

EF3441: Intermediate Macroeconomics

Lectures 10 and 12

The Main Goal of these Lectures

- ▶ Use the real intertemporal model to explain the effects of particular shocks on the economy.
- ▶ Construct the monetary intertemporal economy.
- ▶ Construct a competitive equilibrium in the monetary intertemporal economy.
- ▶ Demonstrate that money is neutral in the monetary intertemporal economy.

Shifts in Output Demand Curve

- ▶ How does output demand change following a change in G ?
 - ▶ If G increases, then T increases (because balance government budget), so w (lifetime wealth) decreases.
 - ▶ If w decreases, then C decreases (because consumption is a normal good).
 - ▶ Change of G is greater than the change of C , So demand curve shifted to the right.
- ▶ How does output demand change following a change in the present value of taxes?
 - ▶ If the present value of taxes increases, so w decreases.
 - ▶ C decreases because of negative income effects, so the demand curve shifts to the left.
- ▶ How does output demand change following a change in future income?
- ▶ How does output demand change following a change in future total factor productivity?
- ▶ How does output demand change following a change in current capital stock?

Shifts in Output Demand Curve

- ▶ How does output demand change following a change in G ?
- ▶ How does output demand change following a change in the present value of taxes?
- ▶ How does output demand change following a change in future income?
 - ▶ If future income increases, so w increases.
 - ▶ C increases because of positive income effects, so the demand curve shifts to the right.
- ▶ How does output demand change following a change in future total factor productivity?
 - ▶ If future total factor productivity increases, the future marginal productivity of capital increases.
 - ▶ I increases because of raising future MPK, so the demand curve shifts to the right.
- ▶ How does output demand change following a change in current capital stock?
 - ▶ If current capital stock increases, the future marginal capital productivity decreases.
 - ▶ I decreases because of decreasing future MPK, so the demand curve shifts to the left.

Shifts in Output Supply Curve

- ▶ How does output supply change following a change in G ?
 - ▶ If G increases, then T increases (because balance government budget), so w (lifetime wealth) decreases.
 - ▶ If w decreases, then N^s increases (because leisure is a normal good).
 - ▶ So $zF(K, N)$ goes up, supply curve shifted to the right
- ▶ How does output supply change following a change in z ?
 - ▶ If z increases, then $zF(K, N)$ increases.
 - ▶ If $zF(K, N)$ increases, then N^d increases.
 - ▶ Supply curve shifts to the right!
- ▶ Note: these are exogenous changes, not changes due to r or w .

Algorithm

To solve these exercises, follow these steps:

1. Identify the effect of change on consumer, government, firm (these are exogenous changes, not changes due to r or w)
2. Identify the first tentative equilibrium in the labor market
3. Identify the effect on the output supply curve
4. Identify the effect on the output demand curve
5. Determine changes in Y and r in the goods market.
6. Using result in 2) and change in r determine change in N and w
7. In 5) and 6), specify which result are determinate and which are indeterminate

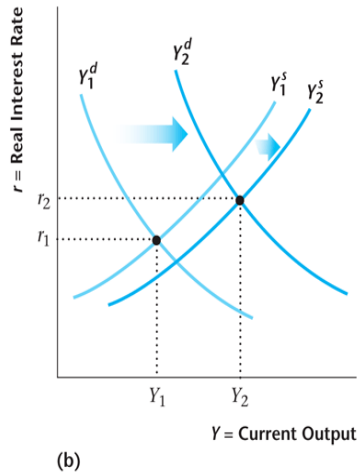
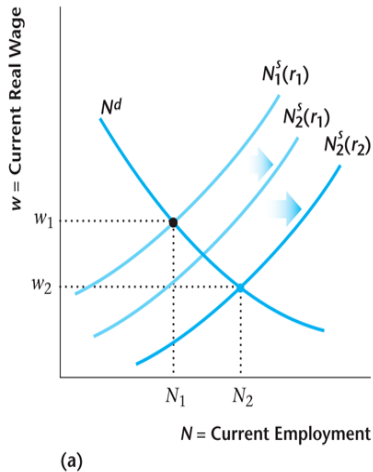
Government Expenditure in Equilibrium

Suppose government temporary increases expenditures: $\Delta G > 0$
and G' unchanged:

1. $\Delta N^s > 0$, Why? (Income effect on normal good)
2. Output supply shifts to the right
3. Output demand:
 $\Delta G > 0$, $\Delta I = 0$, $\Delta C < 0$ but $-\Delta C < \Delta G$, so $\Delta Y^d > 0$

Increase in G : graphical summary

- Note that if Y^s shift “a little” $\rightarrow r$ increases



Increase in G : Summary

The effect of a stimulus:

- ▶ C goes down (government is crowding out private consumption)
- ▶ N goes up (because of income effects) and Y goes up (because N goes up)
- ▶ w goes down (due to shifts on the labor supply curve)
- ▶ r goes up
- ▶ Important: $\Delta Y < \Delta G$. *i.e.* government multiplier < 1

Government Spending and GDP

- ▶ Question: what is the relation between G and Y in the data?
- ▶ Answer: no consensus among economist
 - ▶ Our theory predicts a government multiplier < 1
 - ▶ Keynesian analysis is based on a government multiplier > 1

Government Spending and GDP

Question: what is the relation between G and Y in the data?

