

INTERMEDIATE MACROECONOMICS

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METHODOLOGICAL FRAMEWORKS FOR BUSINESS CYCLES STUDIES

- Using simplified **models** that help us to understand **how the aggregate economy works**.
 - how income, interest rate(s), and prices are determined at the aggregate level → **Equilibrium determination models**
- In **ee212**, all these **aggregate (endogenous) variables** are simultaneously determined, and then are given by their determinants, i.e. **exogenous variables**.
- Changes in the “exogenous variables” can lead to the change in income, interest rate and price, i.e. **response of the endogenous variables to exogenous variables**.

METHODOLOGICAL FRAMEWORKS FOR BUSINESS CYCLES STUDIES

- In **ee312**, we reinterpret the variation of exogenous variables and other determinants of aggregate (endogenous) variables as **“shocks”**.
- **Shocks randomly hit the economy**; causing choppy movement in the aggregate variables we are interested in.
 - Random = uncertainty
- Empirically, we try to identify the **origin of cycles (which shocks matter)**, and understand the way in which **identified shocks get propagated** – e.g. transmission mechanism of shocks.
- Normatively, we try to think about how to *prevent/mitigate* the instability or fluctuations – **taming the cycle**.

MODELS OF BUSINESS CYCLES STUDIES

- There are several models that study about the business cycles; for now, we will focus on the **traditional Keynesian system**.
- After we are done with details on Keynesian system, we will look into the **open-economy context**, i.e. the **extension of closed-economy Keynesian system**.

CORE IDEAS/MODELS: KEYNESIAN SYSTEM IN A NUTSHELL.

- **Three variant** versions of Keynesian model

- 1. Keynesian cross**

- Y is determined by components of AE.
- Components of AE depends on Y, and other non-income factors
- Circularity relationship leads to the equilibrium notion: **$AE(Y^*) = Y^*$**
- Implications: The concept of ***traditional Multiplier effect***

- 2. IS-LM model**

- Understand the determination of “**interest rate**”
- The linkage between goods market and financial market.
- Endogenizing the (real) interest rate.
- The whole of working economy can be conceptualized by two curves: **IS and LM curve**

CORE IDEAS/MODELS: KEYNESIAN SYSTEM IN A NUTSHELL

- Three variant versions of Keynesian model (cont.)

3. AD-AS model

- Price can be adjusted, and hence endogenized
- Provide details foundation on aggregate supply under *nominal* rigidities.
- Provide a complete depiction of how macroeconomy works from the point view of Keynesian macroeconomists; **output, interest rate, employment, and price**

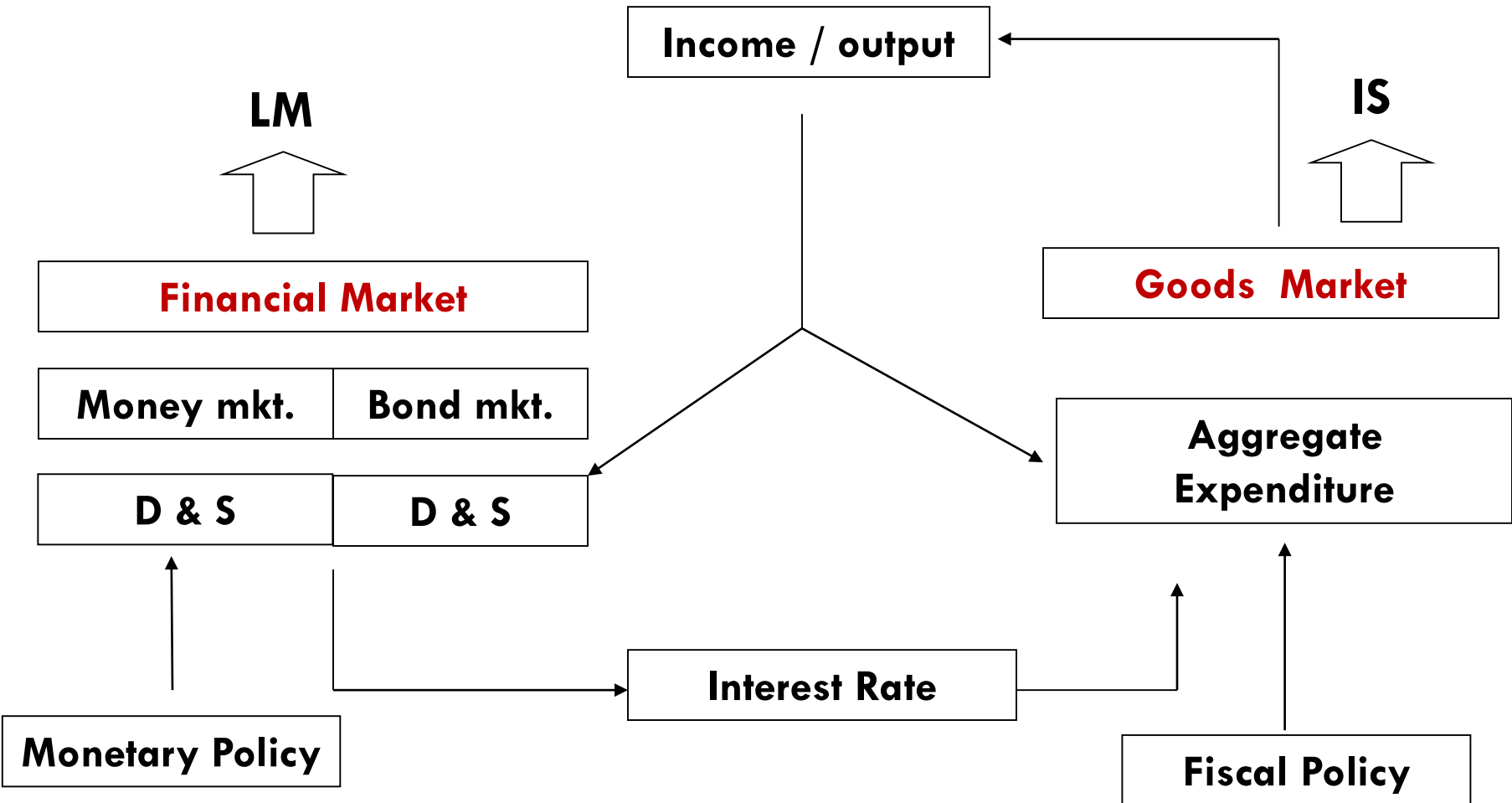
CORE IDEAS/MODELS: KEYNESIAN SYSTEM IN A NUTSHELL

- *Demand shocks* matters a lot the output fluctuations.
- The impact of one-time (temporary) shock lasts quite long; deviation exists in a prolonged fashion.
- Short-fall in the level of aggregate demand, as well as that of over- expansion, can cause *inefficient* level of output.
- Inefficient fluctuations should be corrected by *counter-cyclical policies*; policy interventions are considered *welfare-improving*.

WHAT WE WILL BE DOING

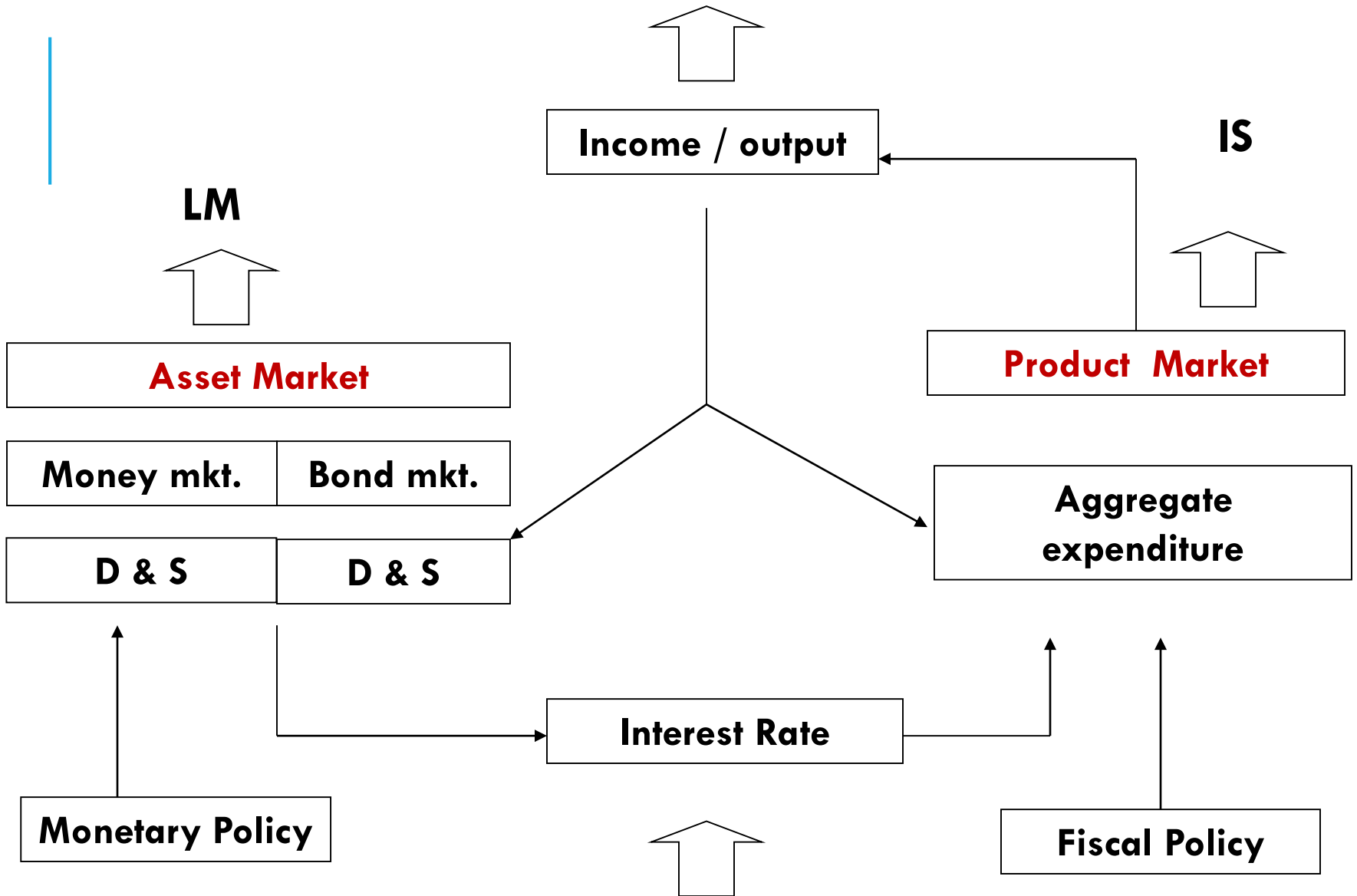
- Review the basic concepts of two important foundations: AD and AS
 - A quick refreshing on **IS-LM-AD**
 - Then, we proceed to the foundation of **AS theory**.
- Next, **analyze the equilibrium** and **shock-propagating mechanism** under AD-AS framework.
- Look into the policy analysis.
- Lastly, validating the Keynesian framework – e.g. how well does the framework fit the data?

THE IS-LM MODEL AND AGGREGATE DEMAND: A QUICK REVIEW



Key assumption: price fixed

Aggregate demand



Price can be adjusted

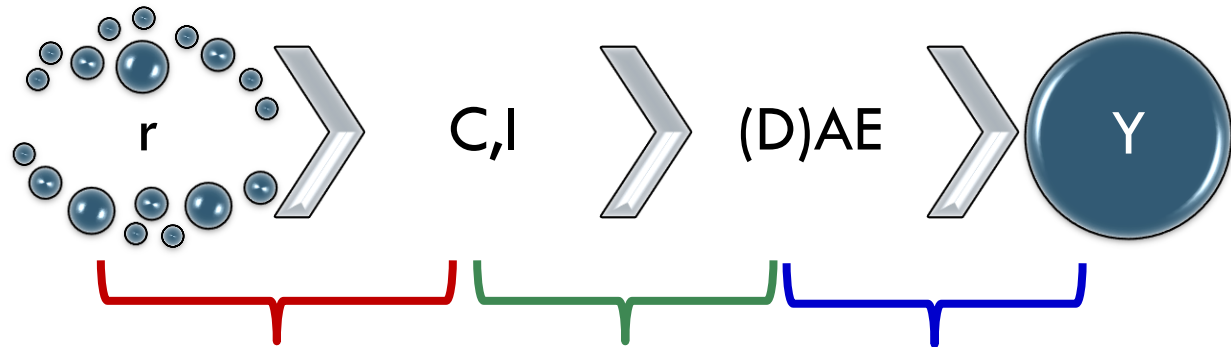
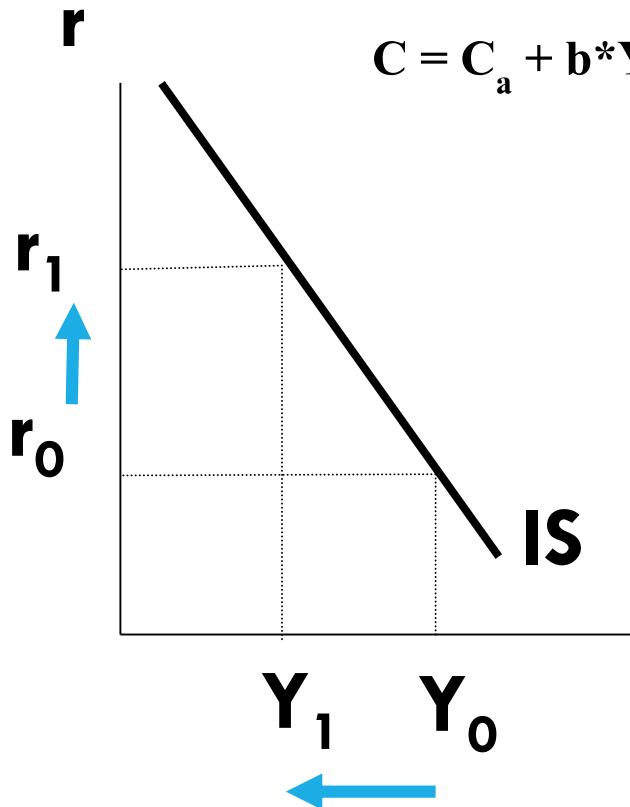
IS CURVE

- Equilibrium relationship between “ r ” and “ Y ” that put the good market under the equilibrium condition, i.e. $Y = AE$.
 - Assuming **closed-economy**.
- **IS curve is downward sloping.** Why?

IS CURVE: WHY DOWNWARD SLOPING?

- (D)AE is determined by “income” and “non-income factors”
 - real interest rate is one of them.

$$C = C_a + b \cdot Y_d - e \cdot r \quad I = I_a - i_1 r + i_2 Y$$

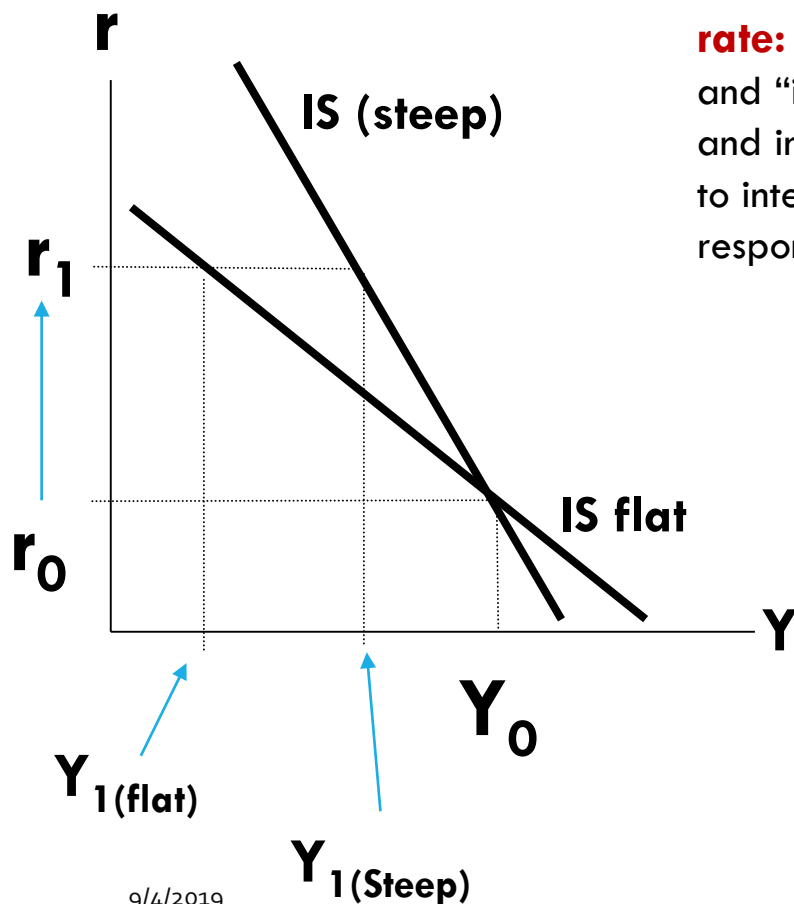


When (real) interest rate increases (r_0 to r_1), investment and consumption will decrease.

Lowering in the investment and consumption causes a drop in aggregate spending (AE).

Change in AE would change the output, based on the multiplier effect. Hence, output would drop (Y_0 to Y_1).

IS CURVE: SLOPE



1. Sensitivity of AE to interest rate:

Interest rate effect: If “e” and “i₁” are high, both consumption and investment are highly sensitive to interest rate. Output is likely to respond more; IS curve is flat.

$$C = C_a + b \cdot Y_d - e \cdot r;$$

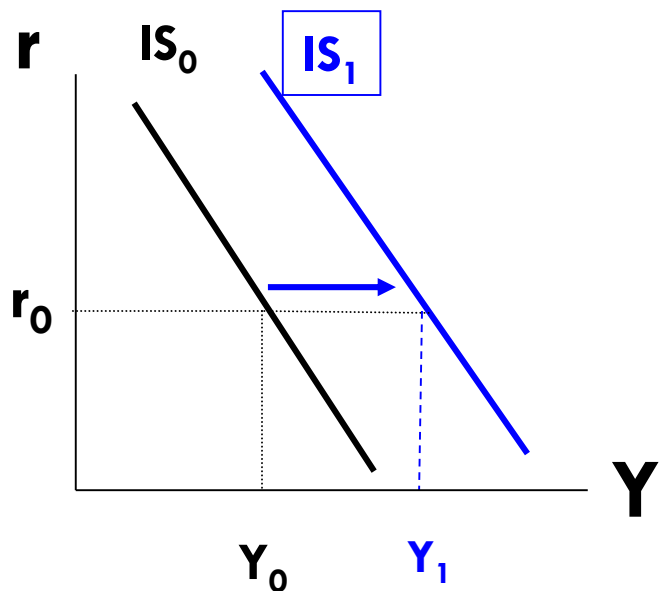
$$I = I_a - i_1 r + i_2 Y$$



2. Sensitivity of Y to AE:

multiplier effect: If “b” and “i₂” are high, one-time change in spending cause a large multiplier effect. Hence, output will be responding more; IS curve is flat.

IS CURVE: SHIFTING THE CURVE



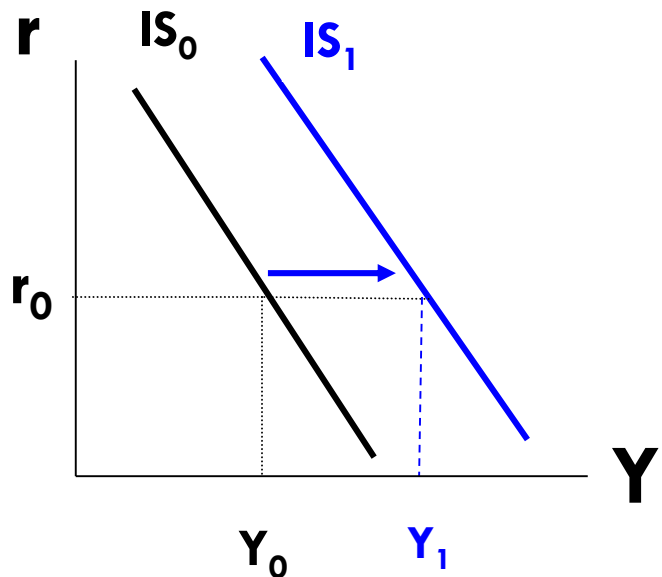
- IS curve is derived under Ceteris Paribus.
- Changes in the exogenous factors can be diagrammatically captured by a horizontal shift of the IS curve.
- The size of horizontal shift depends on the **multiplier effect** of the changing factors.

$$C = C_a + b * Y_d - e * r;$$

$$I = I_a - i_1 r + i_2 Y$$

G; T

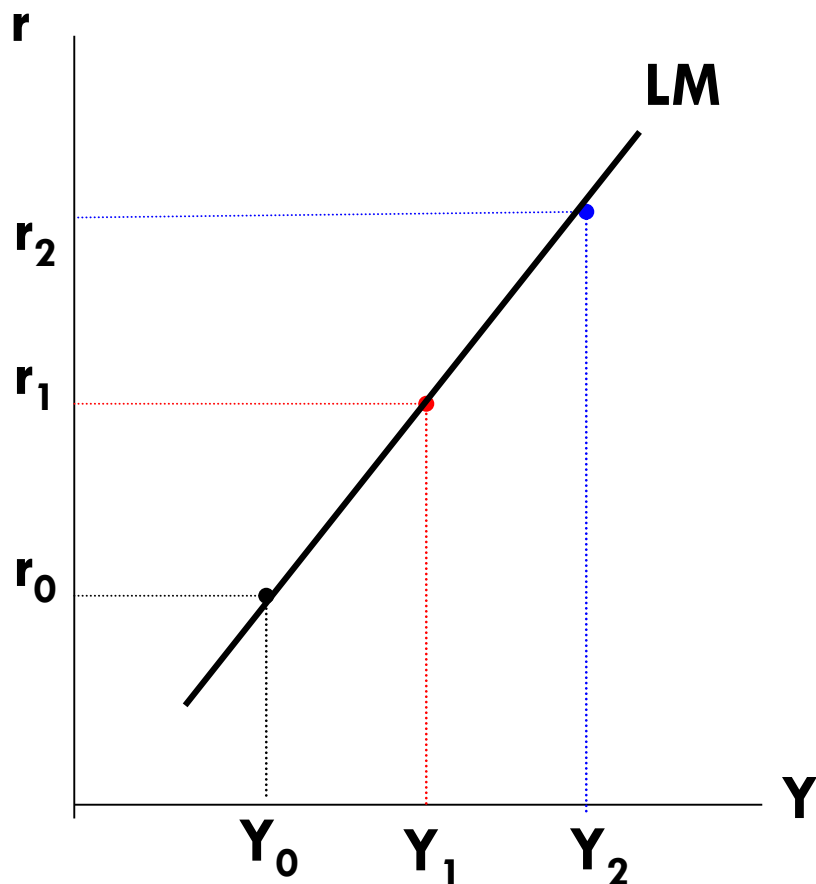
IS CURVE: SHIFTING THE CURVE



- **Question to discuss:**

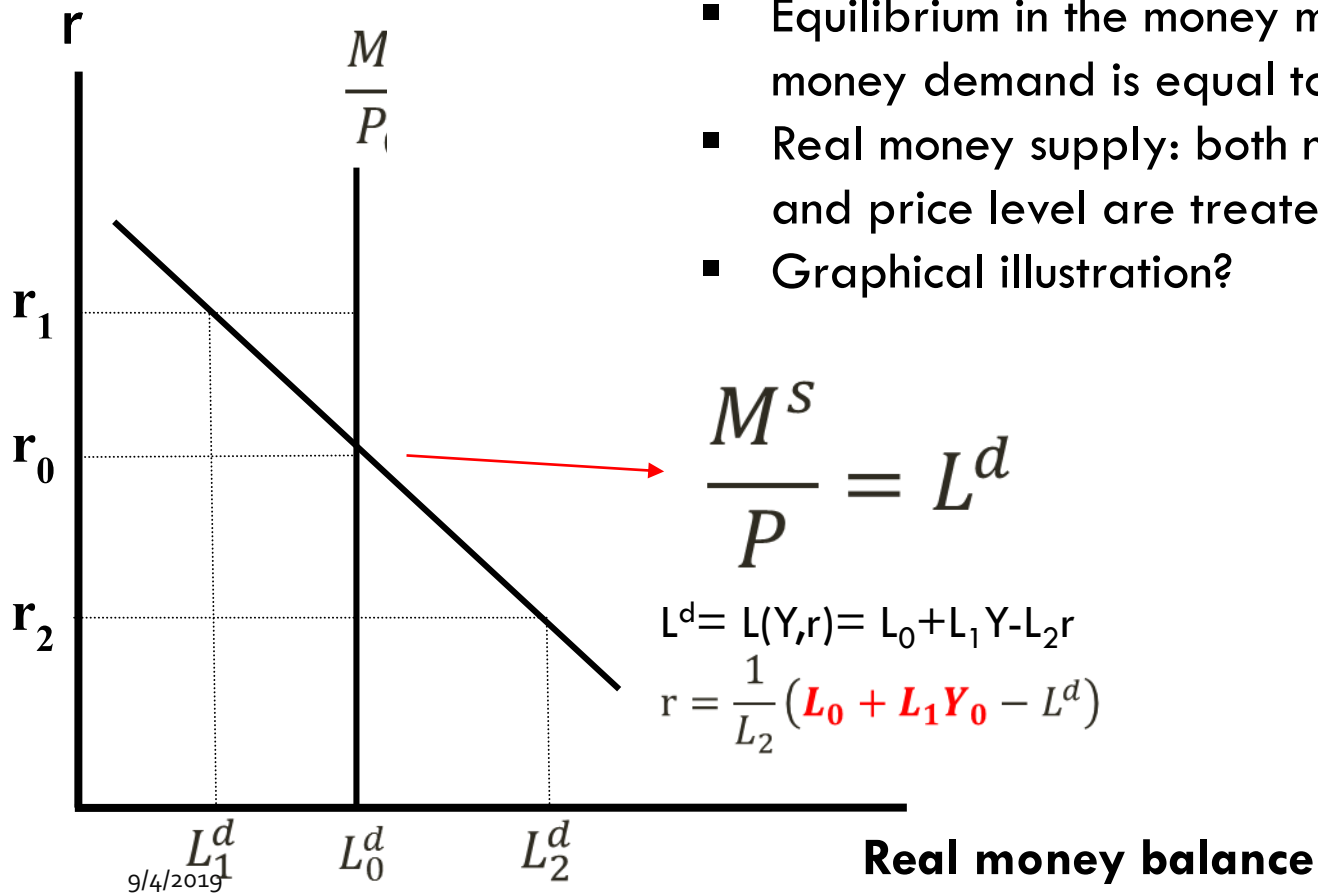
1. For the same amount of the change, which one would produce a bigger shift of IS curve, T or G?
2. Does the size of horizontal shift have any relationship with the slope of IS curve? Why?

