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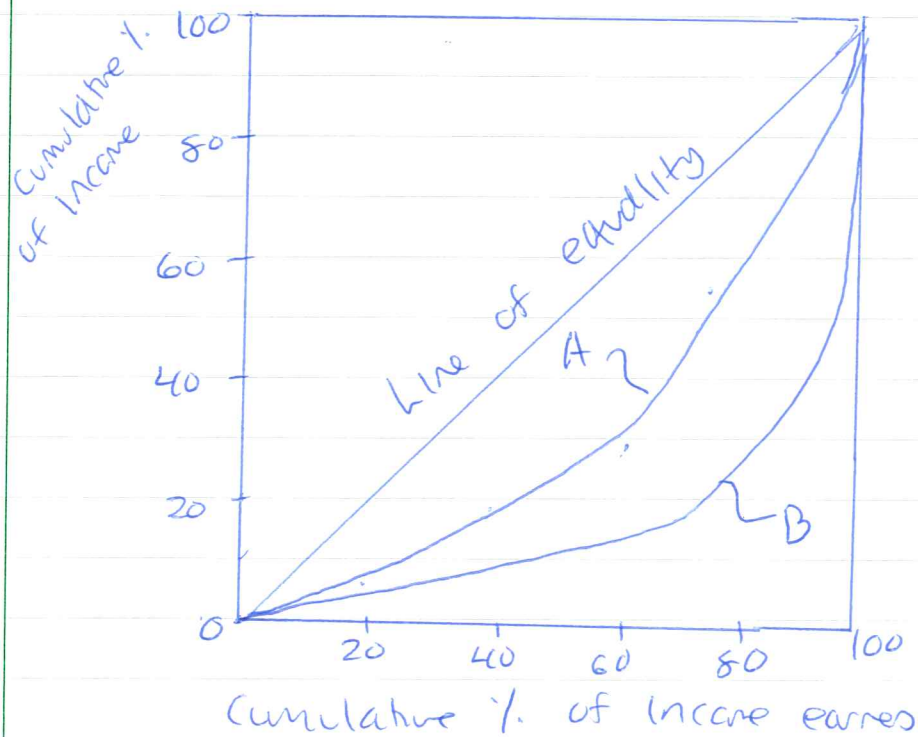
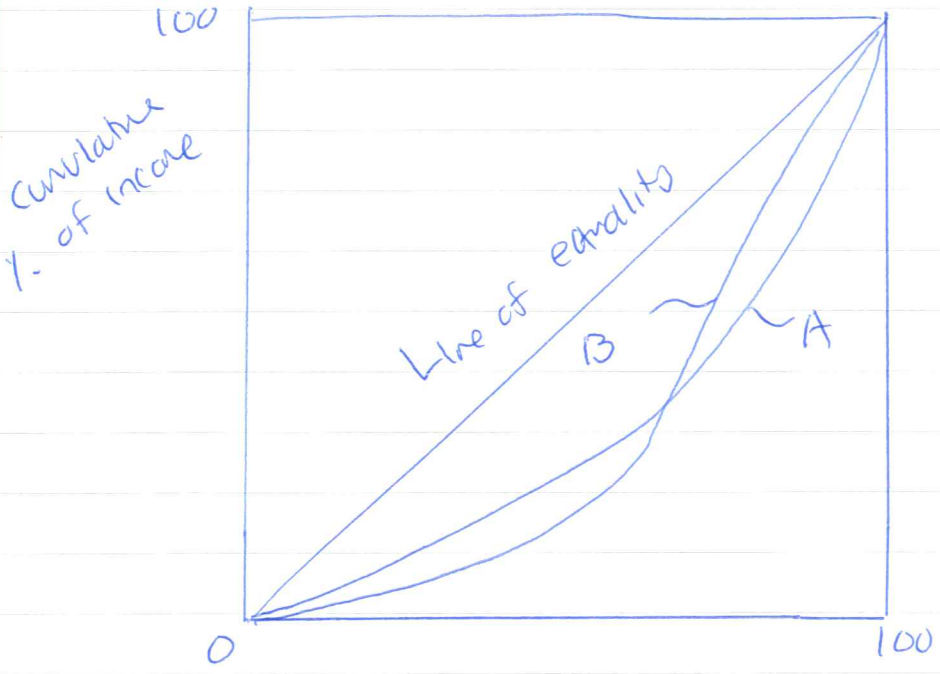
(1)a) A Lorenz curve is a measure of inequality. It is a graphical representation of the income distribution of a county. It shows the relationship between the cumulative percentage of the population ~~and~~ (income - earners), and the cumulative percentage of income. The population and income is divided into deciles or quintiles, such that one can for instance say that 20% of the population recieves 10% of the income. If there is perfect income equality. ~~20%~~ The bottom 20% earn 20% of the income and so on. This is represented graphically as the line of equality (45° degree line). The closer the Lorenz-curve to the line of equality, the more equally income is distributed in the population.



