Tutorial 7

Disequilibrium and Behavioral Macroeconomics

Winter Term 2017/18

Topic: The New-Keynesian Liquidity Trap

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Recommended Readings

- John H. Cochrane. *The New-Keynesian Liquidity Trap.* Working Paper Series of the University of Chicago Booth School of Business, 2 edition, January 9, 2015
- Ivan Werning. *Managing a Liquidity Trap: Monetary and Fiscal Policy*, Manuscript, 2012

Exercise:

We consider again the framework of Cochrane (2015). It is given by

$$\dot{x}_t = ir_t - \pi_t \tag{1}$$

$$\dot{\pi}_t = \rho\pi_t - \kappa(x_t + g_t). \tag{2}$$

Here, x_t is the output gap, i_t is the nominal interest rate, $ir_t = i_t - r_t$ is the natural real rate of interest and π_t is inflation.

Suppose that the economy suffers from a temporarily negative natural rate $ir_t = i_t - r_t = -r < 0$ for $t < T$, that is conditional for the ZLB to become a binding constraint on monetary policy, which lasts until time T. Thereafter, $ir = 0$ for $t > T$. Furthermore, g_t is a constant for the times of ZLB, i.e. for $t < T$ and $g_t = 0$ for $t > T$.

According to Cochrane (2015), the model exhibits three (saddle-path) stable solution paths. They are given by

1. **The Standard Equilibrium:** (equation (9) in paper)

$$\begin{pmatrix} \kappa x_t \\ \pi_t \end{pmatrix} = \begin{cases} \begin{pmatrix} \rho \\ 1 \end{pmatrix} ir - \dfrac{1}{\lambda - \delta} \begin{pmatrix} \lambda^2 & -\delta^2 \\ \lambda & -\delta \end{pmatrix} \begin{pmatrix} e^{\delta(t-T)} \\ e^{\lambda(t-T)} \end{pmatrix} ir & \text{for} \quad t < T \\ 0 & \text{for} \quad t \geq T \end{cases} \tag{3}$$

2. **The Backward Stable Equilibrium:** (equation (11) and (12) in paper)

$$\begin{pmatrix} \kappa x_t \\ \pi_t \end{pmatrix} = \begin{cases} \begin{pmatrix} \rho \\ 1 \end{pmatrix} ir + \dfrac{\delta}{\lambda - \delta} \begin{pmatrix} \delta \\ 1 \end{pmatrix} e^{\lambda(t-T)} ir & \text{for} \quad t < T \\ \underbrace{\dfrac{\lambda \cdot ir}{\lambda - \delta}}_{\pi_T} \begin{pmatrix} \lambda \\ 1 \end{pmatrix} e^{\delta(t-T)} & \text{for} \quad t \geq T \end{cases} \tag{4}$$

Note: The equilibrium time path requires that the economy approaches the steady state as t goes *backwards* in time. This can be achieved by changing the causality of restricting the system to stable subsystems. In particular, when we solve the system backwards, the stable EV δ becomes the unstable one $\rightarrow$ *backward-explosive*. Thus, we set the loading on δ to zero and keep the loading on λ. In this scenario, the central banks does not belief that the economy reaches the steady state at time T immediately, which indicates that $ir_t \neq 0$ even after T.

3. **The No-Jump Equilibrium:** (equation (6) in paper)

$$\begin{pmatrix} \kappa x_t \\ \pi_t \end{pmatrix} = \begin{cases} \begin{pmatrix} \rho \\ 1 \end{pmatrix} ir - \dfrac{1}{\lambda - \delta} \begin{pmatrix} \lambda^2 & -\delta^2 \\ \lambda & -\delta \end{pmatrix} \begin{pmatrix} e^{\delta(t-T)} \\ e^{\lambda(t-T)} \end{pmatrix} ir + \begin{pmatrix} \lambda \\ 1 \end{pmatrix} \pi_T e^{\delta(t-T)} & \text{for} \quad t < T \\ \begin{pmatrix} \lambda \\ 1 \end{pmatrix} \pi_T e^{\delta(t-T)} & \text{for} \quad t \geq T \end{cases} \tag{5}$$

with

$$\pi_T = e^{\delta T} \left[\frac{(e^{-\delta T} - 1)\lambda - (e^{-\lambda T} - 1)\delta}{\lambda - \delta} \right] ir$$

Note: In this scenario, the value of π_T is so that $\pi_0 = 0$.

Assume the following numerical values: $\rho = 0.05$, $ir = i_t - r_t = 0.05$ for $t < T$, $\kappa = 1$, $T = 5$ and $t \in [0, 2T]$.

