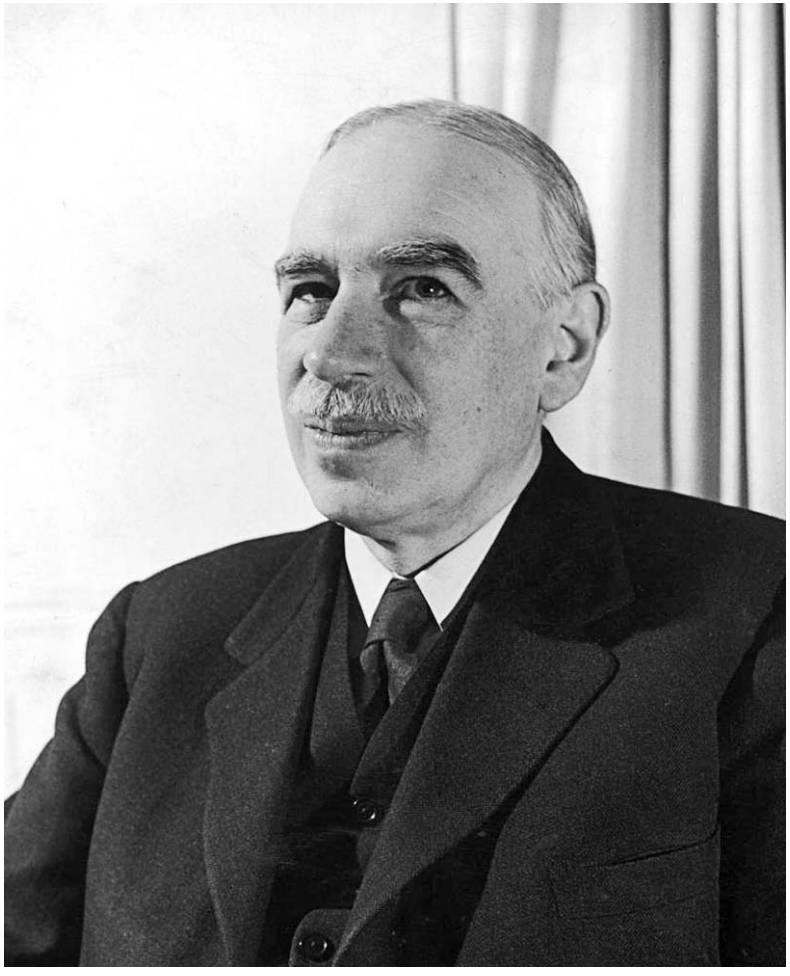
Introduction to Keynesian Economics

Session 6: Nominal Rigidities

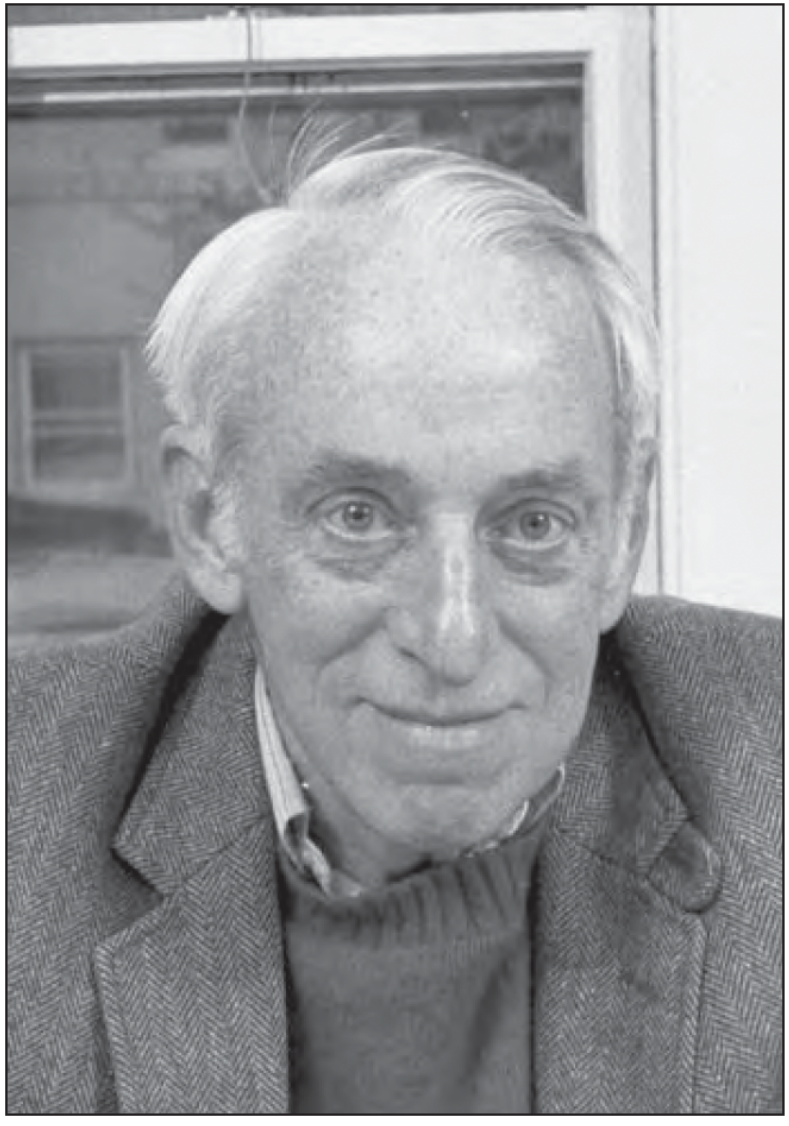
ECO5021F: Advanced Macroeconomics
University of Cape Town

