Topic 3 : The Core AD-AS Framework

EE312 Section 046401: 1/2020

Read: Froyen Ch.3-6, Mankiw Ch.3, 14

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Contents

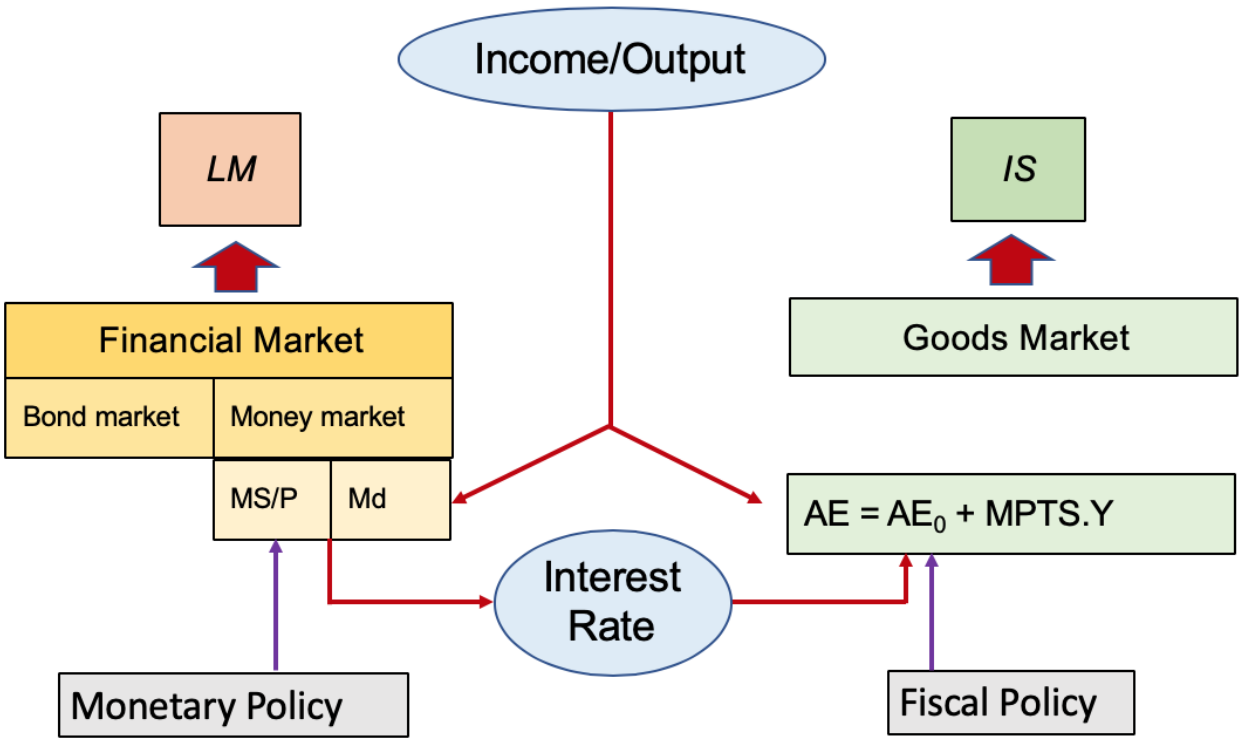
1 Introduction :

- We will discuss about long-run macroeconomy.
- In particular, what determine the "potential output" and "natural rate of unemployment"
- Laid out some important ingredients of market-clearing model for understanding the long-run macro economy.
- Review the basic concepts of two important foundations AD and AS
- Analyze the equilibrium and *shock-propagaing mechanism* under AD-AS framework
- Look into *the policy analysis*

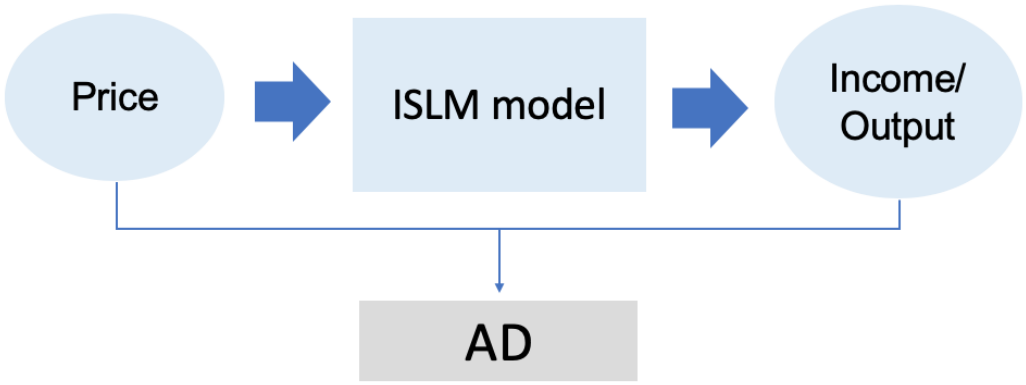
2 The IS-LM model and Aggregate Demand

2.1 Overview

- Price is fixed : ISLM model



- Price can be adjusted : ISLM $\Rightarrow$ AD


Price
ISLM model
Income/
Output
AD

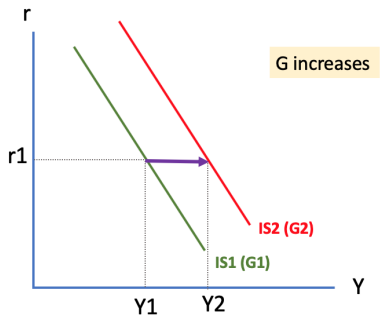
2.2 IS-LM model

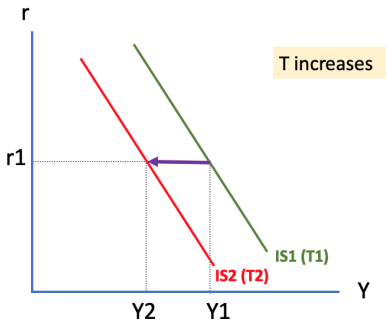
LM	IS
Derivation Equilibrium in the **money** market $Y \uparrow \Rightarrow M^d$..... $\Rightarrow r$..... r and Y has ..... relationship LM has ..... slope	**Derivation** Equilibrium in the **goods** market $r \uparrow \Rightarrow I$.... $\Rightarrow DAE$..... $\Rightarrow Y$..... r and Y has ..... relationship IS has ..... slope
Slope of LM 1. Money demand elasticity of income (ε_Y^{Md}) • Money demand is highly sensitive to income change • $Y \uparrow$ a little $\Rightarrow M^d \uparrow$ ..... $\Rightarrow r \uparrow$ ..... • ε_Y^{Md} is high, LM is ..... 2 Money Demand Elasticity of interest (ε_r^{Md}) • Money demand is highly sensitive to interest rate change • $Y \uparrow \Rightarrow M^d \uparrow$ ..... but MS remain constant $\Rightarrow$ then, r must..... (a .....) to make M^d..... (offsetting the previous increase in M^d to make money market in equilibrium again.) •ε_r^{Md} is high $\Rightarrow$ LM is	**Slope of IS** 1. MPC • MPC is high, income multiplier is ..... • $r \uparrow \Rightarrow I \downarrow \Rightarrow DAE \downarrow \Rightarrow Y \downarrow$ ..... • MPC is high, IS is ..... 2. Interest elasticity of investment (ε_r^I) • Investment is very sensitive to interest rate change $r \uparrow \Rightarrow I \downarrow$ ..... $\Rightarrow DAE \downarrow \Rightarrow Y \downarrow$ ..... • Investment is very sensitive to interest rate change $\Rightarrow$ IS is ..... • ε_r^I is high, IS is .....
Shift in LM $M^S \uparrow \Rightarrow$ LM shifts to the ..... $M^S \downarrow \Rightarrow$ LM shifts to the ..... $M^d \uparrow$ for all levels of r and Y $\Rightarrow$ LM shifts to the ..... P $\uparrow \Rightarrow$ LM shifts to the	**Shift in IS** $G \uparrow \Rightarrow IS$ shifts to the ..... $T \uparrow \Rightarrow IS$ shifts to the ..... $G \uparrow$ by equal amount as $T \uparrow \Rightarrow$ IS shifts to the..... C or I $\uparrow$ for all levels of r and Y $\Rightarrow IS$ shifts to the .....

Question to discuss

Q1. Size of IS shift (horizontally measure = holding r constant)

- Suppose G increases for 1 unit, how does IS shift? to what direction and by how much?
- Suppose T increases for 1 unit, how does IS shift? to what direction and by how much?





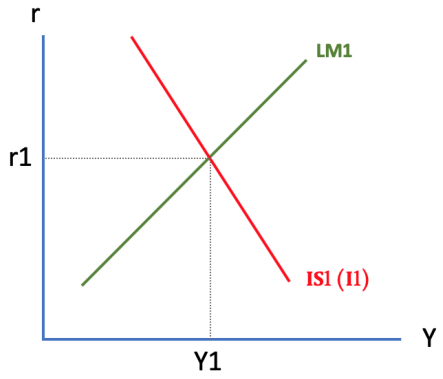
- The size of horizoantal shift depends on **the multiplier effect** of the changing factors.

Q2. For the same amount of the change, which one would produce a bigger shift of IS curve T or G?

Q3. Does the size of horizontal shift have any relationship with the slope of IS curve? Why?

Q4. Does the panic in banking sector affect LM curve?

Q5. How do negative shocks on autonomous investment spending affect the economy? Analyze by using the IS-LM model.

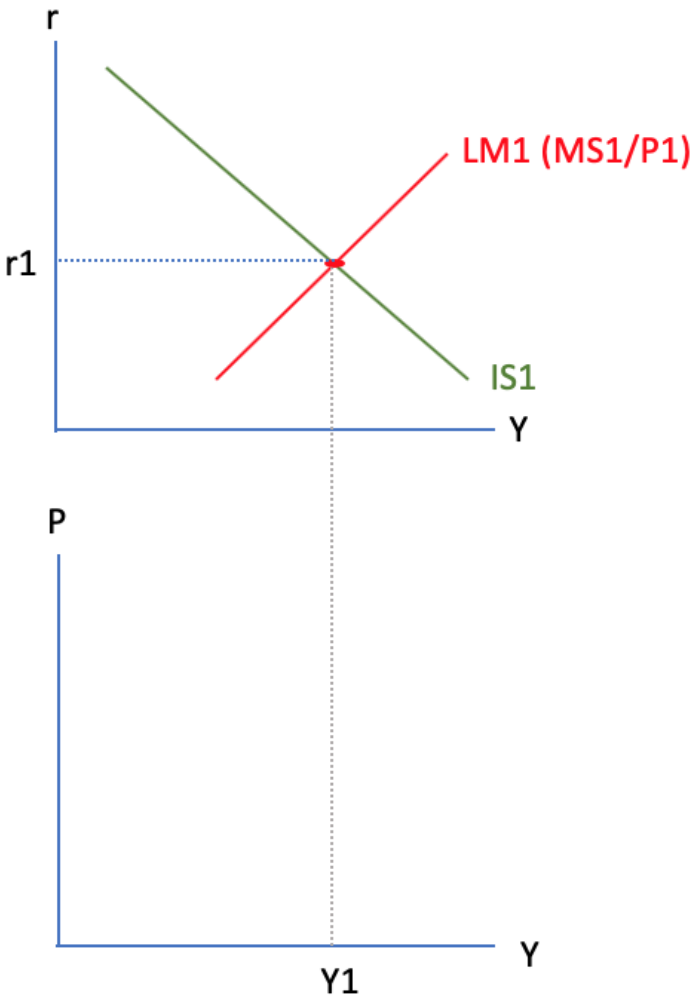


- Investment decreases $\Rightarrow$ IS shifts to the left
- Interest rate cannot be sustanted at r1; too high. Rate is supposed to be falling
- Falling interest rate helps couteracting with the initial negative shocks.
- A decline (recession) in output is smaller than when the interest rate is fixed.

2.3 Aggregate Demand

2.3.1 Derivation of AD curve

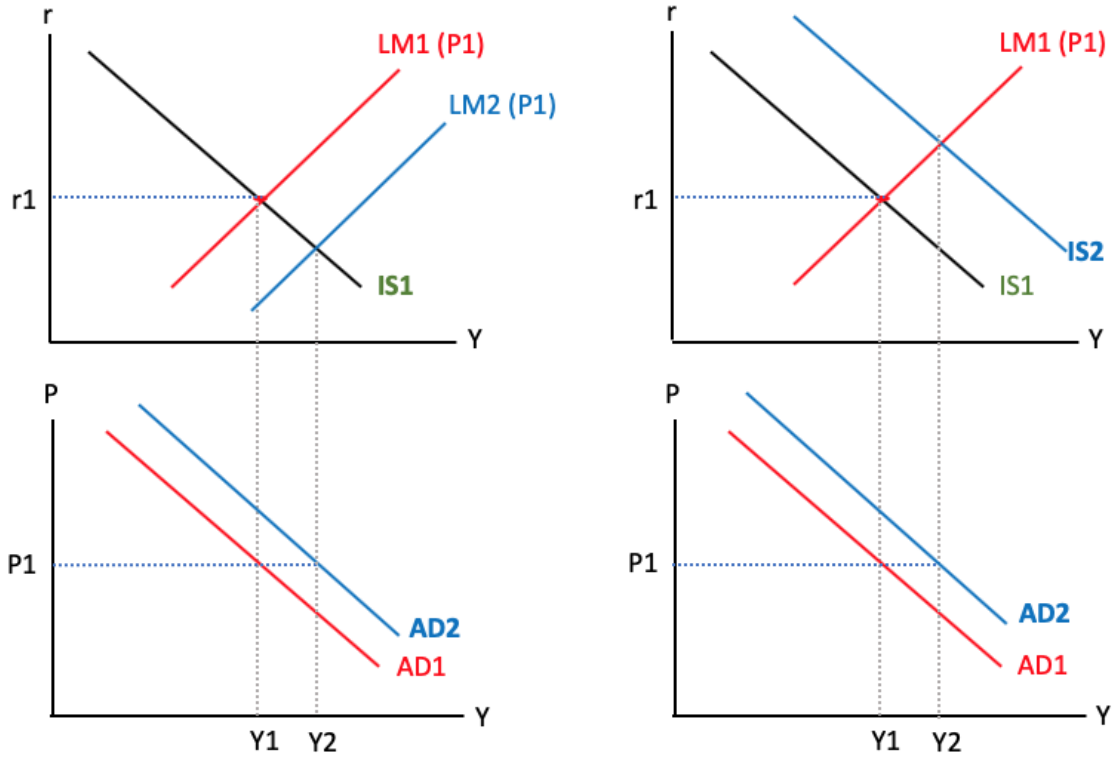
- IS-LM model was built on the assumption that *price is fixed*.
- What if price can be adjusted? How would this affect behavior of aggregate output?
- The relationship that links between "price" and "income" obtained from the IS-LM model is called the aggregate demand relationship.
- Aggregate demand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



- Suppose that nominal money supply is fixed at MS1.
- Initial price level is P1 and IS-LM equilibrium is at (r1, Y1).
- Now consider two alternatibe scenarios : P3 > P2 > P1
- Given the two scenarios, one knows that
$$\frac{MS1}{P3} < \frac{MS1}{P2} < \frac{MS1}{P1}$$
- Graphically, rising price causes real money supply to drop; LM curve shifted left: LM1 $\rightarrow$ LM2 $\rightarrow$ LM3
- AD curve can be derived from the equilibrium of the IS-LM model; downward sloping slope.

