Department of Economics
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ECON239: Development Economics

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Assignment #1 — Answer Guide

Monday October 4, 2010

Section A (40 percent)**:** Briefly discuss the validity of each of the following statements. In your answer define or explain as precisely as possible any terms or concepts which are underlined, with particular reference to the context in which they are being used. The text for each answer should be no longer than a page, but you also should also include diagrams or examples where appropriate. They have equal value.

A1. Developing countries have been successful in achieving their Millennium Development Goals.

The Millennium Development Goals (MDGs) were derived from the United Nations Millennium Declaration, adopted by 189 nations in 2000. Most of the goals and targets were set to be achieved by the year 2015 relative to the situation in 1990. Success in achieving the 8 goals has been uneven around the world. Here's an extremely brief summary of the main items:

(1) Eradicate extreme hunger and poverty: We are on course globally to achieve the target that the number of people living on less than $1.25 per day be halved. However, most of this was due to East Asia and especially China. In Western Asia and North Africa poverty rates have hardly changed, whereas they have actually increased slightly in South-Eastern Europe and CIS countries. In sub-Saharan Africa, although the poverty rate declined marginally, the number of people living in extreme poverty increased. Sub-Saharan Africa is now the only region where more than half of the population still live in extreme poverty. No progress was made in reducing hunger between 2000 and 2007. Since then we've seen the 2008 food price spike which helped hunger rise above 1 billion in 2009. Although some of the latest figures show that there has been progress, current high food prices are likely to set this progress back again.

(2) Achieve universal primary education: In order to meet this goal, we would have needed universal enrolment in the first year of primary school by 2009. Despite significant progress, this has not happened and it's now essentially impossible to meet the goal on time. In half of the sub-Saharan countries with available data, around a third of children drop out of school.

(3) Promote gender equality and the empowerment of women: We have already failed to meet the 2005 target for equal schooling, with gender inequality in primary education still highest in those regions with lowest overall enrolment.

(4) Reduce child mortality: Globally, we are on target to meet the goal of cutting by two-thirds the number of children dying before the age of five. Northern Africa is a particular success story, having almost met the target already. However, once again sub-Saharan Africa falls behind. Here, one in seven children still die before their fifth birthday, leaving little chance of achieving the goal in several countries.

(5) Improve maternal health: As of 2005, not one region was on track to meet the goal of reducing deaths in childbirth by three-quarters. In sub-Saharan Africa there had been almost no progress at all since 1990, with almost one in every hundred births causing the death of the mother.

(6) Combat HIV/AIDS, malaria and other diseases: The rate of new HIV infections has started to fall – a genuine success. Anti-retroviral treatment for those living with HIV/AIDS has increased significantly, but falls far short of the 2015 target of universal access. Treatment in sub-Saharan Africa has tripled but the drugs are still reaching less than half of those that need them.

(7) Ensure environmental sustainability: The target of a significant reduction in the rate of biodiversity loss by 2010 has been missed. Climate change, one of the underlying causes of biodiversity loss, is far from being solved, and as a result, increased biodiversity loss throughout the world seems imminent. All regions except sub-Saharan Africa and Oceania have met or almost met the goal of halving the proportion of people without drinking water. The twin target of halving the proportion of people without access to proper sanitation, on the other hand, is set for failure. The number of people without improved sanitation facilities – currently 2.7 billion – is actually rising.

(8) Develop a global partnership for development: The Gleneagles G8 commitments should have doubled assistance to Africa. In fact aid to Africa has increased by just 3%. The Doha round of Trade talks continue to be stalled.

A2. Using purchasing power parity exchange rates to convert to US dollars distorts ones view of world inequality by making poor countries appear richer than they really are.

