SUMMER TERM 2019

ECON0039: ADVANCED MACROECONOMICS

TIME ALLOWANCE: 2 hours
All questions should be answered.
Part A carries 50% of the total mark, Part B 20% and Part C 30%. Questions B.1 and B.2 have the same weight.

Solution

PART A : Dynamics and Stagnation in the Malthusian Epoch

This problem follows Ashraf and Galor [2011] and proposes a model of the Malthusian regime.
Consider an overlapping-generations economy in which activity extends over infinite discrete time.
In every period, the economy produces a single homogeneous good using land and labour as inputs.
The supply of land is exogenous and fixed over time, whereas the evolution of labour supply is governed
by households’ decisions in the preceding period regarding the number of their children.
Production occurs according to a constant-returns-to-scale technology. The output produced at
time \( t \), \( Y_t \), is

\[
Y_t = (AX)^\alpha L_t^{1-\alpha}, \quad 0 < \alpha < 1,
\]

where \( L_t \) and \( X \) are, respectively, labour and land employed in production in period \( t \), and \( A \) measures
the technological level. The technological level may capture the percentage of arable land, soil quality,
climate, cultivation and irrigation methods, as well as the knowledge required for engagement in
agriculture (i.e., domestication of plants and animals). Thus, \( AX \) captures the effective resources
used. Output per worker produced at time \( t \) is denoted \( y_t \).

In each period \( t \), a generation consisting of \( L_t \) identical individuals joins the workforce. Each
individual has a single parent. Members of generation \( t \) live for two periods. In the first period of life
(childhood), \( t - 1 \), they are supported by their parents. In the second period of life (parenthood), \( t \),
they inelastically supply their labour (one unit), generating an income that is equal to the output per
worker, \( y_t \), which they allocate between their own consumption and that of their children. Individuals
derive utility from consumption and the number of their children:

\[
u' = c_t^{1-\gamma} n_t^{\gamma}, \quad 0 < \gamma < 1,
\]

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where $c_t$ is consumption and $n_t$, is the number of children of an individual of generation $t$.

Members of generation $t$ allocate their income between their consumption, $c_t$ and expenditure on children, $\rho n_t$, where $\rho$ is the cost of raising a child. Hence, the budget constraint for a member of generation $t$ (in the second period of life) is

$$\rho n_t + c_t \leq y_t.$$

A.1 Write the utility maximisation problem of an adult and derive optimal consumption $c_t$ and fertility $n_t$ as a function of income per capita. What is the impact of income on fertility? Comment.

An adult solves the following problem:

$$\max_{c_t, n_t} c_t^{1-\gamma} n_t^\gamma$$

subject to

$$\rho n_t + c_t \leq y_t.$$

Solving FOC gives

$$c_t = (1 - \gamma) y_t,$$

$$n_t = \frac{\gamma}{\rho} y_t.$$

We find that fertility is an increasing function of income, which is well in line with the mechanics of the Malthusian regime.

A.2 Assume that the initial size of the working population is $L_0 > 0$. Explain why the law of motion of adult population is $L_{t+1} = n_t L_t$. Use the result of the previous question to derive the equilibrium law of motion of adult population $L_{t+1} = \phi(L_t)$.

In periods $t$, each adult has $n_t$ children (note that the (unrealistic) assumption in that model is that there is asexual reproduction, as one adult alone can have children). As there are $L_t$ adults, there are $n_t L_t$ children today, and therefore $L_{t+1} = n_t L_t$ adults tomorrow.

Using $n_t = \frac{\gamma}{\rho} y_t$ and $y_t L_t = Y_t$, we obtain $L_{t+1} = \frac{\gamma}{\rho} Y_t$. Using the production function, we then have

$$L_{t+1} = \frac{\gamma}{\rho} (AX)^\alpha L_t^{1-\alpha} = \phi(L_t).$$

A.3 Show graphically in the plane $(L_t, L_{t+1})$ that $L$ will converge to a steady state. Compute that steady state $\bar{L}$. Draw the time path of $L$ starting from $L_0 < \bar{L}$. 

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The steady state is defines by \( L = \phi(L) \), that gives

\[
L = \left( \frac{\gamma}{\rho} \right)^{\frac{1}{\alpha}} AX.
\]

A.4 Population density is defined as \( P_{dt} = \frac{L_{t}}{X} \). Compute steady state population density \( \overline{P}_d \).