LM CURVE



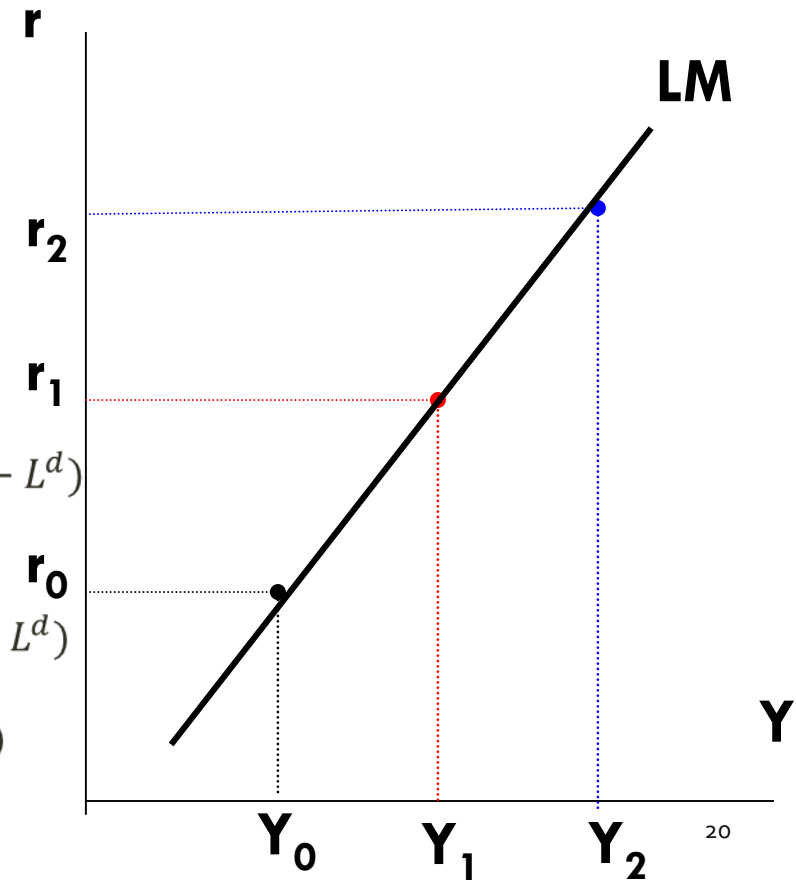
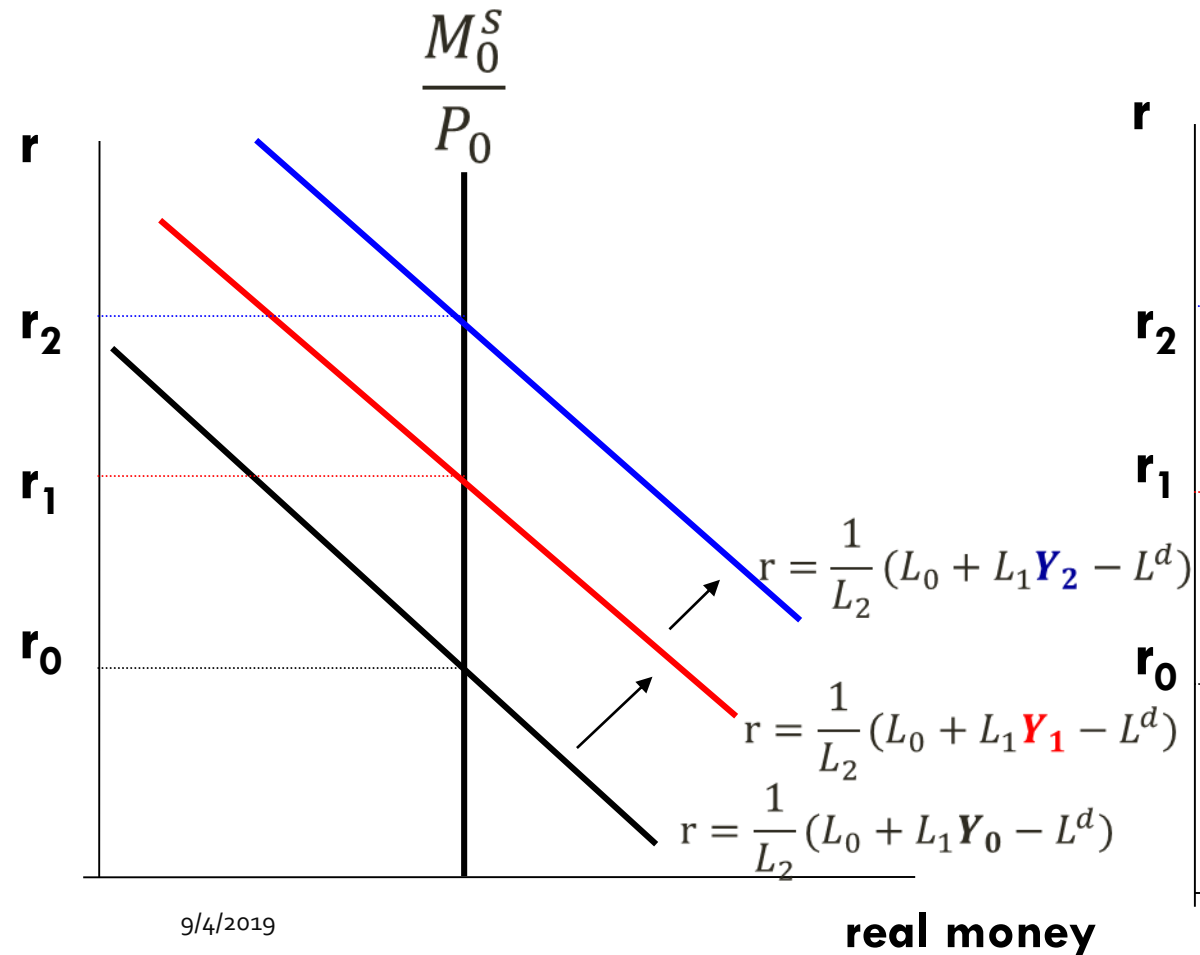
- Pairs of “ r ” and “ y ” that put the money market into equilibrium condition
- LM curve is upward sloping. Why?

THE MONEY MARKET AND LIQUIDITY PREFERENCE THEOREM



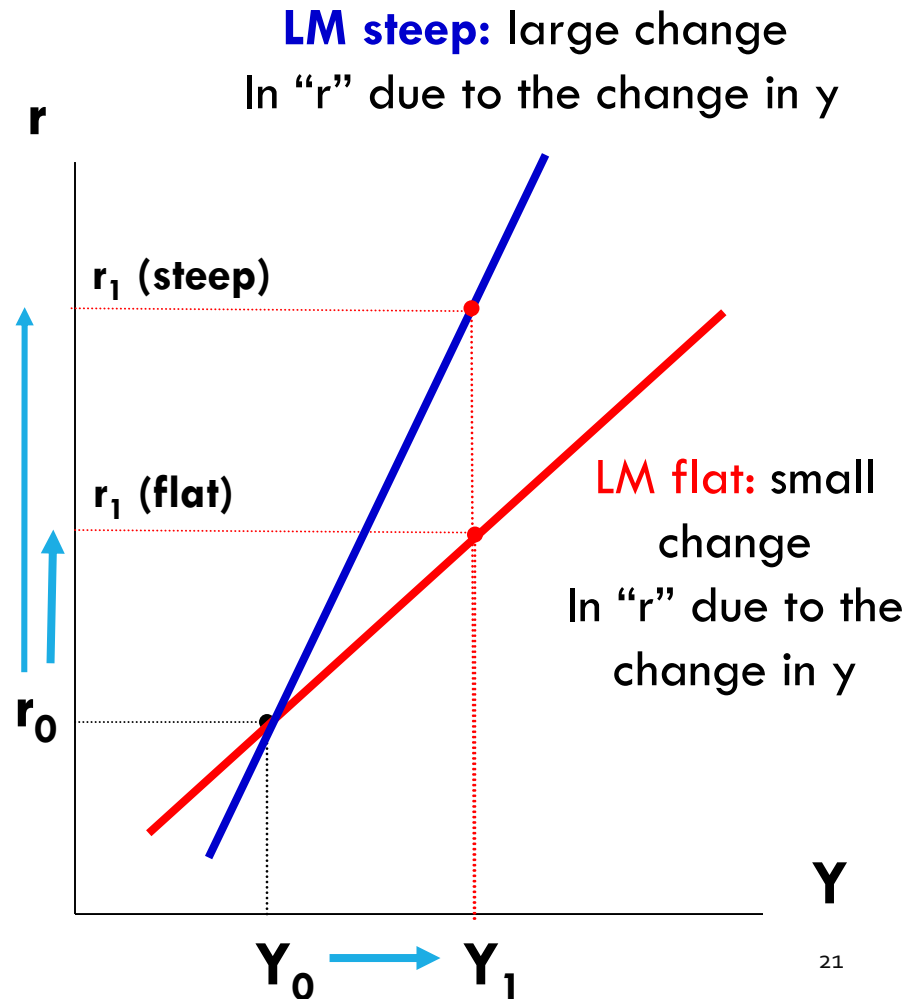
- Equilibrium in the money market occurs when real money demand is equal to real money supply.
- Real money supply: both nominal money supply and price level are treated as given.
- Graphical illustration?

LM CURVE: DERIVATION

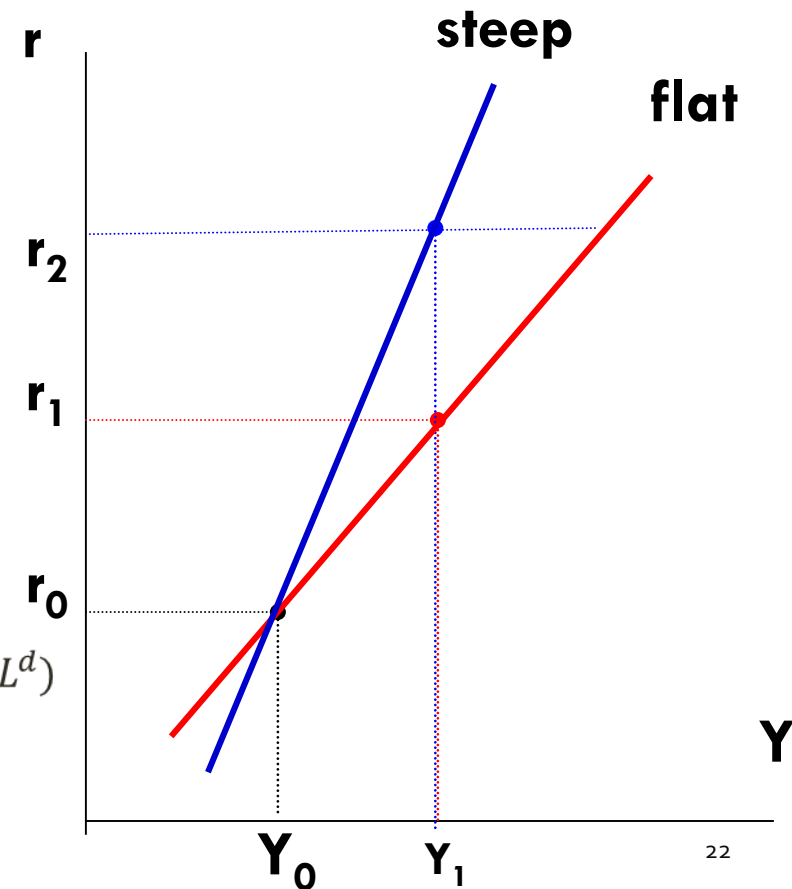
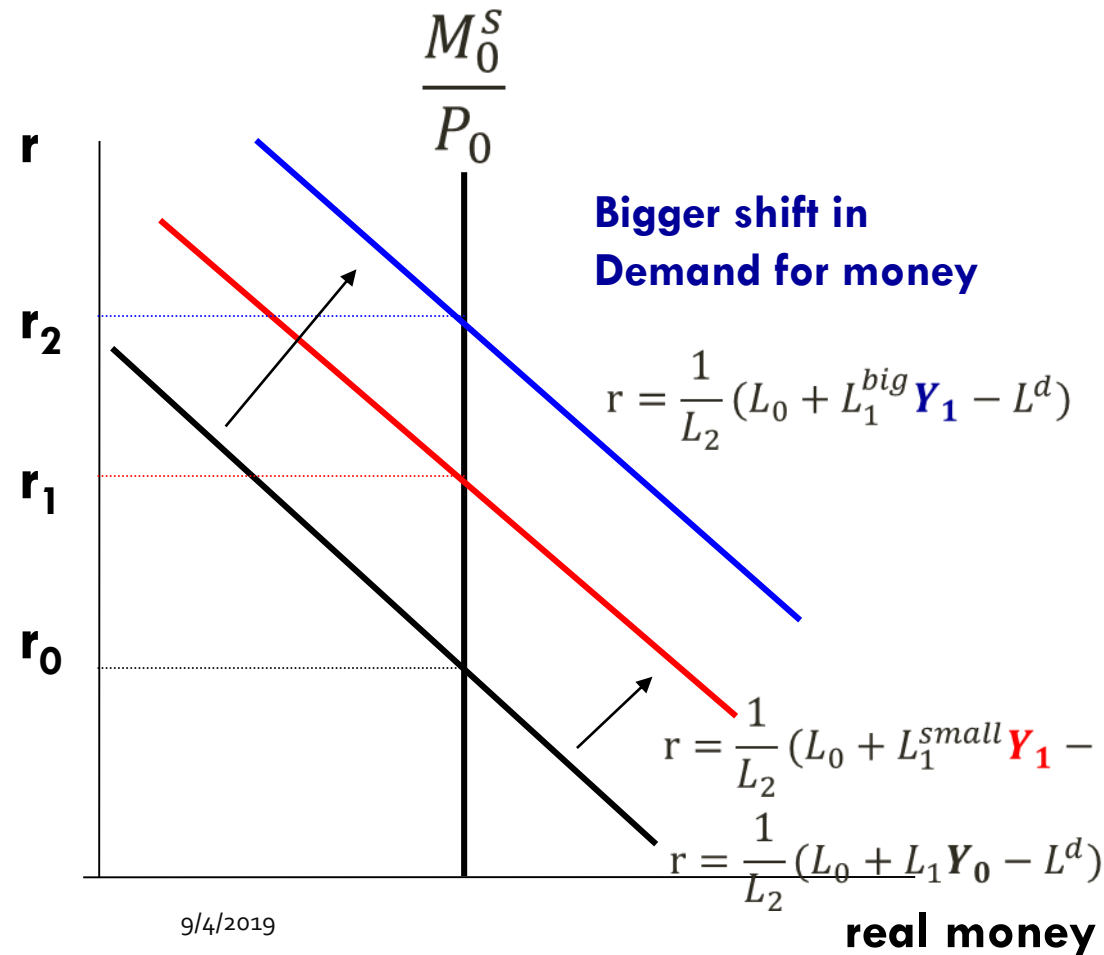


LM CURVE: SLOPE?

- Flat v.s. Steep LM curve
- Two factors: L1 and L2.
 1. How much does the change in income affect the transaction demand for money? (L1)
 2. How sensitive does the speculative demand respond to interest rate? (L2)

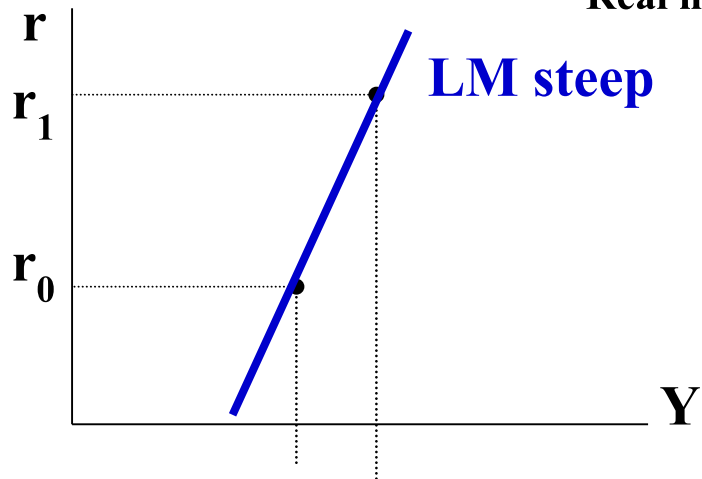
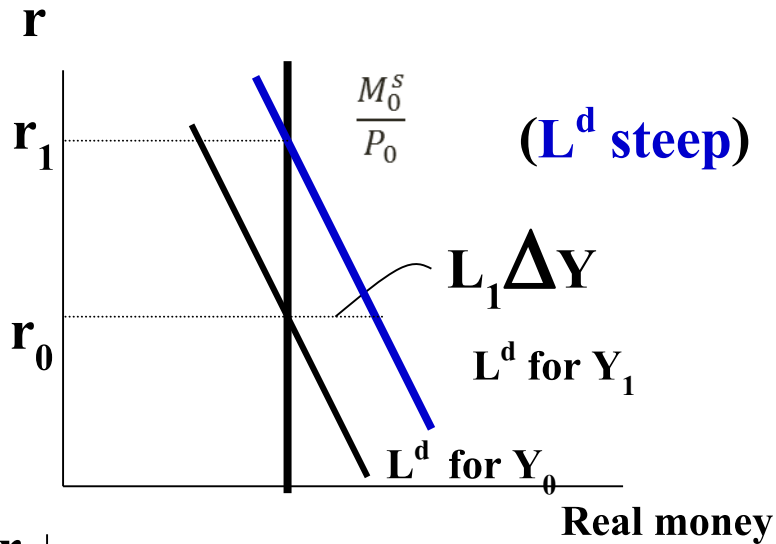


LM CURVE: SLOPE?

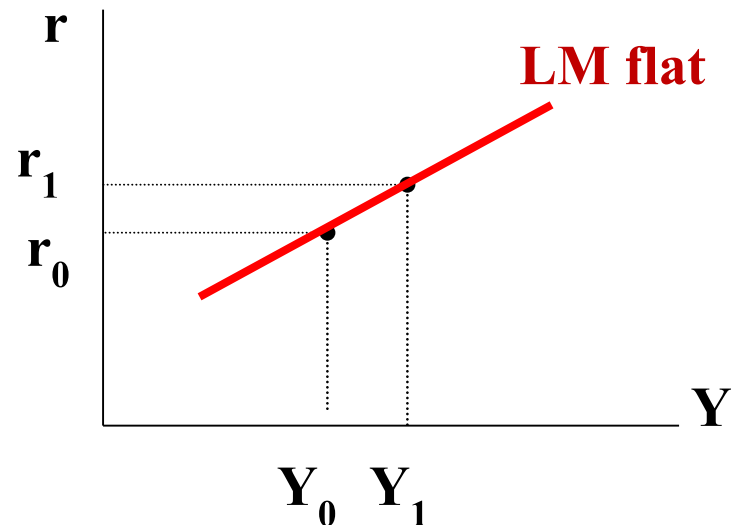
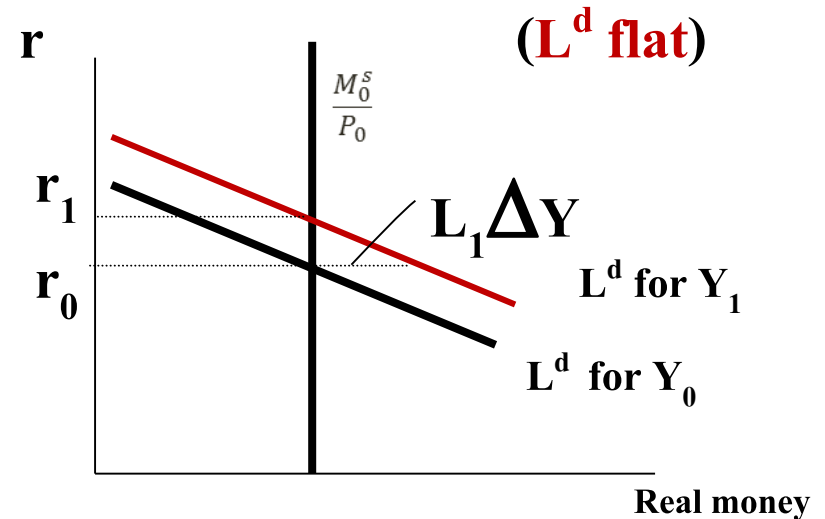


LM curve: Slope?