Taken from: Mountford and Uhlig (2005)

TABLE 2
PRESENT VALUE MULTIPLIERS OF THE POLICY SHOCKS

	1 qrt	4qrts	8 qrts	12 qrts	20 qrts	Maximum
DEFICIT FINANCED TAX CUT	0.20	0.53	2.08	6.19	3.80	9.59 (qrt 14)
DEFICIT SPENDING	0.44	0.31	0.37	0.29	0.33	0.44 (qrt 1)

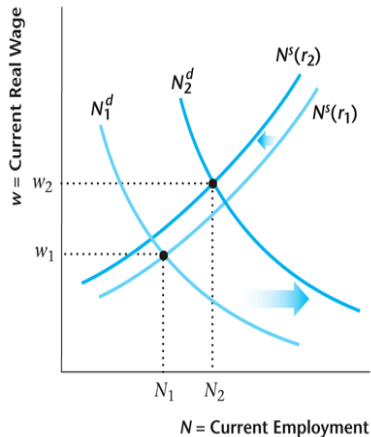
This table shows the present value multipliers for a deficit financed tax cut policy shock and for a deficit spending fiscal policy shock. The multipliers given are the median multipliers in both cases.

Change in Productivity

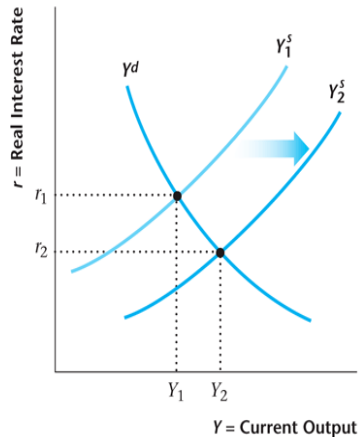
Suppose TFP today increases: $\Delta z > 0$

- ▶ $N^d > 0$, why? the marginal product of labor increases (causes the labor demand curve to shift to the right).
- ▶ Output supply shifts to the right (higher z and N).
- ▶ Output demand: *no shift*.

Change in Productivity



(a)



(b)

Note: Don't forget the effect of r_2 on labor supply.

Change in Productivity

Suppose TFP today increases: $\Delta z > 0$, summarizing:

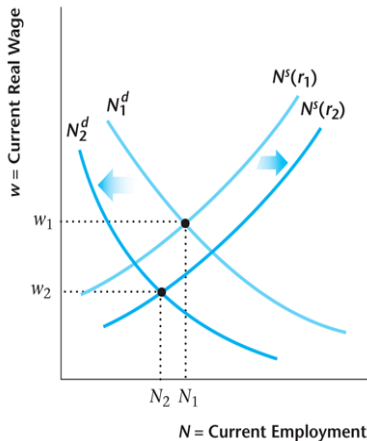
- ▶ Output supply shift to the right, lowers r
- ▶ This causes labor supply to shift to the left
- ▶ In equilibrium:
 - ▶ Effect on N ambiguous (most likely increasing); w increases
 - ▶ Y increases and r decreases

Change in Capital Stock: Japan 2011

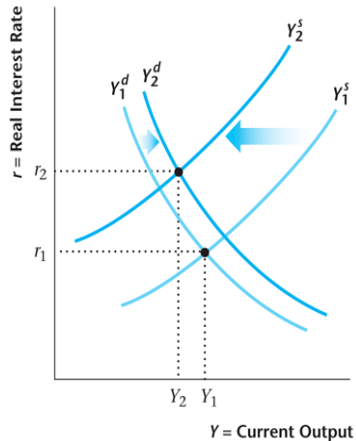
Suppose capital stock today (K) decreases:

- ▶ Labor demand shifts to the left (why?) (marginal product of labor decreases)
- ▶ Output supply shifts to the left
- ▶ Output demand: $I > 0$. Output demand shifts to the right. (Firm increases investment since K decreased)

Change in Capital Stock



(a)



(b)

Note: Don't forget the effect of r_2 on labor supply (Increase in r makes labor supply shift to the right).

Change in Capital Stock

Suppose capital stock today (K) decreases, summarizing:
In equilibrium:

- ▶ I increases
- ▶ Y ambiguous (most likely down), r goes up
- ▶ w decreases; N ambiguous (most likely down)

Japan: **Demand and output**

	2010	2011	2012	2013	Fourth quarter		
					2011	2012	2013
	Current prices ¥ trillion	Percentage changes from previous year, volume (2000 prices)					
GDP at market prices	479.2	-0.3	2.0	1.6	0.8	1.7	1.6
Private consumption	280.8	-0.2	1.3	1.3	0.8	1.0	1.5
Government consumption	96.0	2.3	0.2	-0.1	1.7	0.0	-0.3
Gross fixed investment	98.4	-0.3	5.4	3.7	1.8	5.3	3.4
Public ¹	20.1	-5.5	8.5	-4.2	3.6	6.4	-7.5
Residential	12.7	6.0	7.7	5.0	7.2	6.2	4.2
Non-residential	65.6	0.1	4.0	5.8	0.3	4.8	6.5
Final domestic demand	475.2	0.3	1.9	1.5	1.2	1.7	1.5
Stockbuilding ²	-1.5	0.1	0.2	0.0			
Total domestic demand	473.7	0.4	2.1	1.5	1.4	1.7	1.5
Exports of goods and service:	72.9	1.0	5.0	6.0	2.1	4.4	7.0
Imports of goods and service:	67.4	5.7	5.2	5.4	6.2	4.5	6.2
Net exports ²	5.5	-0.7	-0.1	0.0			

Note: National accounts are based on official chain-linked data. This introduces a discrepancy in the identity between real demand components and GDP. For further details see *OECD Economic Outlook Sources and Methods* (<http://www.oecd.org/eco/sources-and-methods>).