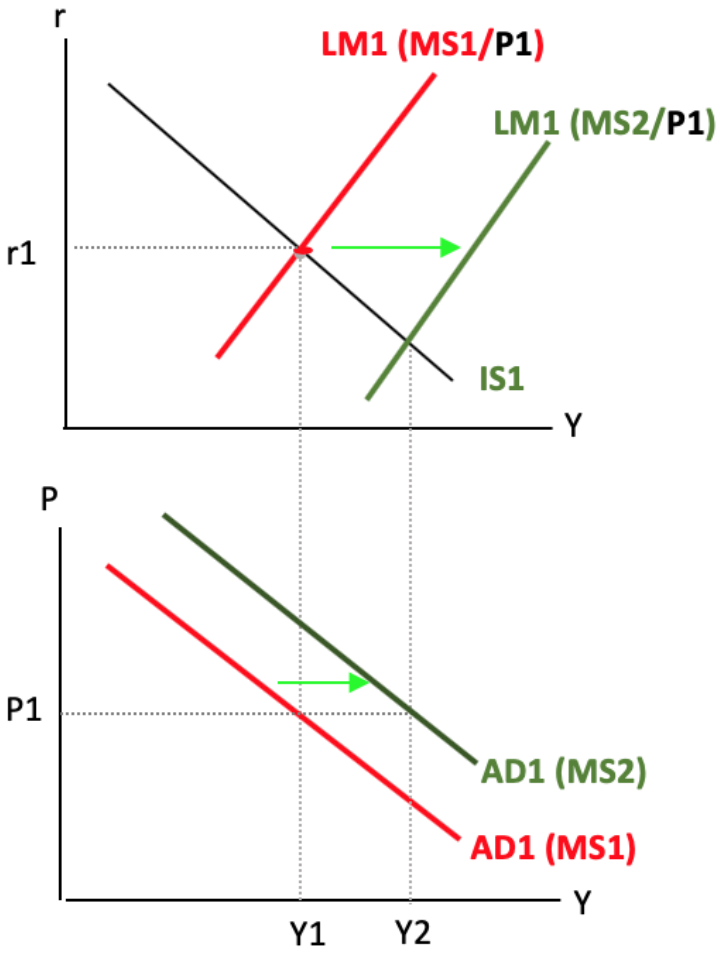
2.3.2 Shift in AD curve

- Aggregate demand can be shifted to the right (more demand for any given prices) and to the left (less demand for any given prices.)
- All underlying factors that determine the IS curve and the LM curve can cause the change in Aggregate demand curve.
- LM shifts to the right ⇒ AD shifts to the right
- IS shifts to the right ⇒ AD shifts to the right



- Consider the effect of fiscal policy and monetary Policy

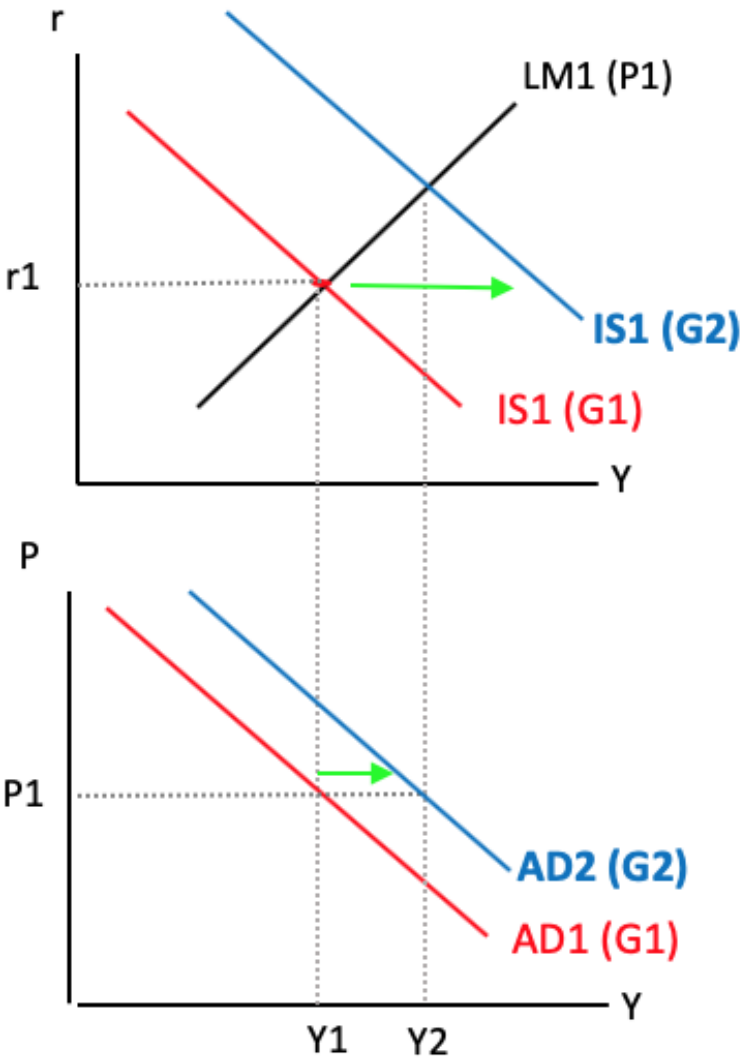
Monetary Policy : Changes in the nominal money supply



- Consider a fixed level of price P1
- Suppose a central bank increases money supply ; MS1 to MS2
- Positive money creation will cause the LM curve to shift right

  LM1 (MS1/P1) to LM2(MS2/P1)
- Income will rise from Y1 to Y2.
- Y1 is no longer aggregate quantity demanded at P1 when money supply is now MS2 > MS1 ; aggregate demand curve then sifts right.
- For any level of prices inceasing money supply would cause LM to shift to the right and hence the AD curve.
- On the contrary, lowering money supply would cause LM to shift to the left and hence the AD curve.

Fiscal Policy : Changes in the government spending



- Consider a fixed level of price, P1
- Suppose government increases spending from G1 to G2
- Positive changes in government spending will cause the IS curve to shift to the right ; IS1(G1) to IS2(G2) ; income will rise from Y1 to Y2
- Y1 is no longer aggregate quantity demanded at P1 when government spending is now G2 > G1; aggregate demand curve then shifts right
- For any level of prices, increasing G (G1 $\rightarrow$ G2) ; aggregate demand curve then shifts right.
- For any level of prices, decreasing G (G1 $\rightarrow$ G3) ; aggregate demand curve then shifts left.

2.3.3 Shift in Aggregate Demand : Question

Question 1 : How does the deterioration in the level of consumer and business confidence affect aggregate demand curve?

Question 2 : How does the introduction and acceptance of digital currency affect aggregate demand curve?

Question 3 : When does the fiscal and monetary policy generate a big shift in AD curve?

Review IS-LM

1. DAE Model : [Constant r, Constant P]

$$DAE = C + I + G$$

$$= [C_a - bT_a + I_a + G_a] + [b + d]Y$$

$$= AE_0 + MPTS.Y$$

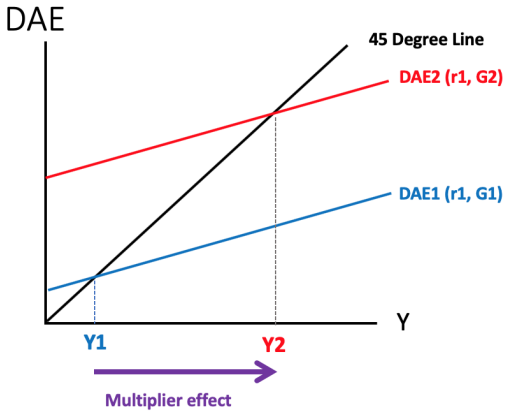
At equilibrium $Y = Y^E = DAE$, Leakage = Injection

$$Y^E = \frac{1}{1-(b+d)} \times [C_a - bT_a + I_a + G_a]$$

$$= \text{multiplier} \times [\text{autonomous expenditure}]$$

$$\text{multiplier (k)} = \frac{\Delta Y}{\Delta \text{Autonoumous Expenditure}} = \frac{\Delta Y}{\Delta AE}$$

$$\Delta Y = k \times \Delta AE : k = \frac{1}{1 - \text{Slope of DAE}}$$



- DAE shift up : autonomous expenditure ↑ (i.e. : $\{C_0, G_0, I_0\}$ ↑or $\{T_0\}$ ↓), Spending(Expenditure) on domestic goods ↑ for all levels of Y
- DAE shift down : autonomous expenditure ↓ (i.e. : $\{C_0, G_0, I_0\}$ ↓or $\{T_0\}$↑), Spending(Expenditure) on domestic goods ↓ for all levels of Y

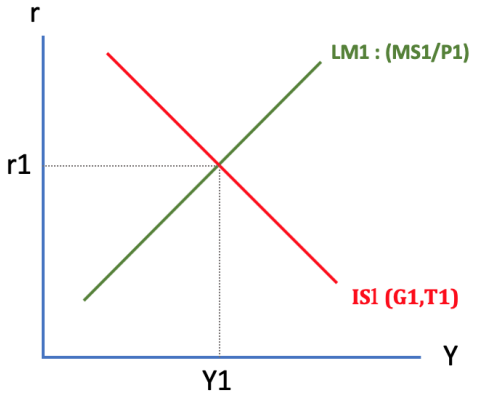
2. IS-LM Model : [r changes, Constant P]

LM

Derivation:
$Y \uparrow \Rightarrow M^d \uparrow \Rightarrow r \uparrow$
Slope of LM :
High ε_Y^{Md}, steep LM,
High ε_r^{Md}, flat LM
Shift in LM :
Real Ms $\left(\frac{MS}{P}\right)$,
Change in Md for all Y, r

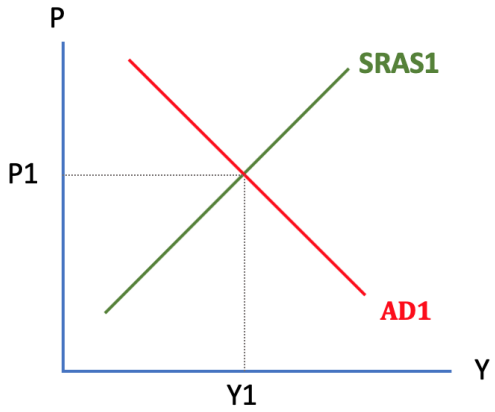
IS

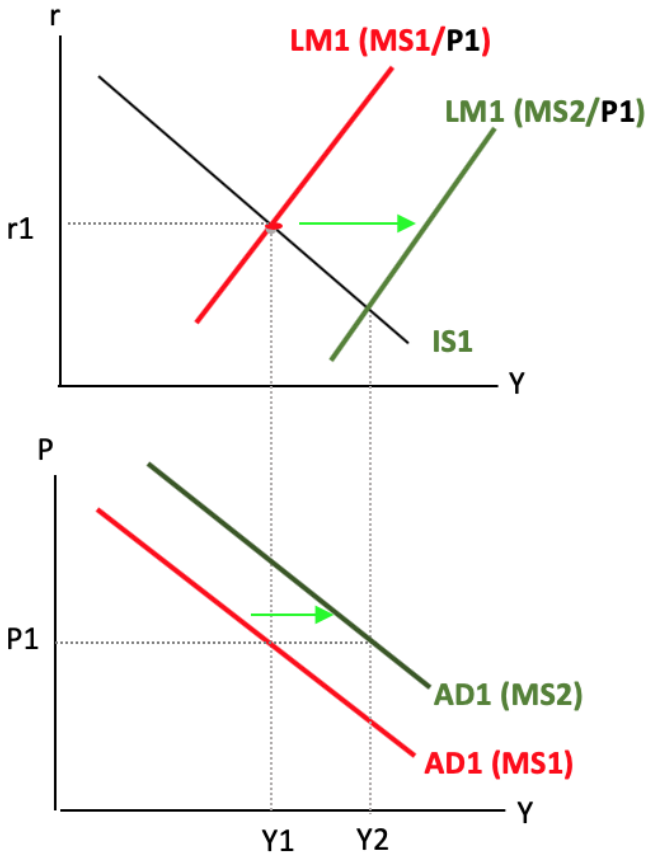
Derivation:
$r \uparrow \Rightarrow I \downarrow \Rightarrow DAE \downarrow \Rightarrow Y \downarrow$
Slope of IS :
High MPC, flat IS
High ε_r^I, flat IS
Shift in IS :
Fiscal Policy (G, T)
Change in C ,S , I for all Y, r

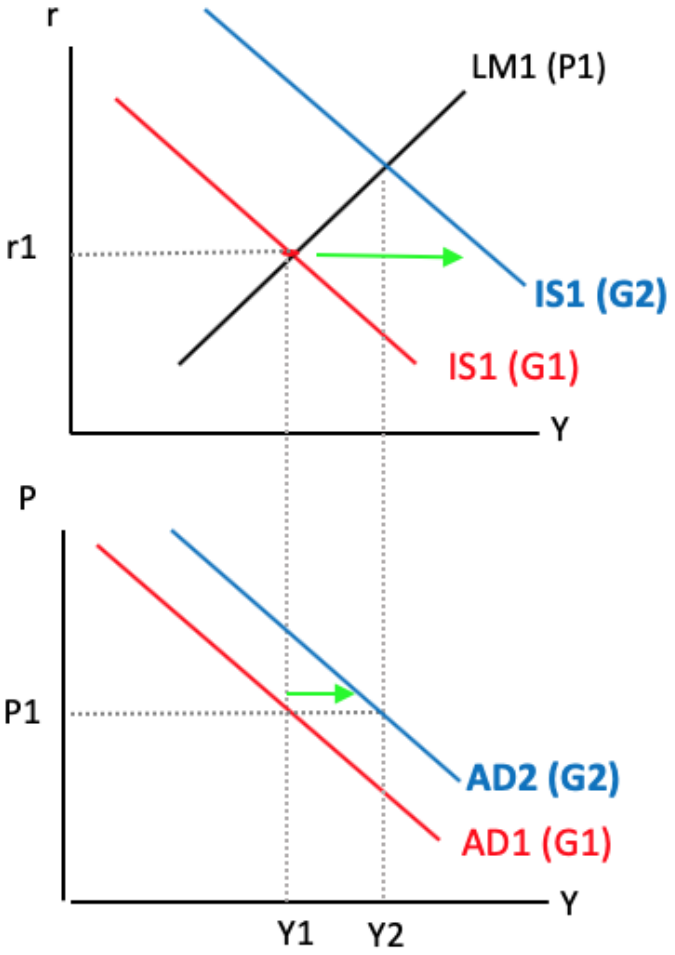


3. Aggregate Demand : [r changes and P changes]

● Price level ↑ ⇒ Real Money Supply $\left(\frac{MS}{P}\right)$ ↓ ⇒ LM shifts to the left ⇒interest rate ↑
⇒ DAE ↓ ⇒ Output (Y) ↓
● IS shift to the right ⇒ Y ↑ for all levels of Price ⇒ AD shifts to the Right
● LM shift to the right (not because of a change in Price) ⇒ Y ↑ for all levels of Price ⇒ AD shifts to the Right




r
LM1 (MS1/P1)
LM1 (MS2/P1)
r1
IS1
Y
P
P1
AD1 (MS2)
AD1 (MS1)
Y
Y1
Y2


r
LM1 (P1)
r1
IS1 (G2)
IS1 (G1)
Y
P
P1
AD2 (G2)
AD1 (G1)
Y
Y1
Y2

3 Aggregate Supply and Labor Market

- 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.
- In the short-run, nominal wages are not completely flexible.
- In the long-run, nominal wages are completely flexible. The economy is always at full-employment.

3.1 Aggregate Production Function

- To understnad about the long-run macroeconomy, economists typically build their concepts upon the idea of aggregate production function.
- Aggregate Production Function : $Y = zF(K, N)$

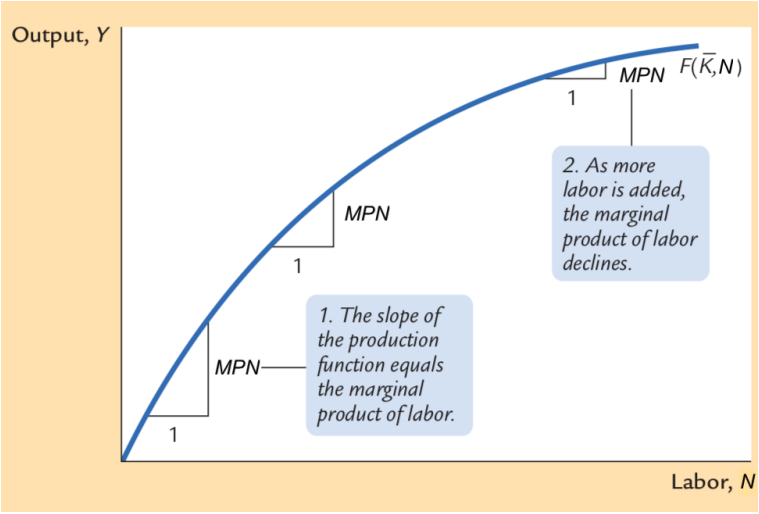
  where:

  Y = output of consumption goods;

  K = capital input;

  N^d= labor input (hours);

  z = total factor productivity (TFP) = the effectiveness with which capital and labor are used.
- Capital stock is treated as fixed.
- Analytical representation of aggregate production function is therefore to focus on the relationship between output and labor input.