In this case, county A has a much more equal distribution than county B. However, both are relatively unequally distributed. In both cases, the upper 20% earn a lot more relative to the bottom 20%.

Two countries' Lorenz curves can be compared in this way ~~straight~~ as long as the curves do not cross. When one curve clearly is closer to the line of equality, as A compared to B, the closest county ~~has~~ is Lorenz-dominant. If the lines cross, one cannot be said to be more equally distributed than the other, and the Gini-coefficient has to be applied



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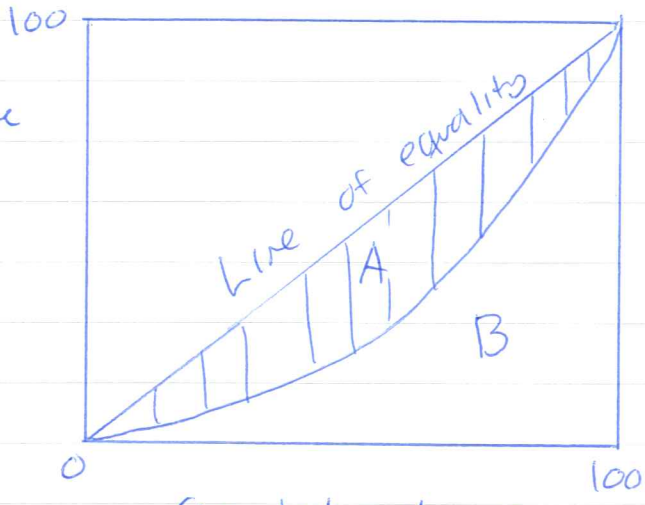
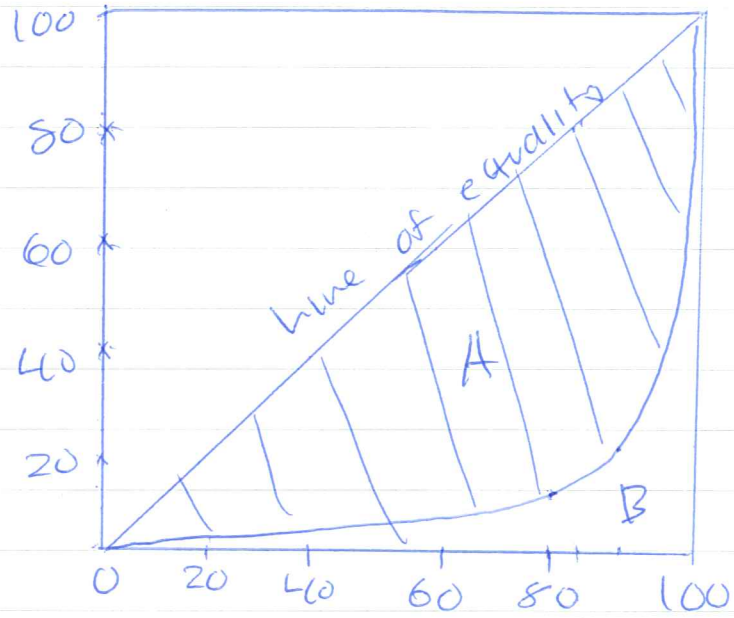
① b) The Gini coefficient is also a measure of the income distribution of a county, and it is derived from the Lorenz-curve.



Gini-coefficient $= \frac{A}{A+B}$ $\quad$ Gini $\in [0,1]$

The Gini-coefficient has a value between ~~1 and 0 because~~ 0 and 1 because it is the ratio of the area between the line of equality and the Lorenz-curve and the total area beneath the line of equality. To explain this, two examples will be used. One where the Gini is close to 1, and another where it is close to 0.

Close to 1: perfect inequality



Here, the area between the line of equality and the Lorenz curve is large. The income distribution is relatively unequal. The bottom 20% earns ~~less~~ about 2,5% of the income. The top 20% earns ~~almost~~ almost 80% of the income. In this case, the Gini would be close to 1, perfect inequality. In the real world, this is not common. But there are still countries with Gini-coefficients above 0.7. ~~The~~ A country's wealth relatively can in some cases be divided between a few individuals or rich families.