Detailed quarterly projections are reported for the major seven countries, the euro area and the total OECD in the Statistical Annex.

1. Including public corporations.

2. Contributions to changes in real GDP (percentage of real GDP in previous year), actual amount in the first column.

Source: OECD Economic Outlook 90 database.

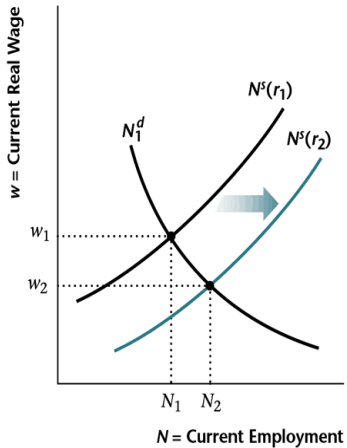
Changing Future Income

- ▶ The peculiarity of the next two examples is that GDP tomorrow will change.
- ▶ In solving for equilibrium, it will be important to understand how the household will anticipate future income changes.

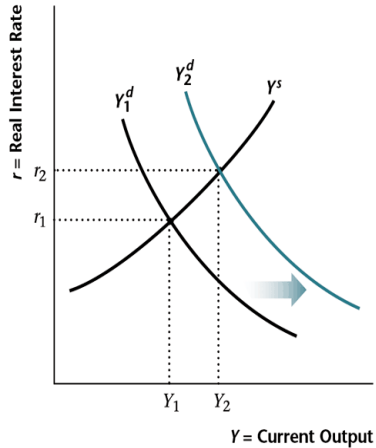
Increase in Future TFP

- ▶ Suppose that z' goes up
- ▶ No change (for now) in the current labor market or labor supply
- ▶ Firm anticipates a higher return to the capital tomorrow, I shifts out. So is Y^d .
- ▶ Interest rate goes up
- ▶ Labor supply shifts to the right

Increase in Future TFP



(a)



(b)

Increase in Future TFP

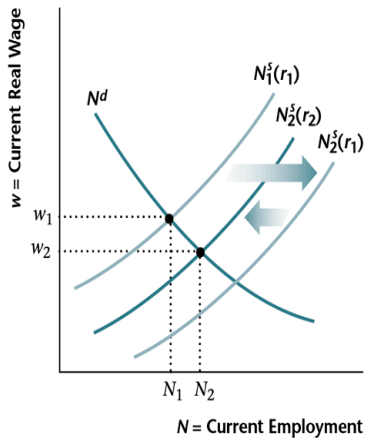
Punchline:

- ▶ C might go up if income effects due to future income increase dominate substitution effect due to higher r
- ▶ I goes up
- ▶ N and Y go up
- ▶ r goes up
- ▶ w goes down

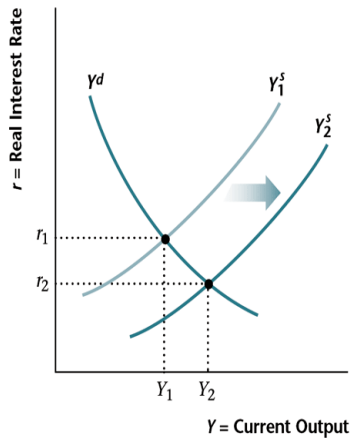
Permanent Increase in G

- ▶ We model permanent changes as changes to G and G'
- ▶ When G and G' increase it implies T or T' go up.
- ▶ Implies labor supply and output supply shift to the right (why?) (Negative income effect, consumes less leisure, that shifts the labor supply curve to the right. This causes the Y^s to shift to the right.
- ▶ The tricky shift is on the output demand curve: the increase due to G increases exactly offsets the decrease in demand due to the permanent decrease in lifetime income. There is no change in the output demand curve.

Permanent Increase in G



(a)



(b)

Note: Don't forget the effect of r_2 on labor supply.

Permanent Increase in G

Punchline:

- ▶ N and Y go up
- ▶ r goes down
- ▶ w goes down
- ▶ C ?
- ▶ I goes up

Recall: The Elastic Consumer

- ▶ Today's budget constraint:

$$c + s = w(h - \ell) + \pi - t$$

- ▶ Tomorrow budget constraint:

$$c' = w'(h - \ell') + \pi' - t' + (1 + r)s$$

- ▶ Lifetime budget constraint:

$$c + \frac{c'}{1 + r} = w(h - \ell) + \pi - t + \frac{w'(h - \ell') + \pi' - t'}{1 + r}$$