The PPP rate is usually defined as the number of units of a country's currency required to purchase the same quantity of goods and services in the local (developing country) market as $1 would buy in the US. Formally, we can calculate this as

$$\begin{array}{c}\text{PPP exchange} \\ \text{rate for country A}\end{array} = \frac{\text{Cost of representative basket of goods and services in US}}{\text{Cost of same basket of goods and services in country A}}$$

Although using the PPP rate to convert to US dollars does make poor countries appear richer (relative to the US) than if we used the market exchange rate, this is in fact a more accurate picture of world inequality. The reason is that (1) poorer countries tend to produce more non-traded goods as a share of overall production than rich countries, and (2) the prices of these non-traded goods tend to be a lot less in poor countries than rich, relative to traded goods. The market exchange rate only reflects the prices of goods that are traded across international borders and therefore makes the relative cost of living appear greater in poor countries than it really is. The PPP exchange rate accounts for these relatively cheap non-traded goods in the relative cost of living. As a result, the real GDPs of poorer nations is increased relative to the US.

A3. In computing the Human Development Index, the logarithm of per capita GNP is used rather than its level. This implies that an increase in per capita GNP has less impact on the HDI for a rich nation than does a similar increment for a poor nation.

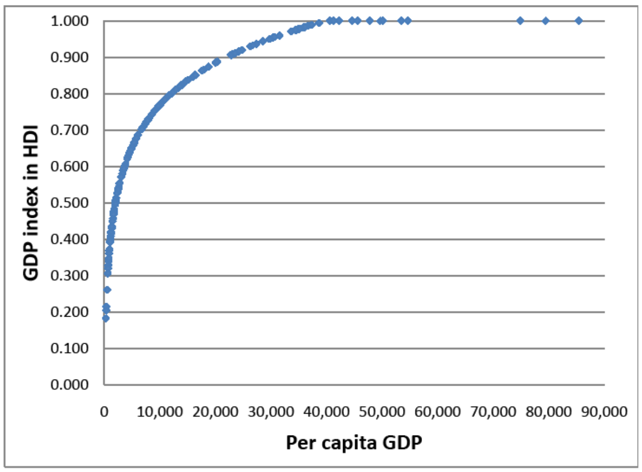


Figure 1: Relationship between the HDI's GDP index and real per capita GDP.

The HDI is defined as follows:

$$\text{HDI} = \frac{1}{3} \times (\text{longevity}) + \frac{1}{3} \times (\text{knowledge}) + \frac{1}{3} \times (\text{standard of living}).$$

Here "longevity" if an index of life expectancy at birth relative to the nation with the highest:

$$\text{longevity index for country } A = \frac{\text{life expectancy in } A - 25}{\text{max. life expectancy} - 25}.$$

"Knowledge" is a weighted average of an adult literacy index and the fraction of its primary, secondary and tertiary age population enrolled in school:

$$\text{knowledge index of } A = \frac{2}{3}(\text{adult literacy index}) + \frac{1}{3}(\text{enrollment rate}).$$

Finally, the "standard of living" is the natural logarithm of real per capita GNP relative to that of the country with the highest per capita GNP:

$$\text{standard of living} = \frac{\log(\text{per capita GNP of A}) - \log(100)}{\log(\text{max per capita GNP}) - \log(100)}.$$

The statement is true because the logarithm is a concave function. Using data for 2007 from the 2009 Human Development Report (Table H) report, Figure 1 plots the standard of living index used in the HDI against per capita GDP. As can be seen when GDP grows from 0 to $10,000, the index increase by about 0.75. However, when we go from $10,000 to $20,000, it only increases by just over 0.1. Once we get above $40,000 the index does not change at all.

A4. Consider the following quintiles for two different income distributions

Quintile	**1st**	**2nd**	**3rd**	**4th**	**5th**
Incomes in Economy 1	**5**	**9**	**13**	**22**	**51**
Incomes in Economy 2	**3**	**10**	**11**	**20**	**56**

The Gini coefficient for Economy 2 is greater than that for Economy 1.
Quintiles represent 20% of the population ordered in terms of income. Thus the bottom quintile represents the poorest 20% of the populations, the second quintile the next poorest 20% and so on. Given the limited amount of information in the table we can approximate the coordinates of the Lorenz curves for these two economies as follows:

Cumulative % of population	20	40	60	80	100
Cumulative % of income in Economy 1	5	14	27	49	100
Cumulative % of income in Economy 2	3	13	24	44	100

