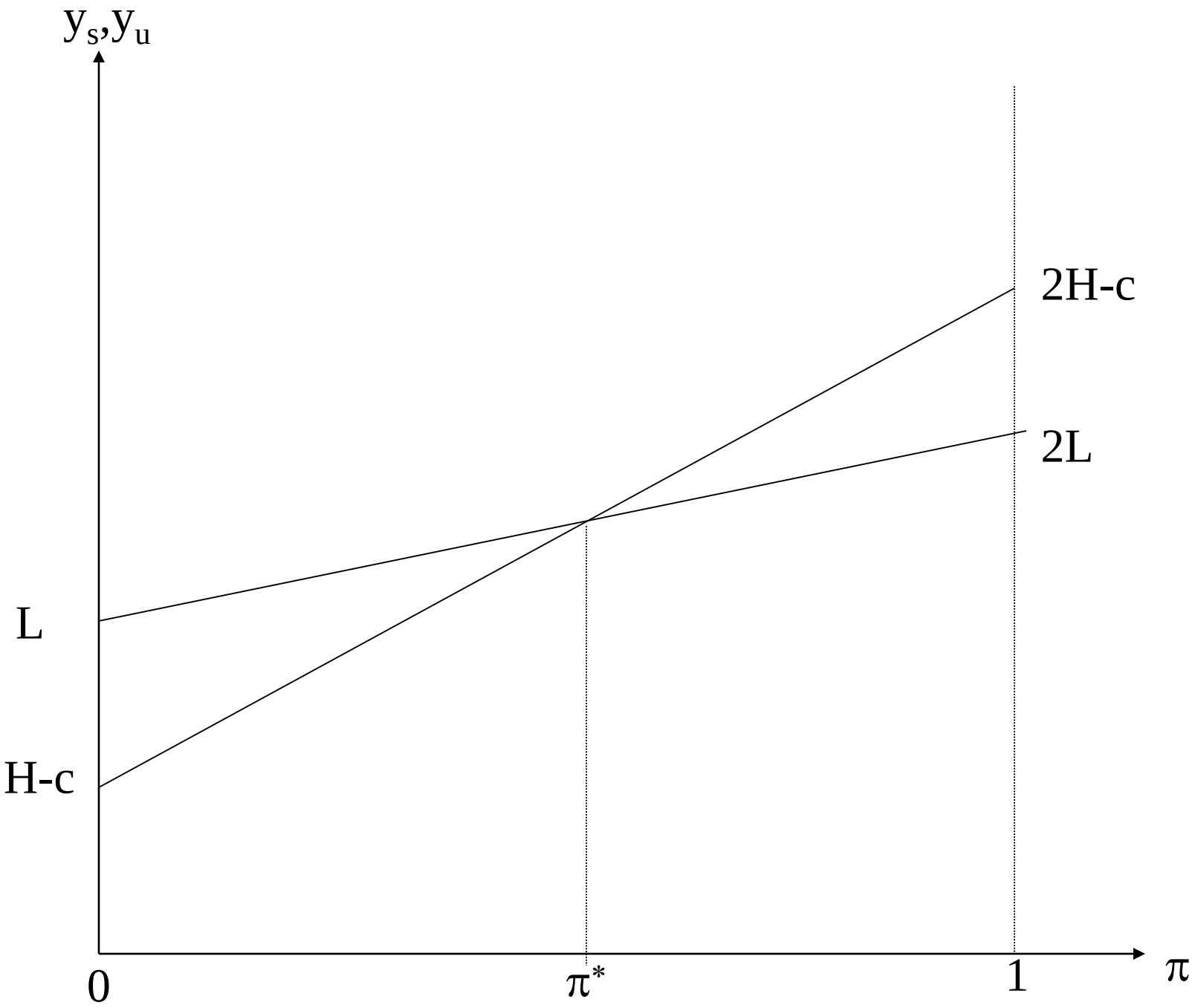

Figure 3: Case 3 (H-L<c<2(H-L)), Multiple Equilibria

- Assume you are in the case where multiple equilibria are possible, that is, $2(H-L) > c > (H-L)$

- Which equilbrium would you prefer?