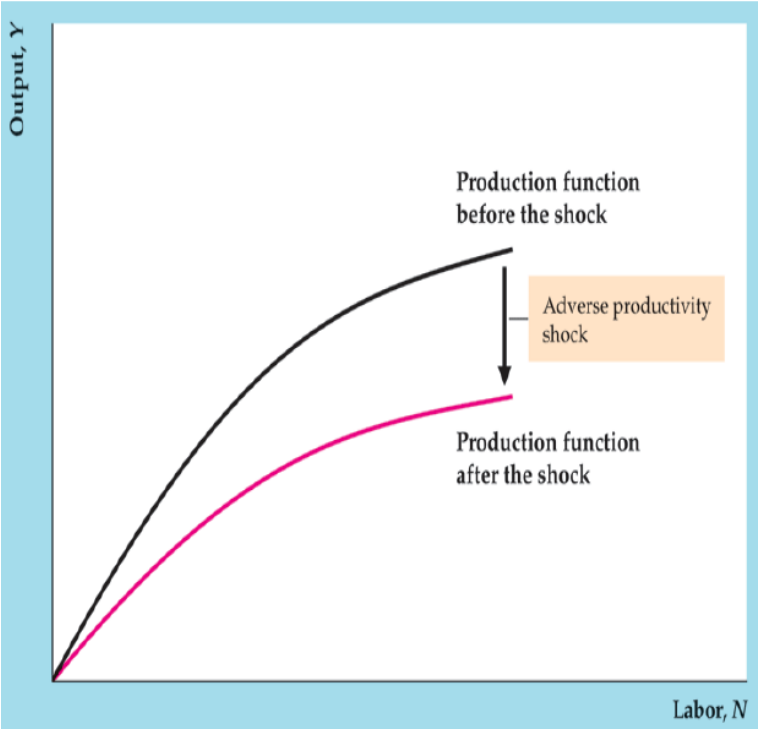


- The shape of the production function
- Marginal product of labor,

  $$MPN = \frac{\Delta Y}{\Delta N}$$
- Equal to slope of production function graph
  - MPN always positive
  - Diminishing marginal productivity of labor

- Shift in production function = productivity shocks
- Change in the amount of output that can be produced for a given amount of inputs.

- Example: weather, inventions and innovations, government regulation, oil prices



- Negative (adverse) shock : usually slope of production function decreases at each level of input (for example, if shock causes parameter z to decline)
- Positive shock : usually slope of production function increases at each level of input (for example, if parameter z increases)

What is the level of total output produced by the macroeconomy?

- Given the aggregate production function, the total output produced will be determined by the level of labor input utilization.
- The level of labor utilization is determined by two forces: labor market demand and labor market supply.

3.2 Labor Market

- Households supply labor force to the labor market. $\Rightarrow$ Labor Supply $\left(N^s\right)$
- Firms hire labor in the labor market $\Rightarrow$ Labor Demand $\left(N^d\right)$

3.2.1 Labor Demand : Firm Decision

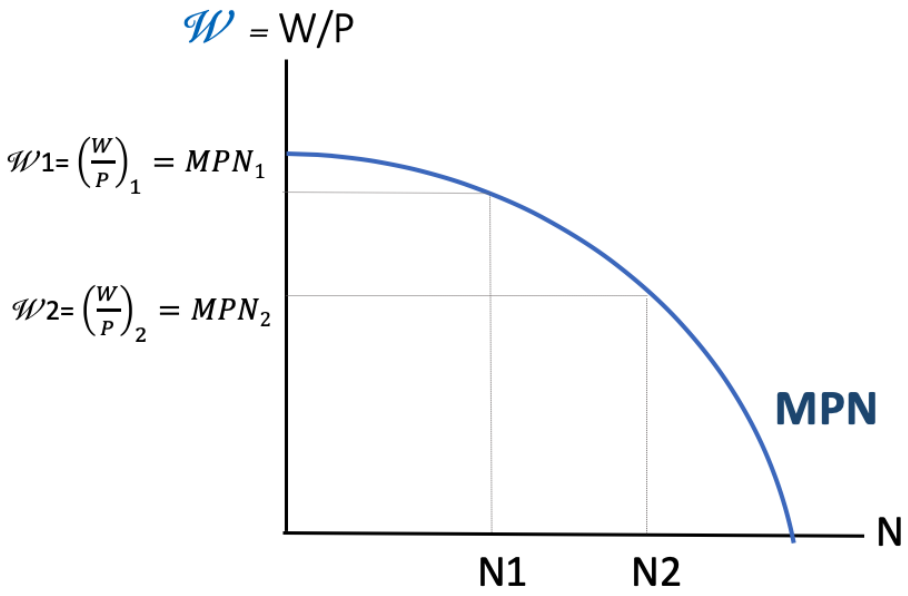
- How much labor do firns want to use?
  - Assumptions
    Hold capital stock fixed
    Workers are all alike
    Labor market is competitive
    Firms maximize profit
- Mathenatically, firm chooses for optimal level of workers (N) that maximizes profit.

$$\begin{aligned}\pi &= TR - TC \\ &= PY - (WN + \text{Fixed Cost}) \\ &= PF(\bar{K}, N) - WN - \text{Fixed Cost}\end{aligned}$$

- **Profit maximising condition** : $\frac{d\pi}{dN} = P\frac{\partial Y}{\partial N} - W = 0$
- Standard optimality condition indicates that the optimal workers hired can be given by
  1. Firms hire workers using the real productivity rule : $\frac{W}{p} = \frac{\partial Y}{\partial N}$
     Real wage = MPN
  2. Firms hire workers using the nominal value of productivity rule : $W = P\frac{\partial Y}{\partial N}$
     Nominal wage = P $\times$MPN =VMPN

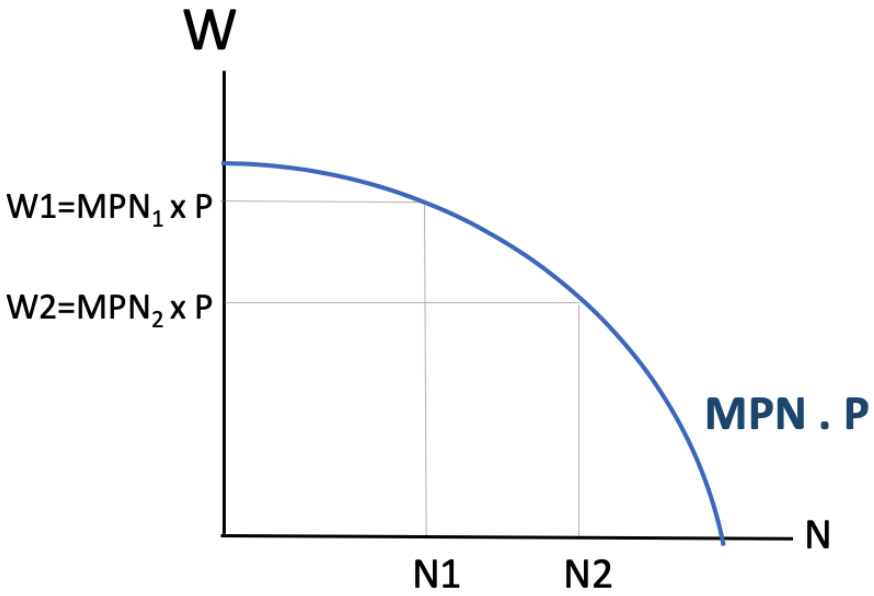
- Example :

Labor (number)	Output (number of output produced)	Marginal Product of labor (MPN)	Value of MPN P=2	Value of MPN P=3
0	0	0		
1	10			
2	19			
3	26			
4				
5				



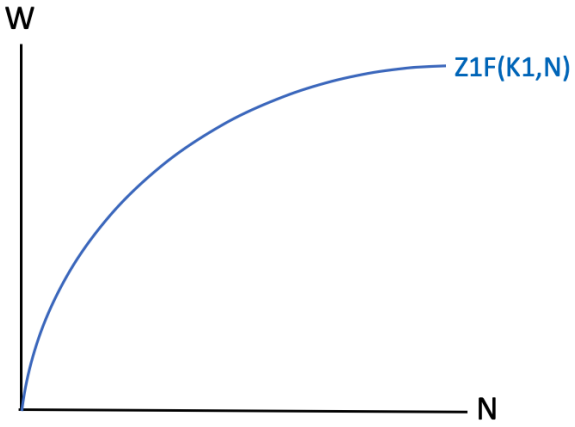
- MPN is the labor demand curve; Downward sloping in real wage

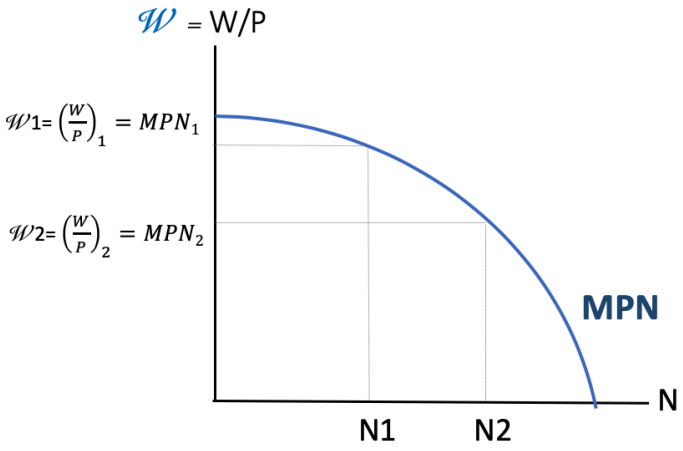
$$N^d = f\left(\frac{W}{P}\right)$$

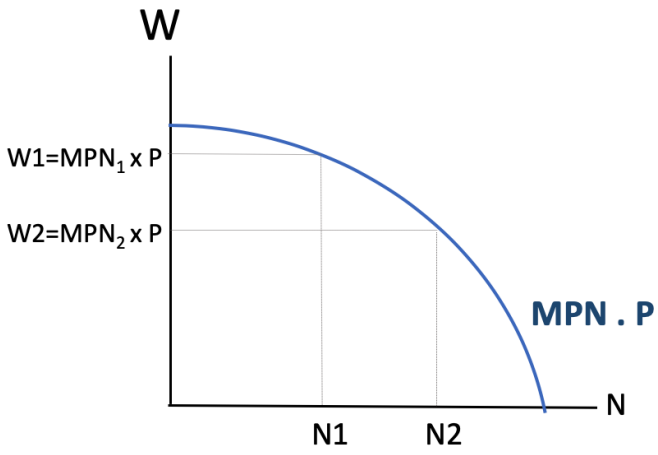


- Alternatively, labor demand curve can be expressed in terms of nominal wage (W), i.e. the VMP curve. For given prices, VMP is downward sloping, and hence labor demand curve.

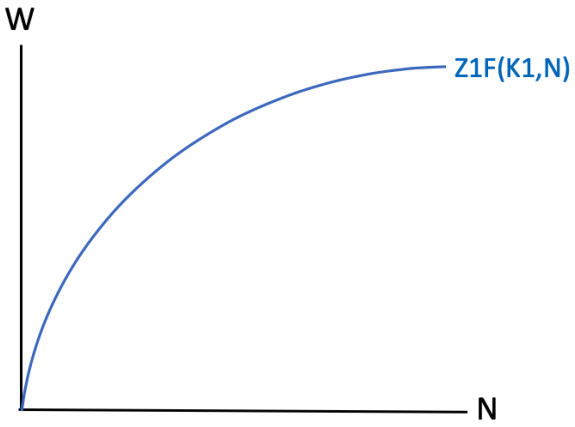
- Question : Price increases. What will happen to the production function and labor demand curve?

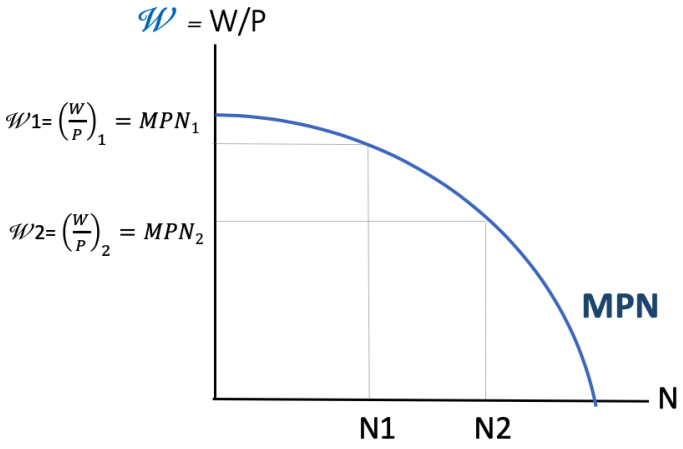


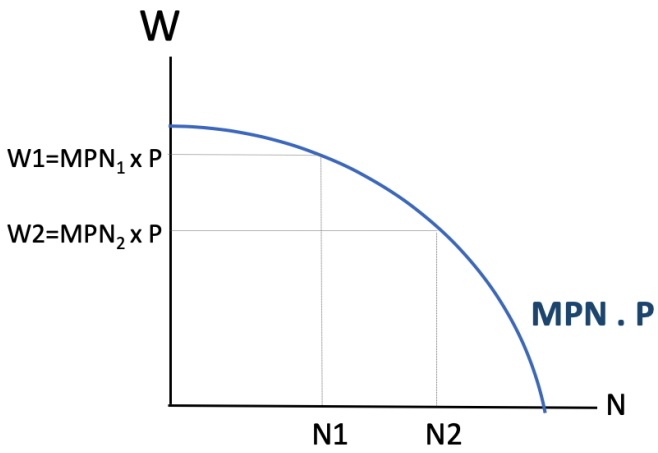




- Question : Positive productivity shocks (higher z) or an increase in capital stock (higher K). What will happen to the production function and labor demand curve?







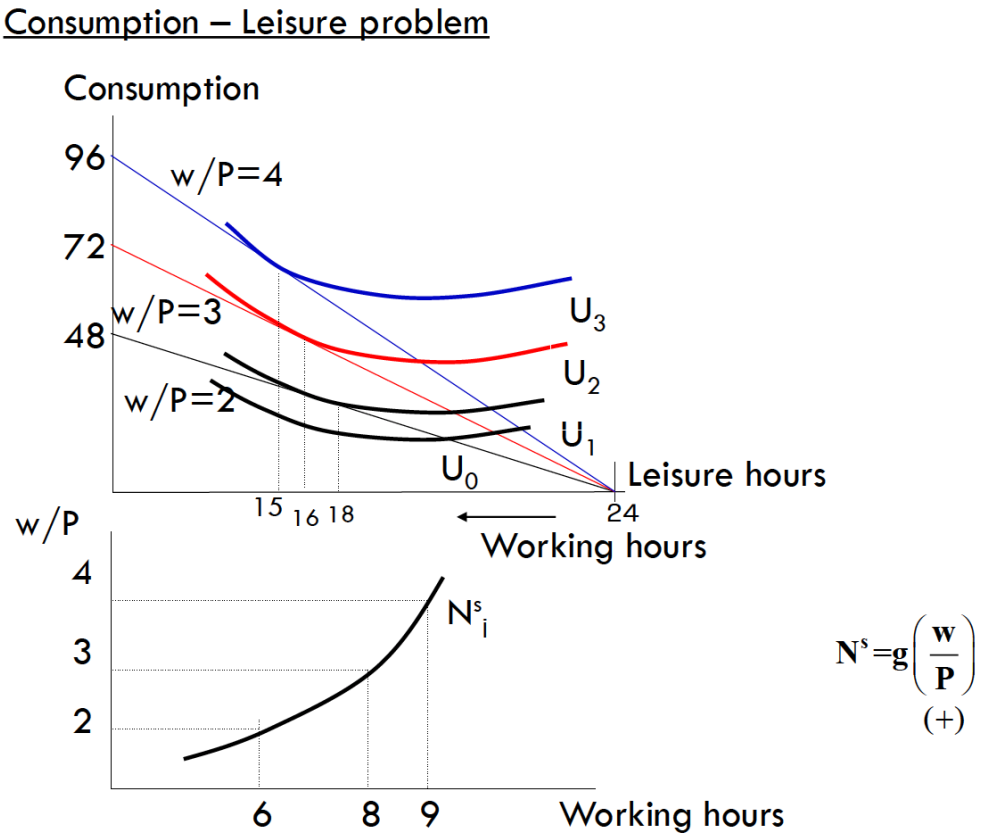
- Factors that shift the labor demand curve
  - Supply shocks : Beneficial supply shocks raises MPN, so shifts labor demand curve to the right; opposite for advese supply shocks
  - Size of capital shocks : Higher capital stock raises MPN, so shifts labor demand curve to the right; opposite for lower capital stock.
- Note a change in the wage causes a movement along the labor demand curve not a shift of the curve.