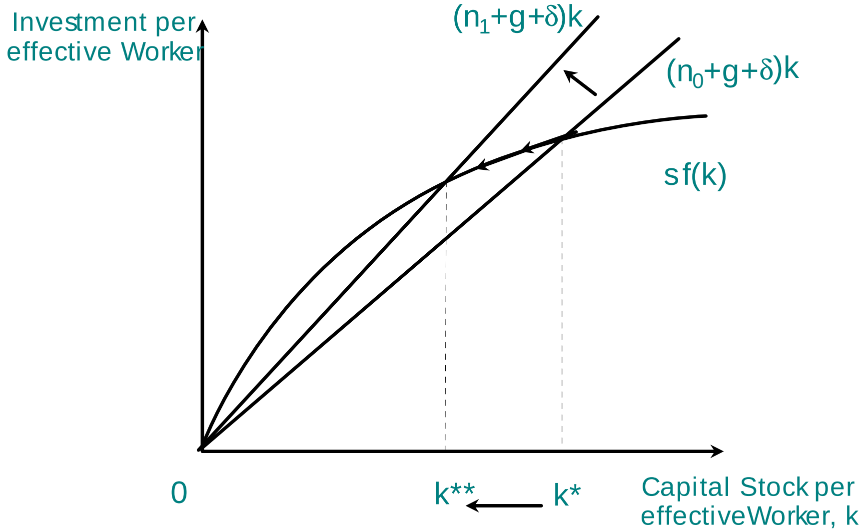
If we plot these Lorenz curves, the Lorenz curve for economy 2 lies everywhere below and to the right of that for economy 1. The Gini coefficient measures the fraction of the triangle below the 45^o line that is covered by the area between the line of equality and the Lorenz curve. Clearly, that area is bigger for economy 2, so it has the higher Gini coefficient.

A5. According to the Solow model, a change in the population growth rate has no effect on per capita income growth.
The Solow growth model relates the change in the capital stock per effective worker, Δk, to savings rates, s, population growth rates, n, depreciation, δ, and technical change, g, according to the following equation:

$$\Delta k = sf(k) - (n + g + \delta)k,$$

where $f(k)$ represents output per effective worker as a function of capital per effective worker. This equation states that whenever an economy's savings per effective worker exceeds a certain break–even level, the capital stock per effective worker will grow.

The statement above is true in the long run, but false in the short run. Figure illustrates two long run steady–states (or balanced growth paths) predicted by the Solow model for an economy with a positive rate of technical change given by g. One for a low population growth rate, n_0 and one for a high population growth rate, n_1. The long–run capital stock per effective worker, when population growth is low, is given by k^*. Notice that along such a growth path, capital and output per *effective* worker are constant, but capital and output per worker grow at the rate g.



An increase in the population growth rate to n_1 causes the new long run growth path to move to the left with a lower capital stock per effective worker k^{**}. Along this new growth path, capital and output per effective worker are again constant, so that capital and output per worker still grow at the rate g. The growth path, however, is now illustrated by a lower time path in Figure 2, since the *level* of output per worker is now lower at each date. However, in moving from A to B, the growth rate of output per worker must slow in the short–run as the economy adjusts to this new lower level. This "transition path" is illustrated by the arrows in Figure . When the population growth rate increases, output and investment per worker declines. However, once the economy adjusts to the new lower level of capital per effective worker, the implied **higher** marginal product of capital that results is just enough to offset the higher population growth rate, so that the economy resumes its original growth in output per worker (though at a lower level).