Highly inelastic L^d to r (L_2 small)



Highly elastic L^d to r (L_2 big)

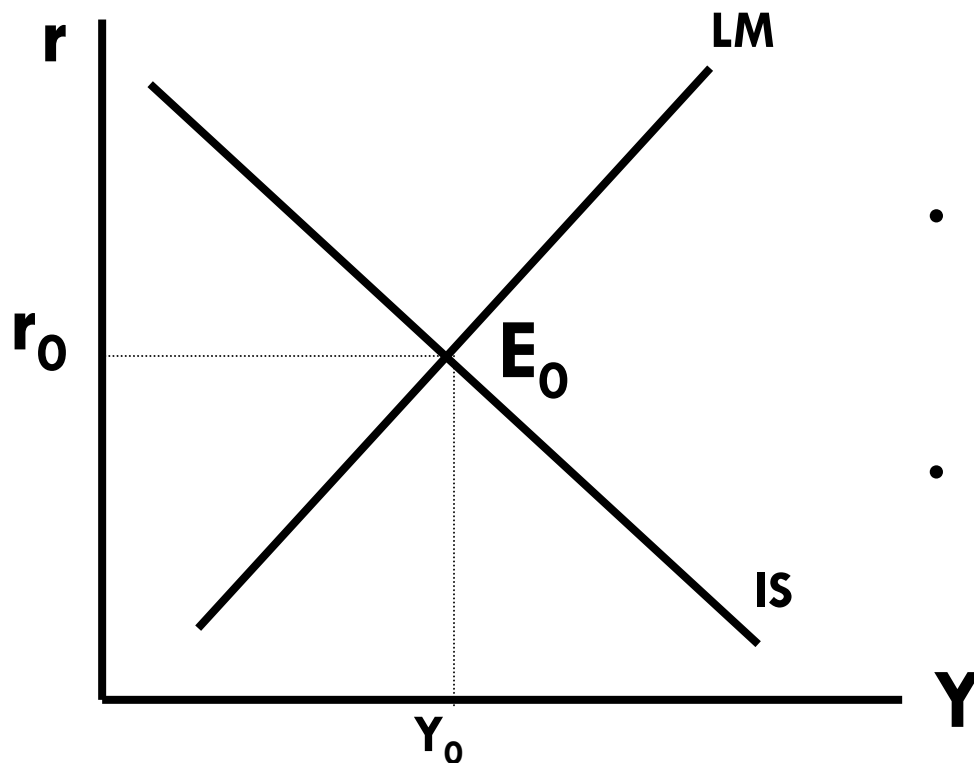


LM CURVE: SHIFT?

- Exogenous variations in demand for money (L_o)
- Change in the level of real money supply
 - Nominal money supply changes
 - Price changes

Question: Does the panic in banking sector affect LM curve?
How? Why?

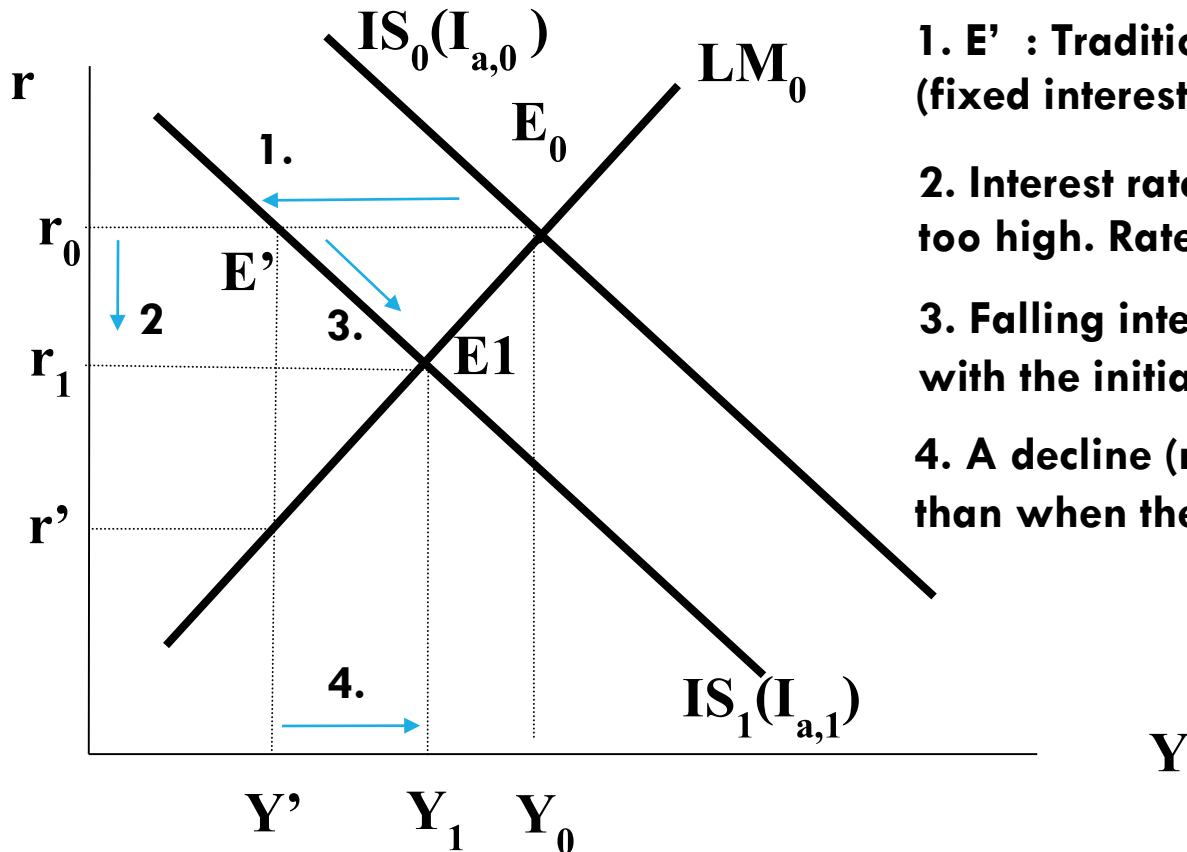
EQUILIBRIUM ANALYSIS UNDER THE IS-LM MODEL



- General equilibrium occurs when **both goods and money market are in the equilibrium.**
- Equilibrium situation can be attained at the intersection point between IS and LM curve.
- E_0 will always be the equilibrium if factors that determine IS and LM curve remain the same.

QUESTION:

NEGATIVE SHOCKS ON AUTONOMOUS INVESTMENT SPENDING

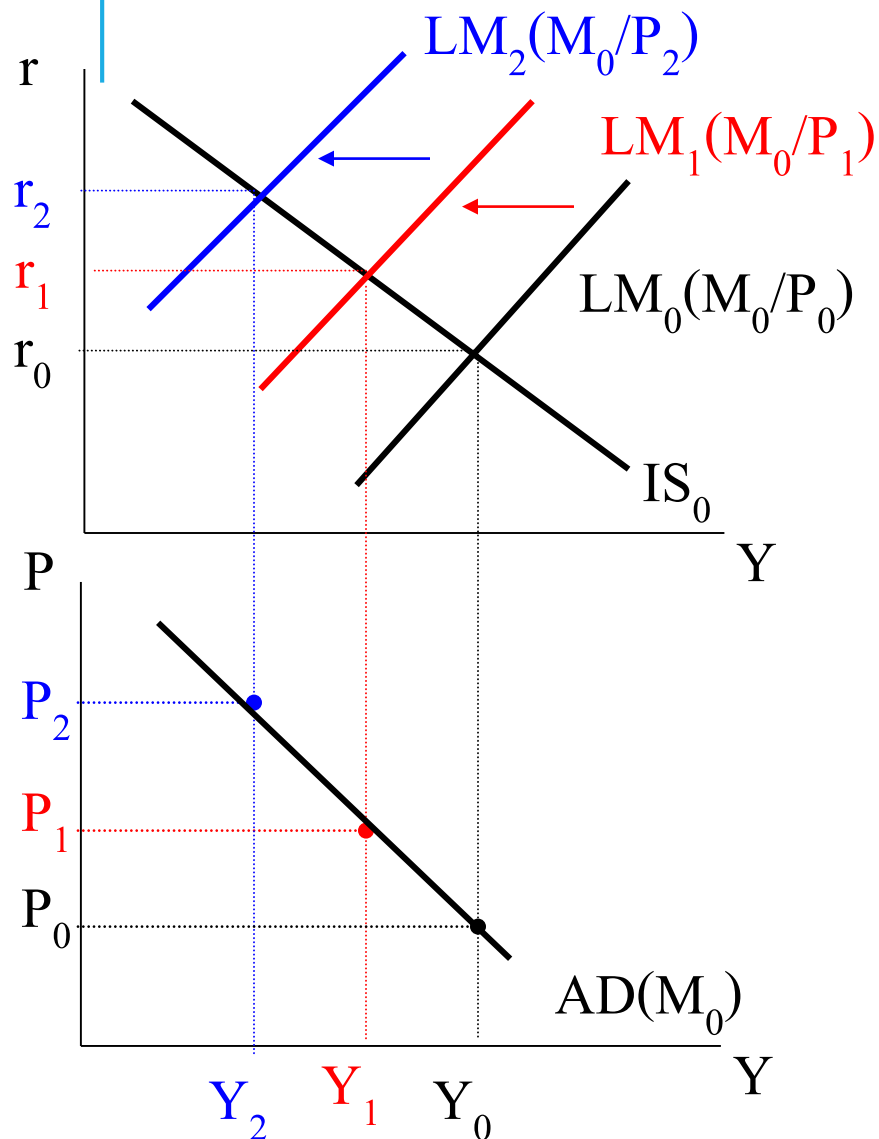


1. E' : Traditional Keynesian Equilibrium (fixed interest rate equilibrium)
2. Interest rate cannot be sustained at r_0 ; too high. Rate is supposed to be falling.
3. Falling interest rate helps *counteracting* with the initial negative shock.
4. A decline (recession) in output is smaller than when the interest rate is fixed.

AGGREGATE DEMAND

- IS-LM model was built on the assumption that *price is fixed.*
- What if price can be adjusted? How would this affect behavior of aggregate output?
- The relationship that links between “price” and “income” obtained from the IS-LM model is called the aggregate demand relationship.
- Aggregate demand curve is downward sloping in price. (why?)

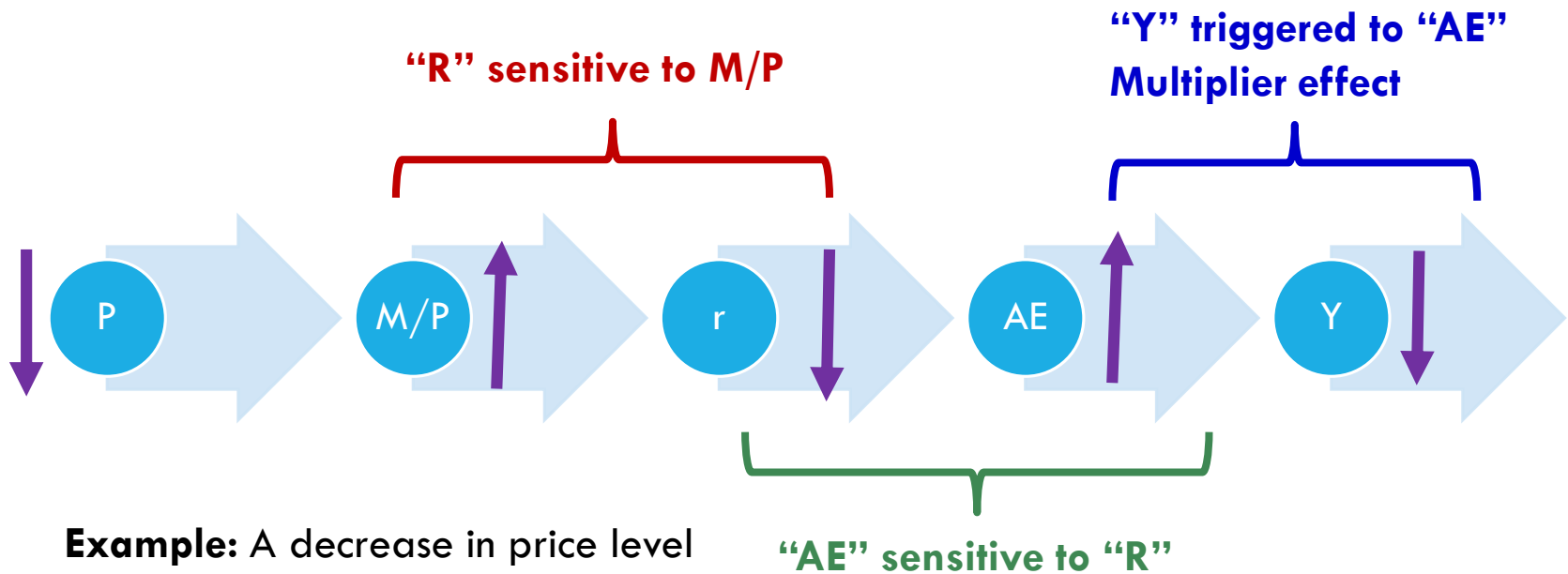
AGGREGATE DEMAND: DERIVATION



- Suppose that nominal money supply (M_0) is fixed
- Initial IS-LM equilibrium is r_0, y_0 (associated with P_0).
- Now consider two alternative scenarios:
 $P_2 > P_1 > P_0$
- Given the two scenarios, one knows that
 $(M_0/P_2) < (M_0/P_1) < (M_0/P_0)$
- Graphically, rising price causes real money supply to drop; LM curve shifted left: $LM_0 \rightarrow LM_1 \rightarrow LM_2$
- AD curve **can be derived** from the equilibrium of the IS-LM model; downward sloping curve.

SLOPE OF THE AGGREGATE DEMAND

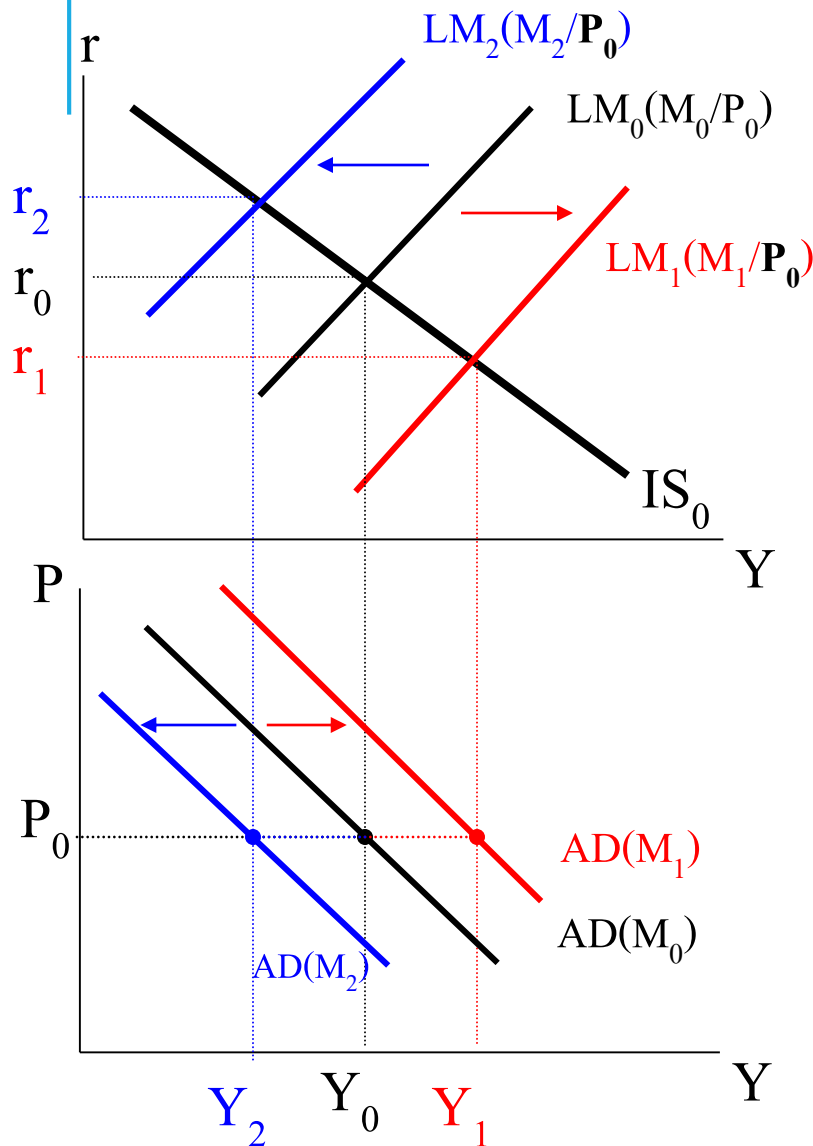
- When is the AD curve flat? When does the aggregate quantity demanded sensitively respond to change in price?



AGGREGATE DEMAND: CHANGES IN THE AD CURVE

- Aggregate demand can be shifted up/right (more demand for any given prices) and down/left (less demand for any given prices.)
- All the underlying factors that determine the IS curve and the LM curve can cause the change in Aggregate demand curve.
- Consider policy variables.

AGGREGATE DEMAND: CHANGES IN THE AD

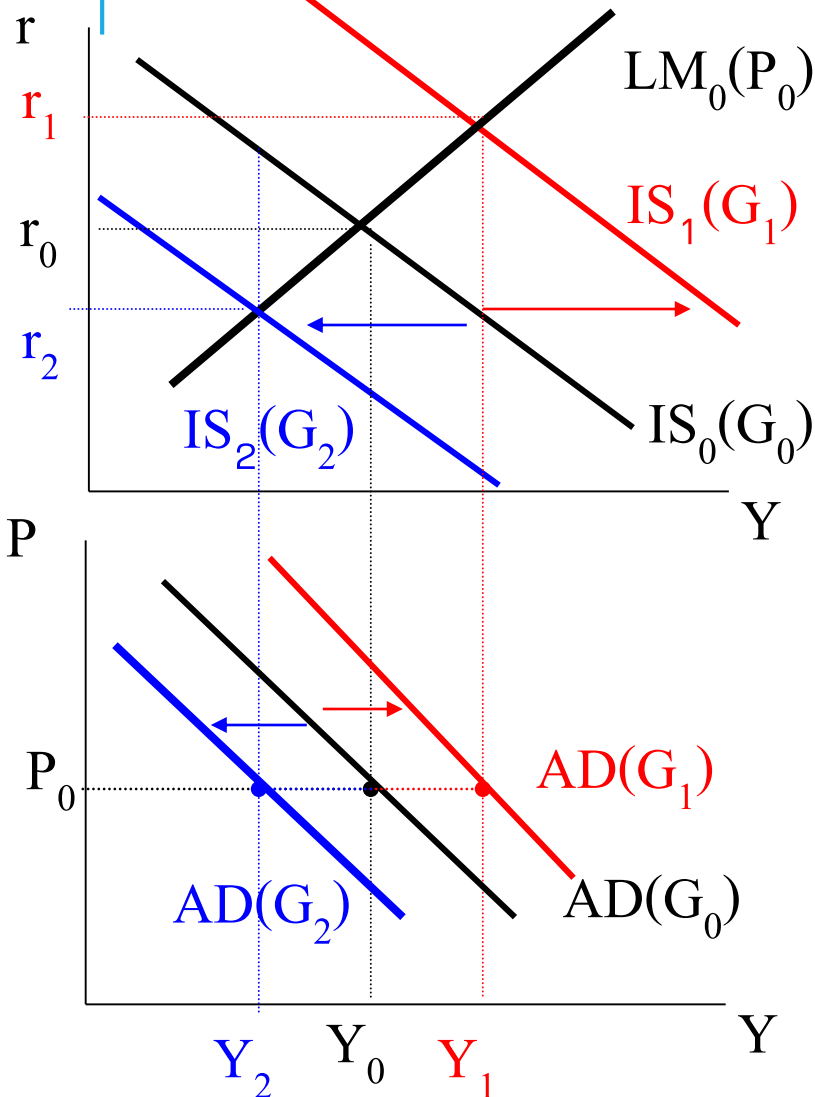


Change in the nominal money supply

- Consider a **fixed level of price P_0** .
- Suppose central bank increases money supply; $M_0 \rightarrow M_1$
- Positive money creation will cause the LM curve to shift right ($LM_0 \rightarrow LM_1$); income will rise from Y_0 **to Y_1** .
- Y_0 is no longer aggregate quantity demanded at P_0 when money supply is now $M_1 > M_0$; aggregate demand curve then shifts right.
- For any level of prices, lowering money supply would cause LM to shift left, and hence the AD curve.

AGGREGATE DEMAND: CHANGES IN THE AD CURVE

Change in the level of Government spending



- Consider a fixed level of price, P_0
- Suppose government increases spending from G_0 to G_1 .
- Positive change in government spending will cause the IS curve to shift right ($IS_0 \rightarrow IS_1$); income will rise from Y_0 to Y_1 .
- Y_0 is no longer aggregate quantity demanded at P_0 when government spending is now $G_1 > G_0$; aggregate demand curve then shifts right.
- For any level of prices, lowering G ($G_0 \rightarrow G_2$) would cause IS to shift left, and hence the AD curve.

AGGREGATE DEMAND: CHANGES IN THE AD CURVE

- **Question:** how does the deterioration in the level of consumer and business confidence affect aggregate demand curve?
- **Question:** how does the introduction and acceptance of digital currency affect aggregate demand curve?
- **Question:** When does the fiscal and monetary policy generate a big shift in AD curve?

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AGGREGATE SUPPLY: FOUNDATION

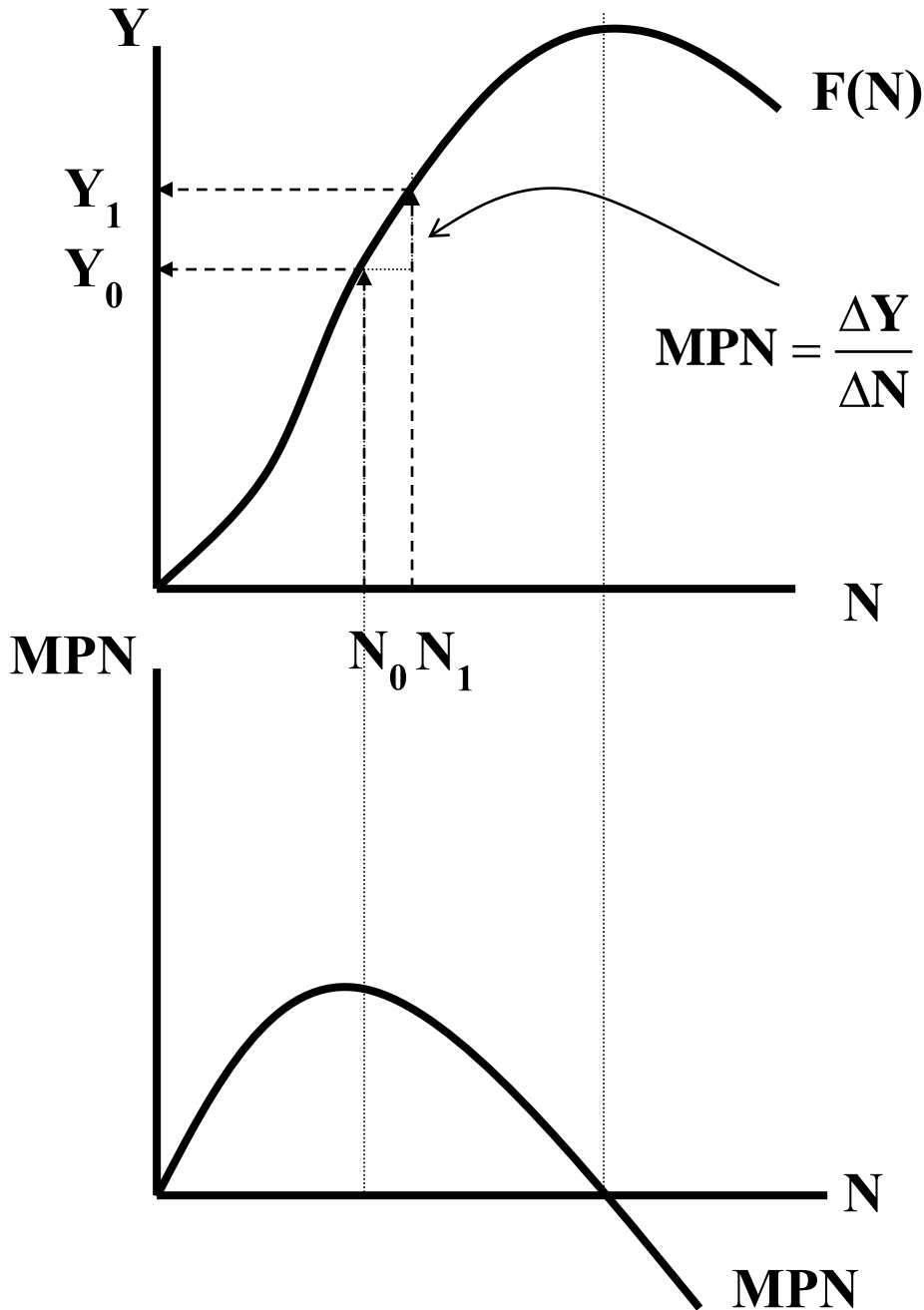
- This section provides a foundation for the theory of aggregate supply.
- Aggregate supply is the theory that describes the relationship between “**price**” and “**(aggregate) amount of the output produced by firms**”.
- The foundation of AS theory can be derived from micro-founded individual supply theory.
- Understanding AS requires your priori understanding on **production function** and **optimal labor input decision**. (will be studied with greater details in the Part II)

AGGREGATE SUPPLY: FOUNDATION

- What does the firm do?
 - Firm is a production unit; transform **inputs** into **outputs** using **production technology** that they have.
- Production technology is usually denoted by concept of the production function.

