Final Exam
180.604
Spring, 2013
Answers

You are expected to answer all parts of all questions. If you cannot solve part of a question, do not give up. The exam is written so that you should be able to answer later parts even if you are stumped by earlier parts.

Write all answers on the exam itself; if you run out of room, use the back of the previous page.
**Part I. Short Questions.**

1. **Imperfect Capital Markets and Monetary Policy in 2008.**
   a) Write down the condition that determines whether an investment is undertaken in the model of imperfect capital markets discussed in class, and indicate the signs with which each variable affects the wedge between \( r \) and the external cost of capital for firms that invest.

   *Answer:*
   
   The condition in the lecture notes is that investment occurs only if:
   
   \[
   \gamma > 1 + r + A(c, r, W, \gamma) \tag{1}
   \]

   where
   
   \( \gamma \) — expected return factor
   
   \( W \) — entrepreneur’s endowment of wealth
   
   \( c \) — cost of monitoring

   b) Explain how you might interpret the financial crisis that erupted in 2008 as an increase in the cost of monitoring in this model.

   *Answer:*
   
   A good answer would mention that one interpretation of the financial crisis was that it occurred when investors suddenly realized that investments that they had thought they understood (like mortgage-backed securities) were much harder to understand and monitor than they had thought. This can be interpreted as an increase in \( c \). Similar interpretations can be applied to all of the “toxic assets” which were made toxic by the fact that the cost of predicting and understanding their properties was revealed to be much higher than investors had anticipated.

   c) If all investment in the economy was determined by a model like this one, explain how a monetary authority like the Fed, which can control \( r \), could offset any effect on investment from the increase in the cost of monitoring.

   *Answer:*
   
   The point here is that, by reducing \( r \) enough, the Fed might be able to boost the set of investments that satisfy (1) even with a higher level of \( c \). To the extent that an important part of the crisis reflected a collapse in physical investment, the Fed in principle had a tool to counteract that.

   d) Discuss the practical limitations that the Fed might face in pursuing such a response to a financial crisis, if its influence over the economy is restricted to affecting the short-term nominal interest rate. Explain why these limitations
might have led the Fed to intervene in markets for other assets (like long-term Treasuries).

*Answer:*

Investment spending was not the only component of economic activity that fell dramatically when the crisis came along. Household consumption spending also plummeted. If the decline in consumption was caused by an increase in uncertainty, and if increase in c was large enough, then a decline in short term interest rates to zero might not be enough to restore either investment or consumption. Long-term Treasury securities affect long-term interest rates, which might affect a broader set of investment and consumption decisions than short-term rates, and so could provide more powerful stimulus than would be available from the Fed’s usual control only over short-term rates.

e) Suppose the Fed affects interest rates enough to restore investment to its pre-crisis level despite a higher cost of monitoring. What side effects might such an intervention have? Discuss whether, in the context of other developments around 2008-2009, those side effects were likely to be desirable or undesirable.

*Answer:*

 Possibly the amount of reduction in either short- or both short- and long-term interest rates sufficient to restore investment spending could either overstimulate or understimulate other components of spending (like household consumption). If total spending was overstimulated, the result could be an increase in inflation (arguably desirable, since inflation was well below even the low target rate of 2 percent). If consumption did not respond very much to the low rates, it is possible that low rates might fuel bubbles in markets for other assets (like, say, the stock market). Since prices in many asset markets collapsed in the crisis, restoring those markets might have been desirable.

2. Explain the two mechanisms by which representative agent DSGE models typically achieve fluctuations in consumption expenditures, and discuss the reasons why each of these mechanisms is problematic empirically.

*Answer:*

See RBC-Prescott.

3. Consider a tropical economy with two kinds of firms. One firm produces garments in indoor factories, and its production is unaffected by the weather. The other firm produces vegetables and its productivity varies from year to year depending on the intensity of the rainy season. Assuming that investors from outside the country are prohibited from owning shares of the two firms, what would the Lucas asset pricing model imply about which firm’s price/dividend ratio will be higher?
Why? Suppose global warming intensifies the size of weather fluctuations from year to year. What would the model imply about the effects of global warming on the firms’ relative share prices?