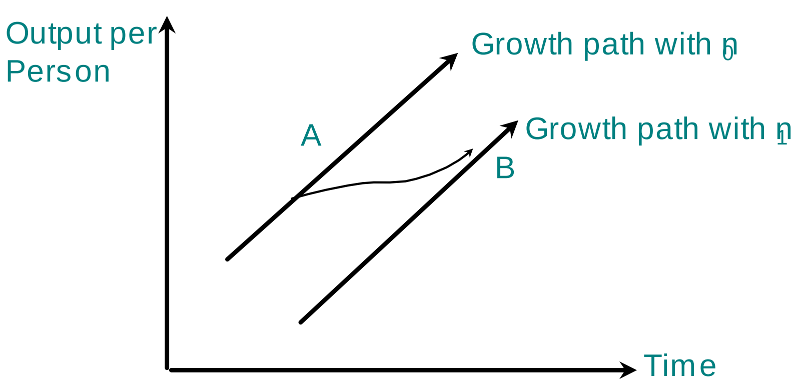


Figure 2: Impact of Change in Population Growth in the Solow Model

Section B (60 percent)**:** Answer the following questions**.** They all have equal value.

B1. The following table provides aggregate information for Canada over the past decade:

	Nominal GDP in millions of $	**Net investment income from non-residents ($m)**	**Consumer Price Index**	**Population**
2000	**1,076,577**	**-28,032**	**95.4**	**30,685,730**
2001	**1,108,048**	**-31,353**	**97.8**	**31,019,020**
2002	**1,152,905**	**-28,868**	**100.0**	**31,353,656**
2003	**1,213,175**	**-28,590**	**102.8**	**31,639,670**
2004	**1,290,906**	**-26,306**	**104.7**	**31,940,676**
2005	**1,373,845**	**-25,748**	**107.0**	**32,245,209**
2006	**1,450,405**	**-14,239**	**109.1**	**32,576,074**
2007	**1,529,589**	**-19,556**	**111.5**	**32,931,956**
2008	**1,599,608**	**-18,595**	**114.1**	**33,327,337**
2009	**1,527,258**	**-21,441**	**114.4**	**33,739,859**

(a) Calculate real total GNP in millions of 2002 dollars for each year. An Excel file containing this data is available on the Assignments and Exams page of the Econ239 website.

The following table gives the numbers for parts (a) and (b):

	Total real GNP (US$ millions)	GNP per capita (US$)
2000	1099104	35818
2001	1100915	35492
2002	1124037	35850
2003	1152320	36420
2004	1207832	37815
2005	1259904	39073
2006	1316376	40409
2007	1354290	41124
2008	1385638	41577
2009	1316274	39012

(b) Calculate real per capita GNP in each year in 2002 dollars. According to these figures, did the average Canadian get richer every year since 2000?

Apparently, the average Canadian got richer every year except 2001 and 2009. These coincide with recessionary years. The decline in 2001 amounting to 1% was much smaller than that in 2009 which was a decline of 6%. Notice that total real GNP did not fall in 2001 — it just grew more slowly than the population.

(c) What was the average growth rate of real total GNP over the whole decade? What was the average population growth?

Average Growth of total GNP $= \left(\frac{1316274}{1099104}\right)^{\frac{1}{9}} - 1 = 0.0202$ or 2.02%

Average population growth $= \left(\frac{33{,}739{,}859}{30{,}685{,}730}\right)^{\frac{1}{9}} - 1 = 0.0106$ or 1.06%

(d) Use you answers from (c) to compute an approximation of the growth in real per capita GNP. How does this compare to a direct calculation of the growth in real per capita GNP using the answers from (b)?

The average growth rate of per capita GNP should be approximately equal to the difference between average growth of total GNP and population growth from (c), which is $0.0202 - 0.0106 = 0.0096$ or 0.96%. Using the answers from (b) we can calculate that

Average Growth of per capita GNP $= \left(\frac{39012}{35818}\right)^{\frac{1}{9}} - 1 = 0.0095$ or 0.95%

Obviously this is very close to the number computed using the approximate method.

(e) What was the average rate of price inflation over the decade? How much of the growth in the nominal value of GNP was due to inflation?

Average inflation $= \left(\frac{114.4}{95.4}\right)^{\frac{1}{9}} = 0.0204$ or 2.04%

Average growth in nominal GNP$= \left(\frac{1{,}505{,}817}{1{,}048{,}545}\right)^{\frac{1}{9}} = 0.0410$ or 4.1%.