- Per capita income is

$$y = \pi\{H(1+\pi) - c\} + (1-\pi)\{L(1+\pi)\}$$

- It is increasing in π as $\frac{\partial y}{\partial \pi} = H - c + 2\pi(H-L)$ given that $H > L$ and $H > c$

- So the $\pi = 1$ equilbrium is the best.

- What are the conditions needed for multiple equilbria?
  - Externalities necessary but not sufficient. Consider a slightly different model:

$$\begin{aligned} y_s &= H + \pi - c \\ y_u &= L + \pi \end{aligned}$$

  - Here the choice does not depend on π,unique eqm
  - Need complementarities. Even with this, need further parameter restrictions (only case 3). Not only MR(π) is increasing in π (for which we need $\triangle > 0$) but fast enough (MR(1) $>$ 0 $>$MR(0))

- General case: if payoff is $f(x_1, x_2)$ a necessary condition for multiple equilibria is:

$$\frac{\partial^2 f}{\partial x_1 \partial x_2} > 0$$

- How about expectations? Suppose everyone, in a wild burst of optimism, thinks $\pi = 1$ tomorrow. Then history does not matter. Expectations will be self-fulfilling.
  - If you introduce costs of adjustment then again history matters.
    - Returns take time to adjust
    - Each player will think, let others go first, I will go next
    - But then no one invests.

- One shot policy enough: if you announce subsidizing skill acquisition, then in equilbrium you can withdraw subsidies.

Predictive Content of Multiple Equilbria Models

- The common feature is positive feedback mechanism - the more you do something, or others do something, the more attractive it becomes.

- Multiple stable equilbria can result

- The poor may stay poor because either they or others around them are at low levels of production/investment

- Downside: Lose predictive power.

- Upsides
  - More realistic (creates a role for history)
  - More optimistic (underdevelopment can be viewed as a bad equilbrium & not because of intrinsically bad parameters)
  - Greater role for policy: one shot policies can have permanent effects. Can remove them once new equilbrium is reached.

- Some authors have thought hard about the predictive content of multiple equilibria models.

- Is it true that they suggest anything can happen?

- Trouble: see only one equilbrium even though potentially there could be multiple equilbria

- Any cross-sectional comparison contaminated by omitted variable problem

- Need a temporary and big shock

- Temporary, because you want to see if the shock goes away then if the economy reverts to the old equilbrium

- Big shock, since equilibria are locally robust

Donald Davis and David Weinstein (AER, 2002 and Journal of Regional Science, 2008)

- Bombing of Japanese cities are industries in World War 2 provides a good test of multiple equilibria theory.

- One implication of this theory is, a big shock can throw the system from one stable equilibrium to the other.

- They show that in the aftermath of these immense shocks, a city not only typically recovered its population and its share of aggregate manufacturing, they also built the same industries they had before.

- This seems more consistent with "locational fundamentals" theory rather than increasing returns.

- As they themselves acknowledge, while thought provoking, this does not settle the issue.

- After all, even if buildings were destroyed
  - Land and ownership claims to it remained the same after the bombing.
  - Labour force specialized to particular industries may have largely survived (even in Hiroshima 80% of the population survived)
  - Infrastructure also remained largely unaffected.

- Therefore the pattern of economic activity prior to the bombing might have acted as a focal point for reconstruction.

- Similar findings by Miguel and Roland (JDE, 2011) about long term effects of US bombing of Vietnam.

- However, Redding, Sturm, and Wolf (Review of Economics and Statistics, 2011) found that location of Germany's primary airport hub did not move back to Berlin (pre-WWII hub) from Frankfurt (hub in W. Germany) after reunification, and this cannot be explained by shift in fundamentals.