3.2.2 Labor Supply : Worker's Decision

- Households supply labor force to the market. They wotk 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.
- Key features of consumption-leisure model
  - Households choose for two things: consumption (C) and leisure (ℓ)
  - Household preference set is defined over the two object bundles (C, ℓ) and can be represented by a utility function.
- Households choose for the optimal "C" and "ℓ" that maximize the utility subject to budget constraint;

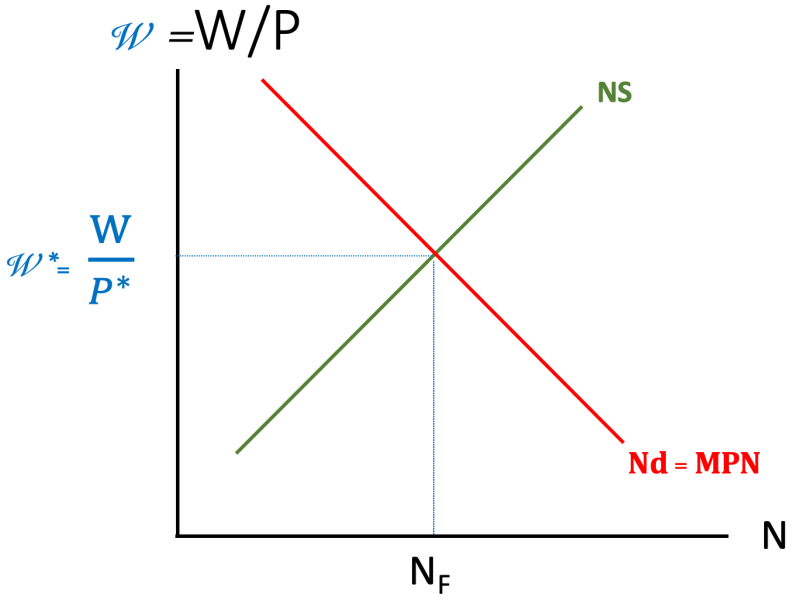
$$Max \quad U(C, \ell)$$
$$\text{subject to } PC = W(24 - \ell)$$

- Households must choose for optimal labor choice, given (known) price (P).
- Conceptually, rising real wage $\left(w = \frac{W}{P}\right)$ makes it costly for households to take leisure; they work more.



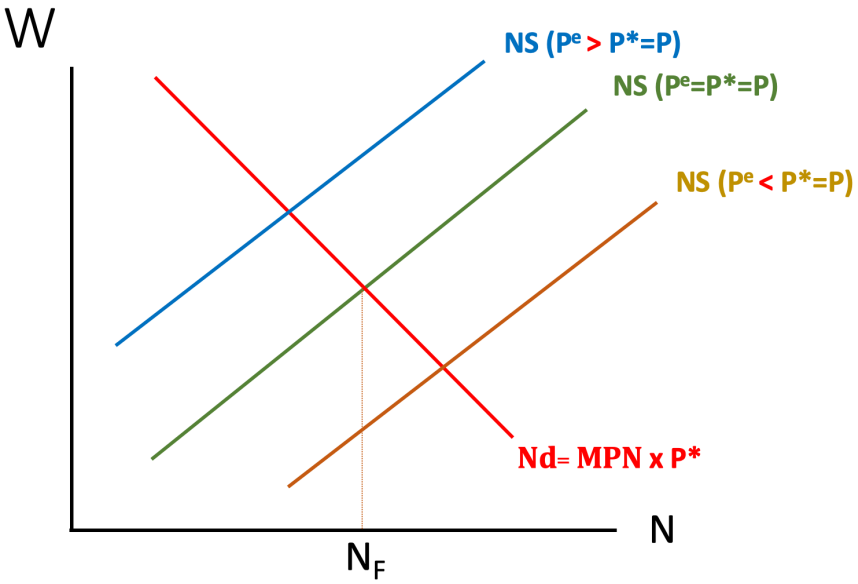
3.2.3 Labor Market Equilibrium

- In the long-run, "fully flexible adjustment in labor market", the equilibrium employment is the level so called "full employment".



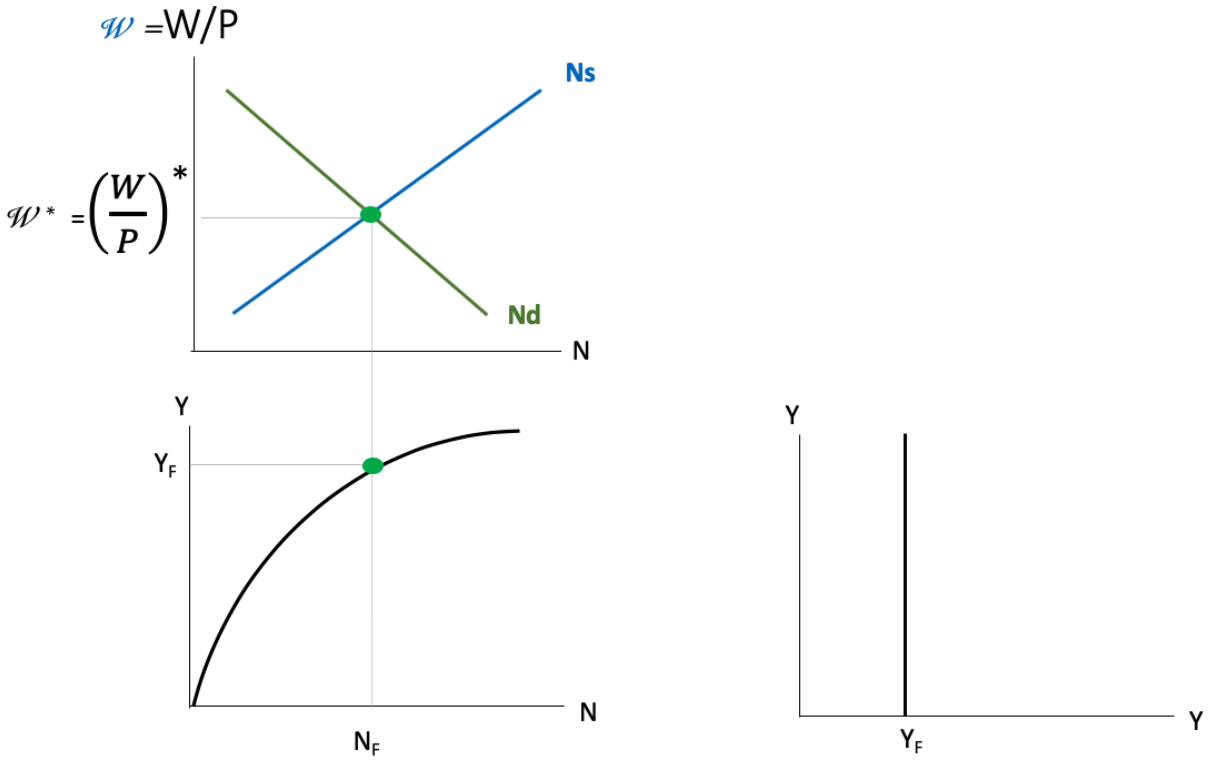
- At w* = $\frac{W^*}{P^*}$, employment = N_F.
- N_F is full-employment equilibrium.

- In the short-run, employment can be different from "full-employment" equilibrium.
  - People make their economic decision based on their expectation on "price level".
  - If they can predict the "price" level correctly. Employment will be at "full-employment" level.



- at $\frac{W}{P} = \omega^* = 10 \Rightarrow N^d = N^S = N_F$
- Suppose $P^* = 2$ at $W^* = 20 \Rightarrow N^d = N_F$
- [1] Suppose $P^e = 2$; at $W^* = 20 \Rightarrow \frac{W}{P} = \omega^* = 10 \Rightarrow N^S = N_F$
- [2] Suppose $P^e = 1$; at $W^* = 20 \Rightarrow \frac{W}{P} = \frac{20}{1} = 20 > \omega^* = 10 \Rightarrow N^S > N_F$
- [3] Suppose $P^e = 4$; at $W^* = 20 \Rightarrow \frac{W}{P} = \frac{20}{4} = 5 < \omega^* = 10 \Rightarrow N^S < N_F$

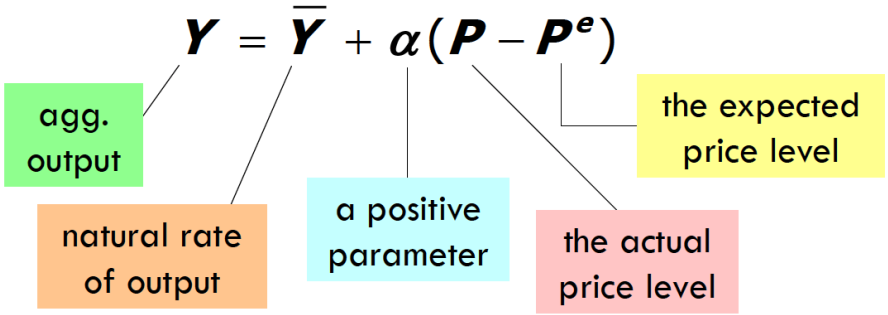
3.3 Long-Run Aggregate Supply and the full-emploument output or potential output



- As price level increases, nominal wage will adjust until the market is at full-employment equilibrium.
- Shift in Long-run aggregate supply
  - change in productivity
  - change in the number of capital input

3.4 Short-run aggregate supply

- Notion of long-run AS is idealistic, and only holds in the long-run.
- Market has nominal frictions and incomplete adjustment.
  - Labor market : wage stickiness (present wages)
  - Good market : price stickiness (present prices)
- Two models of Aggregate Supply
  1. The sticky-wage model
  2. The sticky-price model
- Both models imply :



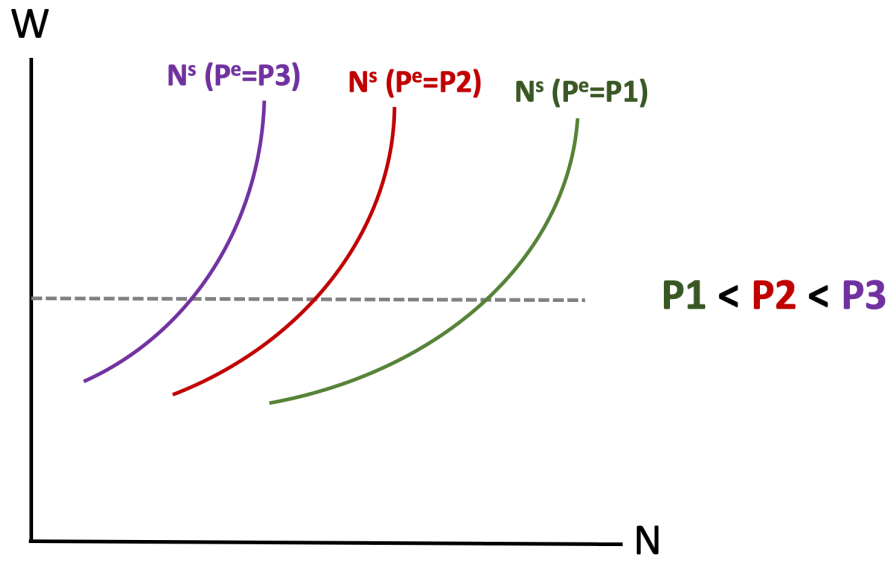
- Output can be different from "natural rate of output" (Potential Output) when "expected price" is different from "price".

3.4.1 The Sticky Wage Model

- In reality, workers get paid in nominal term
- Moreover, firms and worker usually negotiate contracts and fix the nomial wage before they know what the price level will turn out to be
- Households must choose for optimal labor choice, given expected price (P^e) .

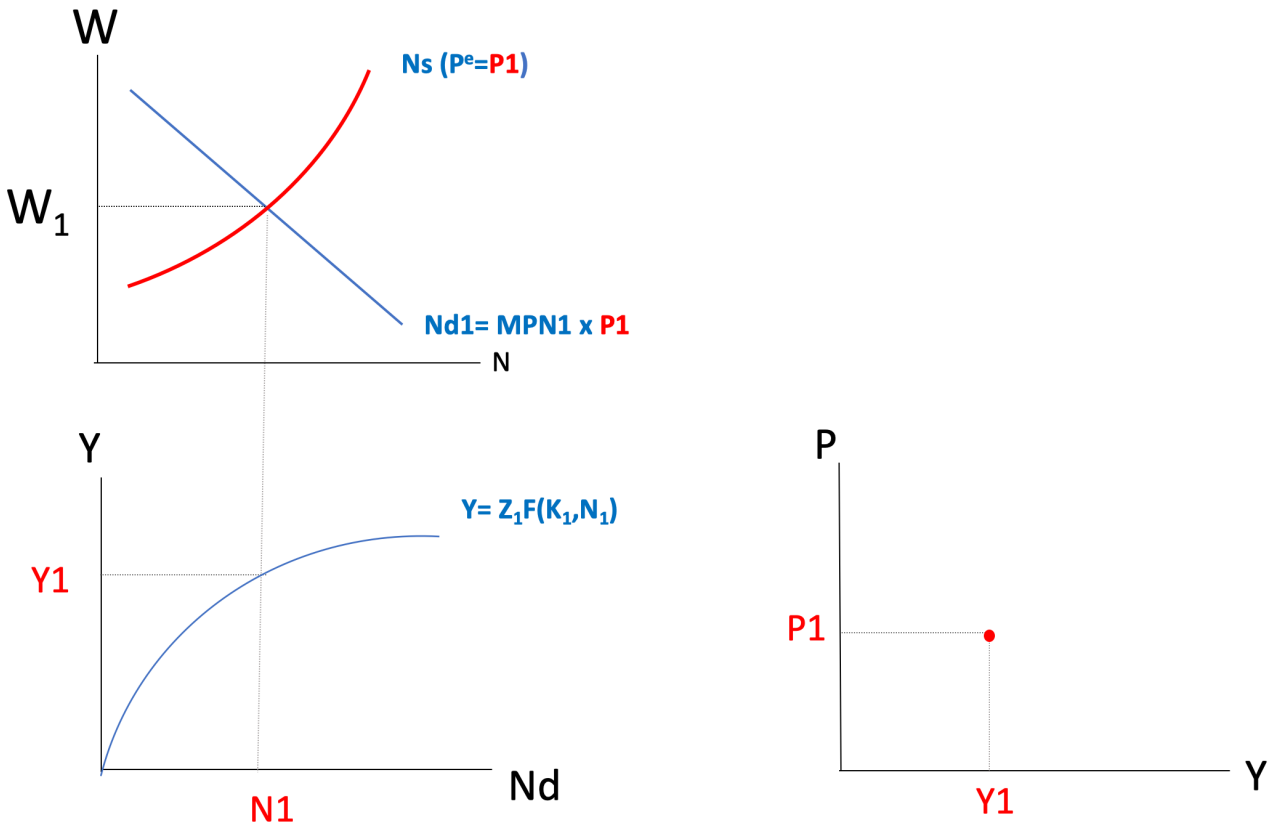
$$\begin{aligned} &Max \quad U(C, \ell) \\ &\text{subject to } P^e C = W(24 - \ell) \end{aligned}$$

Behavior of labor supply under pre-committed wage contract



- Typical labor supply : upward slolping in nomianl wage offered
- Expectation is important
- The higer expected price, the lower labor supply (the higer nomial wage required for each working hour).