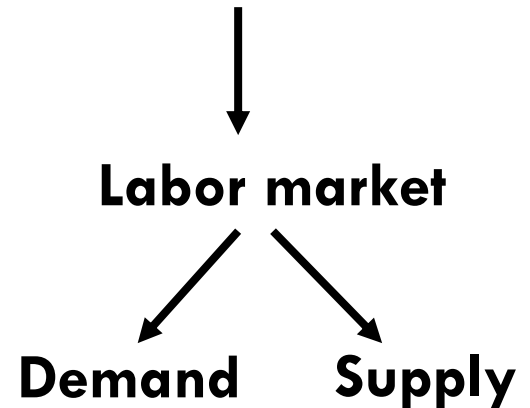
$Y = F(K, N)$ where $K = \text{Capital}$ and $N = \text{labor hired}$

- In the short-run, K is fixed, i.e. $Y = F(\bar{K}, N)$.
 - Firm's production depends on the amount of labor hired/employed.



- Law of diminishing marginal productivity
- Marginal Product of Labor: MPN

Total output supplied (Y) depends on the number of labor employment (N)



THEOREM OF LABOR MARKET DEMAND

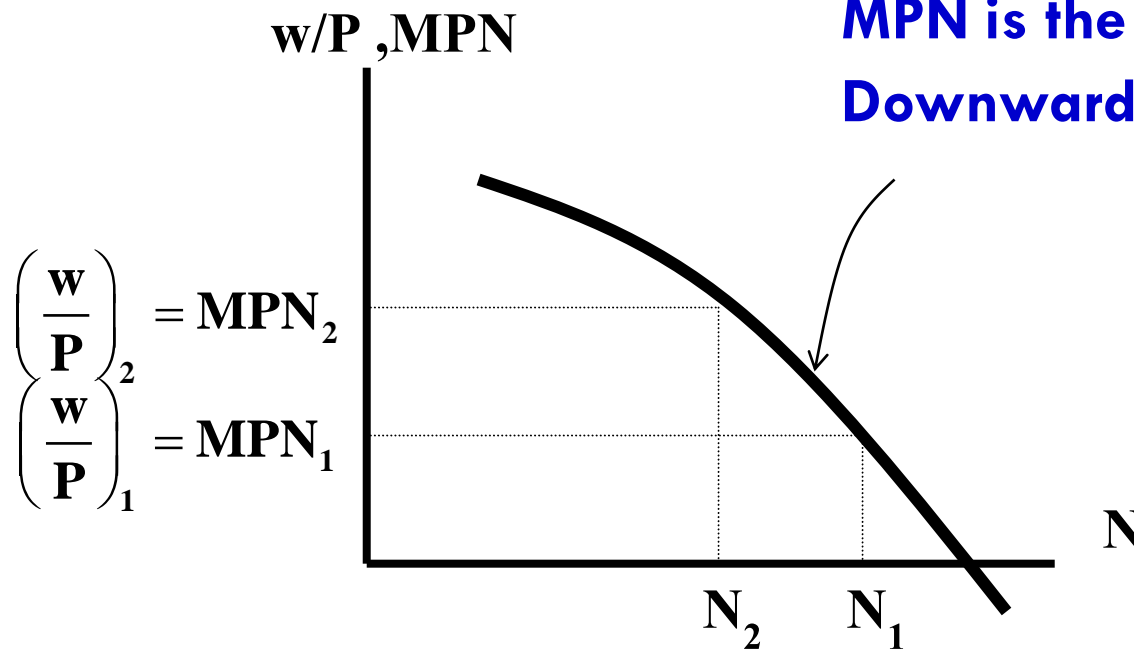
- How to best transform inputs into outputs? (N? into Y?)
- Firm chooses for optimal level of inputs that maximizes profit.
- The optimizing condition suggests that firms choose the optimal level of employment where **marginal cost of labor equalizes with marginal benefit of labor**

$$W/P = MPN \text{ (real wage = marginal product)}$$

$$W = P * MPN \text{ (nominal wage = Value of marginal product)}$$

THEOREM OF LABOR MARKET DEMAND

- **Version 1**



MPN is the labor demand curve;
Downward sloping in real wage

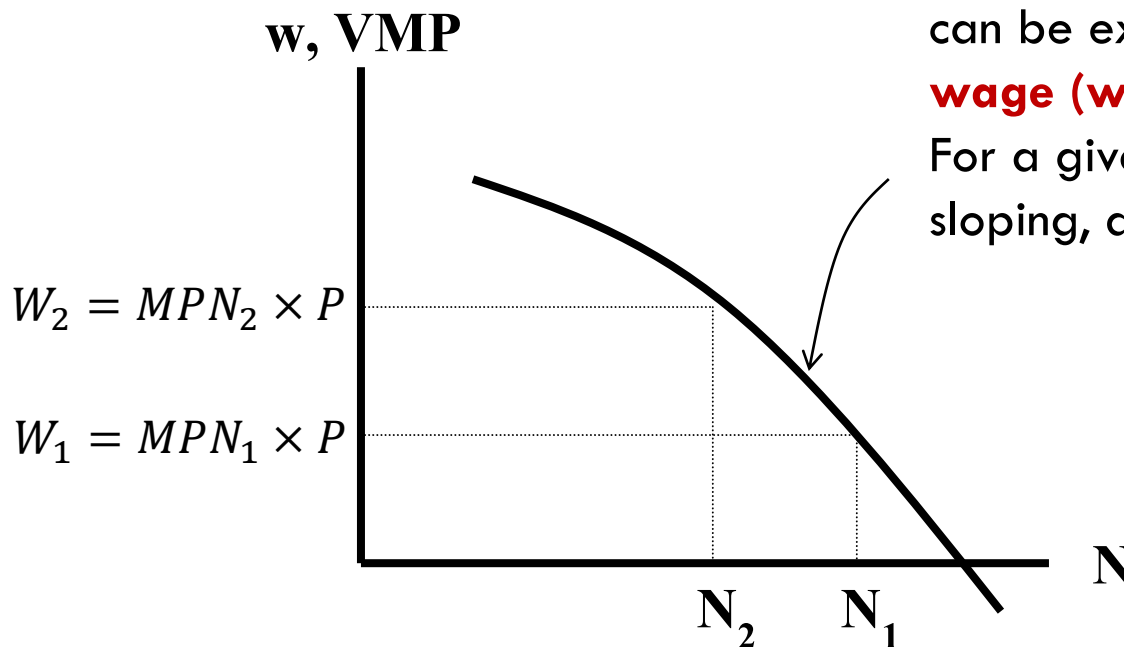
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$$N^d = f\left(\frac{w}{P}\right)$$

(-)

THEOREM OF LABOR MARKET DEMAND

- Version 2



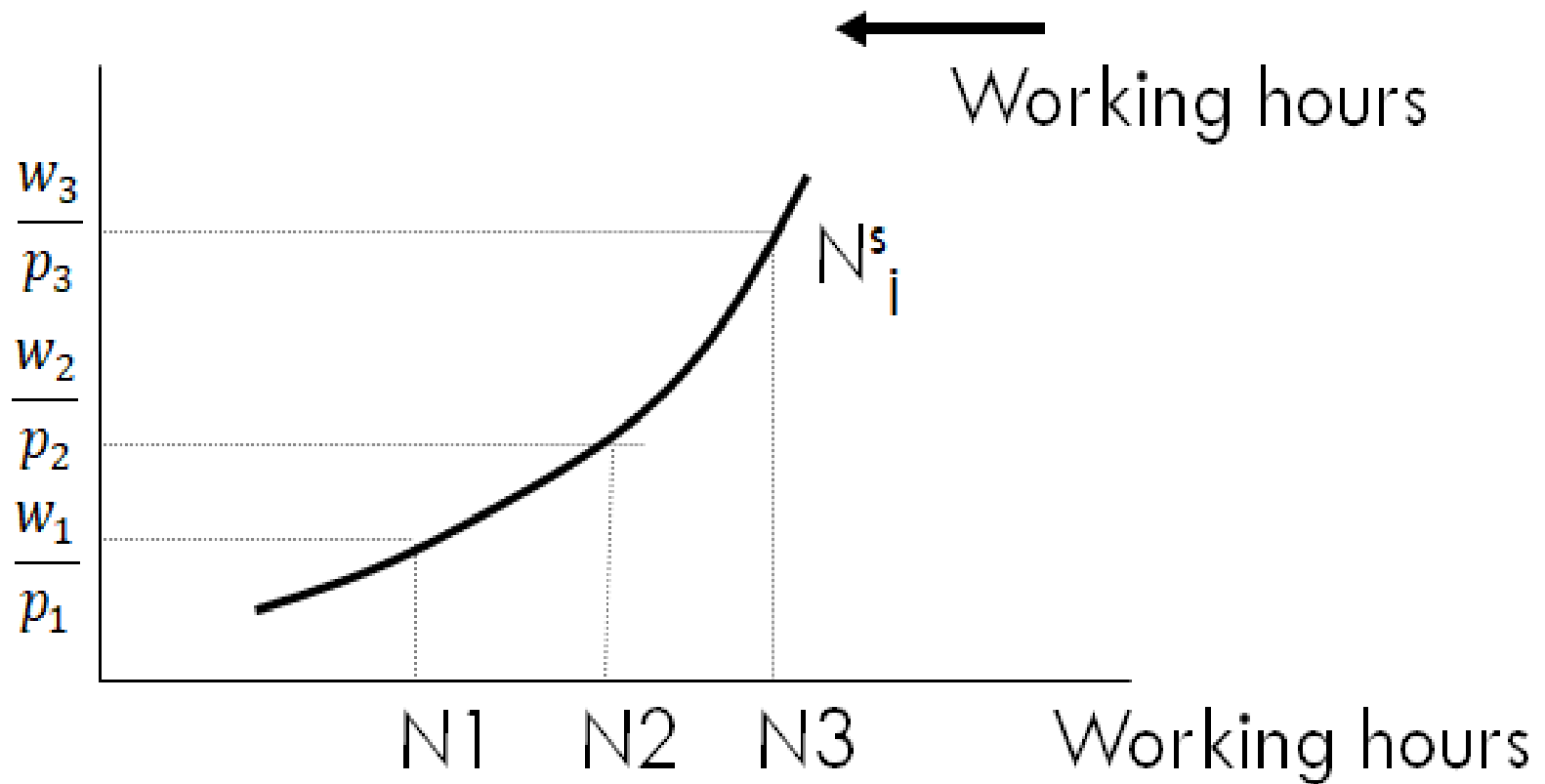
Alternatively, labor demand curve can be expressed in terms of **nominal wage (w)**, i.e. the VMP curve.

For a given price, VMP curve is downward sloping, and hence labor demand curve.

THEOREM OF LABOR MARKET SUPPLY

- Households supply labor force to the market. Why?
 - They work and get paid; income earned can be used for purchasing goods in the goods market.
- Theorem for labor market supply emerges from foundation of individual labor supply, i.e. the **consumption-leisure model**.
- Conceptually, rising “ w/p ” makes it costly for households to take leisure; working more when “ w/p ”.
- Labor supply is upward sloping, given other things!

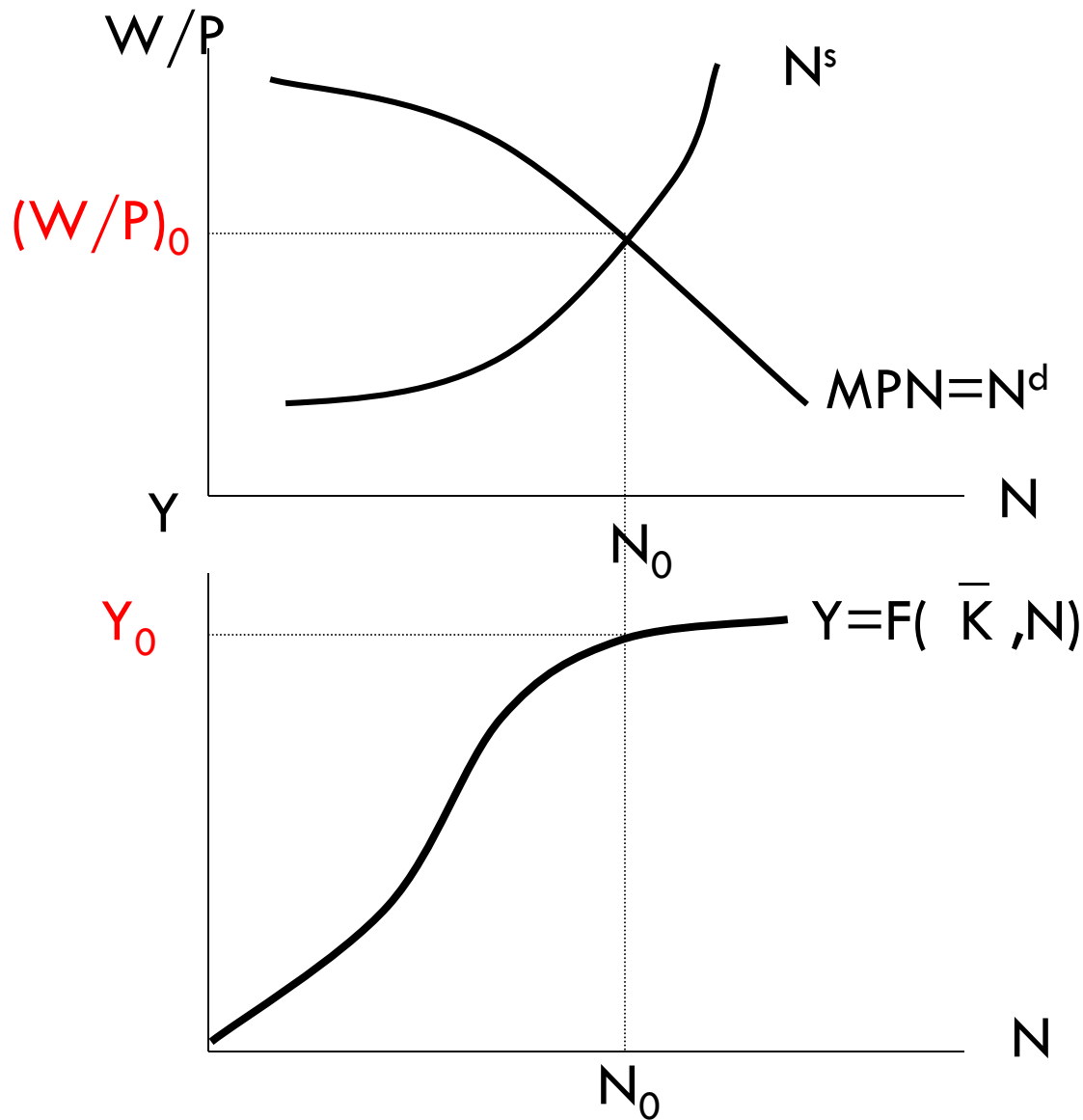
THEOREM OF LABOR MARKET SUPPLY



EQUILIBRIUM LABOR MARKET AND AGGREGATE SUPPLY

- Under the ideal “Neoclassical” situation, aggregate supply of output is independent of the price level.
 - Neo-classical: **Fully flexible adjustment in labor market**
- With the ideal neoclassical condition, labor market fully utilizes the resource. The equilibrium employment is the level so called “**full employment**”.
- The correspondingly level of output is called **full-employment level of output**, i.e. **potential output**.

Equilibrium of labor market and optimal production level



EQUILIBRIUM LABOR MARKET AND AGGREGATE SUPPLY

- Aggregate supply is always a vertical line; **neoclassical/classical aggregate supply (Long-run aggregate supply)**
- The supply concept rests on a very strong, and yet controversial, assumption; **price and wage can be perfectly adjusted with a complete synchronization (no delay).**
- Keynesian theorists then argue that classical foundation to Aggregate supply is misleading; **empirically, nominal wage adjusts slower than nominal price – e.g. no full indexation.**

WHAT'S RIGHT ABOUT LABOR SUPPLY: KEYNESIAN POINT OF VIEW

- Labor market decision involves with **contractual agreement**, and **length and duration of hiring**.
- Wage is usually “**pre-specified**” in advance in “**nominal terms**”, based on the bargaining problem between employers and employees.
- Lot more institution features that make it hard for wage to be adjusted instantaneously over time; **wage stickiness**.

TWO POSSIBLE TYPES OF WAGE STICKINESS

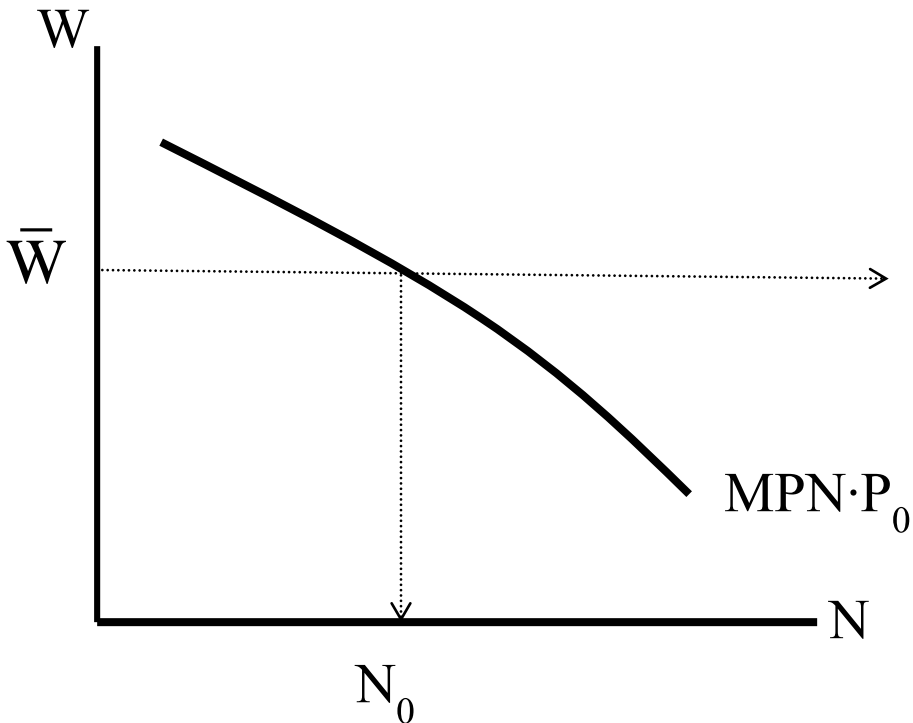
- Possible wage schemes pre-determined in advance.
 - **Constant fixed wage**: horizontal labor supply curve.
 - **Variable wage**: upward sloping labor supply curve.
- Both types involve with a **contractual arrangement** that both employers and employees are **committed** to.

POSSIBLE WAGE SETTING SCHEMES: FIXED WAGE (CONSTANT SCHEME)

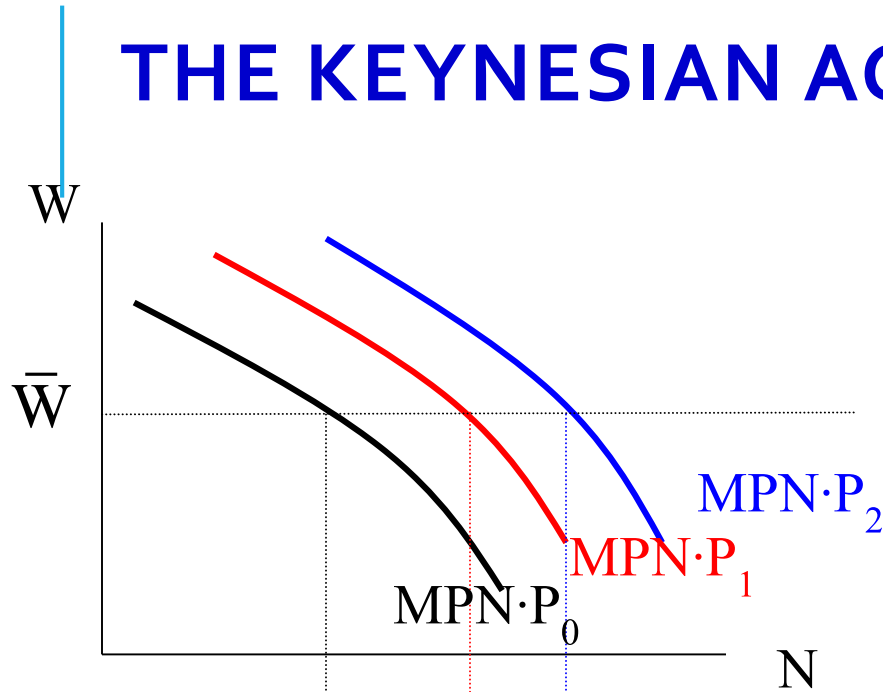
Perfectly rigidity in wage, **Exogenous** long-term **nominal wage** contract.

Labor supply curve is captured by **the horizontal line**.