Steady state population density is

\[
\overline{P}_d = \frac{L}{X} = \left( \frac{\gamma}{\rho} \right)^{\frac{1}{\alpha}} A
\]

A.5 Compute the law of motion of output per worker \( y_{t+1} = \psi(y_t) \). Compute the steady state level of \( y \), denoted \( \overline{y} \). Interpret the result.

Output per worker dynamics is given by

\[
y_{t+1} = \frac{Y_{t+1}}{L_{t+1}} = (AX)^\alpha (n_t L_t)^{-\alpha} = \left( \frac{AX}{L_t} \right)^\alpha n_t^{-\alpha} = \frac{y_t}{n_t^{1-\alpha}}.
\]

Using the expression for \( n_t \), we obtain

\[
y_t = \left( \frac{\rho}{\gamma} \right)^{\alpha} y_t^{1-\alpha} = \psi(y_t).
\]
The steady state level of $y$ is therefore

$$\bar{y} = \frac{\rho}{\gamma}.$$ 

$\bar{y}$ depends positively on the cost of raising a child and negatively on the utility of children.

A.6 Assume that $L_0$ is at its steady state level $\bar{L}$ and that in period 0 technology $A$ permanently increases to the level $\delta A$, $\delta > 1$. Compute $y_0$, $n_0$ and $L_1$.

Draw the time path of adult population $L_t$ and output per worker $y_t$ following that increase in $A$.

The economy starts from $\delta A$ and $\bar{L}$ in period 0. Therefore, $L_0 = \bar{L} = \left(\frac{\gamma}{\rho}\right)^{\frac{1}{\alpha}} A X$ and $Y_0 = (\delta A X)^{\alpha} L_0^{1-\alpha} = \delta^\alpha \bar{Y}$, so that

$$y_0 = \frac{Y_0}{L_0} = \delta^\alpha \bar{y}$$

Therefore, $n_0 = \frac{\gamma}{\rho} y_0 = \delta^\alpha$, and $L_1 = n_0 L_0 = \delta^\alpha \bar{L}$. 

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A.7 Ashraf and Galor [2011] write in their article:

“The Malthusian theory generates the following testable predictions:

(i) Within a country, an increase in productivity would lead in the long run to a larger population, without altering the long-run level of income per capita.

(ii) Across countries, those characterised by superior land productivity or a superior level of technology would have, all else equal, higher population densities in the long run, but their standards of living would not reflect the degree of their technological advancement”

Prove that in the model we have solved, those testable predictions are correct.

Recall that

\[ L = \left( \frac{\gamma}{\rho} \right)^{\frac{1}{\alpha}} AX, \]

\[ \bar{P}_d = \frac{L}{X} = \left( \frac{\gamma}{\rho} \right)^{\frac{1}{\alpha}} A, \]

\[ \bar{y} = \frac{\rho}{\gamma}. \]

Prediction (i) implies \( \frac{\partial L}{\partial A} > 0 \) and \( \frac{\partial \bar{y}}{\partial A} = 0 \). Both are true in the model.

Prediction (ii) implies \( \frac{\partial \bar{P}_d}{\partial A} > 0 \) and \( \frac{\partial \bar{y}}{\partial A} = 0 \). Both are true in the model.
PART B : Questions

For each question, you should give a structured answer in no more than one page.

B.1 What are the consequences of the fact that agents do not internalise the dynamics of natural resources in the Easter Island model seen in class. Relate this to current debates on Global Warming.

- In the Easter island model we have seen in class, the resource regenerates at a slow rate if its size is small.
- But when they decide to use the resource and deplete it, economic agents do not take into account that higher exploitation will increase the future scarcity of the resource. This is because there are no property rights on the resource, and hence no price.
- There is a missing market for the resource, which creates an externality.
- For that reason, people overutilise the resource (cut too many trees, fish too much, etc...) In some situations (depending on the parameters), this can lead to a complete disappearance of the resource, and therefore an economic and ecological collapse.
- Nowadays, using fossil fuels is contributing to the concentration of greenhouse gas in the atmosphere, and therefore to Global Warming.
- But the future consequences of Global Warming are not priced.
- There is therefore a tendency to overconsumption of fossil fuels (compared to what a benevolent planner would choose).
- One way to solve this problem is Pigovian taxation: the price of fossil fuels should be higher (using a carbon tax), so that it includes the marginal future damage made to the environment.

B.2 What are Piketty’s [2014] main contributions to the analysis of inequality?