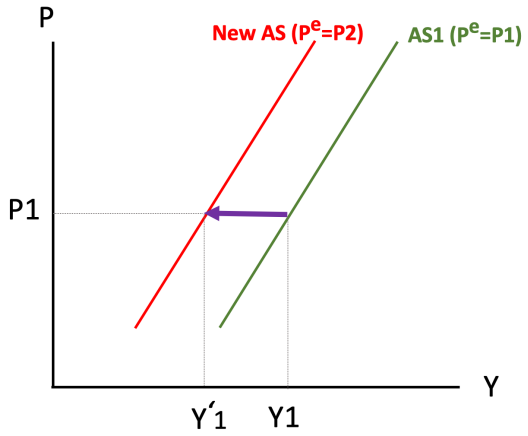
Equilibrium of labor market and the determination of the production level under sticky-wage



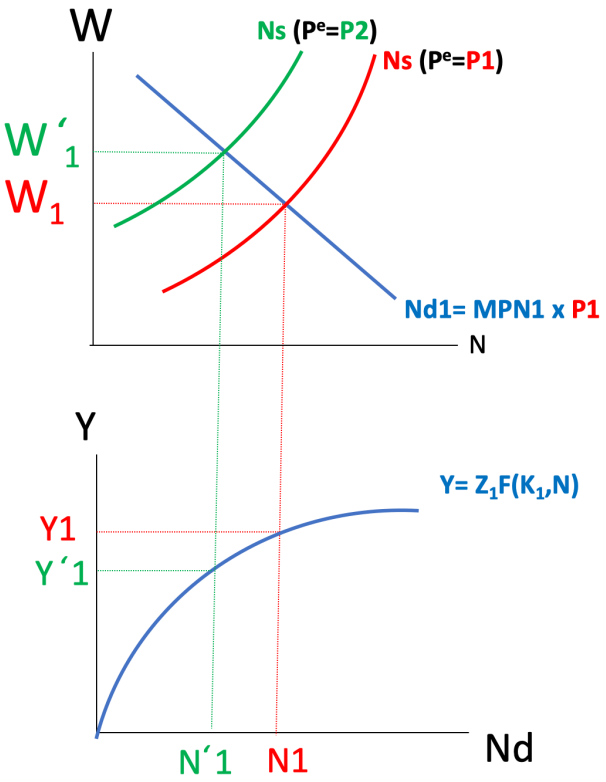
If it turns out that	then
$P = P^e$	Unemployment and output are at their natural rates
$P > P^e$	Real wage is less than its target, so firms hire more workers and output rises above its natural rate.
$P < P^e$	Real wage exceeds its target, so firm hire fewer workers and output falls below its natural rate

Shift in Shor-run AS

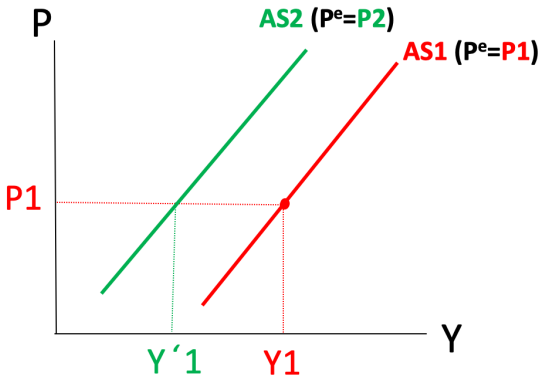
- Output changes for all levels of price
  - Examples
    - Change in expected price
    - Production technology
    - Change in market structure
    - Government policies



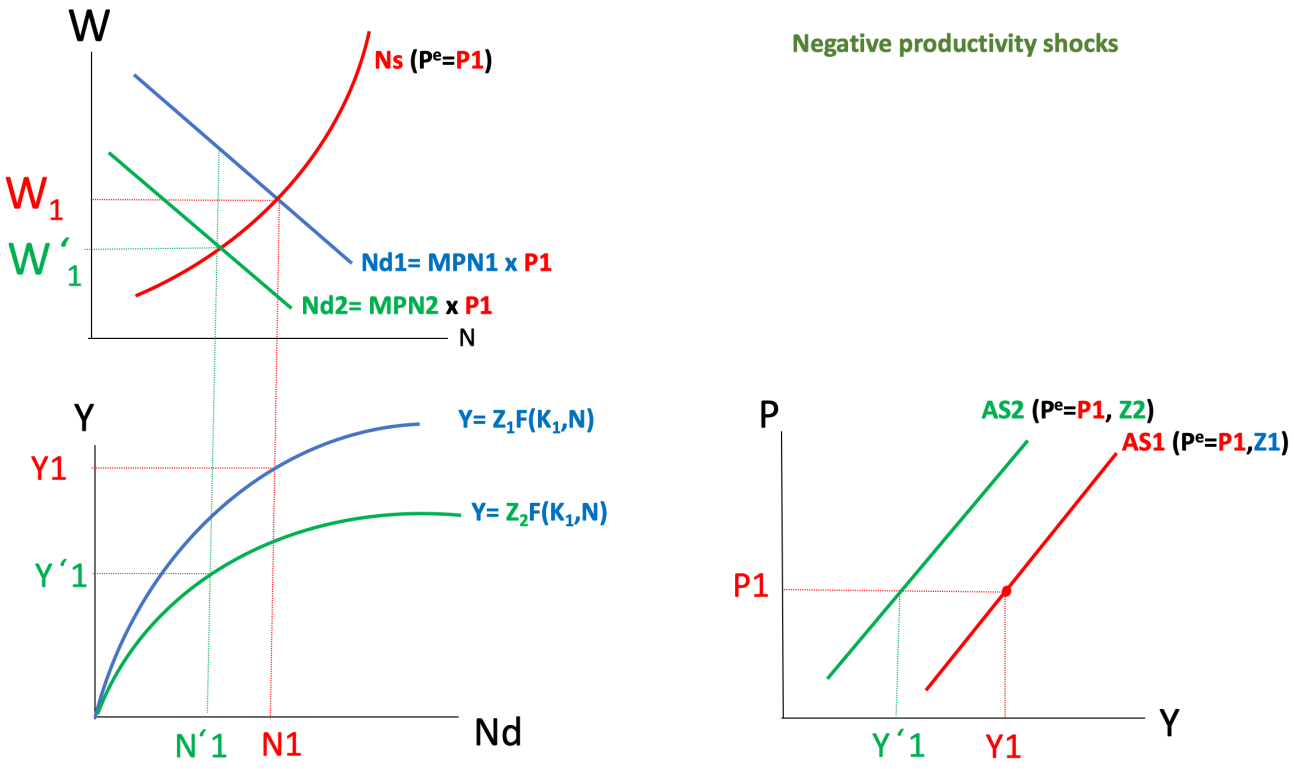
Example : Higher expected price



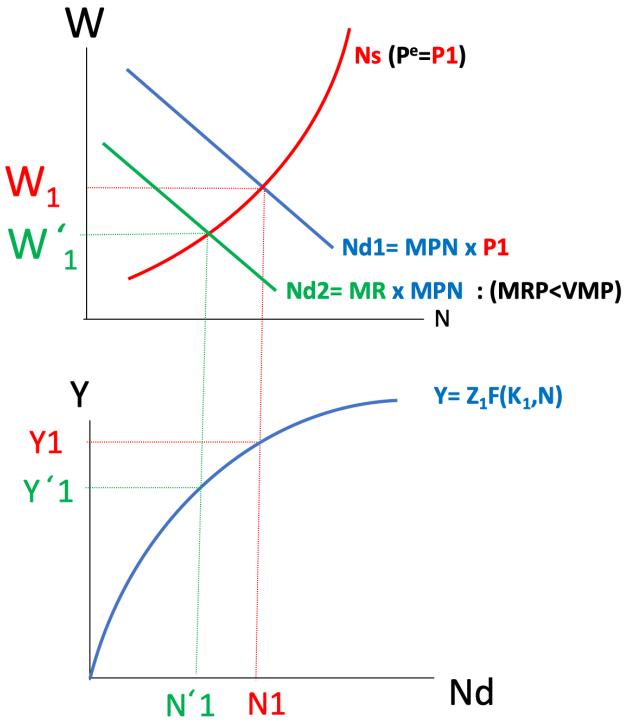
Higher expected price



Example : Negative productivity shocks/ Capital destruction



Example : Firm Monopoly Power (mark-up power)



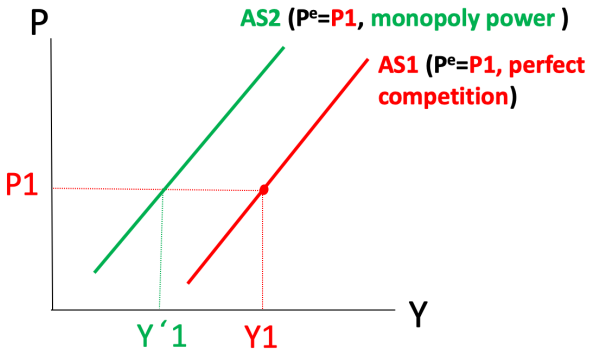
Monopoly power

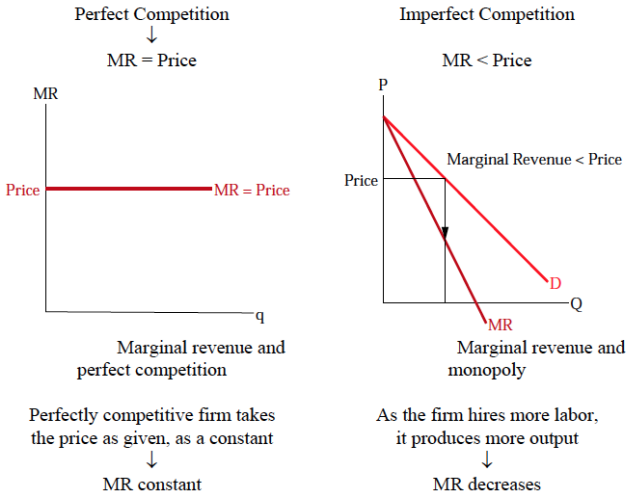
Perfect Competition : $\pi = P \times F(K,N) - WN$

$P \times MPN = W$

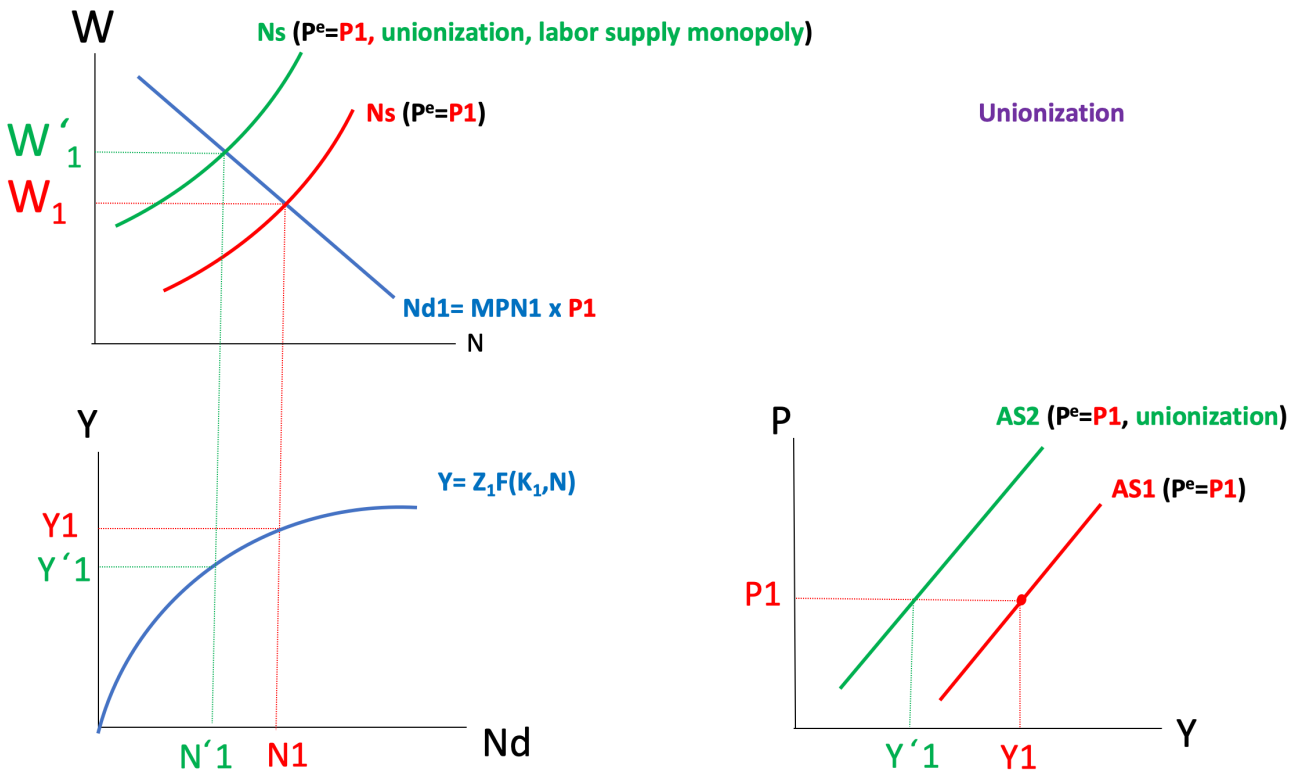
Monopoly: $\pi = P(Y) \times F(K,N) - WN$

$MR \times MPN = W$





Example : Unionization



3.4.2 The Sticky-Price Model

- Reasons for sticky prices:
  - Long-term contracts between firms and customers
  - Menu costs
  - Firms not wishing to annoy customers with frequent price changes
- Assumption :
  - Firms set their own prices (e.g., as with monopolies).
- An individual firm's desired price is

$$p = P + a(Y - \bar{Y})$$

  where $a > 0$
- Suppose two types of firms:
  - Firms with Flexible Prices : set prices as above
  - Firm with Sticky Prices, must set their price before they know how P and Y will turn out

$$p = P^e + a(Y - \bar{Y})$$

- Assume sticky price firms expect that output will equal to its natural rate. Then,

$$p = P^e$$

- To derive the aggregate supply curve, we first find an expression for the overall price level.
- Let s denote the fraction of firms with sticky prices. Then, we can write the overall price level as

$$P = sP^e + (1 - s)[P + a(Y - \bar{Y})]$$

Price set by sticky price firms

Price set by flexible price firms

- Substact $(1 - s)P$ from both sides:

$$sP = sP^e + (1 - s)[a(Y - \bar{Y})]$$

- Devide both sides by s:

$$P = P^e + \frac{(1-s)}{s}[a(Y - \bar{Y})]$$

- High $P^e \Rightarrow$ High P

  If firms expect high prices, then that firms must set prices in advance will set them high.

  Other firms respond by setting high prices.

- High $Y \Rightarrow$ High P

  When income is high, the demand for goods is high.

  Firms with flexible prices set high prices.