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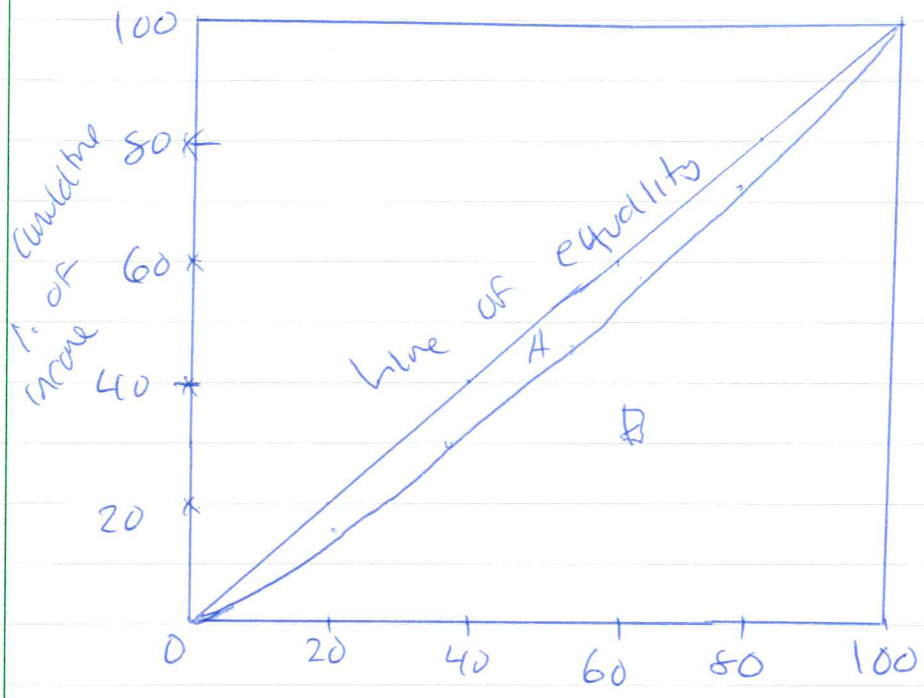
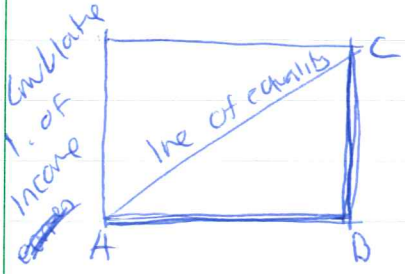
Close to 0: perfect equality



Cumulative % of income earner

This Lorenz-curve represents a county that has an income distribution close to the perfect equality line. The Gini-coefficient is close to 0 because the area A and A+B ~~are~~ have very ~~diff~~ different ~~size~~ sizes. This, the county has an income distribution close to perfect equality.

This, because the Lorenz curve can be between the two extremes, the line of equality, and the angle ABC, the value has to be between 0 and 1 per ~~def~~ definition. When Gini = 1, the "curve" is the line ABC. When Gini = 0 the "curve" is the line of equality.



Cumulative % of income earner

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① c) ~~Why income GDP p.c. is an insufficient~~ measure

There are several reasons why the GDP p.c. can be an insufficient measure of poverty.

~~Income distribution~~ GDP pc. is the value of final goods produced in an economy in a given time period (usually a year), divided by the total population. This gives the income an individual would have if the national income had been divided between all individuals in the population. It does not, however, say anything about the income distribution, as already the Lorenz and Gini-coefficients ~~already~~ discussed. An increase in GDP pc may ~~therefore~~ mean that a small percentage of the population ~~experience income~~ get higher incomes and higher standards of living. This implies more inequality, and the poorest can become worse-off. This is especially the case in oil-rich developing countries, where few often people control a large share of the country's income.