Answer:

There is no analytical difference between this example and the example given in class comparing firms with differing degrees of correlation in their earnings and the business cycle: The firm whose variability in productivity is greater will have a lower share price. The increase in variability associated with global warming should reduce the share price of the agricultural firm because it increases that firm’s riskiness.
Part II. Medium Length Questions.

1. Portugal. Among the “Southern Mediterranean” countries afflicted by the Eurozone crisis, Portugal stands out as perhaps the most puzzling case. It was not afflicted by a housing bubble like Spain, it did not have a wildly dishonest government that secretly ran up enormous debts like Greece, it did not have a banking apocalypse like Ireland, and its problems are not longstanding like Italy’s. Here is one story sometimes told about Portugal. Upon joining the Euro zone in the late 1990s, Portugese consumers and firms believed the political rhetoric which was used to justify creation of the Euro: Its adoption would result in productivity gains for the poorer countries who joined. The questions below ask you to consider some implications of this story using models we have studied in class.

   a) Consider a perfect foresight consumption model in which net worth was zero in period \( t^* \), and with preferences such that consumption was equal to labor income. Now suppose that, at date \( t = 1999 \), consumers’ beliefs about their permanent income suddenly and permanently change to a higher level. From 1999 to 2006, actual income remains the same as it was before 1999, but this is interpreted as a series of temporary negative shocks from the new higher permanent level. Finally, in 2007, the Portugese all conclude that the arrival of the Euro did not magically boost their permanent incomes. Their beliefs revert to where they had been before 1999. Plot the paths of consumption and household wealth from before 1999 to after 2007 associated with this interpretation.

   **Answer:**

   The level of consumption jumps up to the believed new higher level of permanent income. Since this exceeds actual income year after year, the Portugese net worth declines by the corresponding amount every year, until their expectations reset in 2007. However, by 2007, net worth will have declined by an amount roughly equal to 7 years worth of difference between believed new permanent income and actual old permanent income. Therefore, spending will have to be lower after 2007 than it would have been if not for the 1999-2006 spending spree.

   b) How would your results differ, if at all, if you considered a buffer stock model of saving rather than the perfect foresight model?

   **Answer:**

   During the “exuberant” 1999-2006 phase, answers would not be very much different. The amount of the decline in assets would be somewhat smaller, because as assets started to run down the precautionary saving motive would intensify, somewhat mitigating the total size of the decline in assets.
After the “reality” phase sets in from 2007, the decline in consumption is not quite as large (because net worth would not have been run down quite so much). Furthermore, unlike in the perfect foresight model, the level of consumption would gradually recover back to its pre-1999 steady-state because target wealth would not have changed from its pre-1999 value and eventually wealth converges to target wealth (so consumption converges to the same amount as before 1999).

c) Using the $\phi$ model of investment show how the phase diagram changes, and show the path of the investment rate leading up to, during, and after the experiment below. Assume that at the beginning of the experiment, the economy is in a balanced growth steady state. Be sure to show how the path of investment differs depending on whether costs of adjustment are low or high. Experiment: Suddenly and without warning, in $t = 1999$, firms become more optimistic about the future level of productivity: They believe that there will be an improvement in the level of their productivity at some future date (say, 2007). This period of optimism lasts for six years, and then suddenly reverses itself (productivity expectations revert to their previous value when 2007 arrives and productivity does not change).

Answer:

The experiment of a believed increase in future productivity was discussed in $q_{\text{Model}}$. The difference with the experiment discussed there and the problem here is that rather than behaving according to the new saddle path after the transition period, the firms jump back down to the old saddle path. So, the pattern would be a jump up in investment during the “exuberant” phase in which there would be a gradual but substantial increase in the level of the capital stock (how substantial depends on the size of costs of adjustment). Then, when the “reality” phase sets in, the level of investment would plummet to well below its steady state value. Capital would gradually decline back towards its original steady state value, and investment would gradually recover towards its original steady state.

d) Now combine the insights from the previous two questions into a narrative about what you would expect to see for Portugal’s current account. (The current account is the amount by which national saving exceeds investment. Assume that leading up to 1999, the current account was balanced). You can assume that the government runs a balanced budget throughout the experiment. Show how the path of the current account differs depending on whether the cost of adjustment for investment is large or small.