Recall: The Elastic Consumer

- ▶ Today's budget constraint:

$$c + s = wN + \pi - t$$

- ▶ Tomorrow budget constraint:

$$c' = w'N' + \pi' - t' + (1+r)s$$

- ▶ Lifetime budget constraint:

$$c + \frac{c'}{1+r} = wN + \pi - t + \frac{w'N' + \pi' - t'}{1+r}$$

Money in the Neoclassical Model

- ▶ We like to include money in the neoclassical model
- ▶ It is not so easy
- ▶ Why? The model only features one good (e.g., fruit). It makes the medium of exchange role uninteresting
- ▶ We will include money essentially as a store of value and will use money as a nominal unit of account
- ▶ We will take a reduced form shortcut and assume that the household receives utility from holding money
 - ▶ M : stock of money (held between current periods and future period. *i.e.* store of value like s .)
 - ▶ P : price of goods measured in units of money
 - ▶ R : nominal interest rate

Nominal Budget Constraints

- ▶ Household's budget constraint in the current period:

$$Pc + Ps + M \leq PwN - Pt$$

- ▶ Household's budget constraint in future period:

$$P'c' \leq P'w'N' - P't' + (1 + R)Ps + M$$

- ▶ Rewriting budget constraints in real terms:

$$c + s + \frac{M}{P} = wN - t$$

$$c' = w'N' - t' + (1 + R) \frac{P}{P'}s + \frac{M}{P'}$$

- ▶ $\frac{M_t}{P_t}$: real money balances

Fisher Relationship

- ▶ Let i denote the nominal interest rate. Recall: r is the real interest rate
- ▶ The Fisher relationship is a relationship between the real and nominal interest rates
- ▶ It is given by:

$$1 + r = (1 + R) \frac{P}{P'}$$

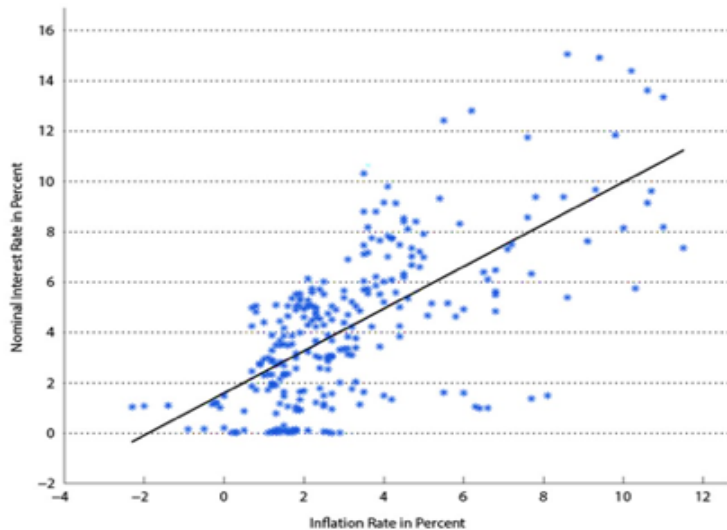
- ▶ Define expected inflation between the current period and future period as:

$$1 + i = \frac{P'}{P}$$

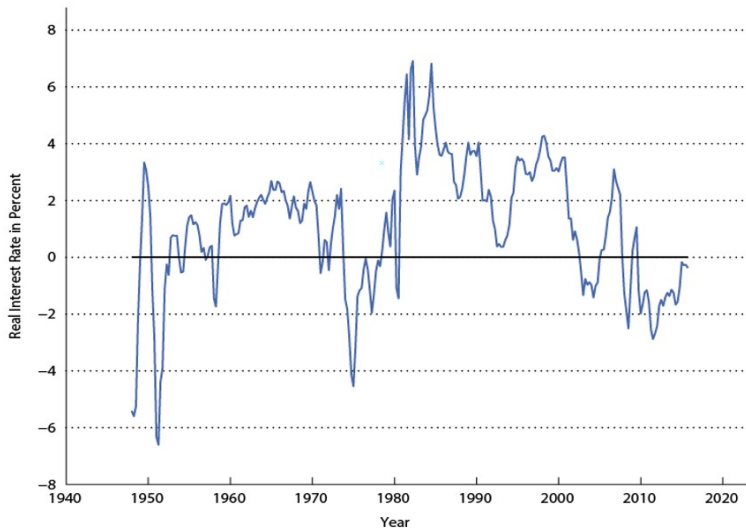
- ▶ Fisher relationship is then approximately:

$$r \approx R - i$$

The Nominal Interest Rate vs. Inflation



The Measured Real Interest Rate



The Real Intertemporal Budget Constraint

- Can write future-period budget constraint as:

$$c' = w'N' - t' + (1+r)s + \frac{1+r}{1+R} \frac{M}{P}$$

$$\Rightarrow \frac{c'}{1+r} = \frac{w'N'}{1+r} - \frac{t'}{1+r} + s + \frac{1}{1+R} \frac{M}{P}$$

- Solve out for s , combining with current period constraint:

$$c + \frac{c'}{1+r} + \frac{R}{1+R} \frac{M}{P} = wN - t + \frac{w'N'}{1+r} - \frac{t'}{1+r}$$

- Exactly the same as before, just this additional expenditure category of $\frac{M}{P}$: $\frac{R}{1+R} \frac{M}{P}$, the costs of holding money

Preferences

- ▶ Note that money is held across periods, not within a period. *i.e.*, it is a store of value.
- ▶ Assume a household receives a utility flow from its holding of real balances via the function V . Increasing and concave
- ▶ Lifetime utility:

$$U = U(c, \ell) + V\left(\frac{M}{P}\right) + \beta \left(U(c', \ell') + V\left(\frac{M'}{P'}\right) \right)$$

- ▶ We know $M' = 0$.