To measure living standards and thus poverty, GDP p.c. ~~can~~ adjusted for purchasing power parity can be a better measure. Standards of living are affected by how much the income of an individual can buy. Purchasing power parity (PPP) uses real exchange rates rather

than nominal exchange rates. Nominal exchange rates can give the wrong impression, because they are affected by other factors, ~~which~~ and are prone to speculation. ~~It's increase in nominal exchange rate appreciation~~ It's appreciation of the country's currency (a decrease in the nominal exchange rate, the unit of the currency needed to get one unit of a foreign currency), can give a false impression of increase in living standards by an increase in GDP pc. However, it can increase living standards because more can be bought from abroad. Still, it reduces the country's competitiveness, by making its exports more expensive to foreigners. Real exchange rates are a measure of how much a representative basket of goods relatively cheap cost in two countries. If the basket is expensive in ~~one~~ one country compared to another, the purchasing power of an individual is lower in that country than the other. Thus, one can buy less with an equal income. Using real exchange rates ~~is~~ therefore gives a better measure of poverty, as many goods are usually less expensive in less developed countries. Adjusting for PPP usually lessens the gap between GDP pc of more developed and less developed countries. Whether a high GDP pc implies low levels of poverty depends on the components of GDP. GDP consists of consumer spending, government spending, investments and net exports (exports - imports)

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~~One can assume that there is less poverty when~~ In the One can assume that living standards are higher if the goverment spends a lot of resources on the provision of public and merit goods. Public goods are goods that are non-excludable and non-rivalrous in consumption. This gives rise to the free-rider problem, which necessitates government intervention. Examples are defence and to some ettent infrastructure (not a pure public good). Merit goods are goods that are private, but that have wide-reaching positive ettendalities to the population as a whole when consumed as a private good. Examples are schooling and health care. If ~~the~~ such goods are provided by the goverment in one county and not another, the same income level would imply different ~~levels~~ standards of living. ~~The same~~ A low-income person would be considered poorer in the latter case than the former. Thus, because GDP pc is a solely monetary measure, it does not capture these effects.

To evaluate what a good measure of poverty is, one has to define poverty. If poverty is defined solely by income, GDP pc. is appropriate. However, if one considers the effect of level of human capital, health and other dimensions to human life and welfare, an entirely different measure is needed. Such a measure is the multi-dimensional poverty index. This measure includes both a measure of income, and deprivation on other dimensions

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GDP pc does not include environmental degradation. A high GDP pc can be due to production that has negative consequences for the environment. In this case, Green GDP can be used, which takes this into accont. Enviromental issues often affects the poor more than the rich. Poverty is measured in other ways, such as the headcount indet.

$$\text{Headcount indet} = \frac{H}{N}$$

H - number of people below the poverty line ($1.25 a day)
N - total population

This is an absolute measure of poverty. Relative measures compares the income of a pesan relative to the other people in the county. For etample could a pesan that does not have access to Internet in Norway be considered poor relative to the majority of the population, but not in a less developed county. The poverty line, such as $1.25 a day is also an absolute measure. Relative Poverty usually gives a higher number of poor in more developed cantries than absolute measures. Poverty cannot simply be measured through income (GDP pc), because it is a dynamic issue & GDP pc has several issues that cannot be ignored.

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(1) d) Empirical analysis, such as those by Easterly (2000) and Burnside & Dollar, shows that, for aid to be effective, there are several factors that have to be considered.

Easterly suggests that one main reason why aid has not been as effective at creating economic growth is because of the motives of the donor countries. Aid can come in the form of either loans that are favorable (low interest rates, long-term etc.) or ~~further~~ as gifts/grants. In either case, there are many motives.

Empirical evidence:
- Japan gives aid to countries that are supportive to its political battle with China
- France gives to former colonies due to a sense of guilt. Feel as if it is expected/ they need to, ~~to~~ in order to get a good reputation
- The US gives to countries that are in favor of their policies (vote in their favor in the UN, etc.)

The "wrong" motives are a main reason why aid does not necessarily have a positive impact on economic growth. The goal in itself is not to create growth, but it is for ~~them~~ the donor countries own

benefit. This is also for example the use of aid during the cold War to gain support for the capitalists and communists, by using other countries as proxies. The motivations are historical, political or economical and this results in aid not going to the countries that need it the most. These are examples of bilateral aid, in which one country gives to another. For aid to be positive for economic growth, the right institutions have to be in place. For example would there not be high levels of corruption, as this can prevent the aid going to the ~~not~~ intended projects, and to the pockets of politicians instead. Due to this, a lot of aid is earmarked. This is less effective, because it creates a Samaritan's dilemma ~~case~~. More aid is given when it is needed. If the projects are effective, aid is not needed anymore, and the country ~~does~~ does not receive the benefits. Aid should not be tied aid for economic growth to ensue. Tied aid is aid that comes with obligations that are beneficial economically for the donor country. For example, goods have to be bought from the donor country.

② Developing canty with three cities A, B and C.

