#### Lecture 18

## The Real Business Cycle Model

Part 5: Application and Matching Data

Hui-Jun Chen

The Ohio State University

May 9, 2022

- Recall that in Lecture 13, there is no production in dynamic model.
- The following 5 lectures is for **Real Business Cycle** (RBC) model:
  - Lecture 14: consumer
  - Lecture 15: firm
  - Lecture 16: competitive equilibrium
  - Lecture 17: formal example
  - Lecture 18: application to bring RBC to data

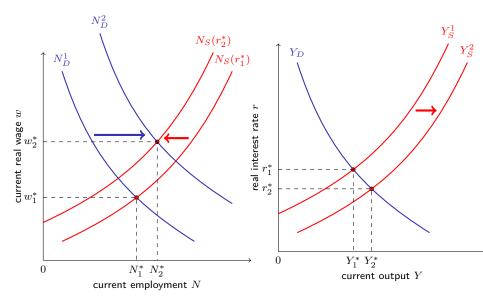
#### Analysis on $z \uparrow$

Suppose current TFP increases from  $z_1$  to  $z_2$ ,  $z_2 > z_1$ 

- labor demand (firm):  $z \uparrow \Rightarrow MPN \uparrow$ , and thus  $N_{D,2} > N_{D,1}, \forall w$
- labor supply (consumer): no direct effect, but  $r^* \downarrow$  leads to  $N_S(r)$  shifts in
- $\blacksquare$  labor market clearing: demand  $\uparrow$ ,  $w \uparrow$ , and  $N^*(r) \uparrow$ , hold r fixed
- lacktriangledown output supply: shifts out  $\because$  labor market,  $Y_{S,2}(r) > Y_{S,1}(r), \forall r$
- output demand: no effect, only move along the curve, because
  - firm: current TFP is not changing optimal investment schedule
  - consumer: no direct effect
  - government: no direct effect

Hui-Jun Chen (OSU) Lecture 18 May 9, 2022 3/16

### Equilibrium Effects of $z \uparrow$



Hui-Jun Chen (OSU) Lecture 18 May 9, 2022 4/16

 $G \uparrow$ 

### Taking Stock: $z \uparrow$

Output supply curve shifts out, while output demand remain the same

- $\blacksquare$  output  $\uparrow$ ,  $Y_2 > Y_1$
- $\blacksquare$  real interest rate  $\downarrow$ ,  $r_2 < r_1$
- $\blacksquare$  decreases in r make labor supply shifts in
  - ullet saving S become less desirable, so no need to work that much
- wage increase because of the shifts in demand and supply
- effect on  $N^*$  is theoretically ambiguous, yet data shows that the effect of intertemporal substitution of leisure  $(N_S \downarrow)$  is small

Recall **business cycle facts**: procyclical labor, real wage, and average labor productivity.

All consistent with model prediction!

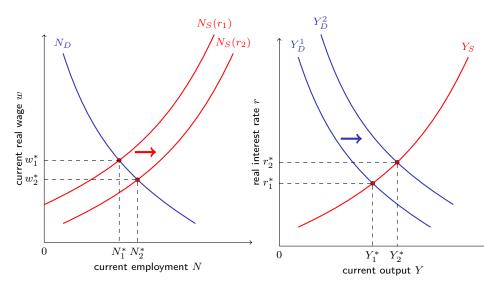
Hui-Jun Chen (OSU) Lecture 18 May 9, 2022 5/16

### Analysis on $z' \uparrow$

- labor demand: no direct effect
- lacktriangle labor supply: no direct effect, yet  $r\uparrow$  cause supply to shift to the right
- output supply: no direct effect
- lacktriangledown output demand: higher  $z'\Rightarrow$  higher  $MPK'\Rightarrow$  firm's investment demand is higher  $\Rightarrow$  demand shifts to the right
  - no direct effect from consumer and government

Hui-Jun Chen (OSU) Lecture 18 May 9, 2022 6/16

# Equilibrium Effect of $z' \uparrow$

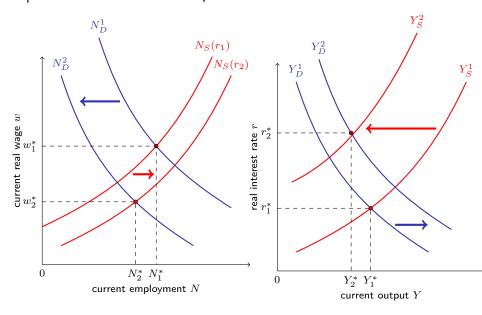


 $K\downarrow$   $G\uparrow$ 

Suppose a natural disaster destroys some initial capital:  $K_1 \to K_2$ , where  $K_2 < K_1$ .