The amount of employment is given by **labor demand** $W = MPN \cdot P$

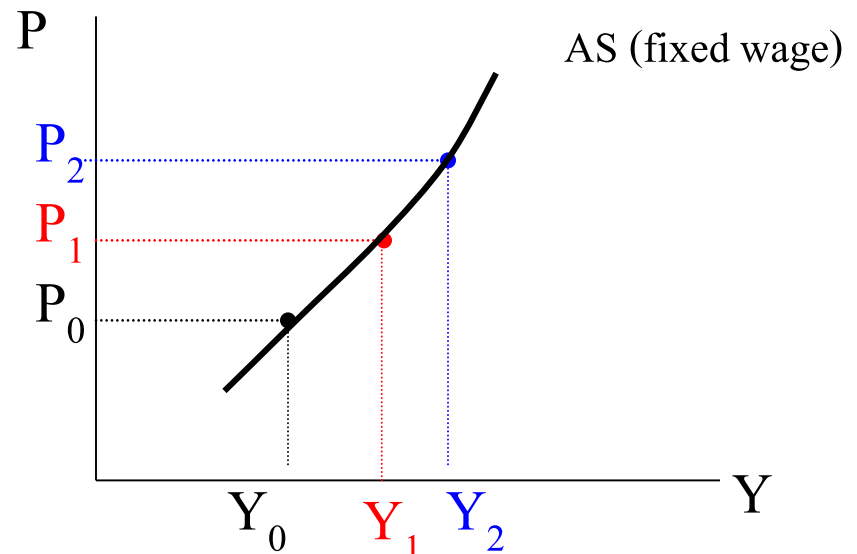
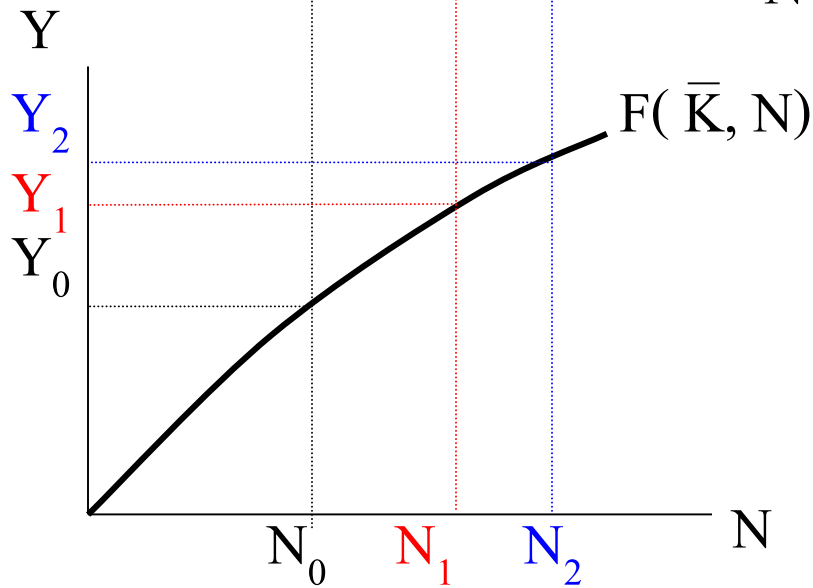


THE KEYNESIAN AGGREGATE SUPPLY I



As price increases, firm hires more labor. Output will increase.

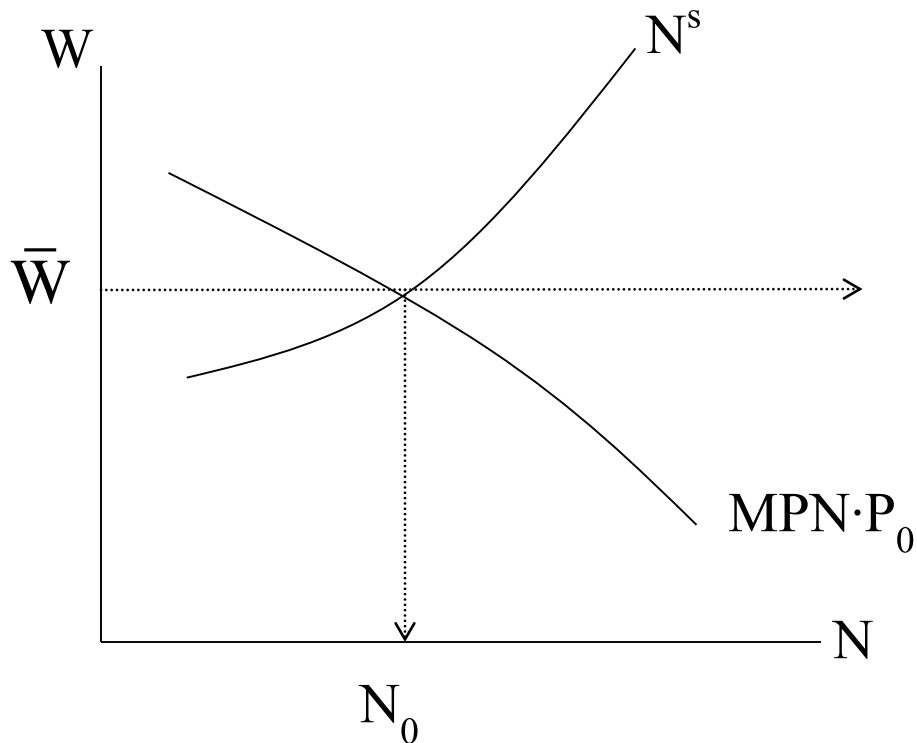
AS is upward sloping



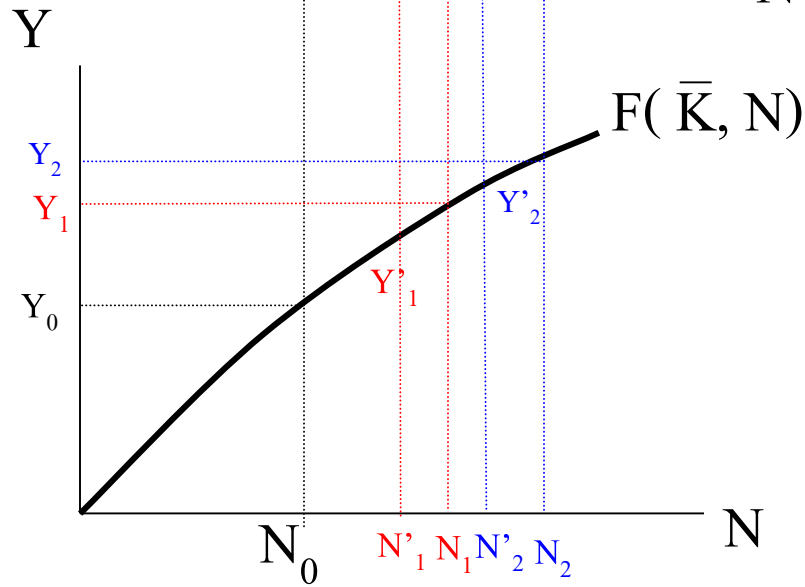
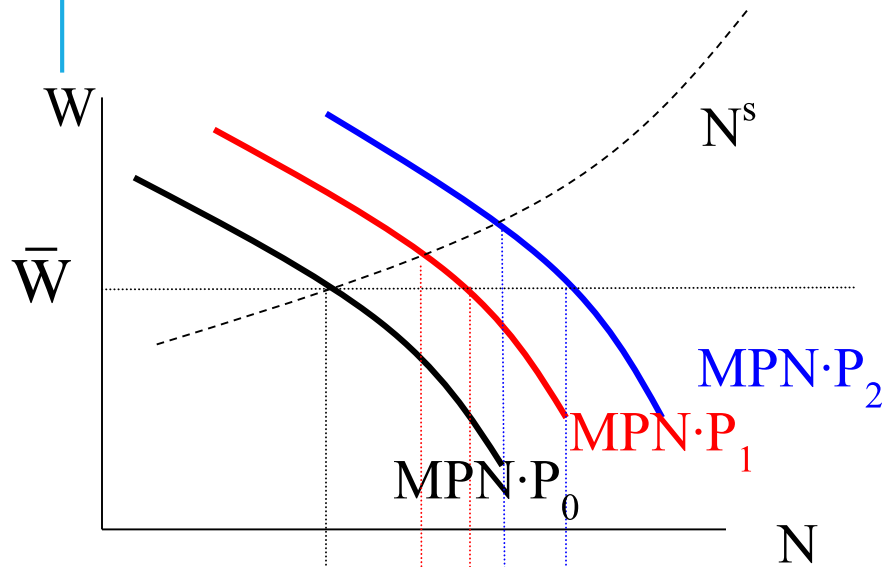
POSSIBLE WAGE SETTING SCHEMES: PRE-SPECIFIED VARIABLE WAGE

Wage schemes are **pre-specified**, but can be varied over the amount of hours – e.g. variable wage per hour.

The supply is now captured by the **upward sloping one**.

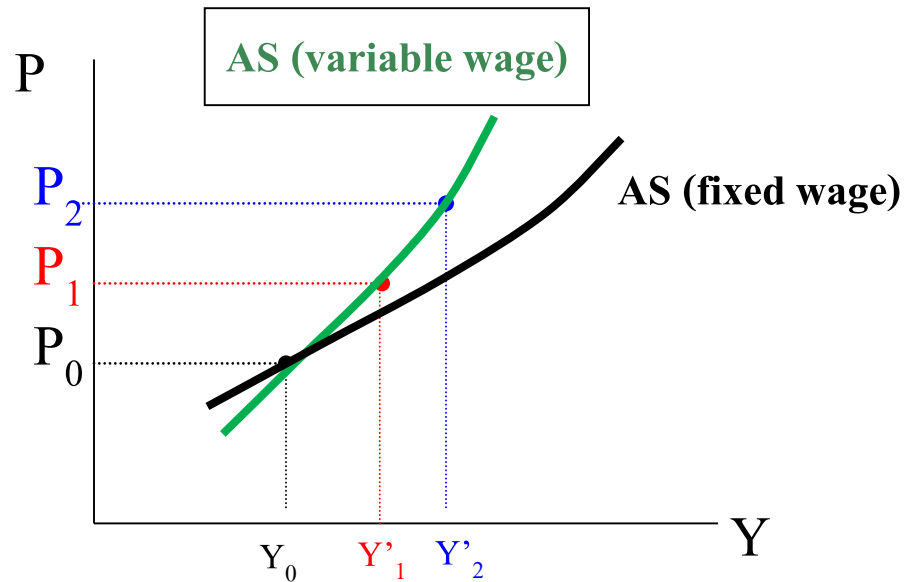


THE KEYNESIAN AGGREGATE SUPPLY II



With variable wage, AS is steeper.

Intuition: Rising wage partially *attenuates* the effect of rising price; output increases less.



FACTORS AFFECTING AGGREGATE SUPPLY CURVE

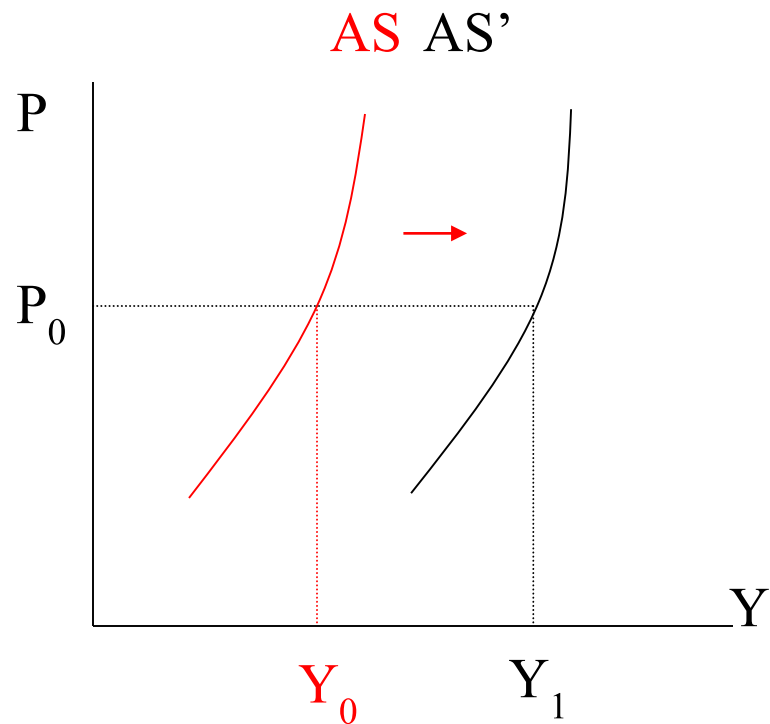
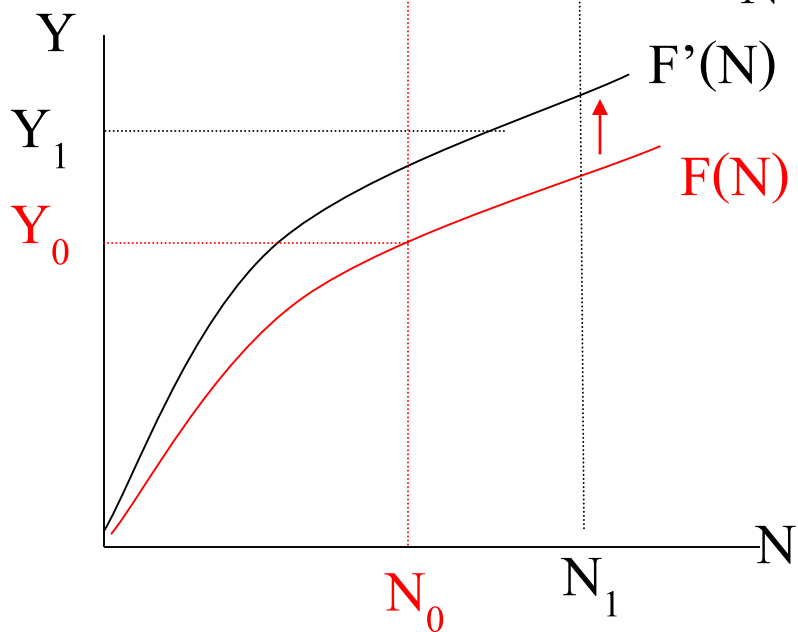
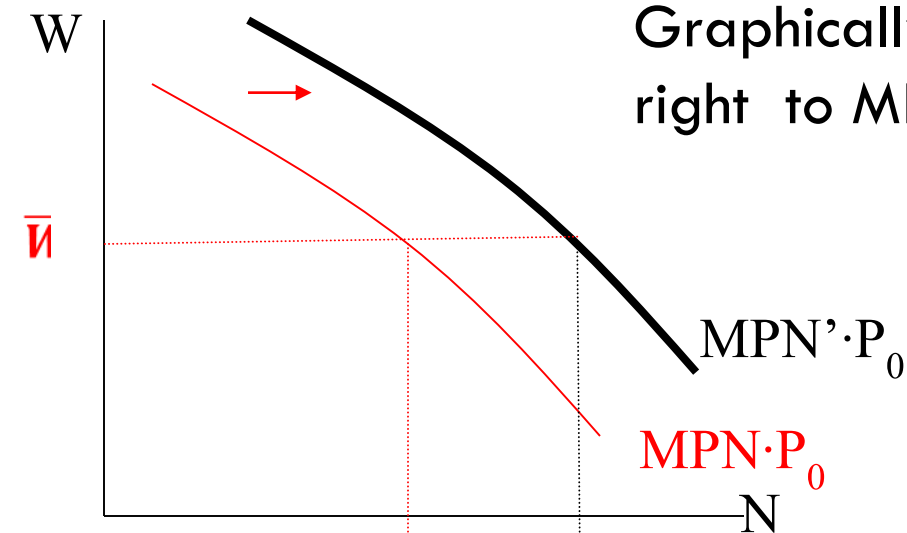
- We knew about the foundation of an upward sloping AS curve.
- Several factors are kept steady while we are deriving the upward sloping curve. What if they change?
- Their changes cause a **shift in the Aggregate supply**.

FACTORS AFFECTING AGGREGATE SUPPLY CURVE

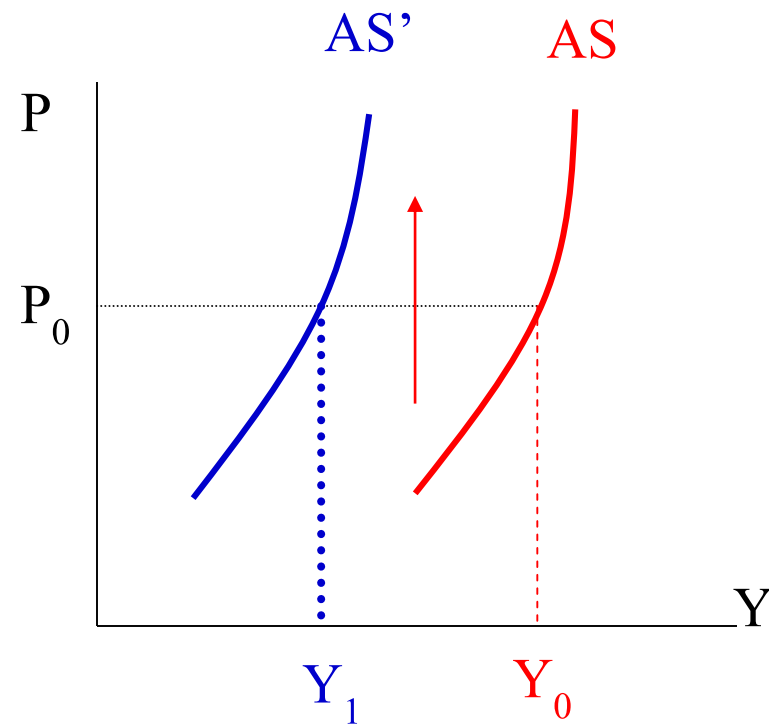
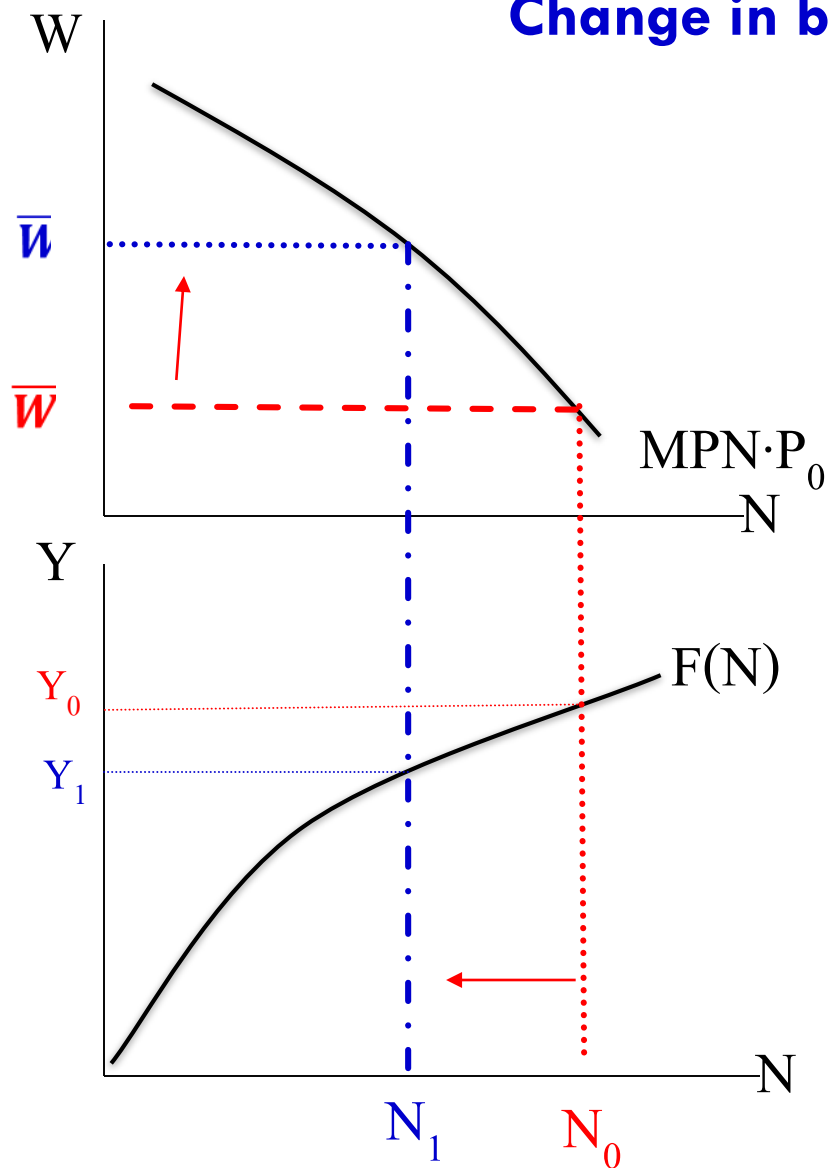
- Technological factors
- Cost-push factor; oil price and material inputs price.
- Underlying factor behind the wage-setting.

The impact of technological improvement / positive cost advantage

Graphically captured by MPN shifted right to MPN'



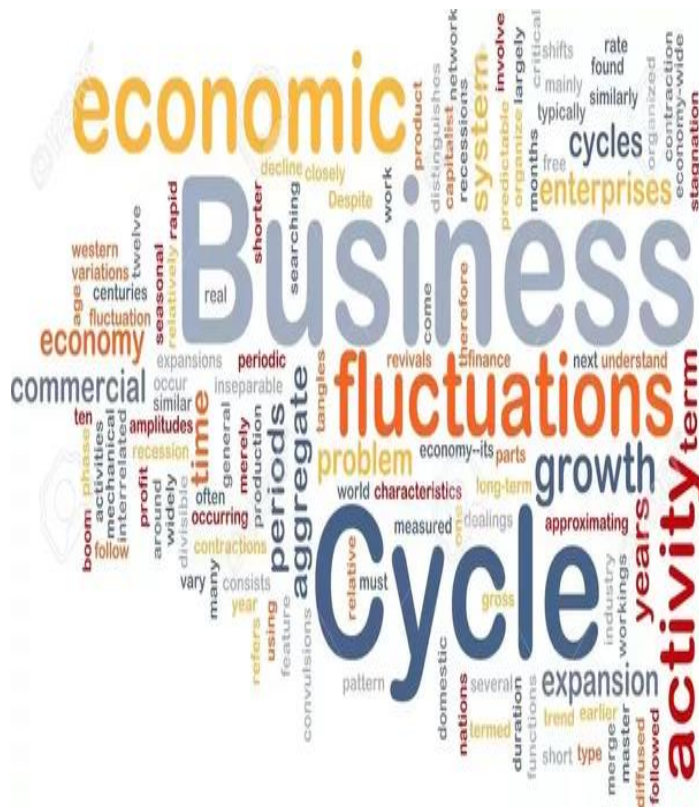
Change in bargained wage (nominal contract)



WHAT DETERMINE THE LEVEL OF BARGAINED (PRE-SPECIFIED) WAGE?

- What are the ultimate drivers that cause the movement in bargained wage?
 - **Structural factor:** Institution features related to the bargaining power between employers and employees – e.g. labor union.
 - **Cyclical factor:** Labor market conditions (tight/slack)
 - **Expectation factor:** Wage's negotiation to keep up with the rising cost of living – e.g. price and inflation expectation.