- First, Piketty is providing a new set of observations on the evolution of income and wealth inequalities in many developed economies (US, France, UK, Germany)
  - He is questioning the Kuznets curve, according to which inequalities (of income) are inverse-U-shaped with income per capita.
  - He shows that income inequalities
    * were larger in Europe than in the US of A in the early XXth century,
    * that this is now reversed,
    * are higher than ever in the US of A for the high end of the distribution.
He shows that for wealth inequalities
* we see again a “great reversal” between the US of A and Europe,
* that they have been increasing everywhere since the 70’s.

Second, Piketty is discussing the future trends of inequalities. Denoting by \( r \) the real interest rate and by \( g \) the rate of growth of the economy, he argues that if wealth is concentrated in the hands of a few, then \( r > g \) (which seems to be the case according to him) will imply an ever growing path of inequalities.

PART C: Discussion

Below is an article published in The Guardian in August 2018 and entitled “Venezuela devalues currency and raises minimum wage by 3,000%”. Read carefully this article before answering the questions below.

C.1 Write a 10-line summary of that article.

- Venezuela is facing a situation of hyperinflation.
- Inflation could hit one million % in 2018.
- In August 2018, President Maduro has announced a plan to end hyperinflation.
- This plan features
  - a 3,000 % increase in the minimum wage,
  - a tax increase,
  - a re-denomination of the Bolivar (divided by 100,000) to create a “new Bolivar”,
  - an increase in petrol prices.
- Some economists and the opposition are very skeptical about that plan.
- The increase in the minimum wage is likely to increase unemployment.
- The economic situation is dramatic: 90% of Venezuelans live in poverty and 2.3 millions people have emigrated since 2015.

C.2 According to that article, what are the consequences of hyperinflation in Venezuela?

Consequences of hyperinflation are
- poverty,
• shortage of food and medicines and a collapse of trade,
• emigration.

C.3 What are the main actions of Nicolás Maduro’s plan to stop hyper inflation? Discuss.

**Maduro’s** plan features:

• increasing taxes and the price of oil: the idea here is to have more fiscal discipline,
• re-dominating of the Bolivar: this is a typical policy in hyperinflation episodes. The idea is to manage expectations by starting again with a clean slate.
• increasing the minimum wage: this seems to be a way of obtaining some political support from the population, but it is unlikely to be a good thing as it is likely to be transmitted to prices, and therefore to aggravate inflation.
• Compared to historical episodes, what seems to lack is a political way out of the hyperinflation.

C.4 According to historical records and theory, what needs to be done to end hyperinflation episode?

We have studied hyperinflation in Germany and Zimbabwe.

• A few observations can be made:
  – hyperinflation happens in periods of political instability,
  – hyperinflation is always related to fiscal deficits being monetised,
  – in anticipation of future inflation, agents run away from money, which reduces the real value of money and further increases inflationary pressures.
• Typical hyperinflation exit plans require:
  – fiscal discipline,[
  – anchoring of expectations (e.g. using re-denomination or “dollarisation”)
• Theory of hyperinflation tells us that expectations are key. Why? Because money demand depends negatively on the nominal interest rate, which is the real interest rate plus expected inflation. If expected inflation is large, the nominal interest rate, which is the opportunity cost of holding money, is large, so that money demand is low, prices are high, and the economy enters a vicious circle.
• In the Cagan model, expectations are adaptive and hyperinflation can be caused by an explosion of money supply or by momentum in expectations (the vicious circle).
• In the Sargent version of that model, expectations are rational and it is the whole future of the money supply that matters, not the past. A credible plan can therefore abruptly end an hyperinflation episode, as seen in Germany in the 1920’s.
Venezuela devalues currency and raises minimum wage by 3,000%, Caracas shears five zeros from bolívar, which will be pegged to new cryptocurrency

by Tom Phillips, Latin America correspondent, The Guardian, Mon 20 Aug 2018

Venezuela moved to shore up its crumbling economy on Monday, devaluing its currency and preparing to raise the minimum wage by more than 3,000% in what the country’s president, Nicolás Maduro, declared a visionary bid to tame rampant hyperinflation.

More than 500,000 Venezuelans have fled overseas this year amid chronic shortages of food and medicine, soaring crime and warnings from the International Monetary Fund (IMF) that inflation could hit 1m% this year.

But on Friday Maduro unveiled a dramatic raft of measures designed to end a depression he blames on an economic war being waged by imperialist foes of the Bolivarian revolution he inherited after Hugo Chávez’s 2013 death.