- lacktriangled labor demand:  $K\downarrow\Rightarrow MPN\downarrow\Rightarrow N_D^2(w)< N_D^1(w), \forall w$
- labor supply: no direct effect, but  $r^* \uparrow \Rightarrow N_S(r) \downarrow$
- lacktriangle labor market clearing: lower wage and quantity of labor, hold r fixed
- $\blacksquare$  output demand: shifts in,  $\because$  labor market effects,  $Y^2_S(r) < Y^1_S(r), \forall r$
- output supply: shifts out, because
  - firm:  $K \downarrow$ , so must  $I_D \uparrow$  to meet same amount of K'
    - remember capital accumulation process  $K' = I_D + (1 \delta)K$
  - consumer and government have no direct effects





lui-Jun Chen (OSU) Lecture 18 May 9, 2022 9/16

 $G \uparrow$ 

example: wartime spending (WWII), Stimulus in recession (COVID check)

Need to trace individual decisions and market clearing conditions to find **overall equilibrium effect**.

- $\blacksquare$  simplification: assume MPC is constant
- interpretation: slope < 1 in output demand curve
- example:  $U(C,C') = \ln C + \beta \ln C' \Rightarrow C' = \beta (1+r)C$ , which implies

$$C = \frac{1}{1+\beta} \left( Y - T + \frac{Y' - T'}{1+r} \right) \Rightarrow \frac{dC}{dY} = \frac{1}{1+\beta}$$

lui-Jun Chen (OSU) Lecture 18 May 9, 2022 10 / 16

#### Impact on Output Demand

 $G \uparrow$  causes a  $\Delta$  amount of shift in the output demand curve. How big is  $\Delta$ , and where do the change comes from?

- **1** direct effect:  $G_2 G_1 > 0$
- 2 indirect effect: increase in taxes decreases the consumption
  - :  $G_2 > G_1$ ,  $T_2 + \frac{T_2'}{1+r} > T_1 + \frac{T_1'}{1+r}$ , and thus consumer's income  $\downarrow$  by the amount of  $G_2 G_1$ .
  - effect on consumption:  $MPC \times (G_2 G_1)$
- $\ensuremath{\mathfrak{g}}$  indirect effect: consumer perceives as increase  $\Delta$  amount of income, and thus increases consumption
  - translate to consumption:  $MPC \times \Delta$

$$\Delta = G_2 - G_1 + MPC \times (G_2 - G_1) + MPC \times \Delta \Rightarrow \Delta = G_2 - G_1$$

note: more complicated if MPC is not constant, or varies across people!

Hui-Jun Chen (OSU) Lecture 18 May 9, 2022 11/16

The elasticity of output demand with respect to government spending is defined as the **demand multiplier**:

$$m_D = \frac{\Delta}{G_2 - G_1} = 1$$

- implication: rightward shift of the demand curve is exactly 1-1
- because of 1-1 relationship, we know  $Y_D^2(r) = Y_D^2(r) + \Delta$

Lecture 18 May 9, 2022 12 / 16

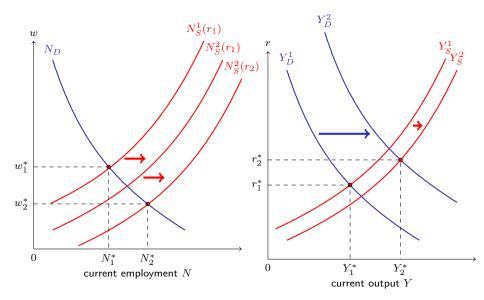
#### Impact on Output Supply

- labor demand: no effect
- labor supply: outward shift,  $\because$  wealth effect of  $T, T' \uparrow$ 
  - holding r fixed,  $N_S^2(r_1) > N_S^1(r_1)$
  - in equilibrium of next slide,  $r^*\uparrow$ , and thus saving become desirable,  $N_S^2(r_2)>N_S^2(r_1)$
- output supply: shifts out, given labor supply shifts

Combine effects:  $Y^* \uparrow$ ,  $N^* \uparrow$ ,  $w^* \downarrow$ , yet  $r^*$  depends on the amount of movement for both demand and supply.

Hui-Jun Chen (OSU) Lecture 18 May 9, 2022 13/16

## Equilibrium Effect of $G \uparrow$



 $G \uparrow$ 

#### Taking Stock: Output

#### What is the total government expenditure multiplier?

- definition: the equilibrium (as opposed to demand or supply only) ratio of increase in output to the increase in government spending.
- result: must is less than 1 without "large" shifts in supply curve
  - shift in output demand curve is  $G_2-G_1$  for each r
  - supply curve slopes up: equilibrium effect  $< G_2 G_1$  (before shift)
  - what determines size of supply curve shift?
    - size of wealth effect on labor supply (small)
    - size of intertemporal substitution effect on labor supply (small)
  - "Keynesian" stimulus: multiplier may be positive in recessions, but need some sort of economic inefficiency for this result.

Hui-Jun Chen (OSU) Lecture 18 May 9, 2022 15 / 16

#### Taking Stock: Everything Else

Imagine supply curve is horizontal:

- lacksquare equilibrium effect:  $Y_2-Y_1=G_2-G_1$ , no change in r
- would have to come from no change in consumer's lifetime wealth, and so would induce no change in current consumption.

With upward slope sufficient to make  $r_2 > r_1$  (empirically plausible case):

- consumption falls due to intertemporal substitution effect
- investment falls due to higher opportunity cost of investing in capital
- "crowding out:" government expenditures here also limit future production
- total: higher output, but at what cost?