AGENDA

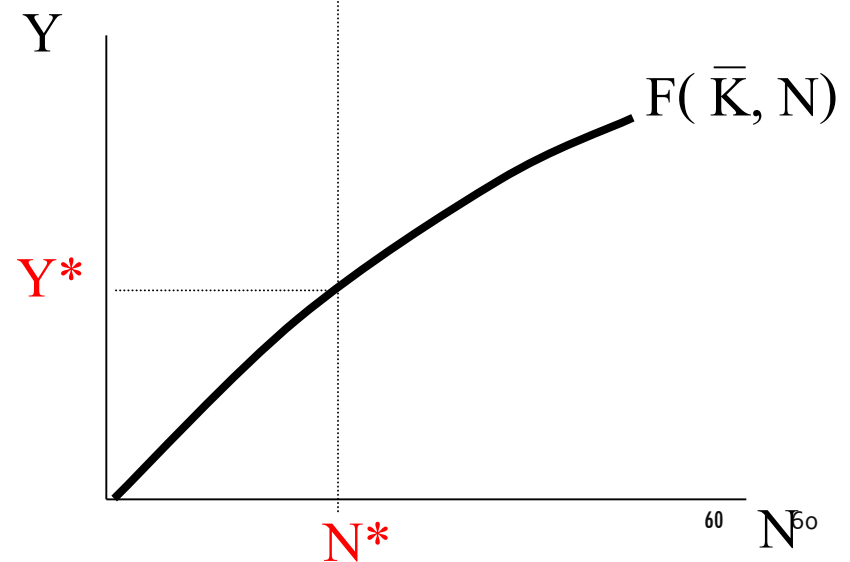
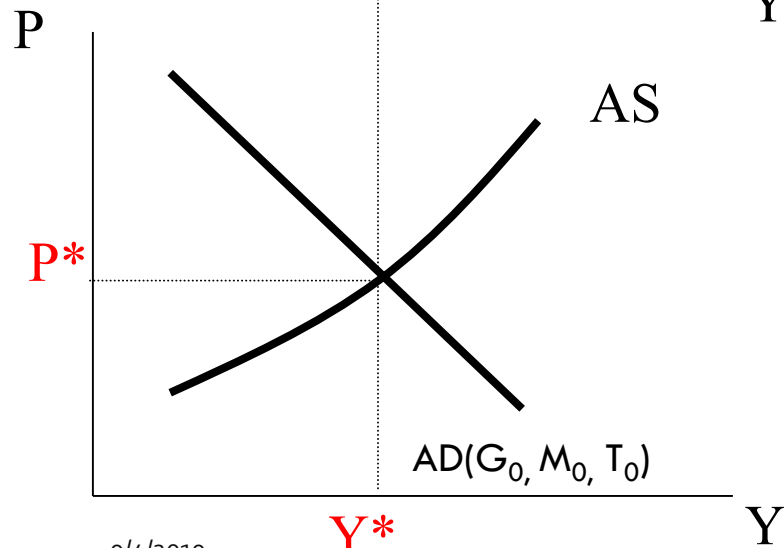
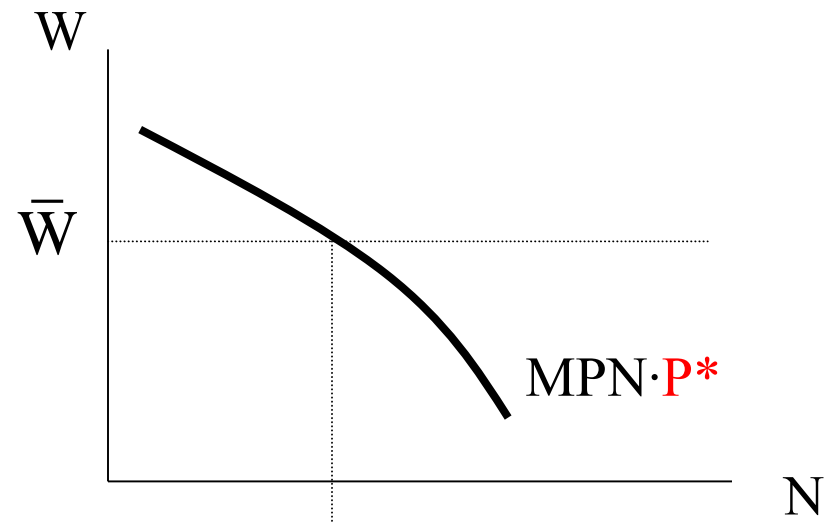
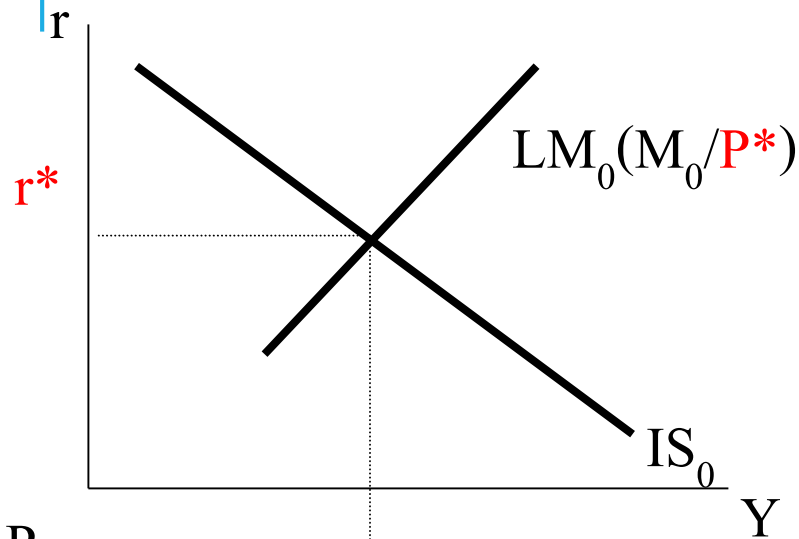


- Keynesian business cycle studies
- Core Keynesian model: AD-AS model
 - IS-LM-AD curve
 - AS curve
- **Equilibrium analysis and propagation of shocks**
- Fiscal and monetary policy analysis
- How does the Keynesian AD-AS model fit the facts?

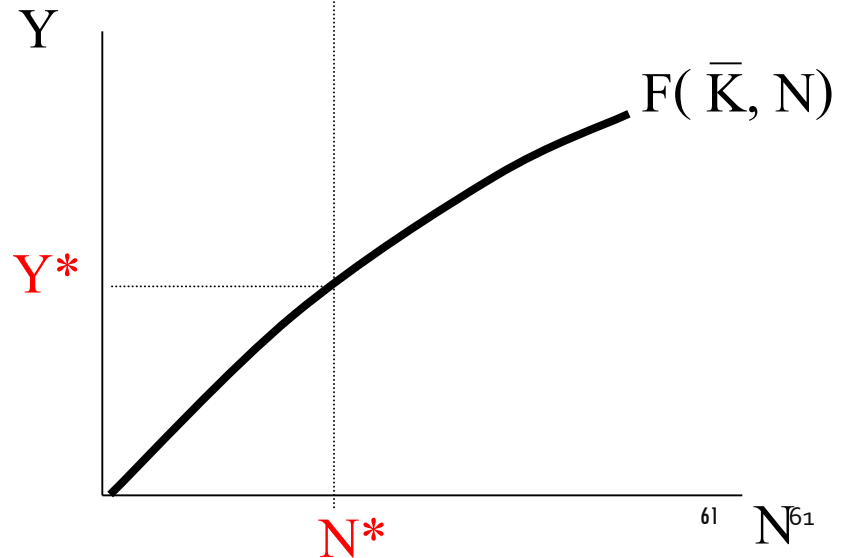
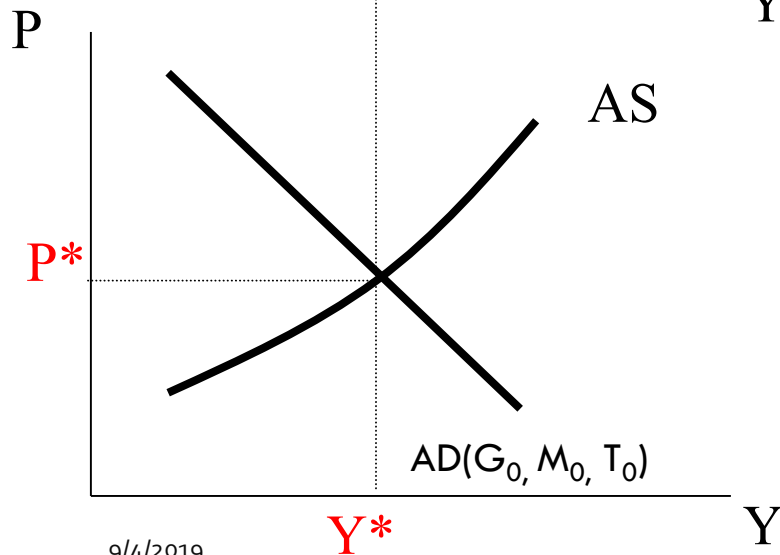
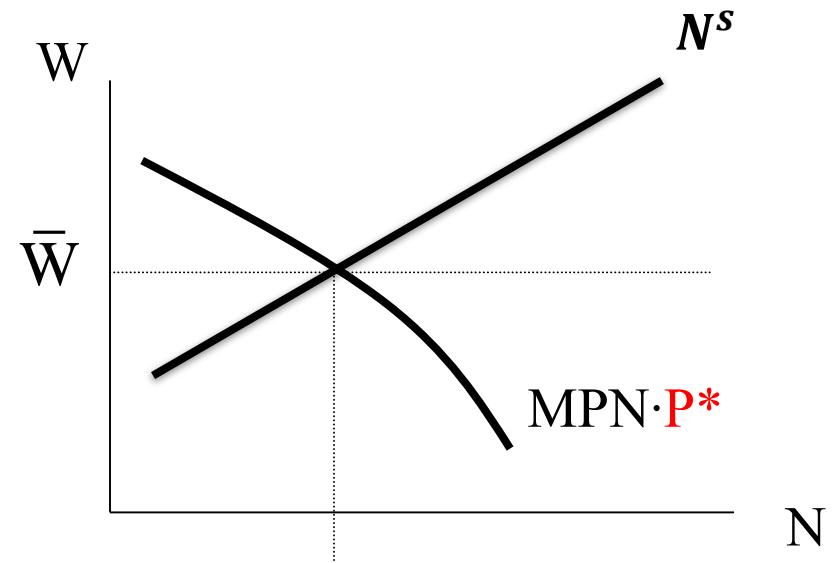
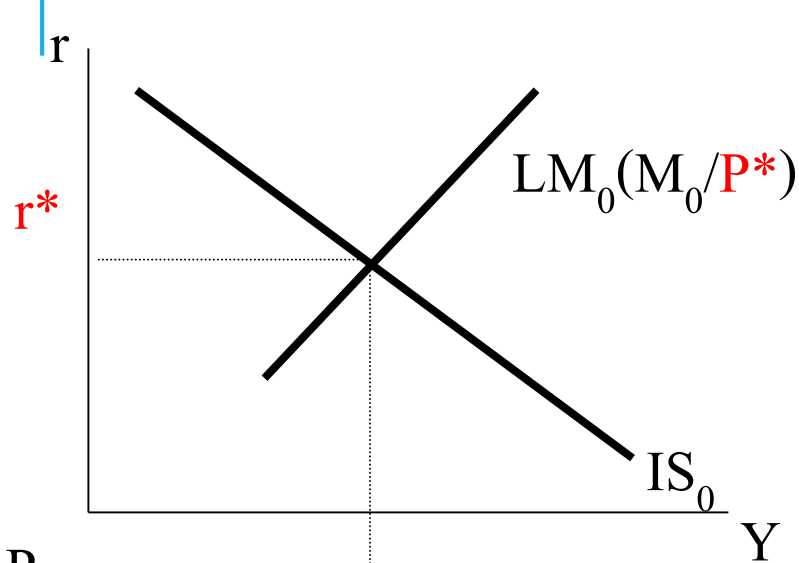
KEYNESIAN EQUILIBRIUM

- Keynesian equilibrium constitutes a set of variables, including Output (y^*), price (P^*), interest rate (r^*), wage (w^*) and labor employment (N^*) that clear all the markets.
- The equilibrium can be captured by **4 main figures**.

AD-AS EQUILIBRIUM ANALYSIS: FIXED WAGE



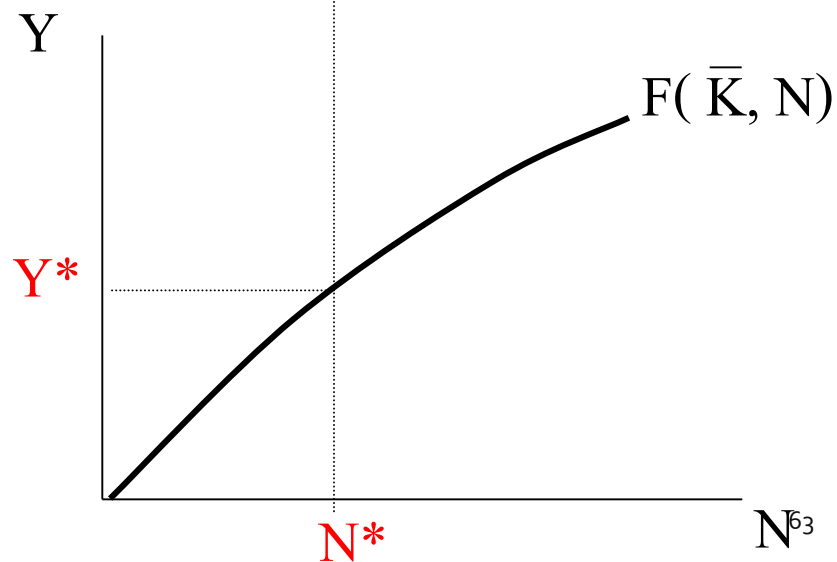
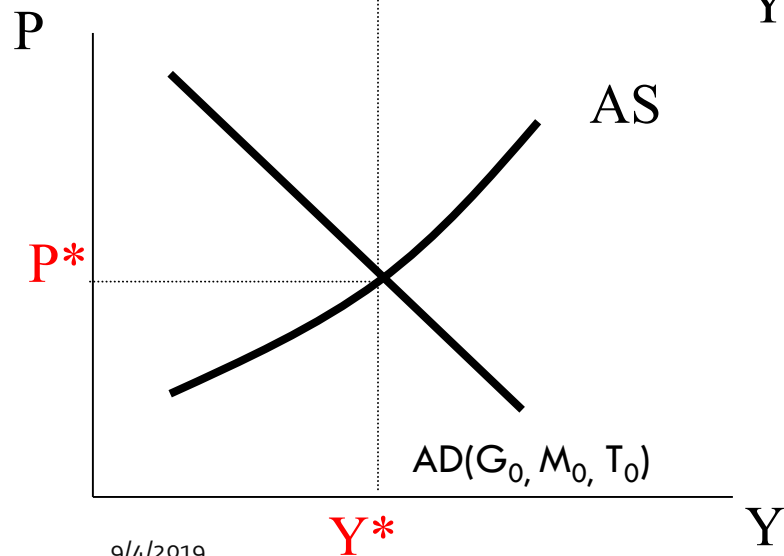
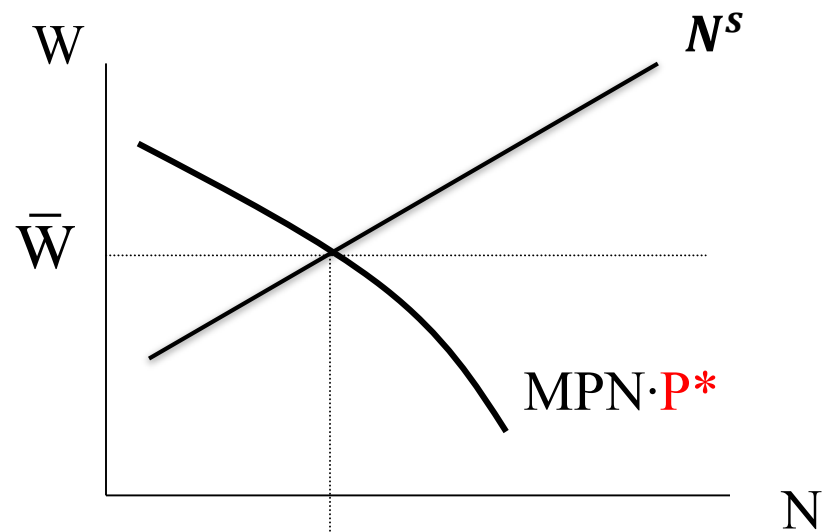
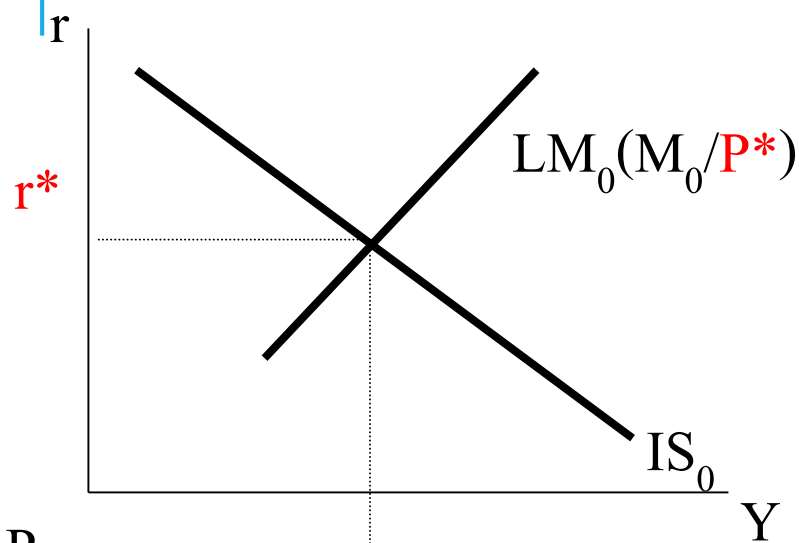
AD-AS EQUILIBRIUM ANALYSIS: PRE-SPECIFIED VARIABLE WAGE



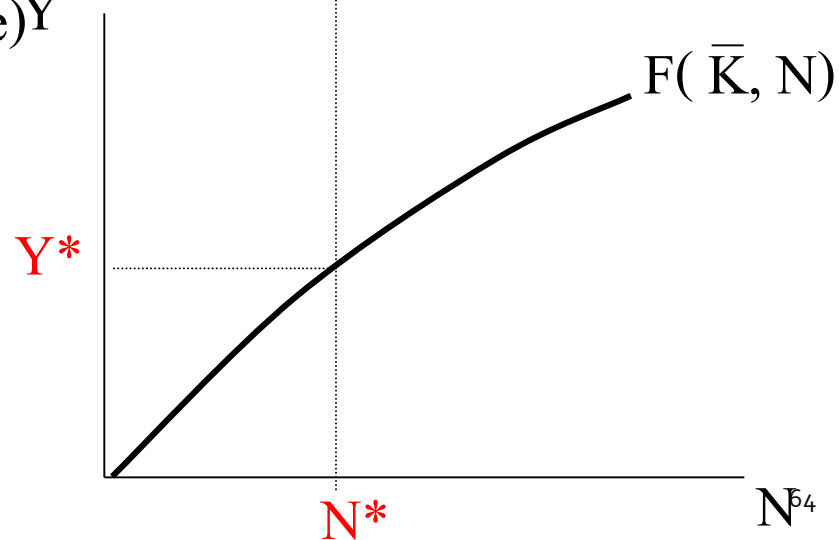
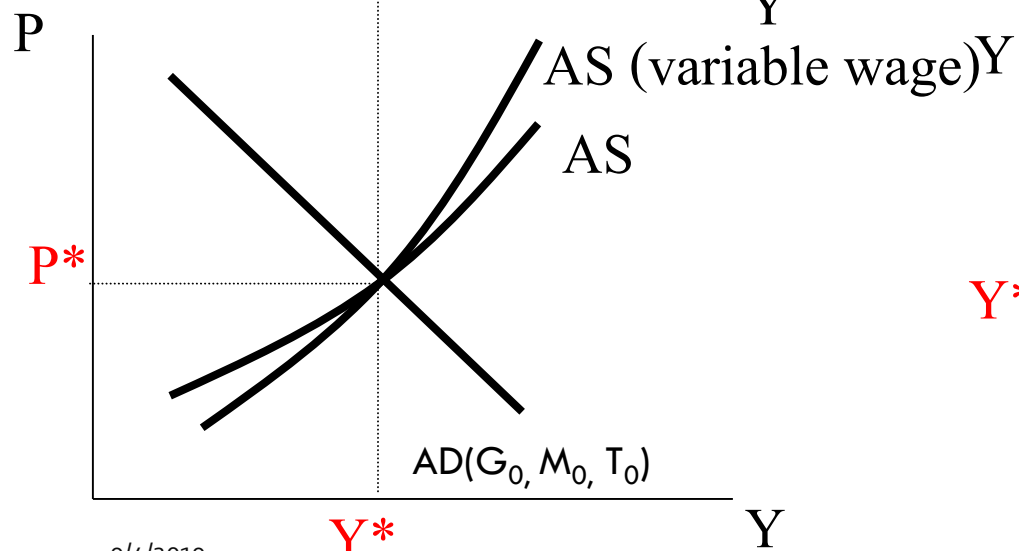
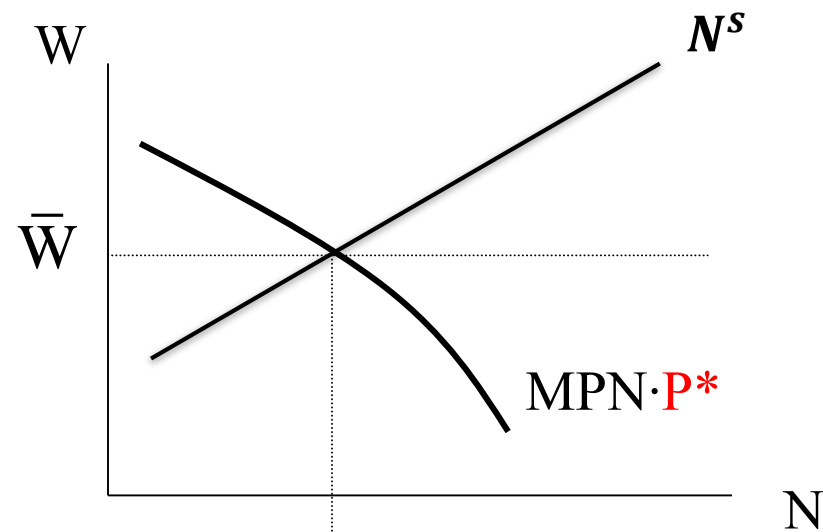
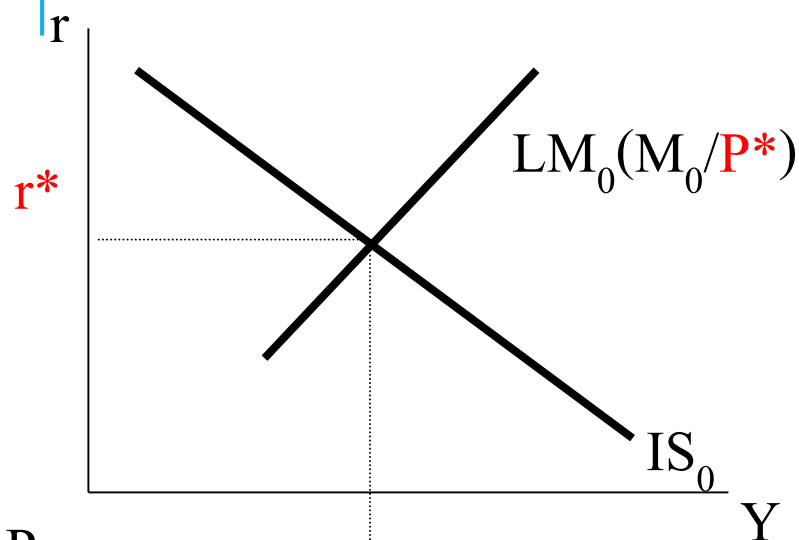
PROPAGATION OF SHOCKS

- Macroeconomy is randomly hit by shocks; business cycle followed.
- **Questions:**
 - How does shock **propagate**? (Transmission?)
 - Does the shock generate **large or small** impact? When?

