EXPLORING PROPERTIES OF A NK DYNAMIC EQUILIBRIUM MODEL

In this exercise, you use the perfect foresight continuous time New Keynesian model we discussed in lecture 7 to explore how the parameters of the policy rules affect behavior of impulse responses.

To do the exercise, you will need to have R on your computer. It can be downloaded at no cost. You will need to install two "local" packages that are in the same directory on the course web page as this pdf file. You download the local packages (`csolve` and `NKex2020`) as zip files, install them as directories on your computer, and install them with `install.packages("<path_to_the_package_on_your_computer>", repos=NULL)`. The "`repos=NULL`" tells R to look for the package on your computer. You also need the `QZ` package from the CRAN respository, which you can get with `install.packages("QZ")`.

Once the packages are installed, each program in them will have a help file that you invoke as you would any other program help in R.

You start the exercise by reading the equation system in with `read.eqsys`. Then you have to create a vector `param` with named elements and numerical values. You also need to construct a named vector of initial guesses for the steady state values. Then you can invoke `ssSolve` to find the steady state. Then (you can actually do this before calculating the steady state; the order doesn't matter) you invoke `g0g1dc` to add to the system functions that calculate derivatives with respect to variable values. Using the results from the steady state calculation and `g0g1dc`, you get the numerical linearized system with `g0g1evalc`. Finally you get the solution to the linearized version of the system from `gensysct`, using the results from `g0g1evalc`. The output from `gensysct` includes `eu`, a two-element vector signaling "existence" and "uniqueness". `eu == c(1,1)` means you have existence and uniqueness, `c(1,0)` means existence but not uniqueness, etc.

You can get impulse response functions by passing some of the `gensysct` output to `impulsct`, and then you can plot them by passing them to `plotir`.

This is a lot of steps to keep track of, but there is in the problem directory an R script that goes through all the steps for am AM/PF version of the model. You will be exploring what happens to existence, uniqueness, and impulse responses as you vary parameters, particular those in the policy rules. To do that you will be modifying the `param` vector and running the script, or parts of it, multiple times. There's no complicated R programming involved.

Note that `gensys` does not know anything about TVC's. It looks only at properties of the linearized system in the neighborhood of a steady state. It also doesn't differentiate between explosive solutions that nonetheless are equilibria (because no TVC's or feasibility constraints are violated) and explosive solutions that violate TVC's. You can, though, by setting `div=.049` in the list of arguments to `gensysct`, get the program to treat roots that imply explosion at the rate $e^{.049t}$ or less, as if they were stable roots. This is a reasonable thing to do if you have set `rhobar` (the private discount rate) to .05 and you are looking at an AF/PM configuration of policies. However, for AM/PF settings of policy, the unstable

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roots that cause inflation to explode can, in the linearized model, be positive but small. So as we are here accepting the convention that unstable inflation paths can be ruled out, it is not a good idea to set `div` to a positive number when considering AM/PF parameter settings. (Ideally, the program could be given the TVC as an argument (a linear combination of variables that can't explode as fast as $e^{\beta t}$), but the program can't do that yet.)

THE EXERCISE

We have looked at the behavior of simple flex-price models analytically, where we can see that when the long-run monetary policy response of the interest rate to inflation (`thet /gam` in this model) exceeds one, an unstable root appears in the system. Also when the response of the primary surplus `tau` to the level of real debt is zero or negative, we get an unstable root bigger than the discount rate.

So in the simple flex-price model, we get existence and uniqueness when the "Taylor principle" (response of interest rate to inflation greater than one in the monetary policy rule) is satisfied and the primary surplus responds to real debt with a positive coefficient. We also get existence and uniqueness when the Taylor principle is not satisfied and the primary surplus does not respond, or responds negatively, to the level of real debt. These are the AM/PF and AF/PM configurations. AM/AF in the flex-price model implies that only explosive equilibria are possible, except in hairline special cases. PM/PF implies indeterminacy.

To what extent do these conclusions generalize to this NK model? If we set `chi` to zero, so fiscal policy looks "active", is it true that we get existence and uniqueness so long as `thet/gam` is below one? Do we get non-existence as soon as `thet /gam` goes above one with `chi` 0?

What about if `chi` is positive? Do we get existence and uniqueness if the monetary policy rule holds the interest rate constant (i.e. `thet` and `phi` both zero)? If monetary policy is a Taylor rule and still `chi` is positive, do we get existence and uniqueness when `thet /gam` is less than one and non-existence as soon as `thet /gam` exceeds one?

I think you won't find a case where `thet/gam` exceeds one and `chi` is zero, yet there is existence and uniqueness, or instead one where `thet/gam` is less than one and `chi` is positive yet there is existence and uniqueness. But if you do, calculate and plot the irf's and comment on whether they look more like an AM/PF or like an AF/PM equilibirum.

Vary the `thet` parameter with `chi` set at zero, and with it set at a positive number. For values of `thet` that deliver existence and uniqueness of a stable solution, what is the effect of increasing `thet` on the sizes of the effects of monetary policy and fiscal policy shocks on output **`c`** and inflation? Illustrate your conclusion with four irf plots, higher and lower values for `thet`, for AM/PF and for AF/PM.

The file listing the equations, `eqchabex.txt` has two "extra" parameters that are set to zero in the script file. They allow exploration of what happens if fiscal policy responds to the debt service burden and/or monetary policy responds to the level of debt. You are welcome to explore this, but it is not a required part of the exercise.