Framework

- Workers not commute from city A to B and vice-vera. Workes from city C can commute to A and B.
- People living in city C can commute to both city A and to city B.
- City A has low-skilled workes (q_A)
- City B has high-skilled wakes (q_B)
- City C has medium-skilled workers (q_C
  - q, $0 \leq q \leq 1$ - skill-level
  - $q_A < q_C < q_B$

A company plans to build a factory in the canty. If the factory is located in city A it will need workes from city A and city C. If the factory is located in city B it will need ~~to~~ workes from city B and from city C.

(1) Factory in A: paper clips

(2) Factory in B: smartphones

Profit in (1) and (2)

(1) $\Pi_{PC} = q_A + q_C$

(2) $\Pi_{SP} = (1 + q_B) q_C$

Assume that the company decides to start production of paper clips → Why does the company make this decision? What consequences does this have?

Given the framework, I deem it appropriate to apply the O-ring Theory. This theory is derived from the failure of a space-shuttle. The O-ring was a small, relatively important part in the bigger picture that failed, and this caused the breakdown and failure of the whole shuttle. This can be applied to production by using the term complementarity. Complementarity in the economic sense means that two factors are dependent on one another. For example consumption of one good and consumption of another in microeconomic theory (right shoe - left shoe). In this case, the productivity of one worker is affected by the productivity of the other workers with which the worker works. The O-ring Theory states that high-skilled workers work best with high-skilled workers, i.e. the production is highest with coordination. As an informal example, one can picture A-students working with D-students. The A-student will not get as high a "production" in the sense of study output as if the student worked with another A-student. When this theory is applied to production, it implies that a country can get stuck in a low-skilled equilibrium. Because high-skilled workers work best with high-skilled workers, there will not be an incentive for an individual to obtain higher skills unless there are other people

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In the country that already ~~have~~ are high-skilled. Low-skilled workes work best with low-skilled workes, and unless enough of the country's work-force obtain higher skills, so the incentives for obtaining skills are high, the equilibrium where the economy has high-skilled workes will not be reached. Thus, there exist multiple equilibria. One for low-skilled and another for high-skilled. Policies may be necessary for the incentives to become high enough. The O-ring Theory is an example of a contemporary model of economic development, with multiple equilibria and the possibility of a country getting stuck in a "bad" equilibrium.

Analytically

(1) $\Pi pc = q_A + q_C$

The profits are dependent on the ~~productivity~~ skills of the workes in city A and C. The productivity of the workes (i.e. the skills) are in this case independent of each other.

$\frac{\partial \Pi}{\partial q_A} > 0 \quad \frac{\partial \Pi}{\partial q_C} > 0$

Profits increase when either of the skill levels increase.

Numerical example:

~~For example $q_A = 0.1$, $q_C = 0.5$~~ $q_A = 0.2$

~~$\Pi pc = 0.1 + 0.5 = 0.3$~~ $q_C = 0.5$

$\Pi pc = 0.2 + 0.5 = 0.7$

(2) $\Pi sp = (1 + qB)qc$

$\Rightarrow \Pi sp = qc + qcqB$

Here, the profit are decided by the productivity of the medium-skilled worker and the interaction of the ~~skill level of the~~ productivity of the medium-skilled and the high-skilled worker. Thus, the medium-skilled worker's productivity is affected by the high-skilled worker's productivity. The complementarity discussed earlier applies in this case.

$$\frac{\partial \Pi sp}{\partial qc} = (1 + qB) \qquad \frac{\partial \Pi sp}{\partial qB} = qc$$

The profit are increasing with skill level in both cases. The increase in profit with an increase in qc is dependent on qB. If qc increases, ~~Example~~ production will increase by more than if qB increases.

Numerical example:

$qc = 0.5$

$qB = 0.7$

$\Pi sp = 0.5 + (0.5 \times 0.7) = 0.85$

$qc = 0.6$ qc ↑ from 0.5 to 0.6

$qB = 0.7$

$\Pi sp = 0.6 + (0.6 \times 0.7) = 1.02$ Increase of $1.02 - 0.85 = 0.17$

q_{BP} from 0.7 to 0.8

$\Pi_{SP} = 0.5 + (0.5 * 0.8) = 0.9$ Increase of $0.9 - 0.8 = 0.1$

Profits are higher in production of ~~p~~ smart phones than in production of paper clips, because of the higher productivity of the high-skilled workes and their impact on the medium-skilled workes.