“I want the country to recover and I have the formula. Trust me,” Maduro said in a televised address from the presidential palace, adding, ominously, that “no experts were involved” in the elaboration of that plan.

Maduro began to implement his blueprint – known as the “programme for recovery, growth and economic prosperity” – on Monday, claiming it would represent an inflection point for his once wealthy nation.

“We are going to begin a process of recovery in the coming days, weeks and months,” Venezuela’s 55-year-old leader vowed on Sunday in a live Facebook broadcast. “It is a revolutionary formula ... unique in the world!”

The recovery package includes measures such as raising taxes, increasing petrol prices for some drivers, and introducing a rebranded currency – the sovereign bolívar – which will have five fewer zeros than its inflation-stricken predecessor, the bolívar.
“Venezuela is going to experience an economic miracle,” Maduro boasted.

Economists and opposition figures, who are calling a nationwide strike for Tuesday in protest, are sceptical the plan will fix an economy so broken that a Venezuelan version of Who Wants to be a Millionaire had to be scrapped because the prize had become so worthless.

A recent survey found that about 90% of Venezuelans now live in poverty while more than 60% admitted to waking up hungry because they lacked the means to buy food. Henrique Capriles, a prominent opposition leader, denounced Maduro’s move as a Venezuelan “Black Friday” that would go down as one of the darkest days for the country’s already reeling economy.

“The government has decided to thrust us into one final disaster,” Capriles wrote in an online essay in which he accused Maduro of plunging the oil-rich nation into “the greatest tragedy in its history”.

Another opposition leader, Andrés Velásquez, said: “The measures announced on Friday are not any economic recovery plan for the country. On the contrary, they represent more hunger, more ruin, more poverty, more suffering, more pain, more inflation, more deterioration of the economy.”

Henkel García, director of the Caracas-based consultancy Econometrica, told Bloomberg Maduro’s plan was “a head-scratcher”. “This series of measures is a mix of incoherent and contradictory ideas ... It is a worrying contraption that generates a lot of uncertainty about how it will be executed,” he said.

During Sunday’s Facebook broadcast, Maduro claimed he was ushering in a period of “definite and necessary economic change”. He alleged the recent botched attempt to assassinate him with explosive-laden drones was intended to thwart this bright new economic dawn. “I’m alive ... and I am ready to give my whole life for the recovery and economic prosperity and growth of this country,” he said.

“Everything will work out. I have such great faith. I love Venezuela profoundly and I know when you turn love into politics miracles can happen.”

The estimated 2.3m Venezuelan citizens who have abandoned their country since 2015 – mostly for Brazil, Chile, Colombia, Ecuador and Peru – have no such optimism. The situation is critical and it will get worse, predicted Marisela Guédez, a 38-year-old civil servant who fled through Colombia into the Ecuadorian border town of Tulcán last week, having sold her hair for 100,000 pesos (about £26) in order to pay for the journey. “I never, ever thought about leaving Venezuela – not once,” added the homeless mother-of-five, who had left her children behind in Caracas. “Venezuela was such a rich country.”
Reinaldo Rivera, a 33-year-old from Maracaibo who had moved to the same border town, said skipping the country with his wife and 18-month-old son had been the only way of keeping them all alive. “In Venezuela you work for a month and it only allows you to eat for two days,” he said. “It was almost a question of life or death ... I said: ‘Either we get out of Venezuela or we die of hunger’.”

On a recent afternoon Maria Consuelo García López, a Dominican nun who helps run a soup-kitchen for economic exiles near Ecuador’s border with Colombia, served lunch to hundreds of famished and penniless Venezuelans who had taken the same decision. “How could we just cross our arms and do nothing”? she said. “These people arrive with nothing but their suffering.”

Oliver Stuenkel, an international relations specialist from Brazil’s Fundação Getulio Vargas, predicted the exodus was likely to accelerate further a result of this week’s economic changes. “Maduro’s economic reforms – particularly the dramatic increase of the minimum wage – are likely to have a terrible effect on employment, increasing the number of those leaving Venezuela,” he tweeted.

Those migrants are likely to face growing obstacles. In recent months Chile, Colombia, Ecuador and Peru have all made life more difficult for Venezuelans wishing to enter their territory.

On Monday the northern Brazilian state of Roraima called on the country’s supreme court to halt the entry of Venezuelan immigrants following anti-immigrant riots on the weekend that saw about 1,200 Venezuelans forced back over the border.