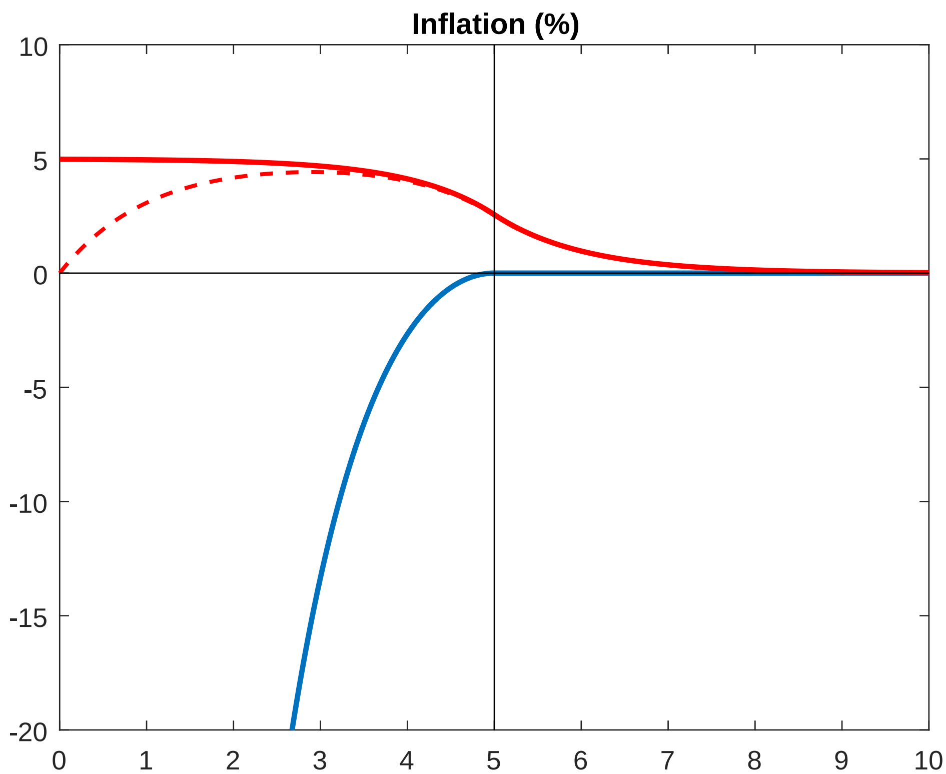
a) Compute the eigenvalues δ and λ

b) Compute the equilibrium paths of output and inflation

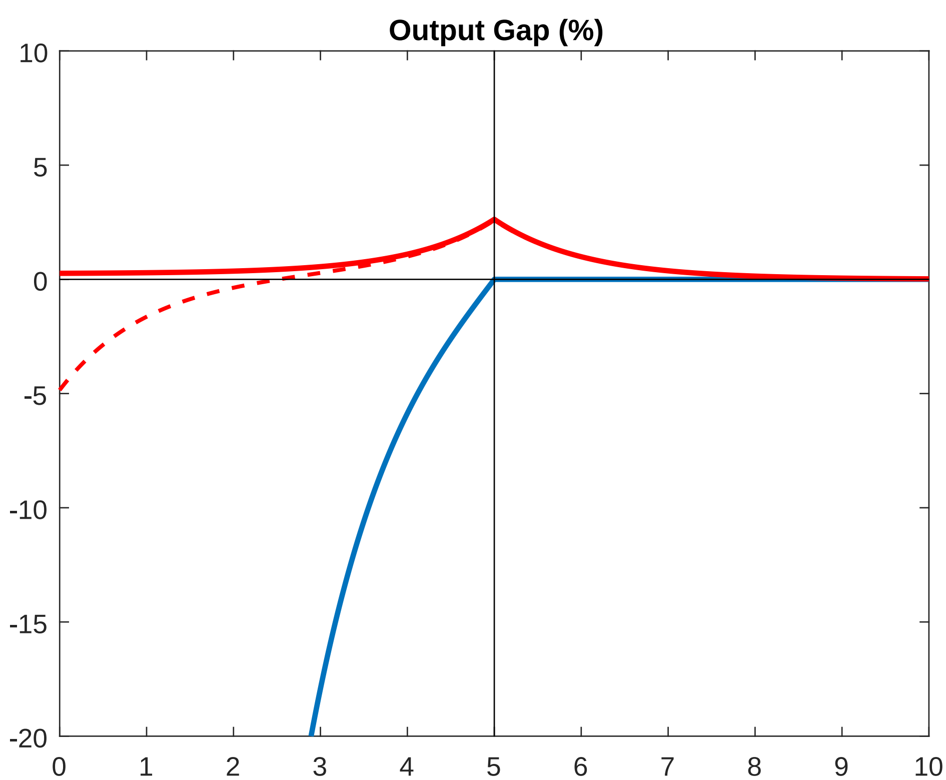
c) Plot the IRFs in a graph and discuss the results. How do the results differ?

Solution:

- Its about the expectations of what will happen once the trap passes
- The standard equilibrium (S EQ) says that the liquidity trap produces a large output gap and deflation, that longer-lasting traps are exponentially worse, and that expectations of low probability traps in the far-off future are worse still



(a) Inflation π_t



(b) Output x_t

Figure 1: Note: The blue line refers to the S EQ, the red line to the BS EQ and the dashed line to the no-jump EQ

- The only difference between a gentle inflation and a disastrous recession (backward VS. Standard EQ) is people's expectations of inflation in the immediate aftermath of the liquidity trap
- Unlike the standard solution, that gets exponentially worse for longer traps, the backward-stable (BS) EQ is insensitive to trap length
- According to the BS EQ, news of a trap further in the future has larger effects on inflation and output today
- In sum, the BS EQ suggests that a negative natural rate and the zero bound is a mild event, associated with a mild inflation, which will emerge on its own without any additional policy, and little output variation. It suggests that longer traps are if anything less of a problem, because prices have more time to adjust, and that expectations of far off events have smaller and smaller effects today
- The No-Jump EQ assumes that people learn about the trap, $\pi_t = 0$. It is also BS. News about traps further in the future have no effect on inflation today, and lower effects on output
- We learned that the equilibrium choice is central to the model's economic predictions. The analysis shows that equilibrium selection, rather than just the path of expected interest rates, is vitally important for understanding these models' predictions $\rightarrow$ interest rate policies are central, but the equilibrium paths are important as well.