So roughly half the growth in nominal GNP was due to inflation.

B2. Use Table 4 in Lloyd-Ellis ch. 1 to answer the following. Suppose the poverty line for this economy is determined to be 2.1 income units.

(a) What is the headcount index of poverty?

The poorest 6 individuals are below the poverty line. The headcount index is therefore $6/20 = 0.3$ or 30%.

(b) Calculate the total poverty gap, the average poverty gap and the normalized poverty gap.

The total poverty gap is

$$TPG = 6 \times 2.1 - (0.8 + 1.0 + 1.4 + 1.8 + 1.9 + 2.0) = 3.7$$

The average poverty gap is

$$APG = \frac{3.7}{20} = 0.185$$

The normalized poverty gap is

$$NPG = \frac{0.185}{2.1} = 0.088$$

Suppose that the government of this economy can affect poverty by transferring money to the poorest individuals. Suppose it is told by the World Bank that it will obtain favourable terms for its future loans if it reduces poverty by 50%.

(c) What would be the cheapest way to reduce the headcount index by 50%? By how much would this reduce the poverty gap?

The cheapest way would be to take the 3 richest poor individuals (numbered 4, 5 and 6) and bring them all up to the poverty line. The cost would be $(2.1-2)+(2.1-1.9)+(2.1-1.8) = 0.6$. The poverty gap would therefore be reduce to 3.1 or by only 16%.

(d) What would be the most equitable way to reduce the poverty gap by 50% ? What impact would this have on the headcount index?

We want to reduce the poverty gap to 1.85 (i.e. by 50%). If we think of "equitable" as meaning everyone gets the same transfer, this would imply giving everyone 0.31 money units. This would raise the three least poor pople above the poverty line, thereby reducing the headcount by 50%. Alternatively, if we think of it as meaning reducing overall inequality (which is what I intended) we could share it between the poorest three individuals, so that the poorest gets 0.883 and the second poorest gets 0.683 and third poorest gets 0.283. This would give them all 1.683. In this case there is no effect on the headcount index because everyone would remain below the poverty line.

(e) What do you conclude from this exercise? Does it matter how poverty is measured?

Given that the resources of policy–makers are limited, the fact that it is cheaper to shift those just below the poverty line up to it, than it is to shift up those well below it, will imply a "bigger bang for the buck" in targeting the "not–so poor". This potential bias illustrates the importance of thinking carefully about formulating target measures for policy. If the poverty gap is the target measure then policies that increase the incomes of the very poor would have an equal impact on the measure as those that increase the incomes of the not-so poor. Reducing the poverty gap by 50% is more equitable but is over 3 times as expensive, in this example, as reducing the headcount index by 50%. Clearly it matters how poverty is measured for the nature of policy.

B3. Consider a Solow economy that is closed, has no government sector and no technological change. Total savings in the economy amount to 15% of GNP each year, the labour force grows at 5% a year and 10% of the capital stock depreciates each year. The relationship between aggregate GNP and productive inputs is given by

$$Y_t = K_t^{\frac{1}{3}} L_t^{\frac{2}{3}}$$

(a) In 2000 the initial labour force is 10 million workers and the initial capital stock is 5 million units. Compute the level of GNP and the GNP per worker in 2000.

GNP is given by

$$Y_{2000} = (5)^{\frac{1}{3}}(10)^{\frac{2}{3}} = (1.71)(4.64) = 7.94 \text{ million}$$

GNP per worker is then

$$y_{2000} = \frac{7.94}{10} = 0.794$$

(b) Assuming that all savings are channeled into investment, compute the capital stock, K_t, and capital stock per worker, k_t, in 2001. What are the labour force and the implied level of GNP in 2001.