  The greater the fraction of flexible price firms,

  the smaller is s and

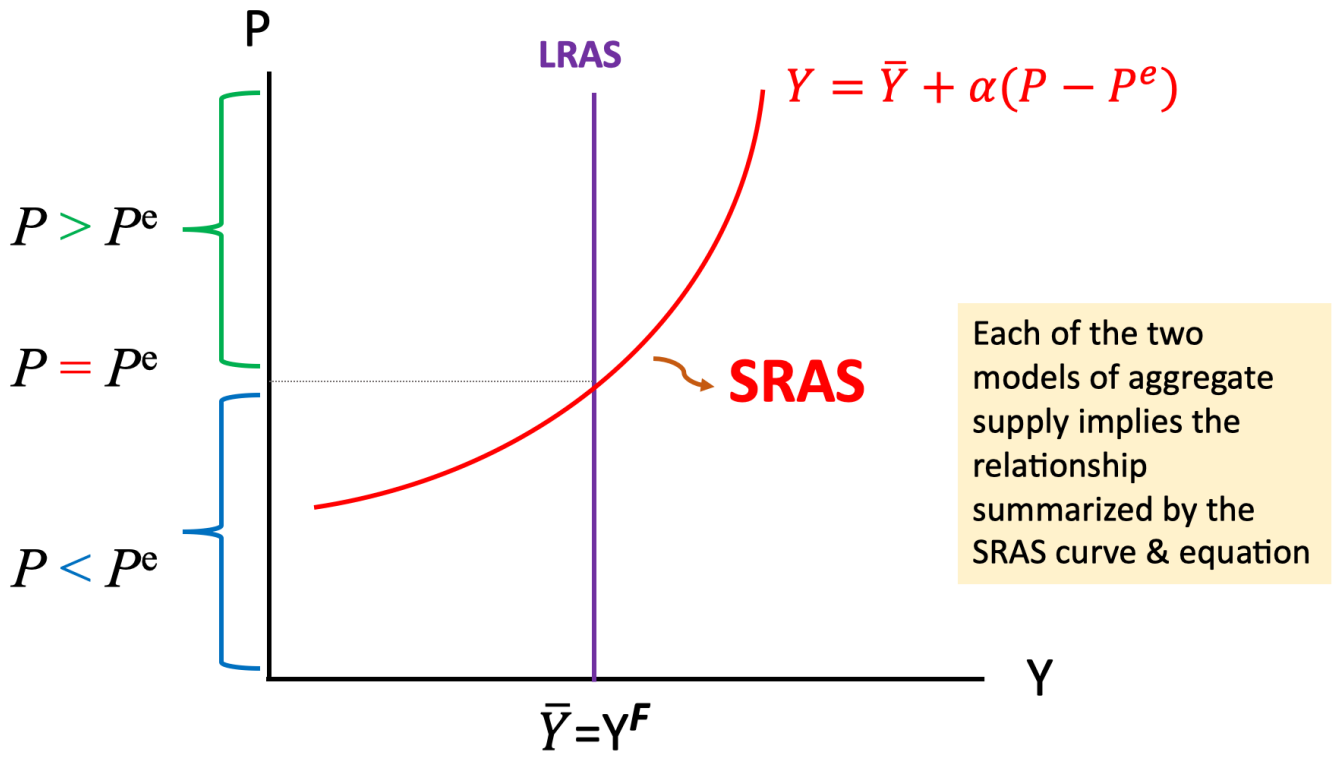
  the bigger is the effect of ΔY on P

- Finally, derive AS equation by solving for Y

$$Y = \bar{Y} + \alpha(P - P^e)$$

where $\alpha = \dfrac{s}{(1-s)a}$

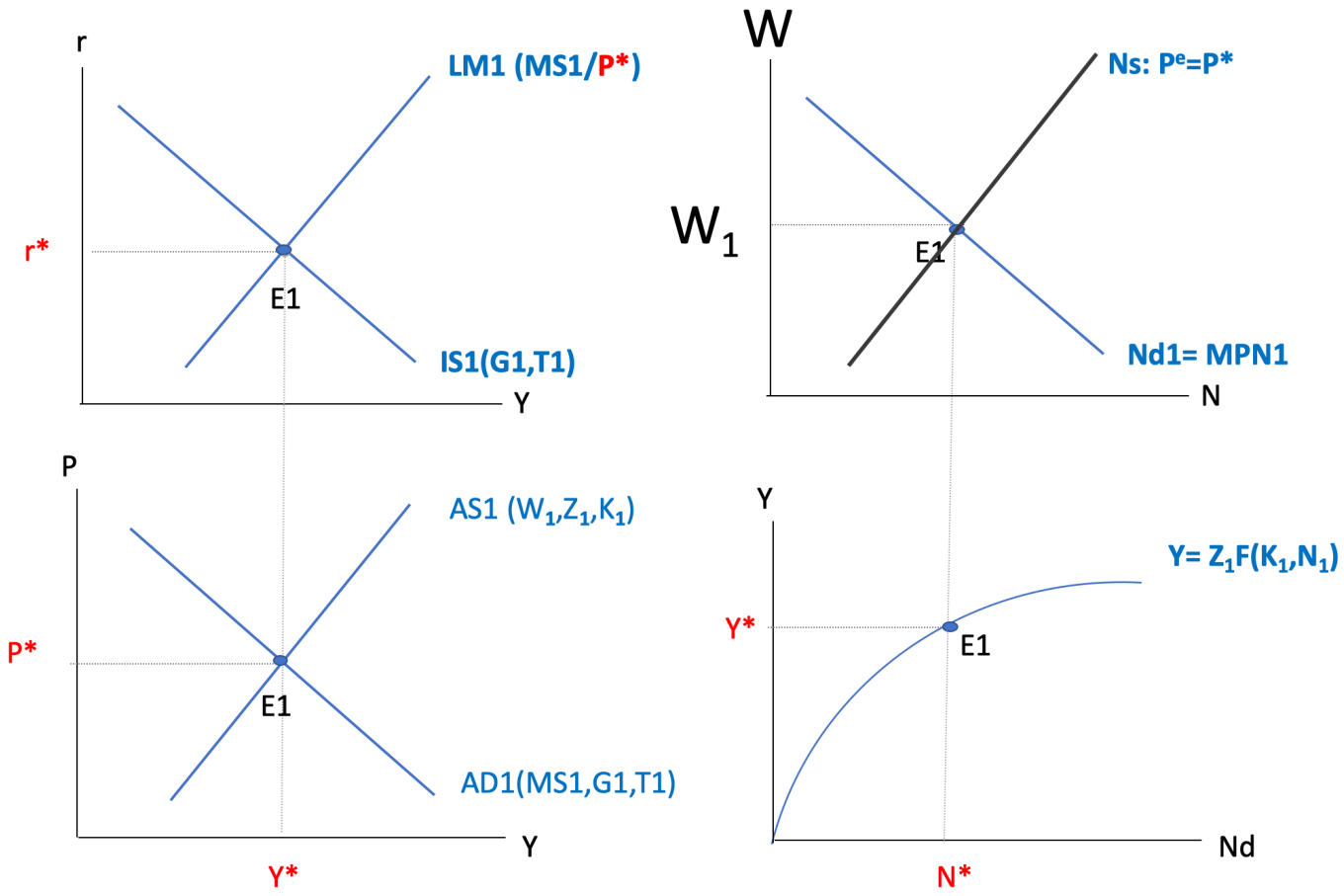
- Short-run AS and Long-run AS



4 AD-AS Equilibrium Analysis

4.1 AD-AS Equilibrium : Define

- Given the expected price, AD-AS equilibrium constitutes a set of variables, including output (Y^*), price (P^*), interest rate (r^*), nominal wage (W^*) and labor employment (N^*) that clear all the markets.
- The equilibrium can be capute by 4 main figures

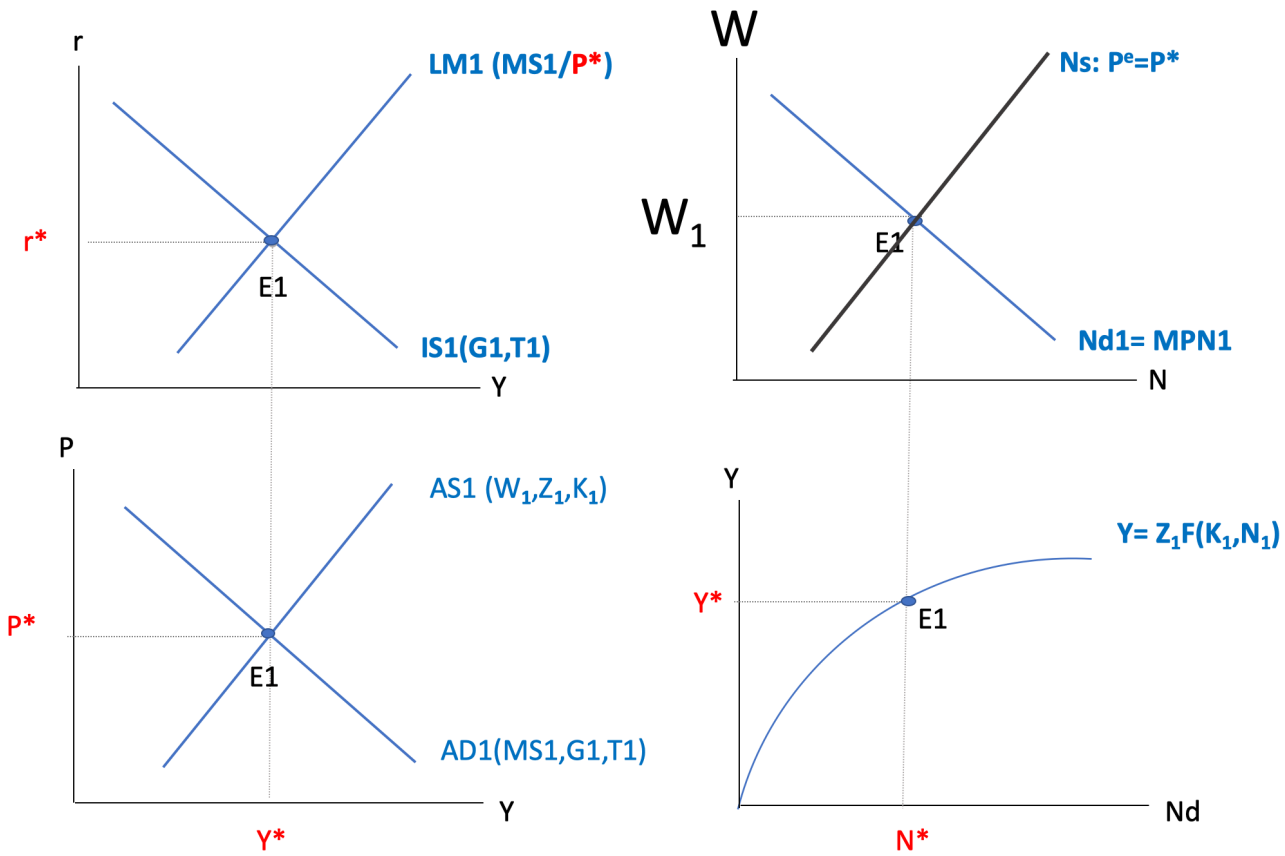


4.2 Business Cycles from AD-AS Perspective : Short-Run and Medium-Run

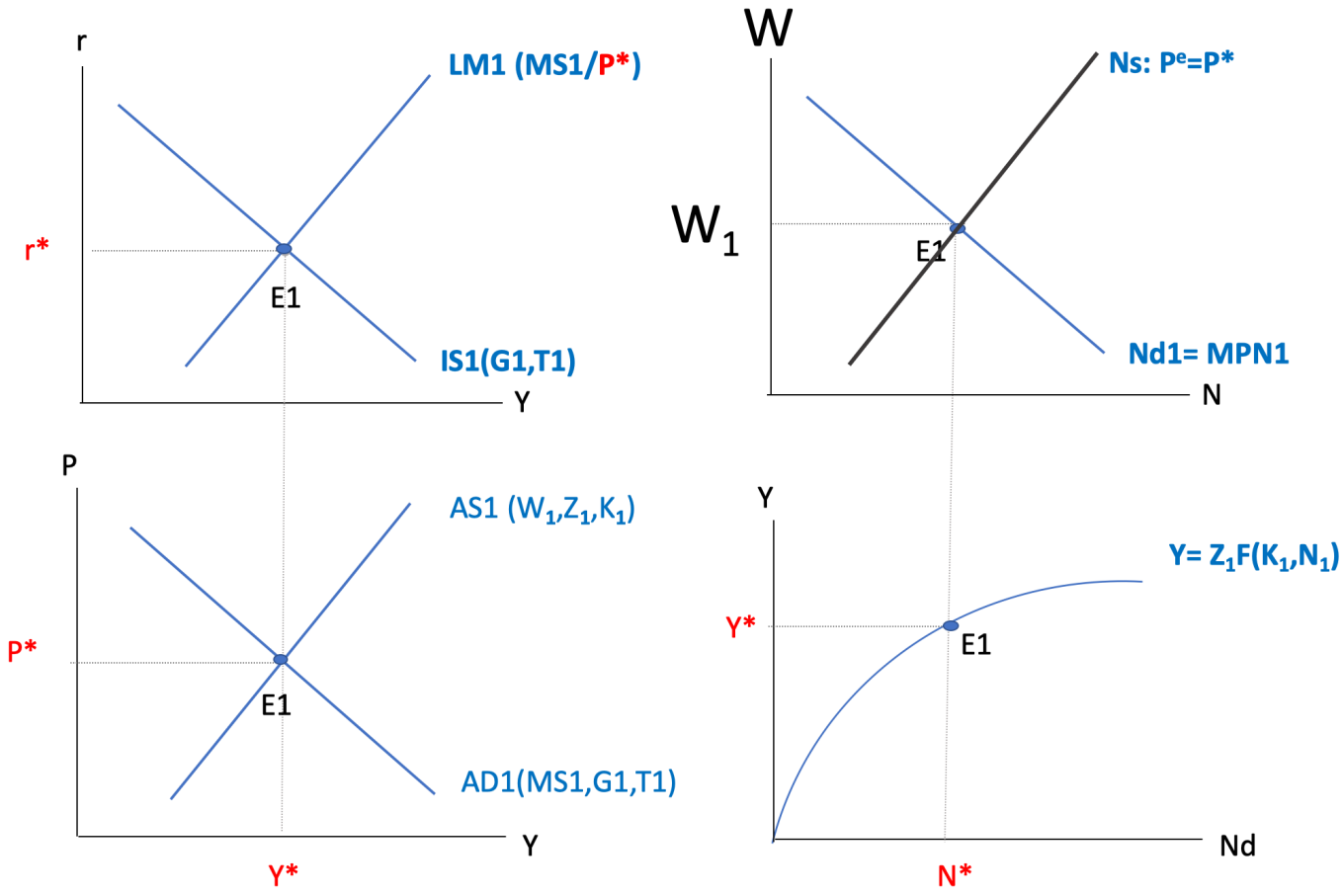
- Suppose we assume that initially the economy is at $Y^* = Y^F$, the potential level of output.
- The economy will deviate from Y^* if the economy is hit by shocks.
- The AD-AS frameworks can shed lights on our understand over (i) the channel of transmission of shocks (shock propagation) and (ii) the pattern. nature of business cycles (large/small)
- In our framework, shockes can be classified into two types
  1. AD shocks (IS-shocks or LM-shocks)
  2. AS shocks
- The time frame of the analysis can be divided into two horizon
  1. Short-run : when shock hits and causes a deviation
  2. Medium-run : when the economy adjusts and revers to long-run potential level