Optimality Conditions

- ▶ New FOC for money:

$$V' \left(\frac{M}{P} \right) = \frac{R}{1+R} U_c(c, \ell)$$

- ▶ Interpretation: marginal (utility) benefit of money equals marginal (utility) cost of money.
- ▶ Demand for Money M^d depends on price level P and function L :

$$M^d = P \cdot L(Y, R) = PL(Y, R)$$

- ▶ Intuition: L is **positive** correlative with Y and L is **negative** correlative with R .

Optimality Conditions

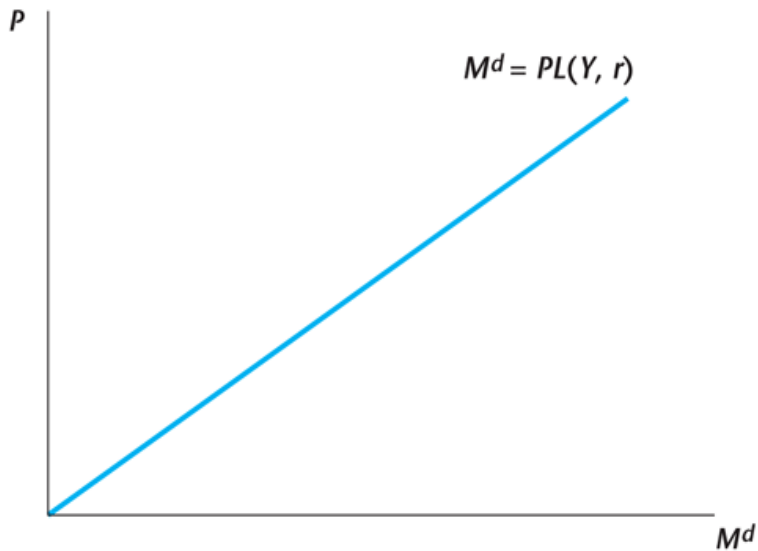
- ▶ Increasing in real income
 - ▶ c and ℓ increases, so $U_c(c, 1 - N)$ decreases (Why?)
 - ▶ From FOC for money, $V'(\frac{M}{P})$ decreases, so M increases (Why?)
- ▶ Decreasing in the nominal interest rate.
 - ▶ The nominal interest rate is the opportunity cost of using the currency in transactions
 - ▶ higher R implies greater use of credit in transactions and less use of currency
- ▶ Nominal money demand
 - ▶ Substitute using the approximate Fisher relation.

$$M^d = PL(Y, r + i)$$

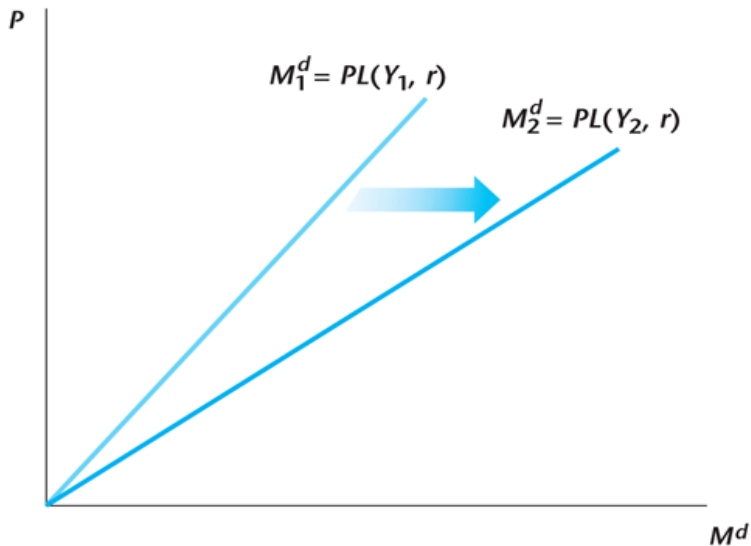
- ▶ For our experiments, suppose the inflation rate is zero

$$M^d = PL(Y, r)$$

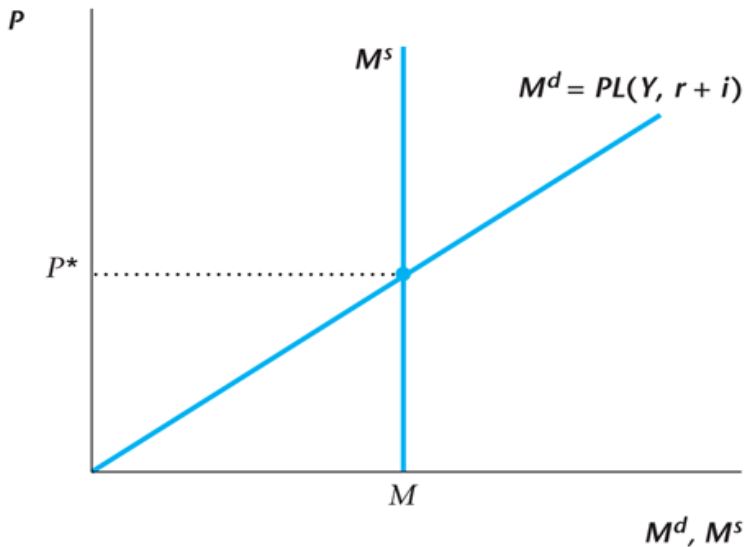
Nominal Money Demand



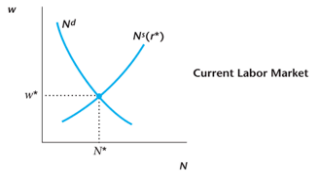
Nominal Money Demand: an Increase in Current Real Income



