This Midterm Exam includes content from chapters 4, 5, 6, and 7. You are allowed the use of a calculator as well as writing utensils. No additional materials may be used beyond that. You have 50 minutes to complete the exam. The exam is worth 100 points. **Please make certain to put all of your answers (including multiple choice) on the additional paper provided.**

Name: _____

Contents

1 Multiple Choice Questions

1.1 Question 1

1. (4 points) Modern *Homo sapiens* emerged roughly 100,000 years ago. Assume that originally there were 10,000 *Homo sapiens* and that today there are 7 billion. What has the average annual growth rate of the population been? What would have been the annualized growth rate if there were just two *Homo sapiens* 100,000 years ago?
   (a) 0.01 percent and 0.02 percent growth, respectively.
   (b) 0.02 percent and 0.03 percent growth, respectively.
   (c) 0.03 percent and 0.04 percent growth, respectively.
   (d) 0.04 percent and 0.05 percent growth, respectively.

1.2 Question 2

2. (4 points) What is the UN forecast for the growth rate of the world population in the year 2200?
   (a) Less than zero due to increased income per capita around the world.
   (b) Approximately zero on account of falling fertility rates in countries that are currently above replacement rate.
   (c) Greater than zero as the inclination to have children is stronger than the income effect.
   (d) The United Nations does not have a forecast for the growth rate of the world population.

1.3 Question 3

3. (4 points) Suppose that in a particular country, the TFR fell to zero and remained there. Also suppose that there was no immigration or emigration. Immediately following the fertility reduction, would the working-age fraction rise or fall and why?
   (a) The working-age fraction would rise because the older population experience higher mortality rates than the population that is working age and there are no children being born into the younger ages.
   (b) The working-age fraction would fall because the number of people dying is decreasing.
   (c) The working-age fraction would remain the same as the TFR does not immediately impact the number of people in that age group.
   (d) The working-age fraction would rise because the TFR does not directly change the distribution of the age.

1.4 Question 4

4. (4 points) Country A and Country B differ in their intrinsic health environments. Specifically, for a given level of income per capita, workers in Country A will be healthier than workers in Country B. Suppose we observe that the two countries have the same level of income per capita, but people in Country A are healthier than people in Country B. What can we conclude about the aspects of production not related to health in the two countries?
   (a) The impact of health on output in Country A is ambiguous compared to Country B.
   (b) The impact of health on output in Country A is greater than in Country B.
   (c) The impact of health on output in Country A is equal to that in Country B.
   (d) The impact of health on output in Country A is less than in Country B.

1.5 Question 5

5. (4 points) Which of the following is a positive externality associated with health?
   (a) Increased wealth.
   (b) Decreased use of cell phones.
   (c) Increased cost of healthcare.
   (d) Decreased marginal cost of medical technology.

1.6 Question 6

6. (4 points) Countries A and B have the same rates of investment, population growth, and depreciation. They also have the same levels of income per capita and returns to capital. Country A has a higher rate of growth than Country B. According to the Solow model, which country is further from its steady-state value?
   (a) Real data do not support the idea of a steady-state value.
   (b) Country B should be further from its steady-state value than Country A.
   (c) Country A should be further from its steady-state value than country B.
   (d) We cannot tell which country is further away from its steady-state value.

1.7 Question 7

7. (4 points) Human capital is typically measured in real data as years of schooling. However, countries differ in the number of days of school that make up a school year. High-income countries tend to have more days in their school years than low-income countries.

Suppose that instead of data on school years, we used data on school days. How would these new data change our assessment of the role of productivity in explaining variations in output per worker among countries?

(a) This would increase the ability of physical capital to explain cross-country variation in income.

(b) This would increase the ability of productivity to explain cross-country variation in income.

(c) This would decrease the ability of both factors to explain cross-country variation in income.

(d) This would increase the ability of human capital to explain cross-country variation in income.

1.8 Question 8

8. (4 points) What is the primary reason for rejecting the Malthusian model today?

(a) The variation in population growth rates across countries is evidence that there is not a steady-state growth rate for population.

(b) The simultaneous increase in living standards and population provides evidence against the Malthusian model.

(c) Variation in income across countries does not meet the assumption that higher population growth rates push down the income per capita.

(d) The simultaneous increase in living standards and decrease in population is inconsistent with the Malthusian model.

1.9 Question 9

9. (4 points) Why is health considered a part of human capital?

(a) Health is a measure of technology in the country.