The production of paper-clips require lower levels of human capital than the production of smart ~~ph~~ phones. This may be one reason why the campany decides to produce paper-clips. The given framework does not say how many high-skilled workes there are relatives to medium-skilled and low-skilled. If the number of high-skilled workes ~~are is higher~~ is lower than the other groups, which usually is the case in less developed countries, production can be higher. There are other factors atside the model that may play in, such as cost of labor.

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The consequence for the developing country's economy is that it may get stuck in a low-development trap, ~~It is an example~~ as explained earlier. The international company (could be an example of FDI by an MDC), uses the available low-skilled workes, and thus does not give incentives for workes to obtain higher ~~states~~ skills. Thus, though it may cause economic growth trough increased production, it does not cause development.

③a) Productivity growth ($\hat{A}$) is given by:

$$\hat{A}(t) = g(H) + c(H)\left[\frac{T(t)}{A(t)} - 1\right]$$

This is the Nelson-Phelps specification.

A - domestic productivity level
T - the productivity at the technological frontier (the world's leading country technologically)
g, c - positive functions of the human capital level
H - level of human capital
t - time

Assumptions
- technology at the frontier grows at a steady rate of λ. $\frac{\dot{T}}{T} = \lambda$
- Neutral technological progress: Productivity growth is analogous to technological progress. Neutral technological progress means that the same output can be produced using the same factor inputs. It can in other cases be capital-saving, labor-saving, labor-augmenting or capital-augmenting.
- It is exogenously given
- $g(H) > \lambda$. Innovation at home is less than the productivity growth at the frontier

$g(H)$ - innovation term; $c(H)\left[\frac{T(t)}{A(t)} - 1\right]$ - technology adaption term

~~From this, we see that~~

From this, we see that:

(a) Productivity growth depends both on innovation (R&D) and on technology adaption. These are the two main sources of productivity growth. R&D requires large amounts of human and physical capital, and is usually carried out in developed country centres. ~~Technology~~ It ~~adaption is easier to~~ is easier to achieve productivity growth through technology adaption because it requires (For example) less human and physical capital. This can be to copy products. ~~etc~~ This implies that productivity growth will be higher for a given level of human capital the further the country is from the technology frontier (the world's leading country technology-wise) (b) This is termed the catching-up hypothesis. This implies an advantage of backwardness.

From the model, ~~we have that~~ with Nelson-Phelps' specification, we have that

$$\dot{A}(t) = g(H) + C(H)\left[\frac{T(t)}{A(t)} - 1\right]$$

$$\Rightarrow \dot{A}(t) = g(H) + C(H)\left[\frac{\frac{1}{A(t)}}{\frac{1}{T(t)}} - 1\right]$$

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$\frac{A(t)}{T(t)}$ gives the relative productivity level

This can be shown graphically. The productivity level is a function of the relative productivity level. We take the first and second derivative of the productivity level wrt. the relative productivity.

$$\frac{\partial \hat{A}}{\partial\left(\frac{A}{T}\right)} = -\frac{C(H)}{\left(\frac{A}{T}\right)^2} < 0 \Rightarrow \text{decreasing function}$$

$$\frac{\partial^2 \hat{A}}{\partial\left(\frac{A}{T}\right)^2} = 2\frac{C(H)}{\left(\frac{A}{T}\right)^3} > 0 \Rightarrow \text{convex function}$$

We have that $\hat{T} = \lambda$

Equilibrium is given by $\hat{A} = \hat{T}$

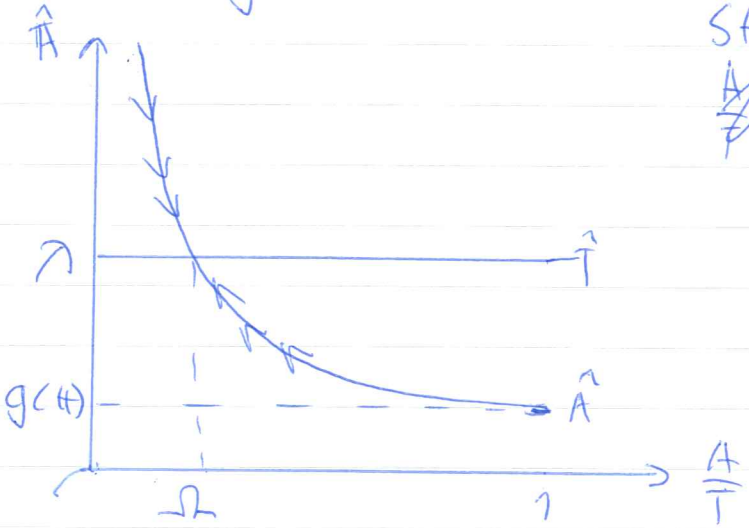
$$\hat{A} = \hat{T} \Rightarrow g(H) + C(H)\left[\frac{1}{\frac{A(t)}{T(t)}} - 1\right] = \lambda$$