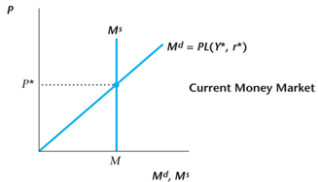
Equilibrium in the Money Market



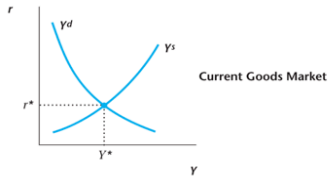
The Complete Monetary Intertemporal Model



(a)



(c)



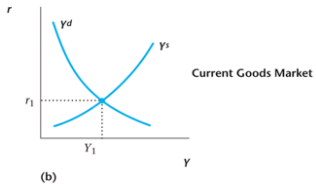
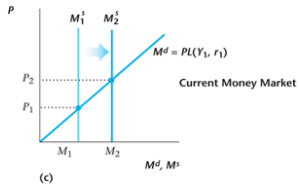
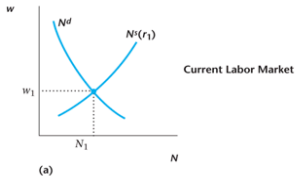
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The Neutrality of Money

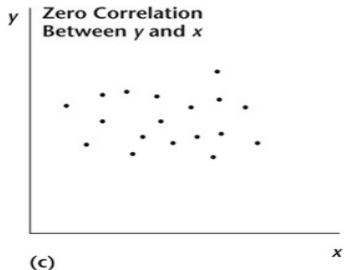
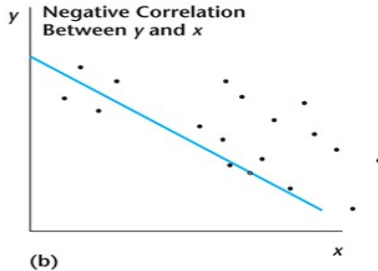
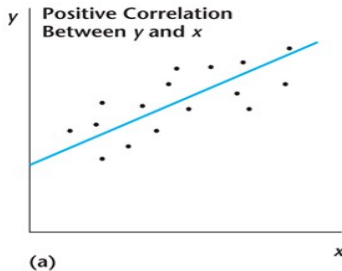
In the intertemporal monetary model

- ▶ a level increase in the money supply increases the price level
- ▶ and the nominal wage in proportion to the money supply increase,
- ▶ **but** has no effect on any real macroeconomic variable.

The Effects of a Level Increase in M



Correlations Between Variables y and x



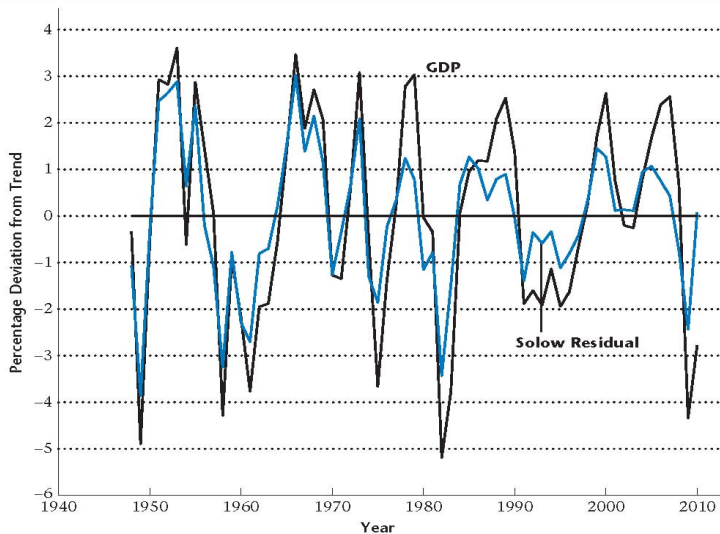
Correlation with Real GDP

- ▶ If the deviations from the trend in a macroeconomic variable are positively (negatively) correlated with the deviations from the trend in real GDP, then that variable is procyclical (countercyclical).
- ▶ If a macroeconomic variable is neither procyclical nor countercyclical, it is acyclical.