- Again, not a clean test, because this assumes that post reunification the fundamentals are the same as they were before WW2 which is not plausble.

- See Nunn (2009, Annual Review of Economics) for more discussion.

- Alternative promising approach: micro-level technology adoption decisions

- Take similar villages and then give them for free varying amounts of some technology that is likely to be subject to complementarities (e.g., mobile phones)

- Make available this technology for purchase at some resonable cost to others who did not get them for free

- See if adoption is higher in villages where the initial number of free mobiles crossed some threshold

- Also, you can offer subsidies for some time and then withdraw them

- If there are no complementarities then they will stop using them after the subsidies are gone.

- However, with strong complementarities, we will observe the technology being used even when the subsidies are gone.

Sorting & Segregation

- Final example of positive feedback mechanism
- Suppose your productivity depends positively on the productivity of your co-workers.
- What kind of a production function will generate this? One where skills of various workers are complements.
- Suppose output is produced by two tasks (theory, econometrics).
  - The skill of a worker in task 1 is denoted by q_i

- The skill of a worker in task 2 is denoted by q_j

- The production function is:

$$y = f(q_i, q_j).$$

- The marginal product of a worker of skill q_i in task 1 (equal to the wage in a competitive market)

$$w_i = \frac{\partial f(q_i, q_j)}{\partial q_i}$$

- This is increasing in the type of his co-worker if

$$\frac{\partial w_i}{\partial q_j} = \frac{\partial^2 f(q_i, q_j)}{\partial q_i \partial q_j} > 0$$

- That is, the skills are complements.

- Similarly the wage of a worker of skill q_j in task 2 is

$$w_j = \frac{\partial f(q_i, q_j)}{\partial q_j}$$

and

$$\frac{\partial w_j}{\partial q_i} = \frac{\partial^2 f(q_i, q_j)}{\partial q_i \partial q_j} > 0.$$

- Suppose there are two skills levels in both tasks, i.e., $q_i \in \{H, L\}$ and $q_j \in \{H, L\}$ with $H > L > 0$.

- We want to look at stable matchings of workers.

- These have the property that it is not possible for an individual worker to rematch and be better off.

- We allow unrestricted side payments: e.g., a worker can offer a higher wage to attract a potential partner, than what he is currently getting.

- Then we have the following important result that is widely used in a various contexts:

Result 1: The unique stable match involves positive assortative matching, i.e., workers of type H are matched with workers of type H, and workers of type L are matched with workers of tyep L.

- Suppose there are 4 workers, two of each type.

- Under the proposed match total output is

$$f(H,H) + f(L,L).$$

- If workers are matched non-assortatively, total output is

$$f(H,L) + f(L,H).$$

- The condition for the former to exceed the latter can be written as:

$$f(H,H) - f(H,L) > f(L,H) - f(L,L).$$

- But from the assumption of complementarity

$$\frac{\partial f(H,x)}{\partial x} > \frac{\partial f(L,x)}{\partial x}$$

- So switching from a L-type partner to a H-type partner must be more profitable for a H-type worker than a L-type worker.

- But that means a low type worker currently matched with another low type worker can never profitably bid away a high type worker who is currently working with another high type worker.■

Corollary: In a competitive market if the initial match is non-assortative, then assortative matching makes high types workers strictly better off, and low type workers strictly worse off.

- Directly follows from the fact that the wage rate is equal to the marginal product of a type of a worker, and the marginal product is increasing in the type of the co-worker.

- herefore, if you remove labour regulation and allow free "hiring and firing", efficiency will go up, but so will inequality.

- Other Applications:
  - Marriage Market due to Gary Becker
  - School choice (the quality of your education depends on the quality of your peers) - more generally, public goods

- Brain drain (high skilled workers from less developed countries move to developed countries)

- Industrial organization (the quality of your product depends on the quality of your suppliers)