4.2.1 Short-run fluctuations

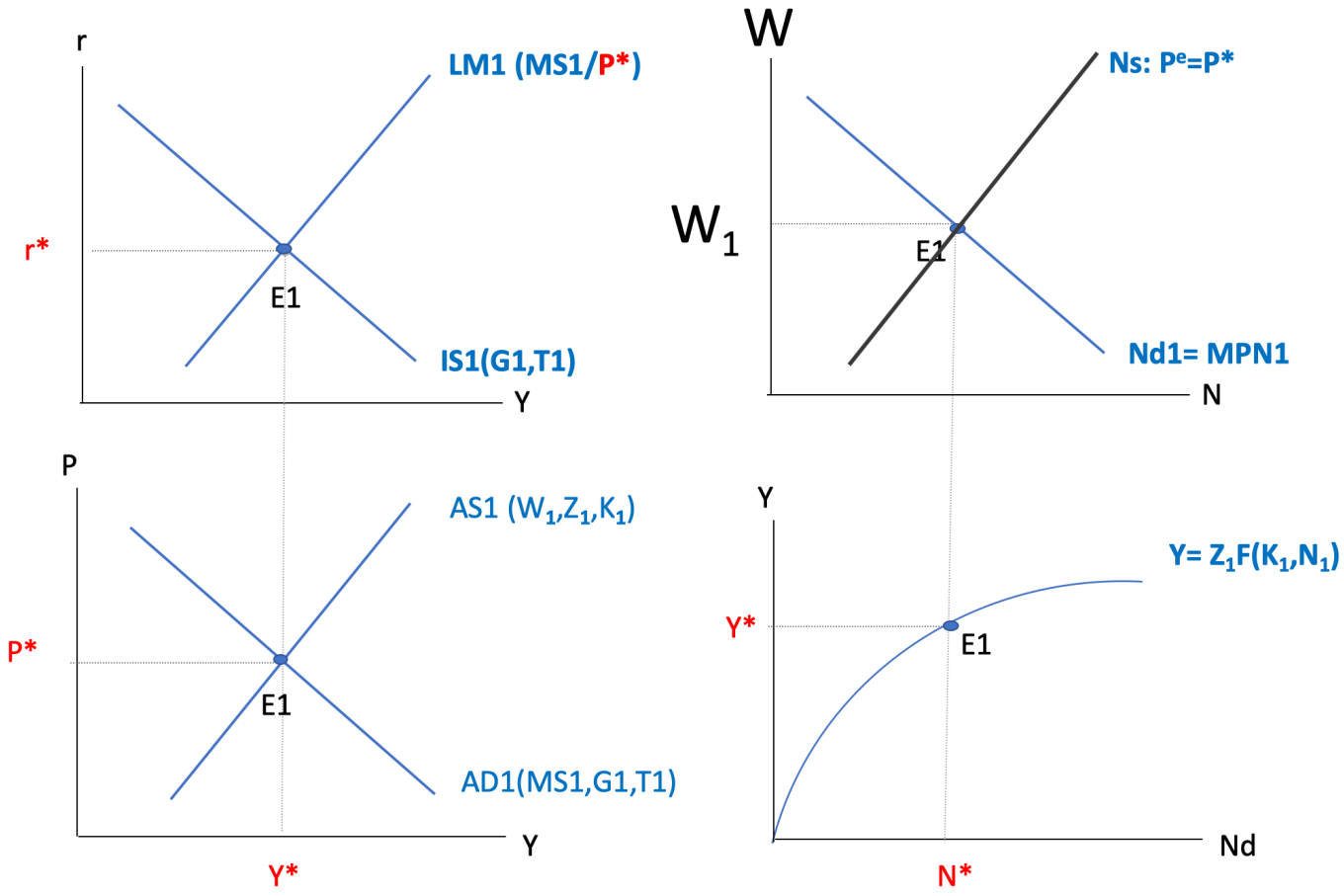
Example : Negative IS shocks



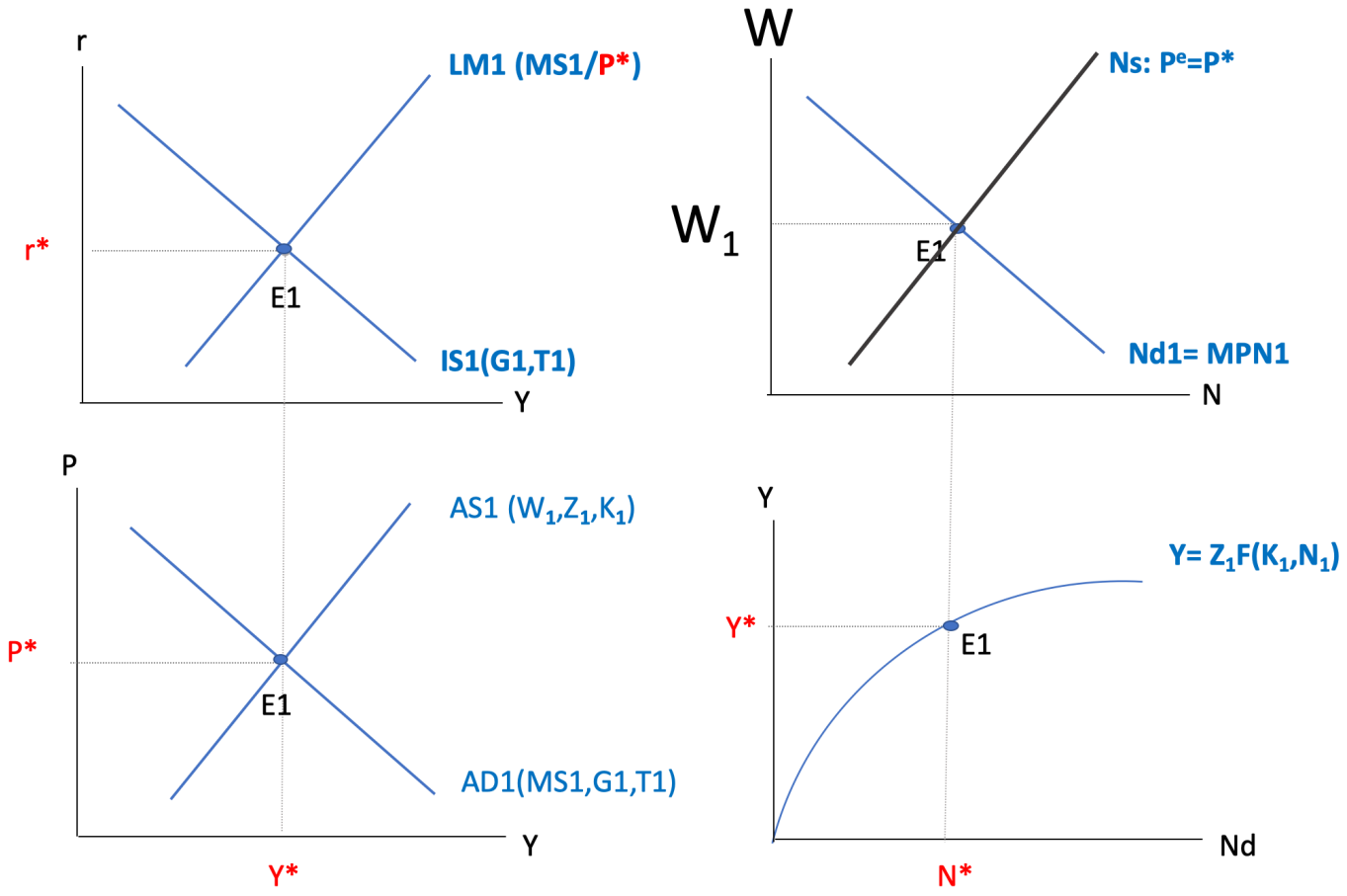
Example : Positive LM shocks



Example : Negative Supply shocks



Example : Fiscal Policy



1. Expansionary fiscal policy $(G \uparrow)$

   If real interest rate remains the same $(\bar{r})$, DAE shifts .....

   $\Rightarrow$ output (Y) ..... for all level of .....

   $\Rightarrow$ IS shift to the ..... ; the size of shift is ..... ΔG

2. As Y ....., Real money demand ..... ,

   Excess ..... , ... bonds, Bond price ..... and equilirbium interest rate .....

   As r ....., investment ....., output ..... (move along IS curve)

   the second effect is called the crowding out effect.

   ** If price were constant , total effect = 1 effect + 2 effect

3. From (1) and (2), IS curve shifts to the ....., and then Y ..... for all levels of price

   Hence, AD shifts to the .....

   Y ..... and P .....

   (a) Labor market

   As P ..... , Labor demand shifts to the ....., nominal wage ..... and Y ..... (movement along AS curve)

   Real wage ..... because N..... and MPN.....

(b) ISLM

As P ....., real money supply ..... to .....

LM shifts to the .....

Output .....

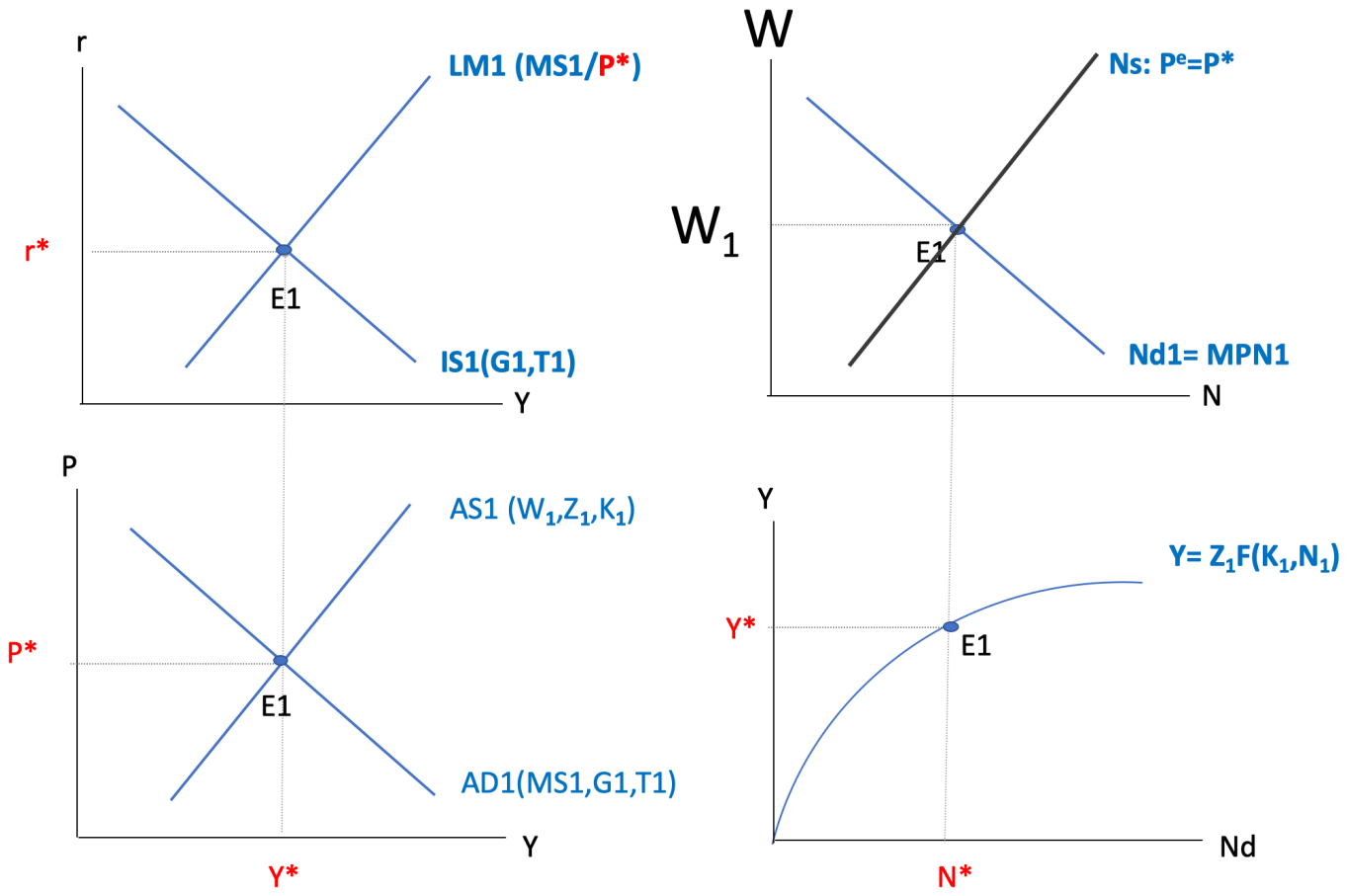
This is called the price effect.

- Rising price offsets the initial impact of "G" as it tends to push up the market interest rate.

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

Example : Monetary Policy



1. Economy is at E. r* N* P* and Y*

   (a) Expansionary Monetary $(MS \uparrow) \Rightarrow \frac{MS}{P}$ shift to the .....
   Excess ..... , people ..... bonds,
   bond price ....., r ..... for all levels of .....
   LM shifts to the .....
   As r..... , investment ..... $\rightarrow$ output (Y) ..... **for all levels of Price**

   (b) As output ..... for all level of Price, AD shifts to the .....
   Price level ..... to ..... and Output ..... to .....

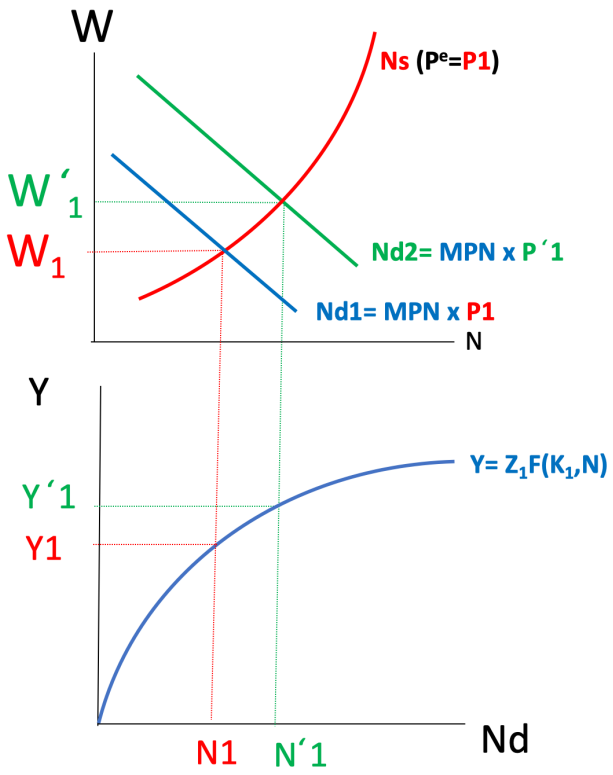
   i. Labor market
   As P ..... , Labor demand shifts to the ....., nominal wage ..... and Y ..... (movement along AS curve)
   Real wage ..... because N..... and MPN.....

   ii. ISLM
   P ....., real money supply ..... to .....
   LM shifts to the .....
   Output .....
   This is called the price effect.

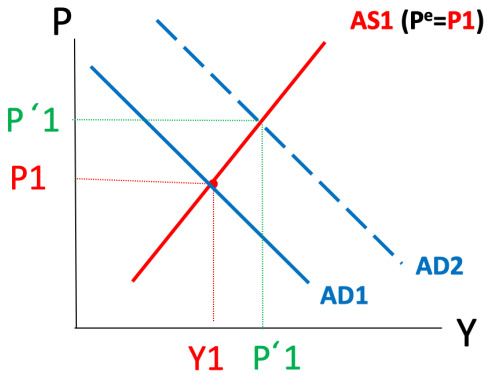
(c) The effect on Y is smaller than the effect under IS-LM Model.

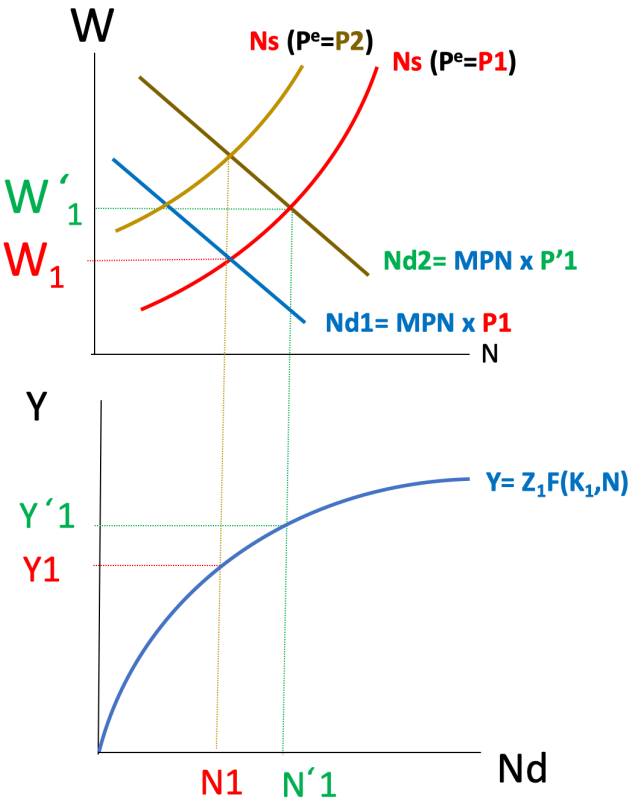
4.2.2 Medium Run Adjustment and Self-Correcting Mechanism

- The effect of shocks die down; as time passes by, the economy reverts to long-term trend, i.e. at potential level of output
- Output gap becomes zero again.
- Economists refer to this process as the medium run adjustment or self-correcting mechanism.
- Self-correcting mechanism
  - Labor market will adjust to the imbalance that is generated by error in the price expectation
  - Workers renegotiate for higher age because they previously underestimated the actual price
  - Contraction in labor supply, and hence a rise wage, would cut the production as the cost of production increase
  - Natural rate or potential level can be restored with the medium-term adjustment process
- Expecttion-driven Aggregate Supply and Effect of demand shock

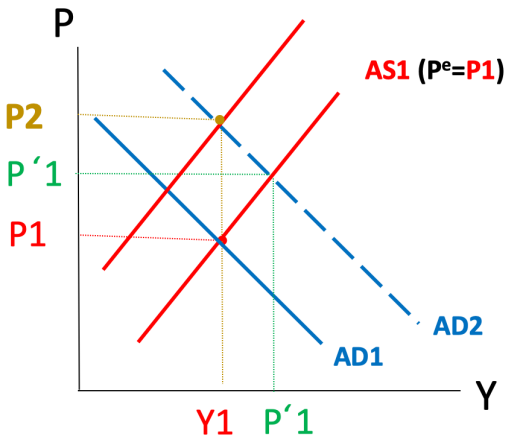


Suppose workers miscalculate the prices; they underestimate the price. Producers calculate the price correctly.

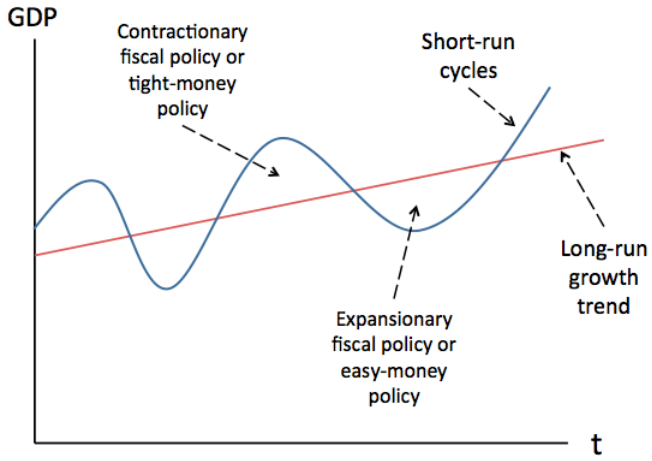




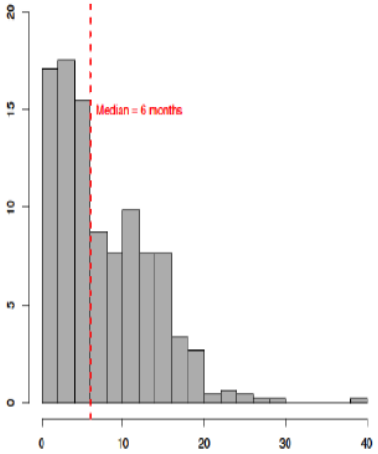
- As workers miscalculated the prices; they underestimated the price.
- Once the time has come, they renegotiate for a new wage that is consistent with correctly expected price



- Medium-run adjustment : issues
  - How long does it take for the self-correction?
  - Economists propose different version of adjustments
    - Swift adjustment : Fast-trend reversion
      - Commonly known "New Classical" business cycle economist
      - No policy needed
    - Slow adjustment and Staggered adjustment : Gradual with persistent impact of shocks
      - Commonly known as Keynesion or New Keynesian business cycles economist
      - Policy might be welfare-improving.