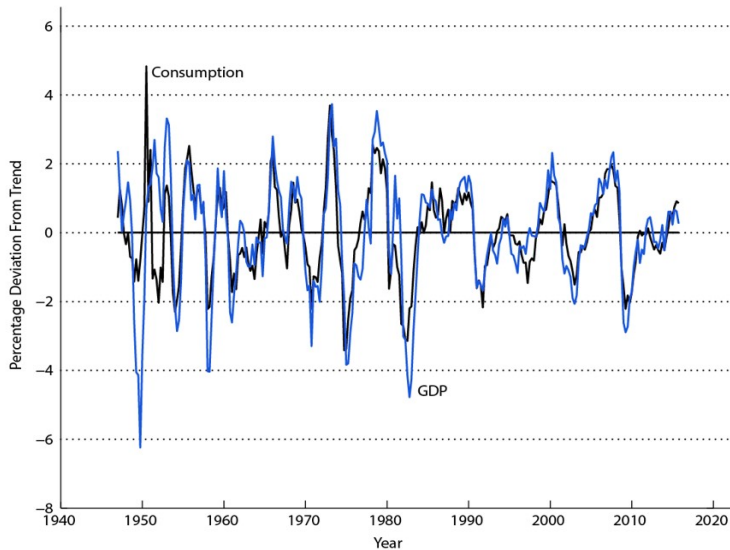
Business Cycle

- ▶ Business cycles are caused by fluctuations in total factor productivity.
- ▶ There is no role for the government in smoothing business cycles
 - ▶ cycles are just optimal responses to the technology shocks.
- ▶ How does the model fit the data?
 - ▶ model fits the data well.

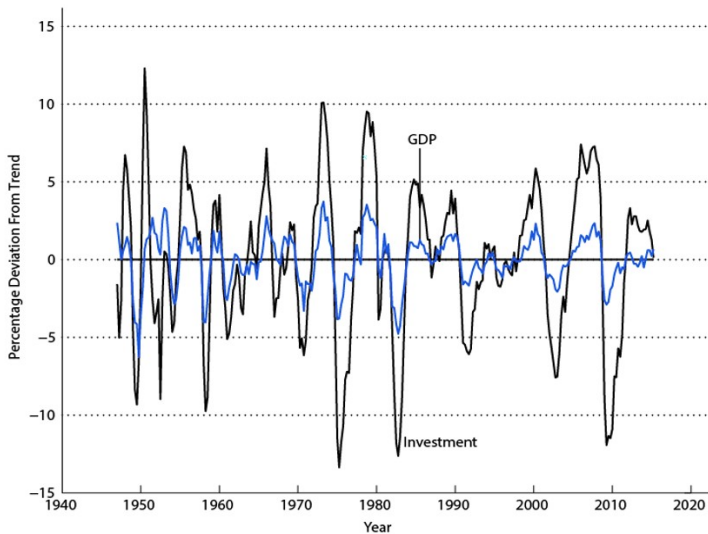
Solow Residuals and GDP



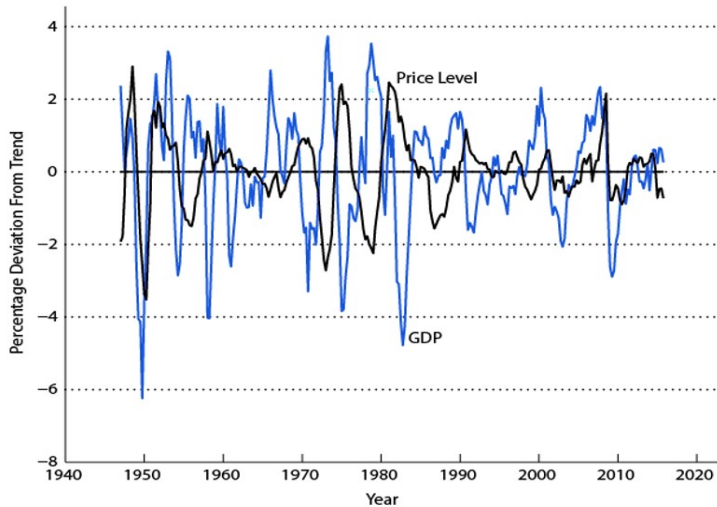
Percentage Deviations from Trend in Real Consumption and Real GDP



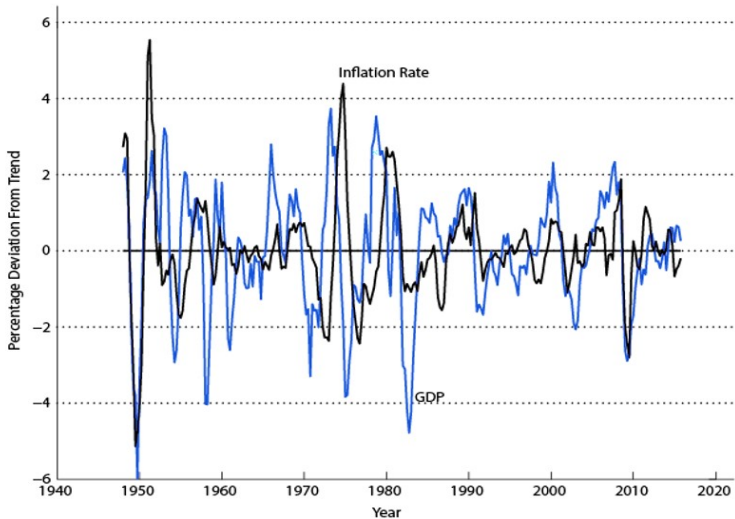
Percentage Deviations from Trend in Real Investment and Real GDP