(b) Health gives a proxy for the efficiency with which inputs are used.

(c) The level of health determines innovation in the health sector.

(d) The level of health determines the amount of labor a worker can supply.

1.10 Question 10

10. (4 points) What is the process used to obtain the equation for productivity growth?

(a) Take the time derivative of the production function, put that into logarithms, and solve for $\hat{A}$.

(b) Take the log of the production function, take the time derivative, and solve for $\hat{A}$.

(c) Isolate $\hat{A}$, take the logarithm, and then take the time derivative.

(d) Isolate A, take the time derivative, and then take the logarithm.

2 Numerical Questions

2.1 Question 1

1. Consider the following Malthusian model. Suppose that the relationship between income per capita (y) and the growth rate of the population ($\hat{L}$) is given by the equation: $\hat{L} = y - 100$. Suppose that output is produced using labor and land, according to the equation $Y = L^{\frac{1}{2}}X^{\frac{1}{2}}$, where X is the quantity of land. Assume that X = 1,000,000.

   (a) Draw a graph with y on the horizontal axis and $\hat{L}$ on the vertical axis, showing the relationship between income per capita and population growth.

   (b) Derive the relationship between population, L, and income per capita, y. (Hint: remember that y = Y/L.) Sketch this relationship on a graph with L on the vertical axis and y on the horizontal axis.

   (c) Use the equations you have derived to compute the steady-state values of L and y.

2.2 Question 2

2. (15 points) Suppose that the world has only two countries. The following table gives data on their populations and GDP per capita. It also shows the growth rates of population and GDP. The growth rates of population and GDP in each country never change.

   (a) What will the growth rate of world population be in the year 2000? Following 2000, will the growth rate of world population rise or fall? Explain why. Draw a graph showing the growth rate of world population starting in 2000 and continuing into the future. Toward what growth rate does world population move in the long run?

   (b) Draw a similar graph showing the growth rate of total world GDP.

   (c) Draw a similar graph showing the growth rate of average GDP per capita in the world.

Country	Pop (2000)	gdppc (2000)	$\hat{L}$ $(\%perYear)$	$\hat{Y}$ $(\%perYear)$
Country A	2,000,000	1,000	0	3
Country B	1,000,000	1,000	2	0

2.3 Question 3

3. (15 points) The table below shows the relative wage for each additional year of education in low-income and high-income countries. Recall that the relative wage is compared to

no years of education and that each successive year has an impact on the returns to schooling (not just the threshold values of educational attainment).

(a) Calculate the returns to schooling in low-income countries.

(b) Calculate the returns to schooling in high-income countries.

(c) To what extent do educational differences between high-income and low-income countries explain income differences (make the *ceteris paribus* assumption).

Highest Level of Education	Years	Relative Wage	Low Income	High Income
No Schooling	0	1.00	20.8	2.5
Incomplete Primary	4	1.65	10.4	3.4
Complete Primary	8	2.43	18.0	12.3
Incomplete Secondary	10	2.77	19.3	17.8
Complete Secondary	12	3.16	23.2	37.4
Incomplete Higher	14	3.61	2.9	9.9
Complete Higher	16	4.11	5.3	16.6

2.4 Question 4

4. (15 points) The following table provides data on the annual growth rates of output, physical capital, and human capital per worker for three countries. For each country, calculate the growth rates of productivity and factor accumulation. In which country does factor accumulation account for the largest share of growth? In which country does productivity account for the largest share of growth?

Country	Output Growth ($\hat{y}$)	P. Capital Growth ($\hat{k}$)	H. Capital Growth ($\hat{h}$
Argentina	0.66	0.31	0.52
Uruguay	1.82	1.83	0.51
Panama	1.73	0.9	0.84

3 Extra Credit

Assume that the fertility function and the hazard function (probability of death rather than survival) both depend on time and are given by the following functional forms:

1. $F(t) = -0.005(t-30)^2 + 0.5$ for $20 \leq t \leq 40$, and zero otherwise.
2. $\pi(t) = 0.0125t$ for $0 \leq t \leq 80$.

(a) Find the Total Fertility Rate (TFR)

(b) Find the Net Rate of Reproduction (NRR)

Suppose that $\beta = \frac{1}{2}$ and recall the following equations:

1. $TFR = \Sigma_{t=0}^{t=80} F(t)$
2. $NRR = \beta * \Sigma_{t=0}^{t=80} F(t) * \pi(t)$

End of Exam ■