

Lecture 18

The Real Business Cycle Model

Part 5: Application and Matching Data

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- 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
- **labor market clearing**: demand \uparrow , $w \uparrow$, and $N^*(r) \uparrow$, hold r fixed
- **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

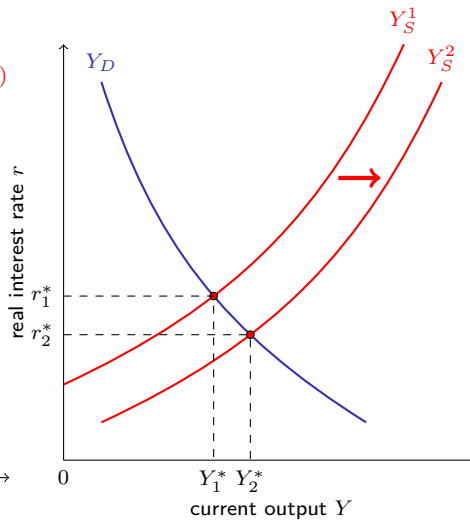
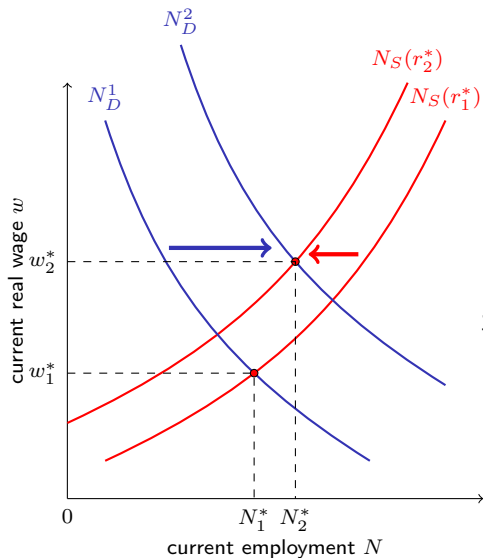
Equilibrium Effects of $z \uparrow$

$z \uparrow$

$z' \uparrow$

$K \downarrow$

$G \uparrow$



Taking Stock: $z \uparrow$

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

- output \uparrow , $Y_2 > Y_1$
- real interest rate \downarrow , $r_2 < r_1$
- decreases in r make labor supply shifts in
 - 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!

Analysis on $z' \uparrow$

$z \uparrow$

$z' \uparrow$

$K \downarrow$

$G \uparrow$

- **labor demand**: no direct effect
- **labor supply**: no direct effect, yet $r \uparrow$ cause supply to shift to the right
- **output supply**: no direct effect
- **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

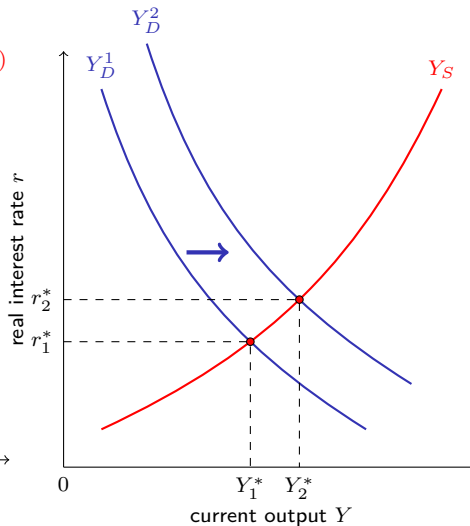
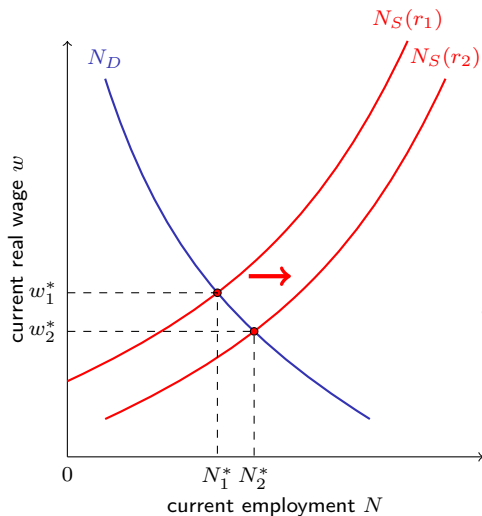
Equilibrium Effect of $z' \uparrow$

$z \uparrow$

$z' \uparrow$

$K \downarrow$

$G \uparrow$



Analysis on Destruction of Initial Capital $K \downarrow$

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

- **labor demand**: $K \downarrow \Rightarrow MPN \downarrow \Rightarrow N_D^2(w) < N_D^1(w), \forall w$
- **labor supply**: no direct effect, but $r^* \uparrow \Rightarrow N_S(r) \downarrow$
- **labor market clearing**: lower wage and quantity of labor, hold r fixed
- **output supply**: shifts in, \therefore labor market effects, $Y_S^2(r) < Y_S^1(r), \forall r$
- **output demand**: 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