DEMAND SHOCK: NEGATIVE ANIMAL SPIRIT (FIXED WAGE)



DEMAND SHOCK: NEGATIVE ANIMAL SPIRIT (VARIABLE WAGE)



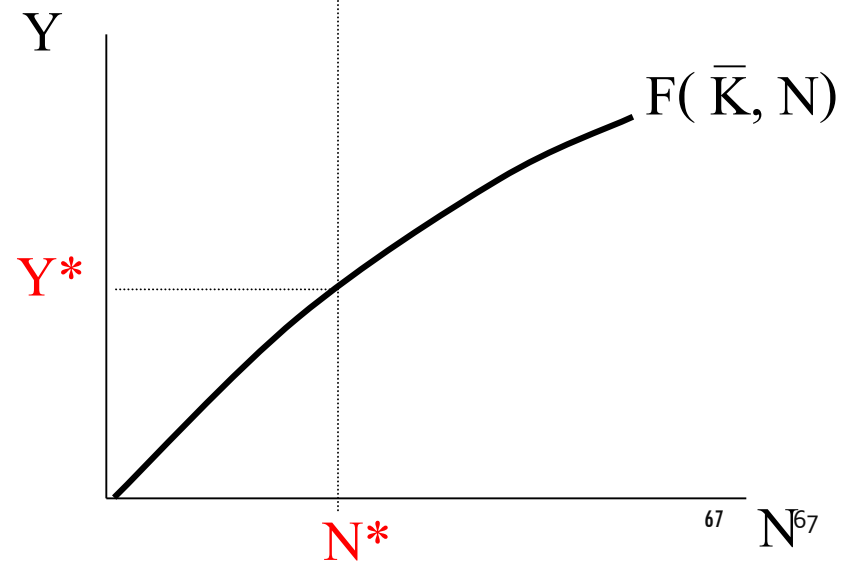
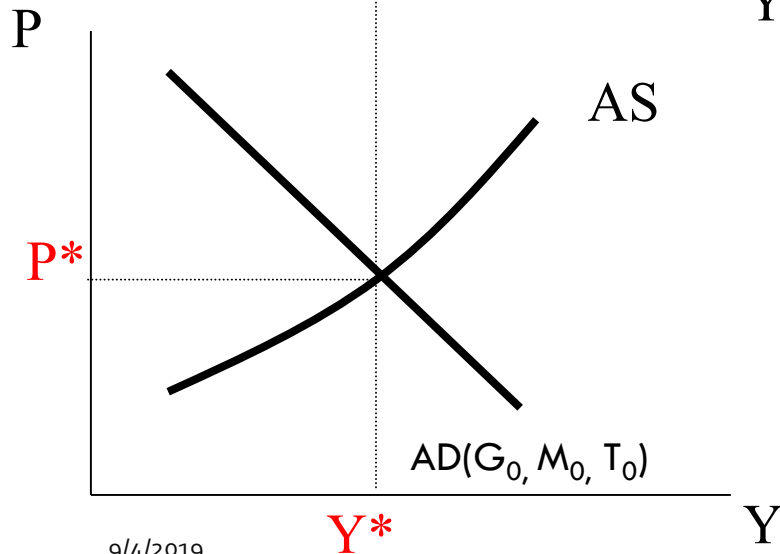
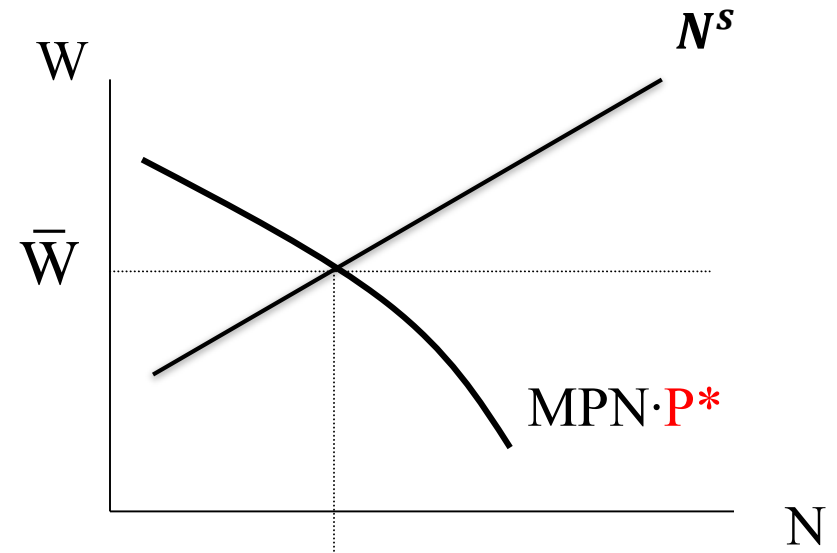
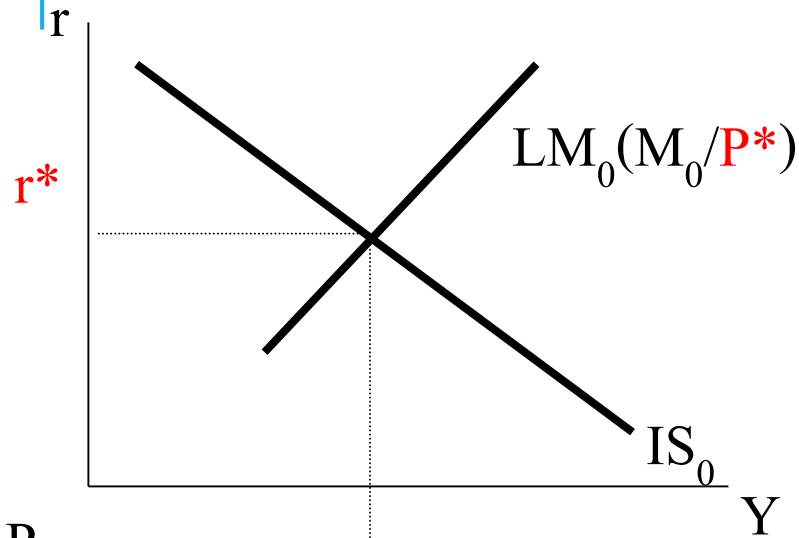
PROPAGATION MECHANISM OF DEMAND SHOCKS

- Under **demand shocks**, it follows that
 - 1. Shift in the AD curve (forward/backward)**
 - Stemming from the shift in IS/LM curve; those basic mechanisms underlie the IS/LM framework apply here – e.g. multiplier/crowding-out/slope.
 - 2. Effect of AD shocks would be stronger under fixed price system.**
 - Price adjustment will partially attenuates the effect of demand shocks – e.g. deviation of output would be relatively.

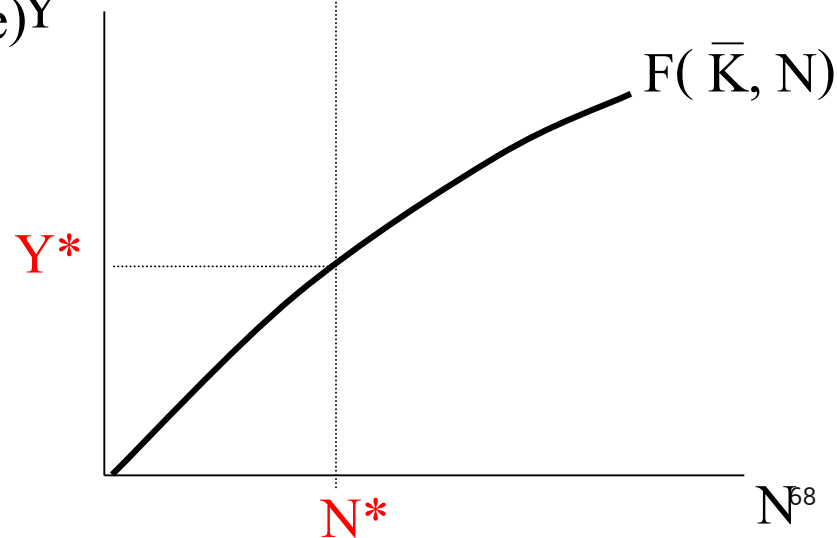
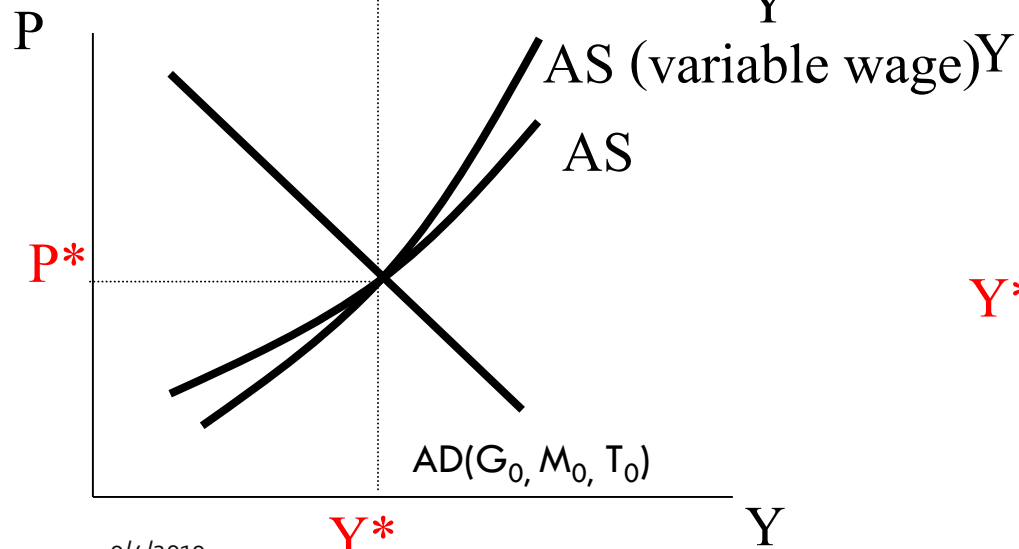
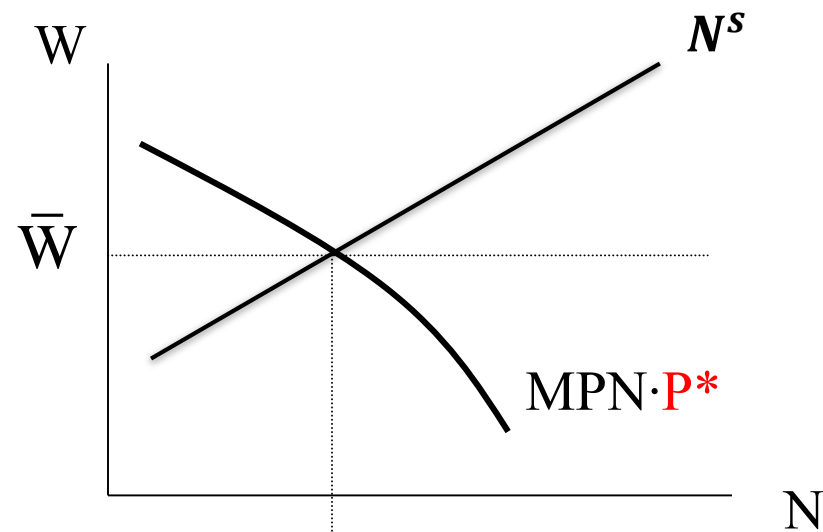
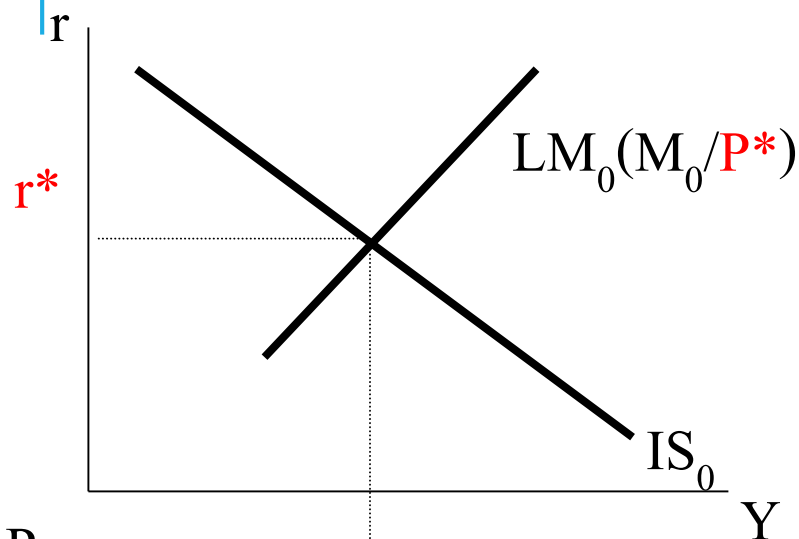
PROPAGATION MECHANISM OF DEMAND SHOCKS

- Under **demand shocks**, it follows that
 - **3. Effect of AD shocks would be further mitigated under variable wage system.**
 - Variation in wage limits the adverse effect of demand shocks.
 - If the nominal wage were fixed, change in price will result in a change in real wage.
 - Under fixed constant nominal wage, this causes a large swing in the employment, and hence output.

SUPPLY SHOCK: NATURAL DISASTER



SUPPLY SHOCK: NATURAL DISASTER



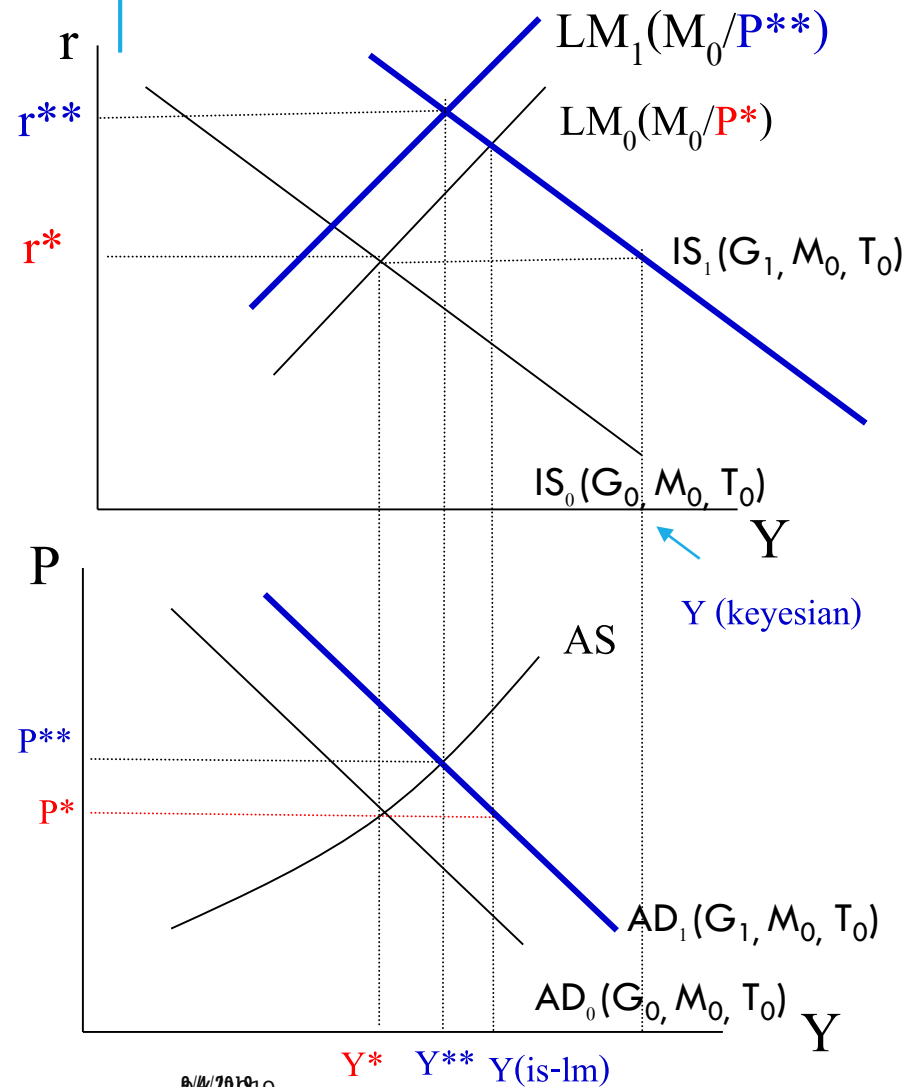
PROPAGATION MECHANISM OF SUPPLY SHOCKS

- Under **supply shocks**, it follows that
 - 1. Shift in the AS curve (forward/backward)**
 - Change in price will affect the quantity of aggregate demand.
 - 2. Effect of AS shocks would be stronger under the flat AD curve.**
 - Aggregate demand is more responsive to price .
 - When do we have a flat aggregate demand curve?

PROPAGATION MECHANISM OF SUPPLY SHOCKS

- Under **supply shocks**, it follows that
 3. **Effect of AS shocks would be stronger if AS is steep.**
 - Bigger impact on the horizontal shift of AS under steep AS curve.

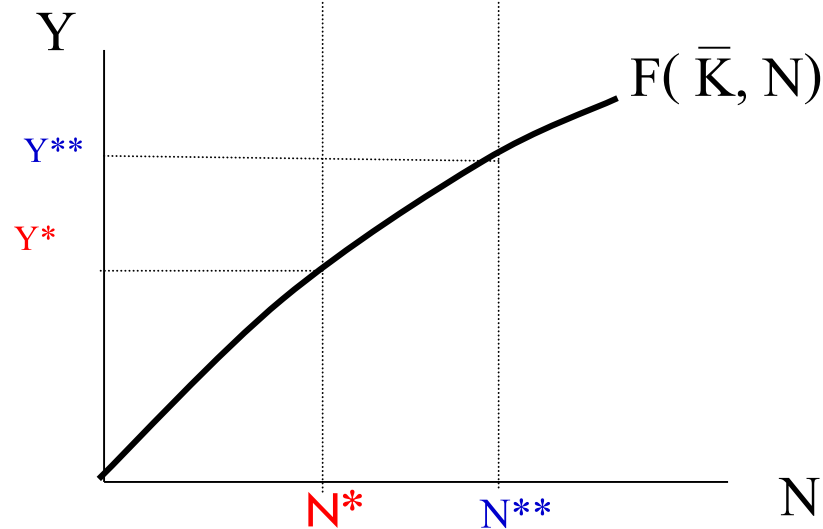
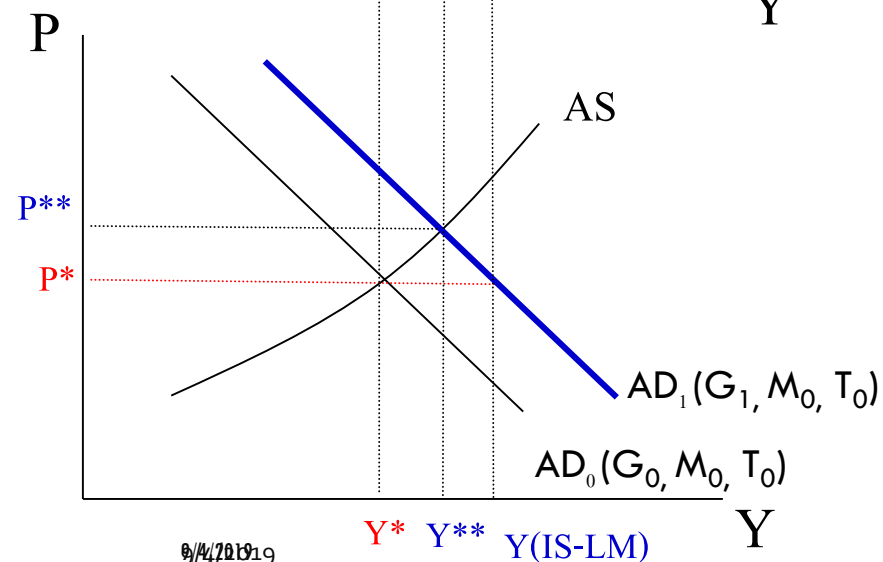
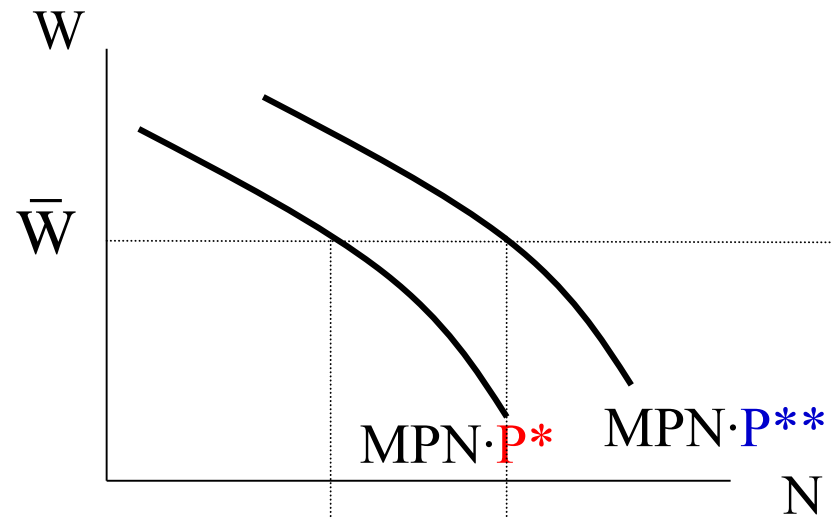
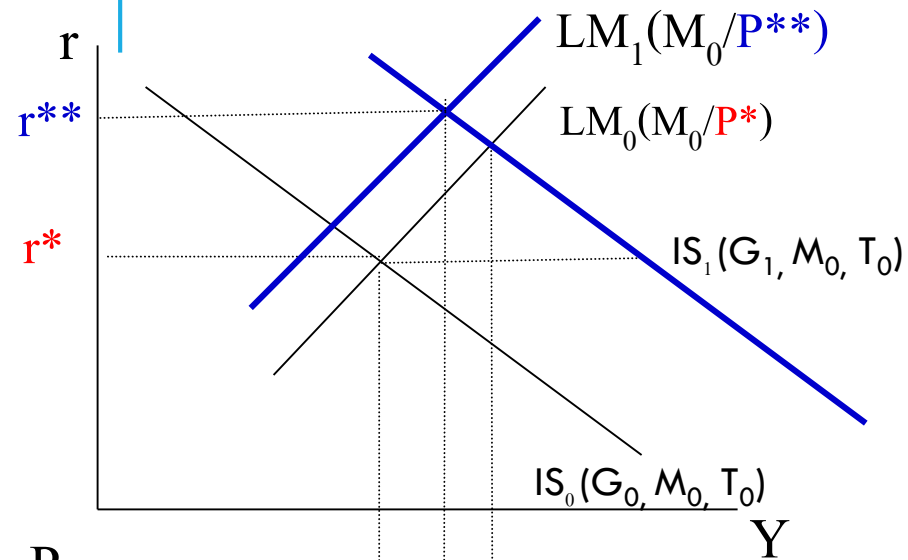
EQUILIBRIUM ANALYSIS: FISCAL POLICY



Mechanisms of Fiscal policy

1. Suppose price fixed equal to P^* .
2. $G_0 \rightarrow G_1$; IS_0 curve shifted to IS_1 .
3. AD_0 shift to AD_1 . (Horizontal shift?)
4. At P^* , we have excess demand; price starts to rise from P^* to P^{**} .
5. Rising price offsets the initial impact of "G" as it tends to push up the market interest rate; this is called the **price effect**.

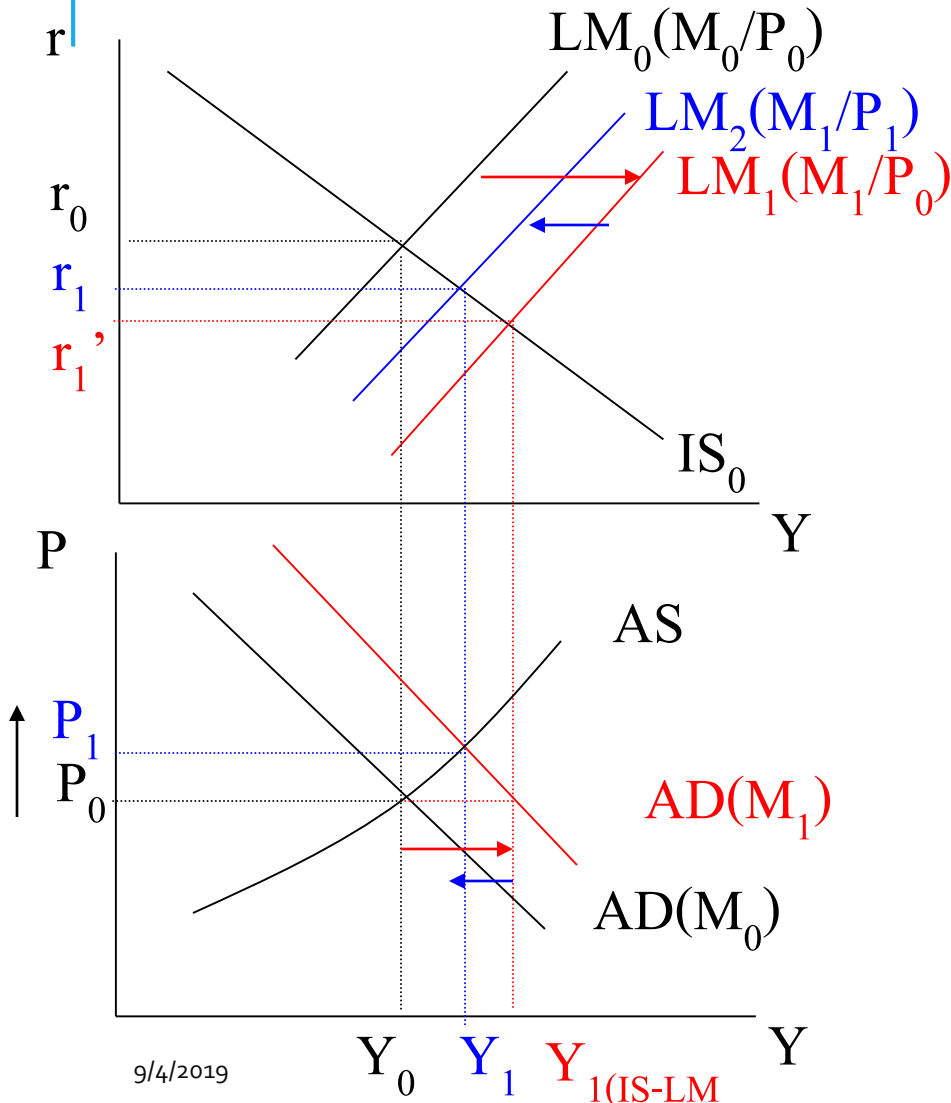
EQUILIBRIUM ANALYSIS: FISCAL POLICY



FISCAL MULTIPLIERS

Multipliers	Scenario
Traditional multiplier	Typical Keynesian cross Fixing “r” and “p”
IS-LM multiplier	r endogenously adjusted. Crowding-out effect; However, price remains fixed
AD-AS multiplier	Price changes along with the state of excess demand and excess supply.

