Problem Set 5
Intertemporal Choice

1 Some preliminary instructions

This problem set asks you to work through some φ-model experiments, using computational representations of the model and Jupyter notebooks. This will require some setup on your computer.

1.1 Install Dolo

The first step is to install Dolo.

You can install Dolo from the Anaconda prompt with the command `pip install dolo`. If this does not work, more detailed instructions are available in Dolo's docs. If this still does not work, get in touch with Mateo.

1.2 Download the q-model computational tools

Download Mateo's Q-Investment repo. This contains the tools that you will use to solve the problem set.

1.3 Find the template file and make sure it works

Mateo has created a template file that loads all the required tools, provides examples of how to use them, and defines functions you might find useful. It is located in `Examples/Problem_set_template.ipynb` of the Q-Investment repo you just downloaded.

Locate the file and run it. It is important that you run this file from its exact location, so that it can "find" the external files that define the tools that it uses. Verify that the whole file runs without errors.

1.4 Modify the template to add your answers

Modify the template adding your answers. You can answer both questions in the same file. Please read the questions carefully (**intuitively explaining why the diagrams you produce look the way they do is a very important part of the questions**).

1.5 Submit your solution by email to Mateo

Submit your solution by email. Your solution must be either single Jupyter notebook file, or a notebook for each question.

1. **Dynamics of Investment in Response to a Temporary ITC in the q Model.**

   Answer the following questions using an Abel (1981)-Hayashi (1982) q model of investment.

   You are expected to answer the questions not just quantitatively (e.g., with figures or numbers) but also conceptually. That is, you must explain, in intuitive terms, *why* the variables do what they do.

   a) Leading up to date t, the economy is in steady state. At date t, the government unexpectedly introduces a permanent increase in the investment tax credit, $\zeta \uparrow$. Show the effects on a phase diagram and show dynamics of investment, capital, share prices, and q following the tax change. Explain why λ, the share price of the firm, *drops* when the ITC is implemented.

   b) Leading up to date t, the economy is in steady state. At date t, the government unexpectedly introduces a *temporary* increase in the investment tax credit, $\zeta \uparrow$. The low ITC will last for two years, and then the ITC will revert back to its normal level. Show the effects on a phase diagram and show dynamics of investment, capital, share prices, and q, and the capital stock under two scenarios: (1) costs of adjustment for the capital stock, ω, are high; (2) costs of adjustment are low.

   c) Leading up to date t, the economy is in steady state, and an ITC of 20 percent has existed since the beginning of time. At date t, the government unexpectedly *announces* that in three years (that is, in year $t+5$), there will be a *permanent* decrease in the investment tax credit, $\zeta \uparrow$. Show and explain the effects on a phase diagram and show dynamics of investment, capital, share prices, and q, and the capital stock under two scenarios: (1) costs of adjustment for the capital stock, ω, are high; (2) costs of adjustment are low. EXPLAIN your results

   d) Explain why the logic of the examples you just went through helps understand why, whenever a member of Congress introduces a bill to increase the investment tax credit, that bill is always 'retroactive.' That is, if the ITC change ever passes, it will apply to investments made during the period between the introduction of the bill and its passage into law.

2. **An Increase in Interest Rates in the q Model.** Consider a perfectly competitive industry with costs of adjustment to capital that was in equilibrium with interest rate $\underline{\mathsf{r}}$ leading up to period t, at which date the interest rate increases permanently to $\bar{\mathsf{r}} > \underline{\mathsf{r}}$.

   a) Draw a diagram that shows how the $\Delta\lambda_{t+1} = 0$, $\Delta k_{t+1} = 0$ loci and the saddle path change in response to the increase in the interest rate. Is the new equilibrium level of the capital stock $\breve{k}_{\text{post}}$ higher or lower than before? Why?

b) Draw diagrams showing the time paths of share prices, investment, and the capital stock following the increase in the interest rate. Explain the time pattern of share prices over time; in particular, explain the relationship between any depicted movements in share prices, and the proposition that stock prices follow a random walk.

c) Suppose that, in response to the increase in interest rates, the government wanted to pursue a tax policy that would prevent any changes in the level of the capital stock. Describe the two options the government has, and explain how the two policies would differ or be similar with respect to their implications for dynamics of ϱ and λ.

References

Abel, Andrew B. (1981): "A Dynamic Model of Investment and Capacity Utilization," *Quarterly Journal of Economics*, 96(3), 379–403.

Hayashi, Fumio (1982): "Tobin's Marginal Q and Average Q: A Neoclassical Interpretation," *Econometrica*, 50(1), 213–224, Available at http://ideas.repec.org/p/nwu/cmsems/457.html.

Ramsey, Frank (1928): "A Mathematical Theory of Saving," *Economic Journal*, 38(152), 543–559.