$$g(H) + \frac{CH}{\frac{A(t)}{T(t)}} - C(H) = \lambda$$

$$\Rightarrow \left(\frac{A}{T}\right)^* = \frac{C(H)}{C(H)+g(H)-\lambda} = \Omega$$

steady-state, long-term equilibrium

Graphically:



Stable equilibrium:

$\hat{A} > \hat{T} \Rightarrow \frac{A}{T} \uparrow$

$\hat{A} < \hat{T} \Rightarrow \frac{A}{T} \downarrow$

In the long run $\hat{A} = \hat{T} = \Omega$

$\frac{A}{T} \to 0 \Rightarrow \hat{A} \to \infty$

$\frac{A}{T} \to 1 \to \hat{A} \to g(H)$

An increase in the human capital level (H) causes a rightward shift, through the innovation channel, and a steeper curve, through the technology adaption channel. This gives a higher steady-state equilibrium relative productivity (long-run).

This can be shown analytically

$$\left(\frac{A(t)}{T(t)}\right) = \frac{C(H)}{C(H)+g(H)-\lambda} \Rightarrow \frac{A(t)}{T(t)} = 1 + \frac{C(H)}{g(H)-\lambda}$$

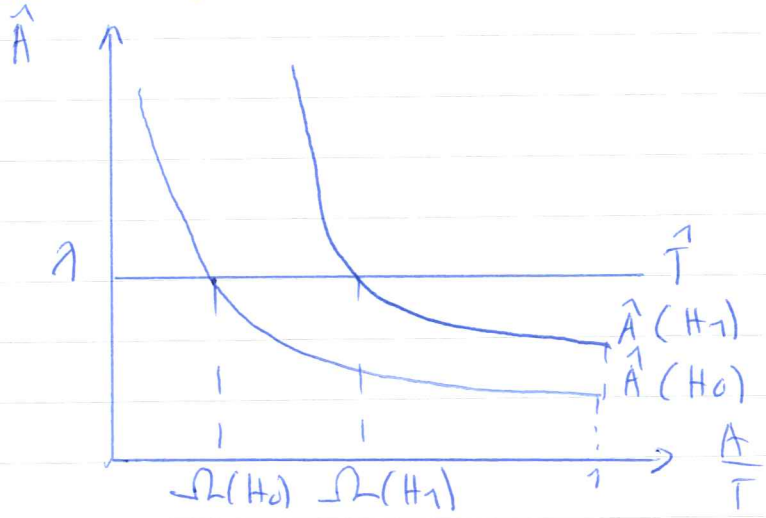
Dropping the indexes and reversing gives

$$\Rightarrow \frac{1}{\frac{A}{T}} = 1 - \frac{\lambda + g(H)}{C(H)}$$

$$H\uparrow \Rightarrow 1 - \frac{\lambda + g(H)}{C(H)} = \frac{1}{\frac{A}{T}} \downarrow \Rightarrow \left(\frac{A}{T}\right)\uparrow$$

$(g(H)\uparrow, C(H)\uparrow)$

Graphically: H↑



H↑ shifts the curve and the country reaches a higher relative productivity level in the long run. In the short run, productivity growth at home is higher than growth at the frontier. When the country is leading, productivity growth can only come through innovation.

$\Omega(H_0) < \Omega(H_1)$

Thus, investment in human capital can give economic growth through increased productivity.

b) The specification can be changed to include increase divergence, as done by Benhabib & Spiegel (1994). They assume that the productivity growth is a linear function of relative productivity. This gives a slightly different conclusion and allows for comparison of developing and developed countries. The model has the same assumptions regarding growth of $T = \lambda$, $g(H) < \lambda$, and H is exogenous.