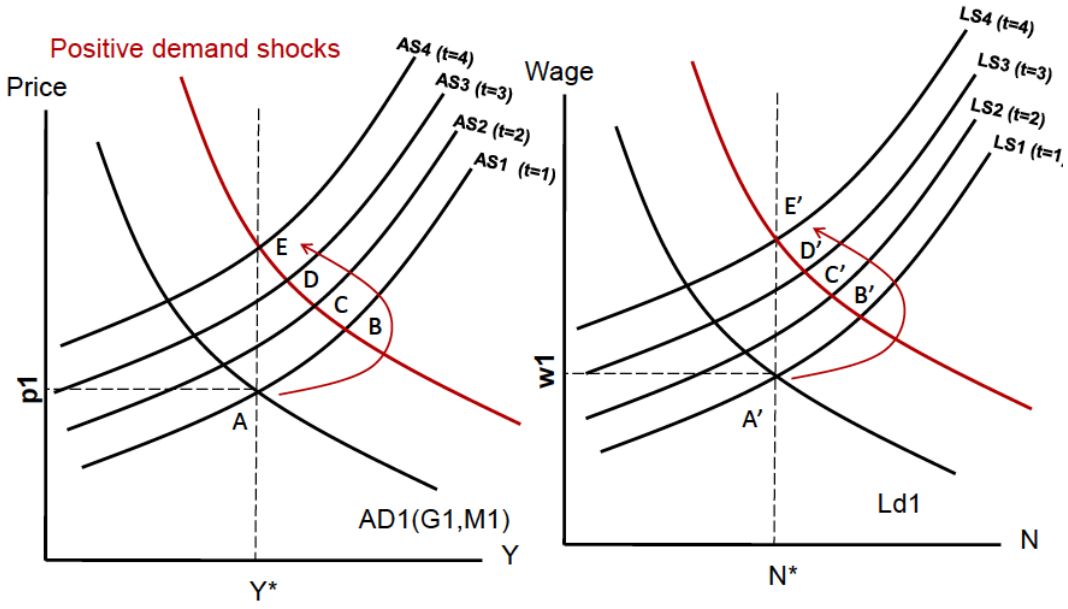
- Micro-evidence on price settings : Aphithan and Pym (2018)



Category	Mean Frequency	Implied Mean Duration (months)	Mean Duration (months)
Food & Non-Alcoholic Beverages	0.23	3.91	5.47
Apparel & Footware	0.03	29.37	13.85
Housing & Furnishing	0.13	7.37	6.57
Medical & Personal Care	0.07	13.03	10.10
Transportation & Communication	0.29	2.86	7.25
Recreation & Education	0.04	22.88	8.79
Tobacco & Alcoholic Beverages	0.11	8.70	7.17
Total CPI	**0.20**	**4.40**	**7.04**

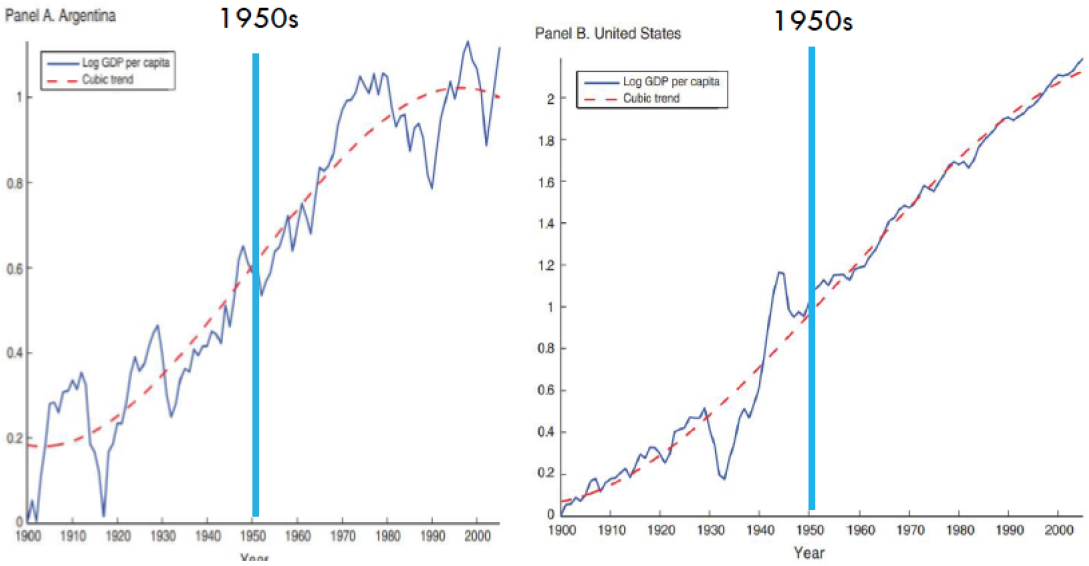
Sector	Mean Frequency	Implied Mean Duration (months)	Mean Duration (months)
Core	0.06	15.13	9.16
Non-core	0.50	1.44	2.50
Control	0.34	2.45	5.28
Non-Control	0.12	7.60	8.10
Service	0.06	16.88	9.72
Non-Service	0.26	3.38	6.07
Durables	0.07	14.38	8.43
Non-Durables	0.22	4.03	6.87
Total CPI	**0.20**	**4.40**	**7.04**

- For an illustrative purpose, consider 4 types of firms with different speed of price adjustment
  - Firm 1 : Gasoline station (fastest)
  - Firm 2 : Logistic company
  - Firm 3 : Electronic product
  - Firm 4 : Service goods (hair cut/ noodle restaurant) (slowest)
- Suppose that workers for each of firm can adjust wage at the same time as their firms adjust price.
  - Things would be profound if we assume different degree.
- Staggered Adjustment
  1. Upward sloping Aggregate SUPPLY in goods
     - Many individual firms might have flat supply curve at each point of time
     - A fraction of firms can adjust the price; individual supply for price-adjusting firm will be upward sloping
     - By aggregation, output should increases with the general price level.
  2. Similar intuition applies to upward sloping of Aggregate supply in labor.


Positive demand shocks
Price
AS4 (t=4)
AS3 (t=3)
AS2 (t=2)
AS1 (t=1)
E
D
C
B
A
p1
AD1(G1,M1)
Y
Y*
Wage
LS4 (t=4)
LS3 (t=3)
LS2 (t=2)
LS1 (t=1
E'
D'
C'
B'
A'
w1
Ld1
N
N*

5 Case Discussion

5.1 What determine the size of business cycle volatilities?



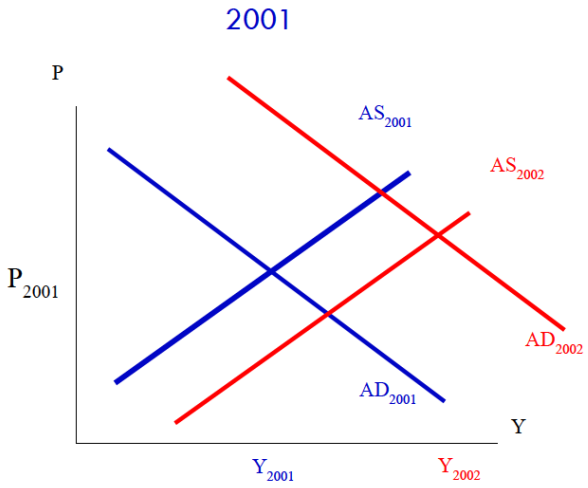
- Business-cycle volatility is empirically obseved.
- Large volatile business cycles could occur because of
  - Hit by many types of shocks
  - Each tyoes of shocks is BIG
  - The structure of macroeconomy is prone to invite the large amplified effect of shocks
    - International frictions, e.g. labor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

5.2 How well does the AD-AS model explain data?

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

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

- Think about AD and AS growing over time.
  - Exanple :
    - Money supply grows over time; Government spending grows over time.
    - The level of technology improvement grow over time.
  - Account for positive inflation; Demand - side factor might need to be growing faster than supply-side factor



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

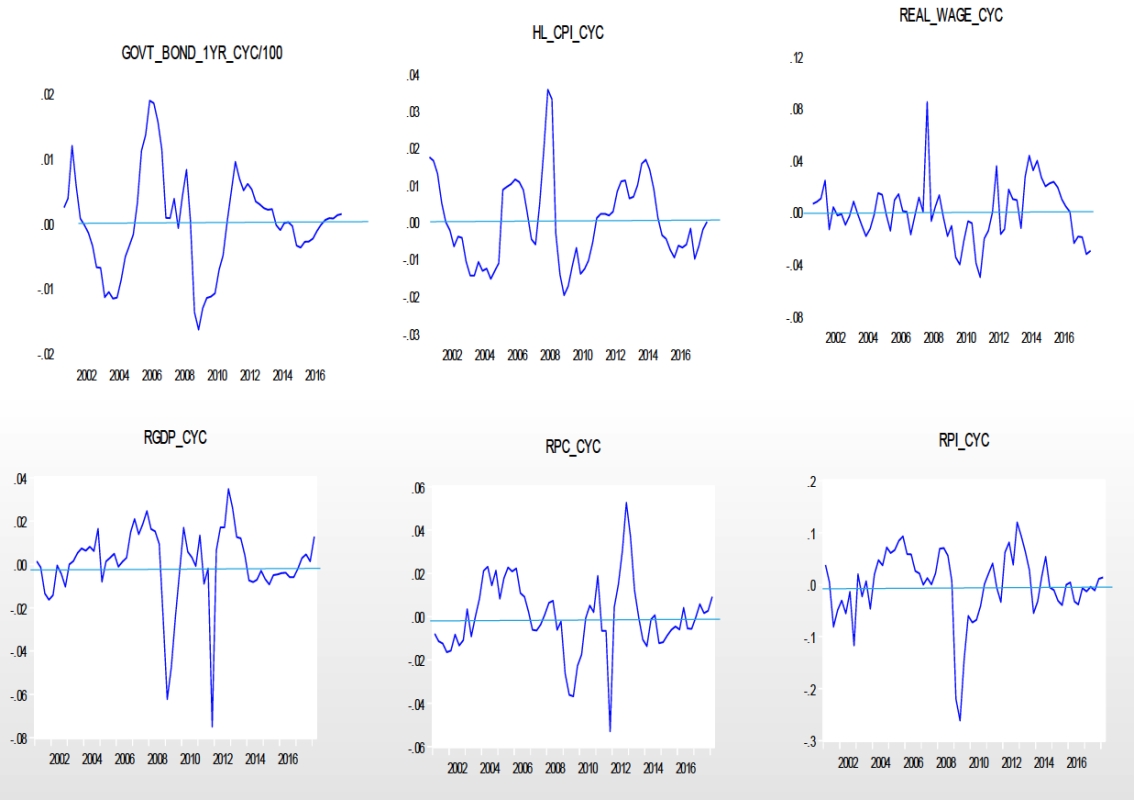
5.2.2 How fit does the AD-AS model explain the world?

Data

- Real GDP/ Consumption/ Investment
- Interest Rate = 1-year government bond
- Real wage = average wage adjusted by headline inflation
- Price = headline inflation

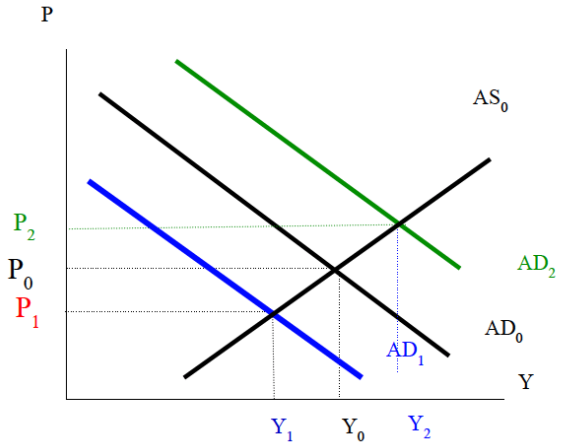
Treatment

- Detrend/ Calculate "Cyclical Variation"
- Compute pair-wise correlation

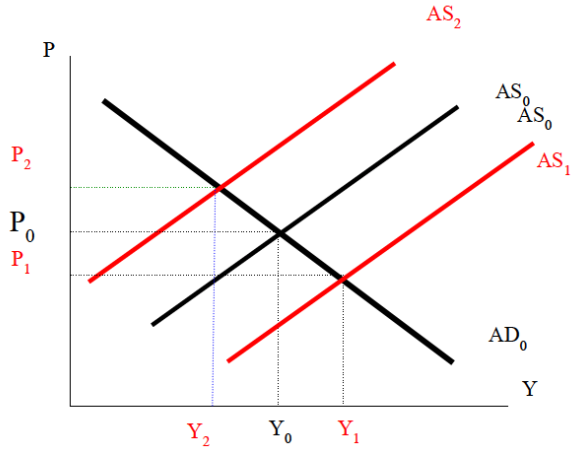


- Since 2001, what we have seen in the data is that aggregate variables are procyclical.
  - GDP, consumption, investment and price level ; move together in the same direction
- Real-wage might be an exception, weakly pro-cyclical (statisitcally acyclical).
- Can AD-AS model account for these stylized 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.

Demand shocks



Supply shocks



Positive correlation: output and inflation

Negative correlation: output and inflation

- Back to our question : How fit does the AD-AS model explain the world?
- In order to generate the qualitative pattern, our economy must be *predominantly* driven by **demand factor**.
  - note this does not mean the supply factor is not important; it states that demand factors dominate the supply factors.

APPENDIX

A1. IS-LM-AD equations

- $C = a...bY^d$
- $I = I_0 - i_1 r$
- $G = G_0$
- $T = T_0$

- $M^S = \frac{M_0^S}{P}$ = real money supply
- $M^d = c_1 Y - c_2 r$

- IS : $Y = \frac{1}{1-b}\left[C_a + I_a + G_a - bT_a\right] - \left(\frac{i_1}{1-b}\right) r = \theta\left[\bar{A} - Br\right]$

- LM : $r = \frac{c_1 Y}{c_2} - \frac{MS/P}{c_2} + = \frac{1}{h}\left(kY - \frac{MS}{P}\right)$

- $\theta = \frac{1}{1-b}$
- $B = i_1$
- $h = \frac{1}{c_2}$
- $k = c_1$

$$
\begin{aligned}
Y &= \theta\left[\bar{A} - B\left(\frac{1}{h}\left(kY - \frac{MS}{P}\right)\right)\right] \\
Y + \frac{\theta Bk}{h}Y &= \theta\left[\bar{A} - B\left(\frac{1}{h}\left(-\frac{MS}{P}\right)\right)\right] \\
\left(\frac{h + \theta Bk}{h}\right)Y &= \theta\left[\bar{A} - B\left(\frac{1}{h}\left(-\frac{MS}{P}\right)\right)\right] \\
Y &= \left(\frac{h}{h + \theta Bk}\right)\theta\bar{A} + \left(\frac{\theta B}{h + \theta hB}\right)\left(\frac{MS}{P}\right)
\end{aligned}
$$

The following table shows the production function and labor supply decision.

N^s	2	3	4	5	6	7	8	9	10	11	12
$w = \frac{W}{P}$	4	6	8	10	12	14	16	18	20	22	24

N^d=labor inputs	2	3	4	5	6	7	8	9	10	11	12
MPN	24	22	20	18	16	14	12	10	8	6	4

- Suppose both workers and producers predict the price correctly i.e. $P = P^e = 1$. What is the equilibrium employment of this economy?
- $N^* =$ .....
- Suppose actual price level is equal to 1. Producers make their economic decision on "actual price". They want to employ 5 units of labor when nominal wage is equal to .....
- Suppose actual price level is equal to 1. Workers make their economic decision on "expected price". They expects the price level to be equal to 2. $P^e = 1$. They want to supply 5 units of labor when nominal wage is equal to .....
- Suppose actual price level is equal to 1. Workers make their economic decision on "expected price". They expects the price level to be equal to 2. $P^e = 2$. They want to supply 5 units of labor when nominal wage is equal to .....