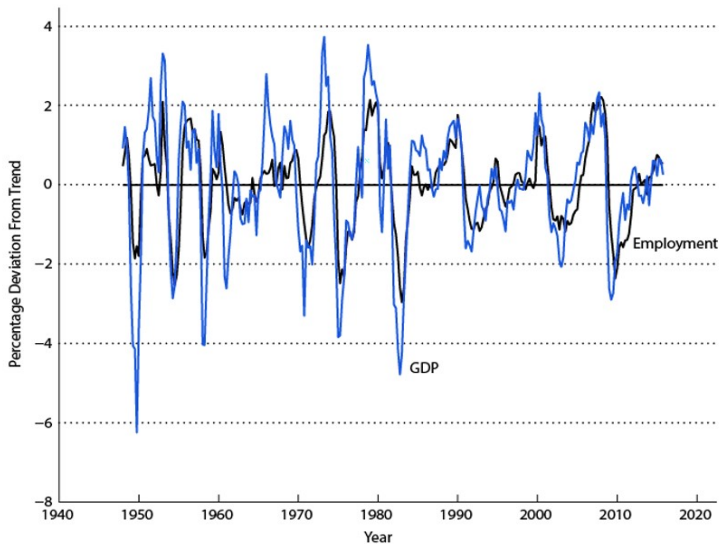
Percentage Deviations From Trend in the Price Level and Real GDP



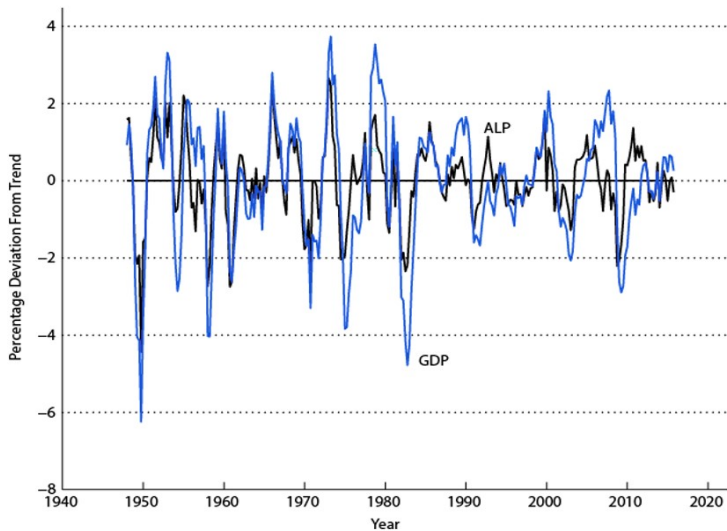
The Inflation Rate and GDP



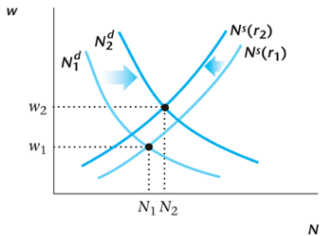
Percentage Deviations from Trend in Employment and Real GDP



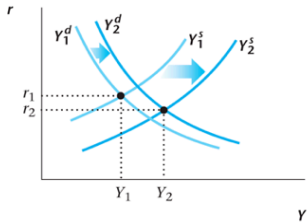
Percentage Deviations from Trend in Average Labor Productivity and Real GDP



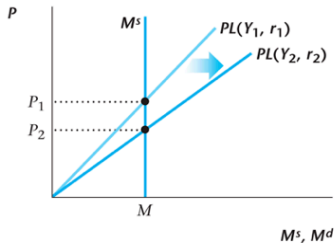
Effects of a Persistent Increase in Total Factor Productivity



(a)

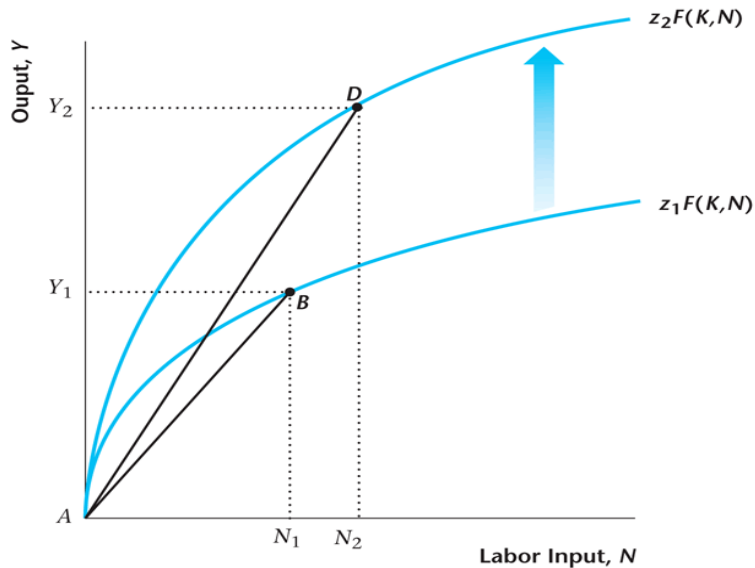


(b)



(c)

Average Labor Productivity with Total Factor Productivity Shocks



Data vs. Predictions of the Real Business Cycle Model with Productivity Stocks

Variable	Data	Model
Consumption	Procyclical	Procyclical
Investment	Procyclical	Procyclical
Price Level	Countercyclical	Countercyclical
Money Supply	Procyclical	-
Employment	Procyclical	Procyclical
Real Wage	Procyclical	Procyclical
Average Labor Productivity	Procyclical	Procyclical

Procyclical Money Supply in the Real Business Cycle Model with Endogenous Money