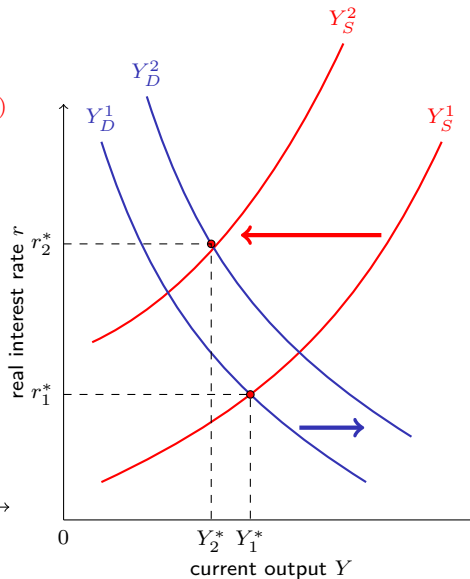
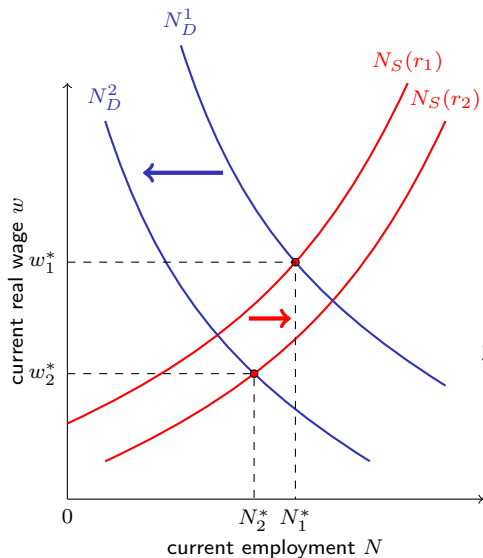
Equilibrium Effect of $K \downarrow$

$z \uparrow$

$z' \uparrow$

$K \downarrow$

$G \uparrow$



Analysis on Government Spending Increase $G \uparrow$

$z \uparrow$ $z' \uparrow$ $K \downarrow$ $G \uparrow$

Suppose $G \uparrow$, holding G' fixed. This is more complicated...

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

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

- **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

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

Impact on Output Demand

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

- ① direct effect: $G_2 - G_1 > 0$
- ② indirect effect: increase in taxes decreases the consumption
 - $\because G_2 > G_1, T_2 + \frac{T'_2}{1+r} > T_1 + \frac{T'_1}{1+r}$, and thus consumer's income \downarrow by the amount of $G_2 - G_1$.
 - effect on consumption: $MPC \times (G_2 - G_1)$
- ③ indirect effect: consumer perceives as increase Δ 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!

Impact on Output Demand (Cont.)

 $z \uparrow$ $z' \uparrow$ $K \downarrow$ $G \uparrow$

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 $Y_D^2(r) = Y_D^1(r) + \Delta$

Impact on Output Supply

$z \uparrow$

$z' \uparrow$

$K \downarrow$

$G \uparrow$

- **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.

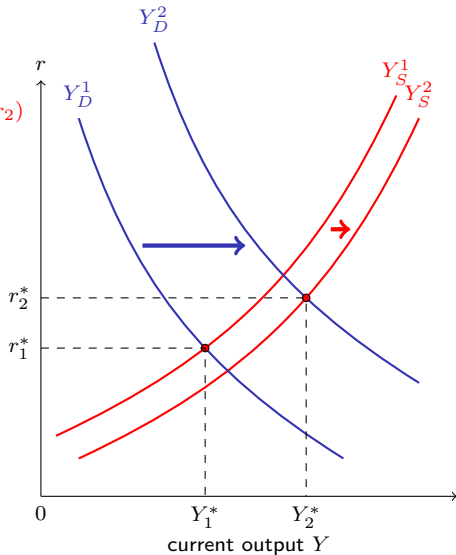
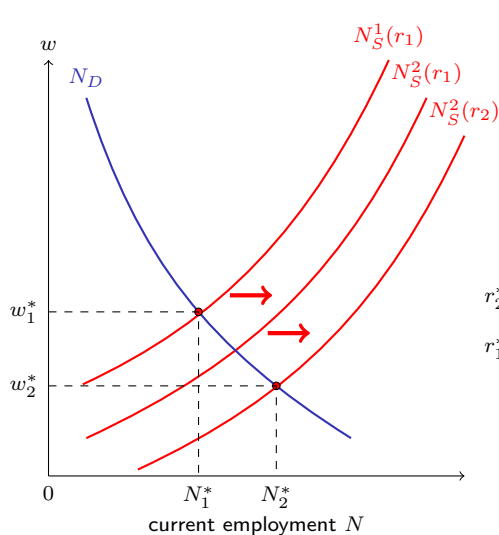
Equilibrium Effect of $G \uparrow$

$z \uparrow$

$z' \uparrow$

$K \downarrow$

$G \uparrow$



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 be 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.

Taking Stock: Everything Else

 $z \uparrow$ $z' \uparrow$ $K \downarrow$ $G \uparrow$

Imagine supply curve is horizontal:

- 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?