The capital stock in 2000 is given by

$$\begin{aligned} K_{2001} &= (1-\delta)K_{2000} + s.Y_{2000} \\ &= (0.9 \times 5) + (0.15 \times 7.94) \\ &= 4.5 + 1.19 \\ &= 5.69 \end{aligned}$$

The labour force in 2001 is given by $L_{2001} = (1.05 \times 10) = 10.5$ million and so the capital stock per worker is

$$k_{2001} = \frac{K_{2001}}{L_{2001}} = \frac{5.69}{10.5} = 0.542$$

The level of GNP is

$$Y_{2001} = (5.69)^{\frac{1}{3}}(10.5)^{\frac{2}{3}} = (1.785)(4.795) = 8.56 \text{ million}$$

(c) Using the same procedure for each year until 2009, create a table showing the evolution of Y_t, K_t, L_t, y_t and k_t over time.

Here's the table created using Excel:

Year	L	K	Y	k	y	MPK	K/Y
2000	10	5	7.937005	0.5	0.793701		0.629961
2001	10.5	5.690551	8.560733	0.541957	0.815308	0.514987	0.664727
2002	11.025	6.405606	9.199675	0.581007	0.834438	0.489875	0.696286
2003	11.57625	7.144996	9.85627	0.617212	0.851422	0.469117	0.724919
2004	12.15506	7.908937	10.53281	0.65067	0.866537	0.451754	0.750886
2005	12.76282	8.697965	11.23148	0.681508	0.880016	0.437086	0.774427
2006	13.40096	9.51289	11.95441	0.709866	0.892056	0.42459	0.795764
2007	14.071	10.35476	12.7037	0.735894	0.902828	0.413867	0.815098
2008	14.77455	11.22484	13.48144	0.759741	0.912477	0.404609	0.832614
2009	15.51328	12.12457	14.28975	0.781561	0.92113	0.396573	0.84848

(d) Using graph paper, plot the relationship between k_t (on the horizontal axis) and y_t (on the vertical axis). Compute the marginal product of capital per worker

between the years 2000 and 2001, and that between 2008 and 2009. Which is bigger and why?

See Figure 3. The approximate marginal products per worker are given in the column headed MPK (you only needed to calculate the first and last of these). They are calculated as

$$MPK = \frac{y_{t+1} - y_t}{k_{t+1} - k_t}$$

The MPK per worker declines as the capital stock per worker rises because there are diminishing returns to capital per worker.

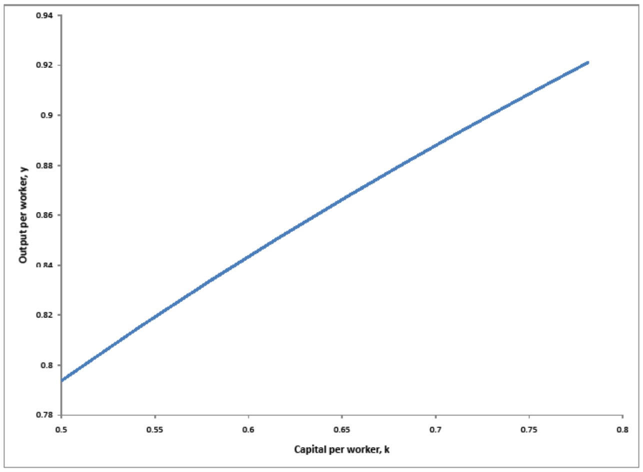


Figure 3: Output per worker vs. capital per worker

(e) Compute the capital–output ratio for this economy in each year. To what value do you think the capital–output ratio will eventually converge? Explain your answer.

The capital-output ratios are given in the last column of the table. In the long–run, the economy converges to a steady state where actual investment is equal to the break-even level:

$$sy = (n + \delta)k$$

It follows that the capital-output ratio in the long run can be expressed as

$$\begin{aligned} \frac{K}{Y} &= \frac{k}{y} = \frac{s}{n+\delta} \\ &= \frac{0.15}{0.05 + 0.1} = 1 \end{aligned}$$

The capital stock per grows as long as $sk^{\frac{1}{3}} - (n + \delta)k > 0$. However, because savings, $sk^{\frac{1}{3}}$ grows less quickly that $(n + \delta)k$ (due to diminishing returns), the difference declines each time. Eventually, the difference becomes miniscule and the steady–state equation holds.