Model in a) modified:

$$\hat{A}(t) = g(H) + c(H)\left[\frac{T(t)}{A(t)} - 1\right] * \frac{A(t)}{T(t)}$$

Dropping the indices and simplifying gives:

$$\Rightarrow \hat{A} = g(H) + c(H)\left[1 - \frac{A}{T}\right]$$

The equilibrium becomes

$$\left(\frac{A}{T}\right)^* = \frac{c(H) - g(H) + \lambda}{c(H)}$$

As in the specification in a),

$$\frac{A}{T} \to 1 \Rightarrow \hat{A} \to g(H)$$

However, as it is linear, it is assumed that productivity growth is not infinite, but it is limited to $g(H) + c(H)$

$$\frac{A}{T} \to 0 \Rightarrow \hat{A} \to g(H) + c(H)$$

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We differentiate between two cases:

Case 1 (developed county):

$g + c > n \Rightarrow$ Innovation and technology adaption converges towards the level at the frontier, and can in the etcend this level. The county can become the leader.

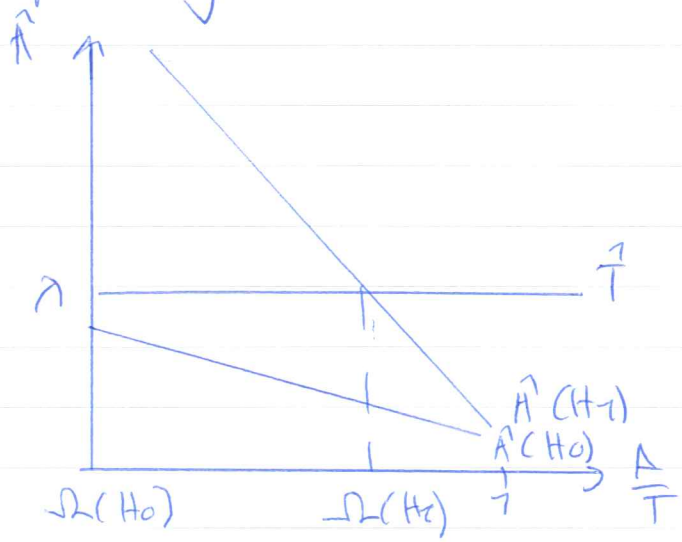
$H = H_1$

Case 2: (developing county):

$g + c \leq n \Rightarrow$ the county can never reach the level at the frontier. This creates an income gap between the two countries. (income divergence) Increase in human capital is necessary to reach a higher level of productivity growth.

$H = H_0$

Graphically:

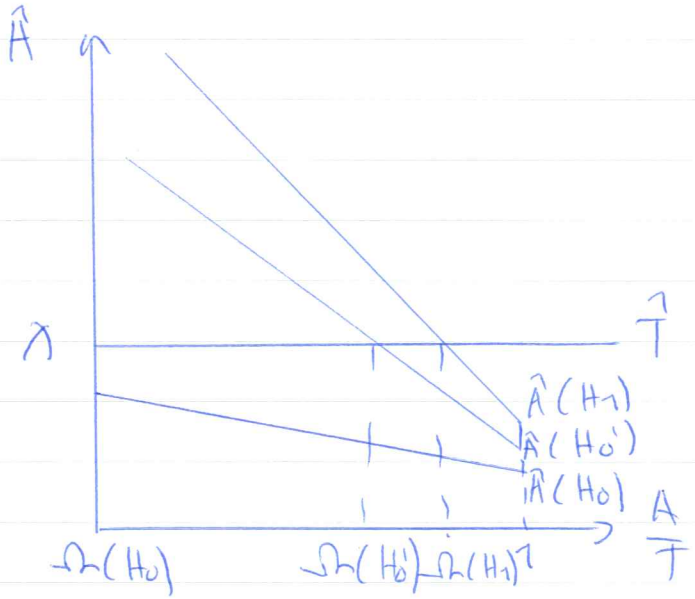


No equilibrium for the developing county (case 2)

Equilibrium in case 1 = $\Omega(H_1)$

If in the specification in a), an increase in human capital affects both innovation and technology adaption, as a certain level of human capital is needed for both. Graphically, this means that there is a positive shift (innovation channel) and a clockwise rotation (technology adaption channel). If the increase in ~~capital~~ human capital is sufficient, the country can reach the technology frontier. This is assumed in the graphical solution in this case.

H↑ from H_0 to H_0'



We assume that H increases sufficiently to bring the developing country out of the low-productivity ⇔ low-income poverty trap.

Thus, the effect of the increase in human capital is ~~at higher~~ a steady-state equilibrium, $\Omega(H_0')$, in which the country has escaped the low productivity-trap. With further increases in human capital, the developing country has the potential to reach the income level of the developed country. Thus, the model explains the crucial role of investment in human capital for development to occur.