EQUILIBRIUM ANALYSIS: MONETARY POLICY



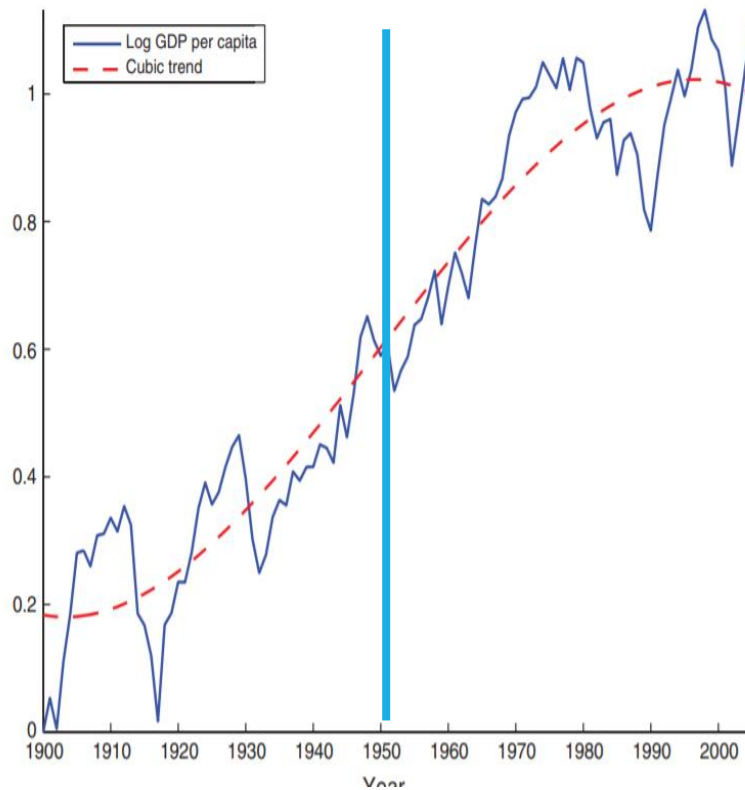
Mechanisms of Monetary policy

- Increase nominal money supply ($M_0 \rightarrow M_1$): LM shifts right.
- At P_0 , AD shift right.
- At P_0 , we have excess demand; price must be rising. It rises to P_1 .
- This causes the LM curve to shift left because real money supply decreases.
- The effect on Y is smaller than the effect under IS-LM model.

END-OF-SECTION DISCUSSION: EQUILIBRIUM MODEL AND BUSINESS CYCLE INTERPRETATION

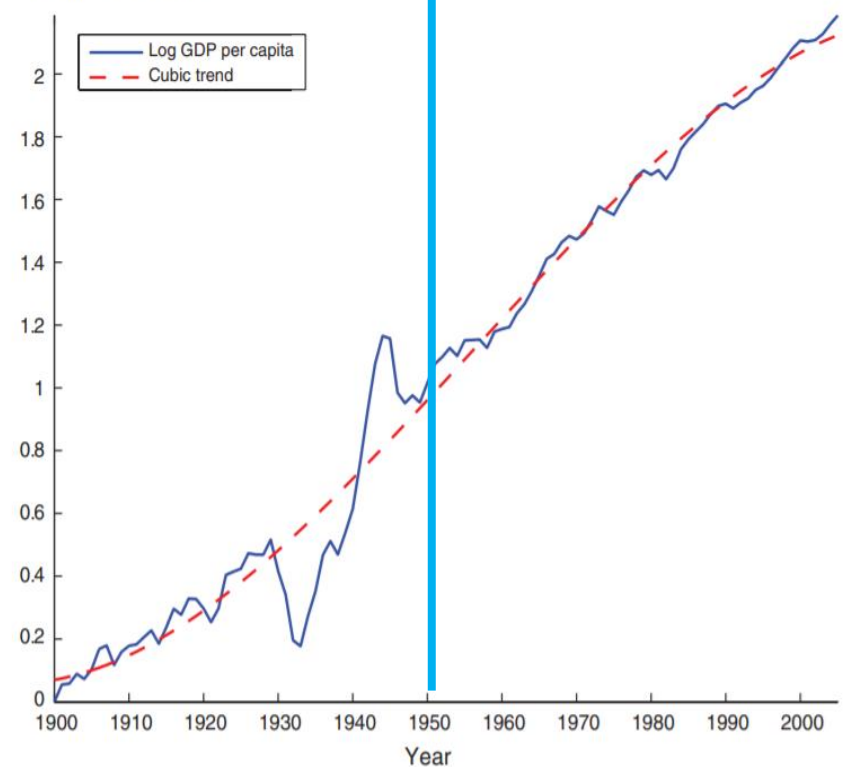
Panel A. Argentina

1950s

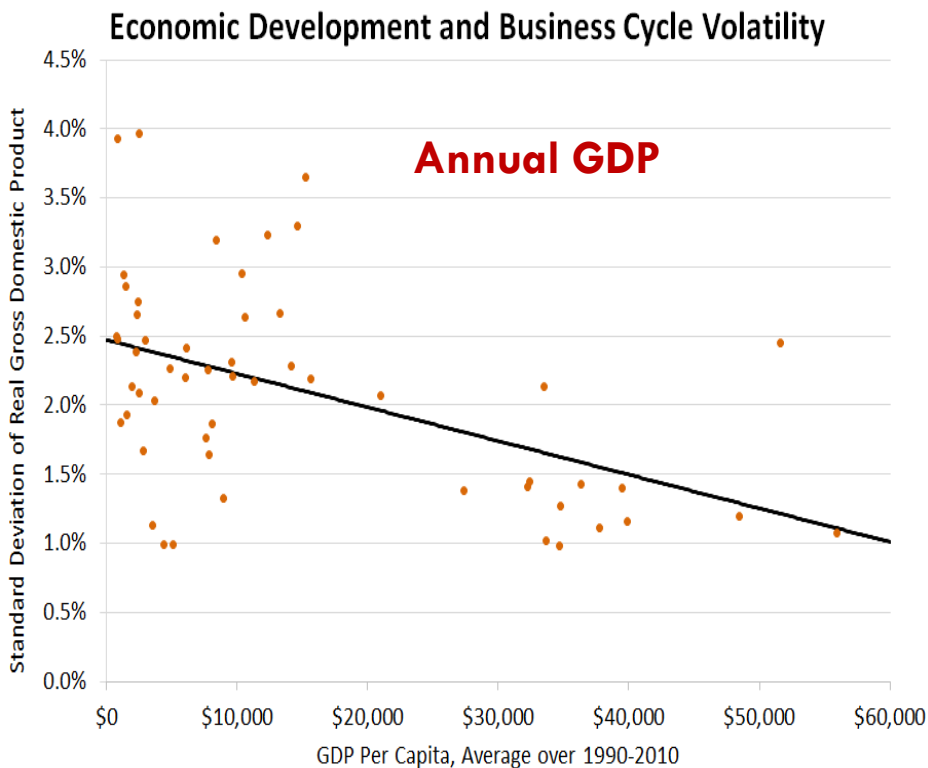


Panel B. United States

1950s



END-OF-SECTION DISCUSSION: EQUILIBRIUM MODEL AND BUSINESS CYCLE INTERPRETATION



SOURCE: World Bank's World Development Indicators.

FEDERAL RESERVE BANK of ST. LOUIS

Excess Volatility of Poor and Emerging Countries

Business-Cycle Statistic	Emerging	Rich
σ_y	8.7%	3.3%

Quarterly GDP

BUSINESS CYCLE INTERPRETATION

- Business cycle volatility is empirically observed.
- Large volatile business cycles could occur because of
 - Hit by many types of shocks!
 - Each type of the shocks is BIG
- The structure of macroeconomy is prone to invite the large amplified effects of shocks.
 - Internal frictions, e.g. labor market is slow to adjust!
 - Policy is inefficient to combat and insulate the impact of shocks. (sometimes, policy is the origin of trouble.)

ACCOUNTING SOME STYLIZED FEATURES IN DATA IN MACROECONOMY WITH MODEL

- **Long-term view**
 - 1. Long-term growth (positive; output growing over time.)
 - 2. Inflation rate is positive (around 2% p.a. after 2001)
- **Short-term view**
 - 1. Output growing more in some periods; choppy fluctuations.
 - 2. Inflation is sometimes higher or lower than the long-term trend (the 2% after 2001)

STYLIZED FEATURES IN DATA IN MACROECONOMY

Question: How can we explain/reconcile all these with in the AD-AS model. How to put all these stories together in the language of AD-AS model?

ACCOUNTING FOR THE LONG-TERM GROWTH

Think about AD and AS growing over time.

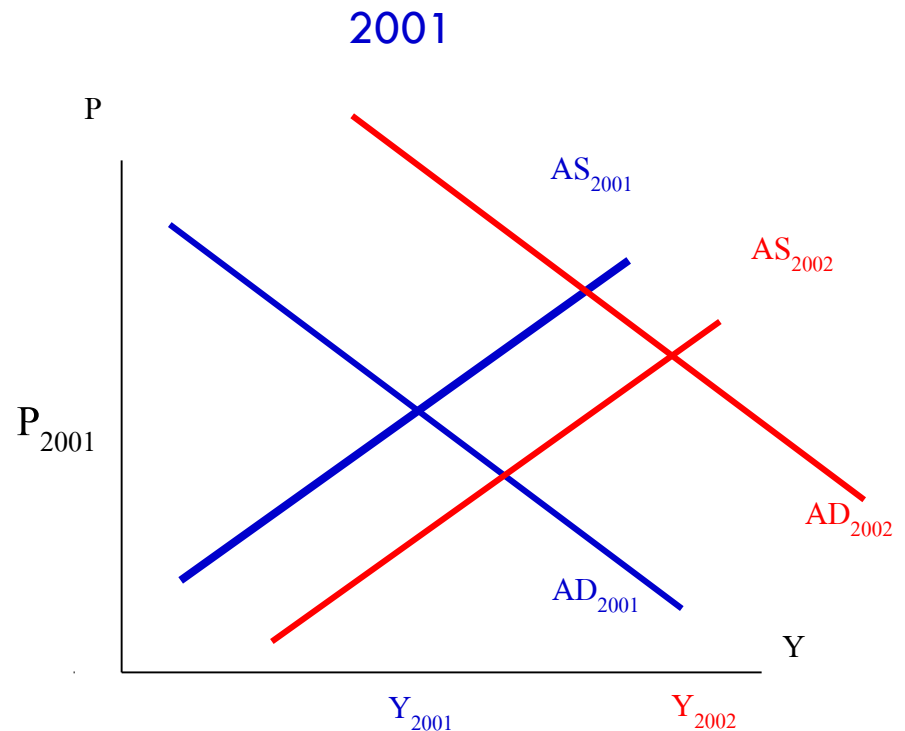
Example:

- Money supply grows over time;
Government spending grows over time.

-The level of technology improvement grows over time.

Account for positive inflation;

Demand-side factor might need to be growing faster than supply-side factor?



ACCOUNTING FOR THE CYCLES

- Then, how does the cycles occur?
 - The cycle occurs because AD and AS might be growing **more or less** than the rate required to ensure $x\%$ output growth – e.g., potential growth.
 - These deviations usually come at surprise; people call and treat them as **shocks/disturbances**.
- AD curve → **Demand shocks**
 - IS shocks: private spending shocks, animal spirits, etc.
 - LM shocks: financial panic, financial innovations, etc.
- AS curve → **Supply shocks**

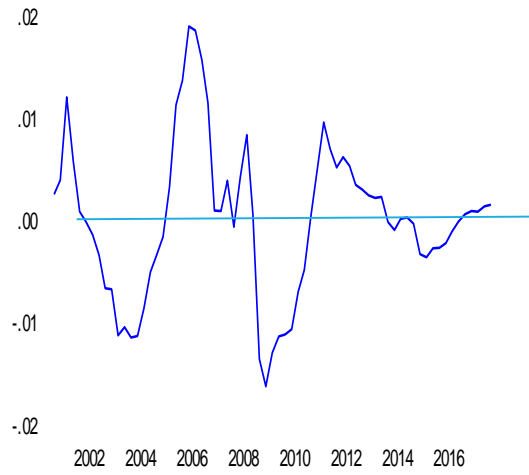
HOW FIT DOES THE AD-AS MODEL EXPLAIN THE WORLD?

- Compare model's prediction and Real-world data.
- **Qualitatively** assesses the fitness of the model!
- What do we see in the data?

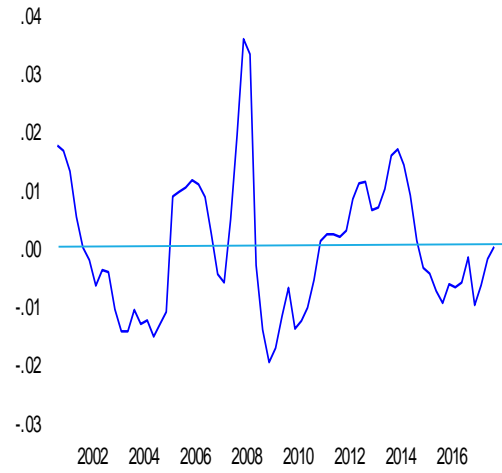
HOW FIT DOES THE AD-AS MODEL EXPLAIN THE WORLD?

- **Data:**
 - Real-GDP / Consumption / Private investment
 - Interest rates: 1-year government bond.
 - Real wage: average wage adjusted by headline CPI.
 - Price: headline CPI
- **Treatment:**
 - Detrend / Calculate: “Cyclical variations”
 - Compute pair-wise correlation.

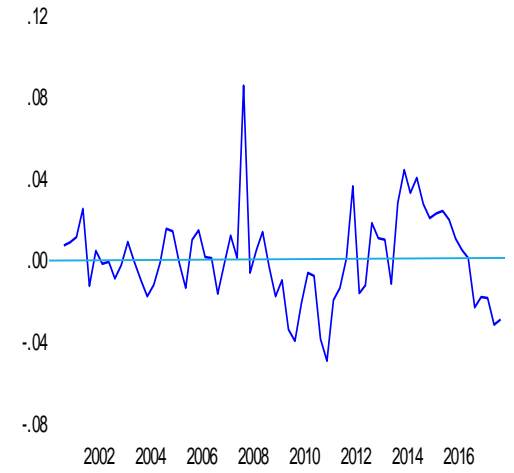
GOVT_BOND_1YR_CYC/100



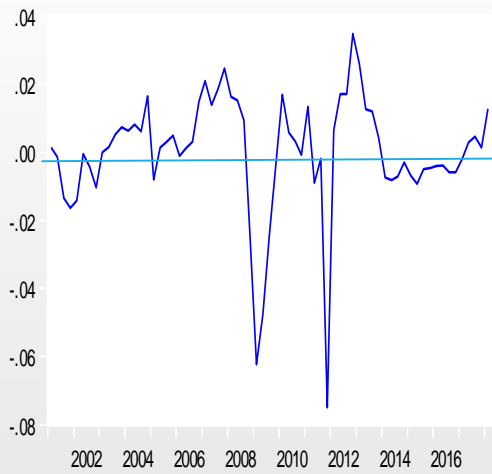
HL_CPI_CYC



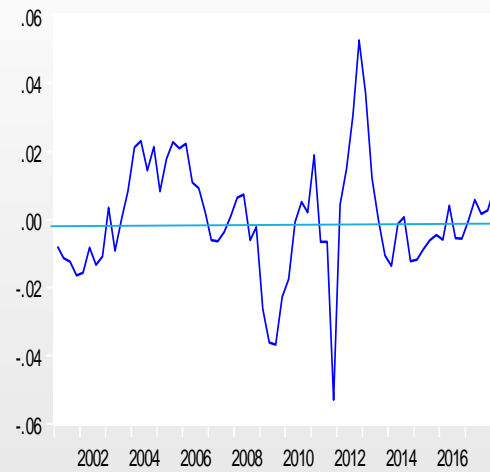
REAL_WAGE_CYC



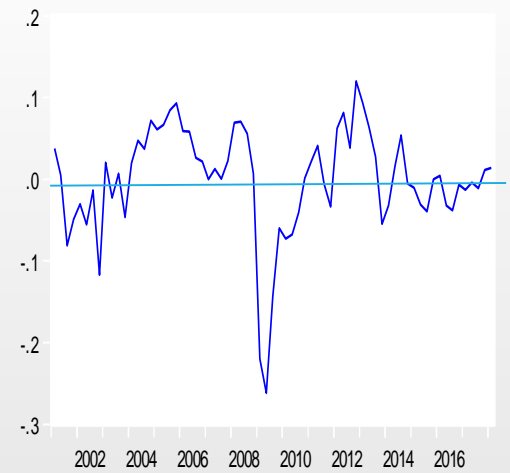
RGDP_CYC



RPC_CYC



RPI_CYC



HOW FIT DOES THE AD-AS MODEL EXPLAIN THE WORLD?

Covariance Analysis: Ordinary
 Date: 08/27/18 Time: 16:16
 Sample: 2001Q1 2018Q1
 Included observations: 69

Correlation Probability	GOVT BON...	HL CPI CYC	REAL WAG...	RGDP CYC	RPC CYC	RPI CYC
GOVT_BOND_1Y...	1.000000 ----					
HL_CPI_CYC	0.687204 0.0000	1.000000 ----				
REAL WAGE CYC	0.134363 0.2710	0.340238 0.0042	1.000000 ----			
RGDP_CYC	0.217482 0.0726	0.240540 0.0465	0.003125 0.9797	1.000000 ----		
RPC_CYC	0.218555 0.0712	0.160057 0.1889	0.025904 0.8327	0.720238 0.0000	1.000000 ----	
RPI_CYC	0.490877 0.0000	0.454588 0.0001	0.191887 0.1142	0.644726 0.0000	0.740333 0.0000	1.000000 ----

HOW FIT DOES THE AD-AS MODEL EXPLAIN THE WORLD?

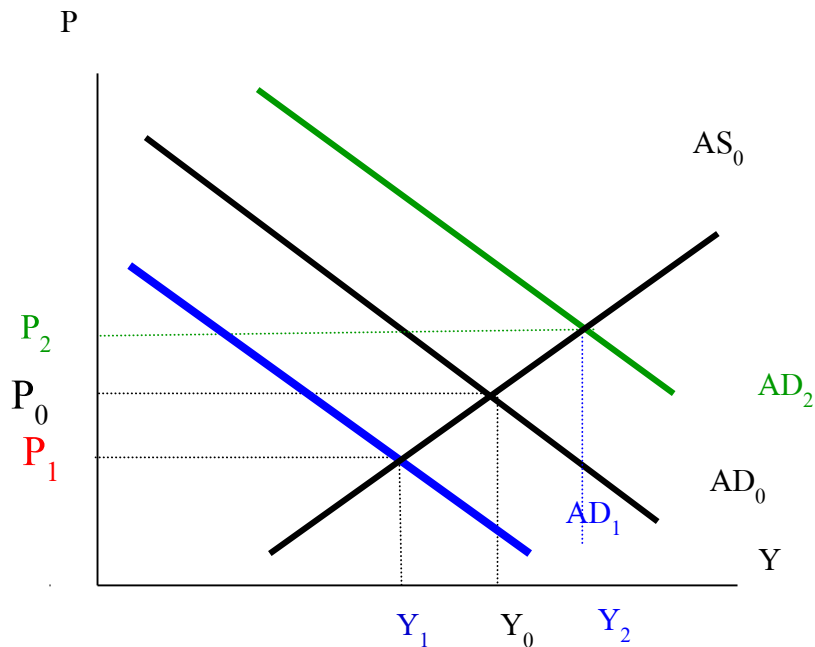
- Since 2001, what we have seen in the data is that aggregate variables are *pro-cyclical*.
- Real-wage is might be an exception – e.g. *weakly pro-cyclical* (*statistically acyclical*).

DATA V.S. MODEL: TESTABLE IMPLICATIONS

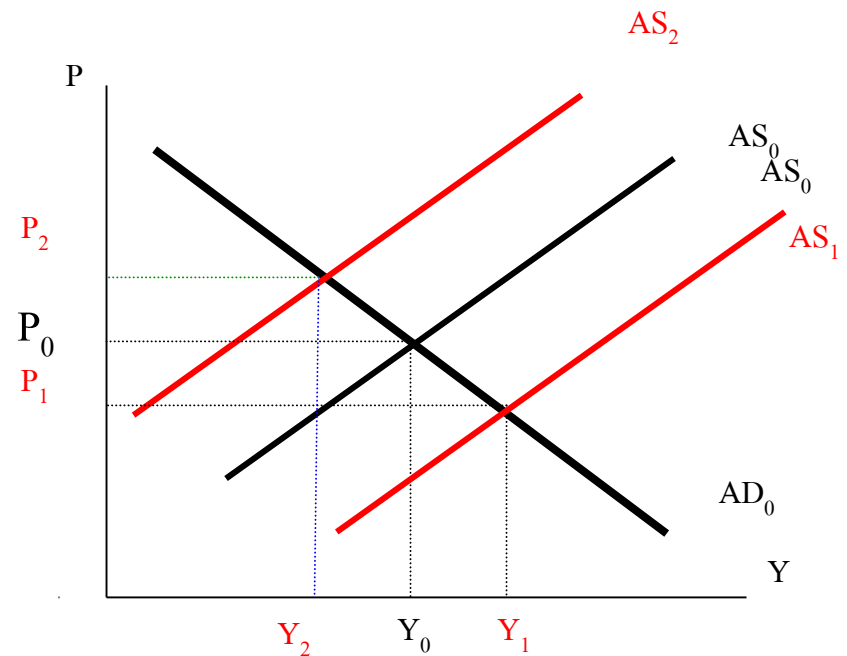
- Can the AD-AS model account for these stylized facts?
 - If you believe that your AD-AS story is right, the answer is *yes*.
 - But a better question to ask is which underlying shocks have dominantly driven the cycles.

SUPPLY V.S. DEMAND SHOCKS: IMPLICATION

Demand shocks



Supply shocks



Positive correlation: output and inflation

Negative correlation: output and inflation

DATA V.S. MODEL: TESTABLE IMPLICATIONS

- Back to our question.
- In order to generate the qualitative pattern, our economy must be *pre-dominantly* driven by *demand factor*.
 - Note this doesn't mean the supply factor is not important; it merely states that demand factors dominate the supply factors.