Answer:
You’d expect a consumption and investment boom at the same time; the consumption boom would correspond to a decline in the household saving rate, and (unless offset by an increase in government saving, which the question instructs you to assume did not occur) the result is lower national saving. Less saving and more investment implies a big increase in the current account deficit during the “exuberant” phase. The size of the increase depends negatively on the cost of adjustment, because with a large cost of adjustment the amount of extra investment that firms do is fairly small, while if the costs of adjustment are small then the investment boom (and resulting need for foreign savings) will be large.

e) Portugal’s government did not run a balanced budget over the period being analyzed here. A measure of the degree of imbalance is that between 2000 and 2007, the government debt-to-GDP ratio increased by 17 percentage points (Reis (2013)). In the context of the expectations hypothesis articulated above, explain why the Portuguese government might have felt justified in running budget deficits during this period.

Answer:

If the government, like households and firms, believed that joining the Euro zone would provide a magical boost to future productivity, it could argue that higher spending was justified today on the grounds that future income would be much higher (thanks to the productivity boost) and so it could afford to do more spending now based on the permanent income hypothesis (from the government’s budget constraint perspective).

f) Figure 1 shows the evolution of the Portuguese national debt compared to the Eurozone average. Compare this profile to what you would expect from the foregoing analysis. (Ignore the data for the “Eurozone average”; this figure was not hand-crafted for this exam and therefore includes this irrelevant data).

Answer:

The figure for government debt is much as one would expect from the analysis above: A big runup.

g) Figure 2 shows real consumption expenditures in Portugal from 1996 to 2010. Compare this figure to the implications of the model analyzed above. Is there another model of consumption (or perhaps more than one) that we studied in class that might be more consistent with this path of consumption expenditures than the model described above? Explain how the alternative model might help to explain the pattern of consumption expenditures. (You are allowed to make plausible modifications to the timing of changes in expectations, e.g. that the arrival of the Euro was not a complete surprise in 1999).
Figure 1  Debt

Portuguese debt compared to Eurozone average

Source: Eurostat (1/2013)
*estimates

Figure 2  Consumption

Portuguese Consumption
Answer:

Between 1994 and 2002 there is a gradual but cumulatively quite large increase in real consumption expenditures. This differs from the scenarios described above, in which you were instructed to interpret joining the Euro zone as something that resulted in a one-time “surprise” increase in the believed level of permanent income that occurred in 1999.

Several interpretations of the difference are possible:

i. Maybe productivity expectations did increase, but the increase was gradually distributed over the period from 1994 to 2002 rather than occurring with no warning in 1999. Note that this is somewhat inconsistent with the “random walk” theory of expectations because the creation of the Euro zone (and Portugal’s inclusion in it) was not something that could reasonably be interpreted as having become known only gradually. Broadly speaking, the random walk theory rules out a pattern in which consumption changes in the same direction year after year in what looks like a predictable way.

ii. A model in which expectations are sticky can explain the gradual increase in consumption better. Some people may have immediately have formed expectations of high future productivity as soon as the treaty establishing the Euro zone was passed, while others may not have noticed or thought through the implications of Euro zone membership until much later.

iii. Another model in which consumption responds gradually to changes in beliefs, even when the change itself happens suddenly, is the model with habit formation in consumption. However, in a habit formation model if expectations had not changed until 1999, consumption would not have started increasing before 1999. So, again, it is necessary to postulate (reasonably) that if people did form beliefs about a higher level of permanent income, those beliefs needed to be taking shape during the period in which consumption growth was rapid, from roughly the mid 1990s on.

2. Government and Growth.

Standard growth models ignore the role of government in determining a country’s level of income per capita. Yet looking across countries, it seems clear that countries with honest, efficient, rational governments are more prosperous than countries with corrupt, inefficient, and irrational governments.
Suppose we can capture the effect of government efficiency with a term $e$ in the per-capita production function:

$$f(k, e) = k^\alpha e^\eta$$  \hspace{1cm} (5)

where a country with a more efficient government has a higher value of $e$. (Assume the population and the level of productivity are normalized at 1, and $\eta < 1$).

Suppose government expenditures translate one-for-one into productive efficiency $e$, and assume that the government must satisfy a balanced budget criterion by the use of lump-sum taxes of amount $\tau$:

$$e = \tau.$$  \hspace{1cm} (6)

For simplicity, suppose that the capital stock is exogenously fixed at $k = \bar{k}$ and does not depreciate but cannot be augmented by extra saving (there is an endowment of capital).

a) Calculate the level of taxes that maximizes per-capita after-tax income $f(k, e) - \tau$ and explain intuitively the reasons for the effects that the parameters have on the optimal choice of government expenditures.

**Answer:**

$$\max_e \bar{k}^\alpha e^\eta - e$$  \hspace{1cm} (7)

has FOC with respect to $e$ of

$$\bar{k}^\alpha \eta e^{\eta-1} = 1$$  \hspace{1cm} (8)

$$e = \left(\bar{k}^\alpha \eta\right)^{1/(1-\eta)}$$  \hspace{1cm} (9)

which says that expenditures/taxes will be higher when 1) the capital stock is higher (because there is more productivity to “enhance” by government expenditures; 2) when the coefficient on capital is higher ($\alpha$ is larger), for the same reasons; 3) $\eta$ is larger, because the larger is $\eta$ the smaller is the rate at which government efficiency improvements have diminishing marginal productivity effects.

b) Now suppose this economy suffers from corruption. Specifically, some of the tax revenues that are raised do not get spent on efficient government expenditures but instead are wasted. Again using $e$ for the amount of efficient expenditures, and again imposing the balanced budget constraint, the new level of after-tax income is

$$f(\bar{k}, e) - \underbrace{\tau}_{=e\chi}$$  \hspace{1cm} (10)

where $\chi > 1$ measures the degree of corruption. Thus, taxes paid $\tau$ exceed expenditures $e$ (the extra taxes represent waste and corruption). Now calculate the level of $e$ that maximizes after-tax per capita output. Is it higher
or lower than in the honest economy (where $\chi = 1$)? Why? Is there a cost to the economy beyond the fact that the tax burden is higher by amount $\chi$? Why?

*Answer:*

The FOC are

\[
\ddot{k}^{\alpha} \eta e^{\eta - 1} = \chi \tag{11}
\]

\[
e = \left( \frac{\ddot{k}^{\alpha} \eta}{\chi} \right)^{1/(1-\eta)} \tag{12}
\]

and since $\chi > 1$ this is clearly a smaller number than the $e$ that was optimal for the honest economy. Notice that after-tax income is lower for *two* reasons: 1) with a lower $e$ the economy produces less output; 2) with a higher $\chi$ the effective tax rate is higher. So pretax income is less while taxes are higher.

c) *Hall and Jones (1999)* find that, looking across countries in the world, only a very small proportion of the differences in output per capita are explained by differences in capital, natural resources, or other observable factors of production. Discuss how this finding might be related to the modeling choice above to assume a fixed level of capital $\ddot{k}$. Speculate on whether permitting capital accumulation would be likely to reinforce or to undermine the results from the baseline model.

*Answer:*

The *Hall and Jones (1999)* finding suggests that capital accumulation is not one of the main influences that make some countries rich and others poor, so an intensive and complex study of optimal intertemporal allocation decisions may not yield much insight about the process of economic growth. While it is not clear from the Hall and Jones finding whether differences in government efficiency are important, a growing literature does suggest that differences in the honesty and efficiency of government across countries are quite important.

Permitting capital accumulation would likely reinforce but not change the logic outlined above; in the more efficient economy, the incentives to save (returns on capital) would be higher, and therefore it is likely that there would be more saving. This effect could act as a “multiplier” on the importance of government efficiency.
References