What will we do today?

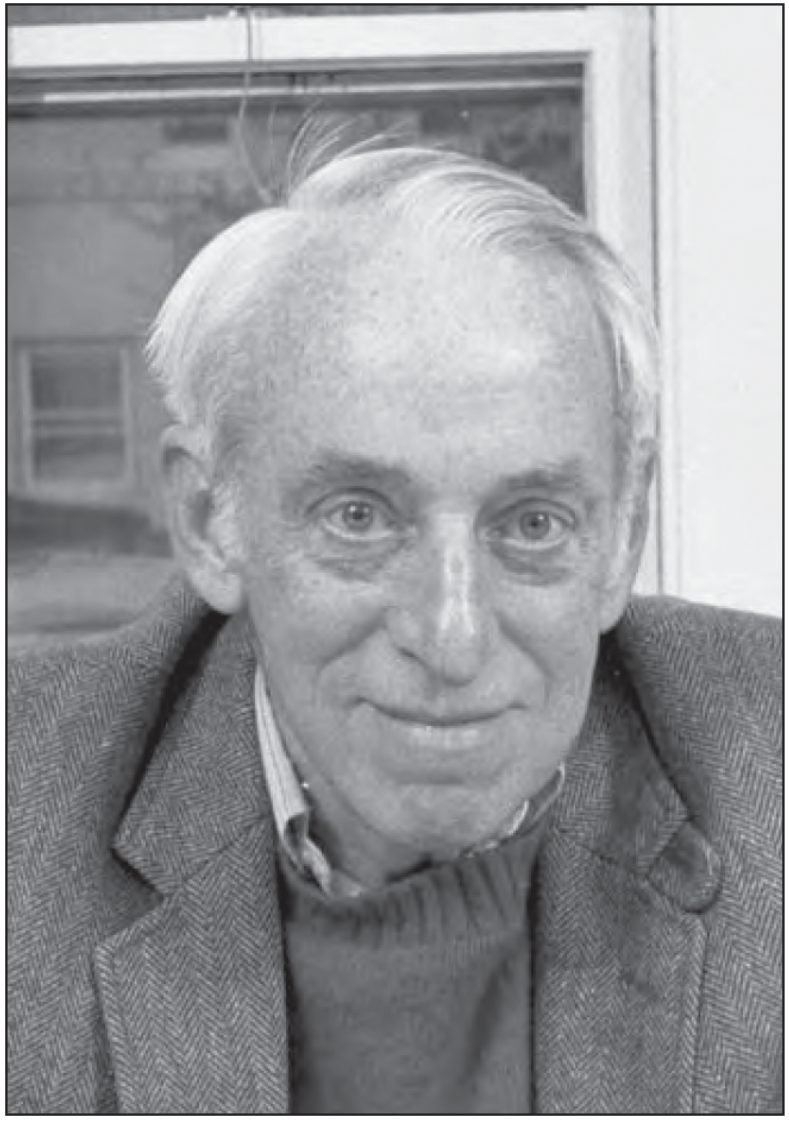
- Required
  - Romer, **Chapter 6.1 to 6.4** (Intro to Nominal Rigidities)
- Recommended
  - Interview with James Tobin in Snowdown and Vane (2005) *Modern Macroeconomics: Its Origins, Development and Current State*, pp.148−162
- Consider today an introduction to **Keynesian economics**



- **John Maynard Keynes**
- (1883 - 1946)
- Challenged the notions of neoclassical economics
- Theories of **aggregate demand**
- In the short run, effective demand determines output
- *In the long run, we are all dead*
- Government intervention to regulate business cycles

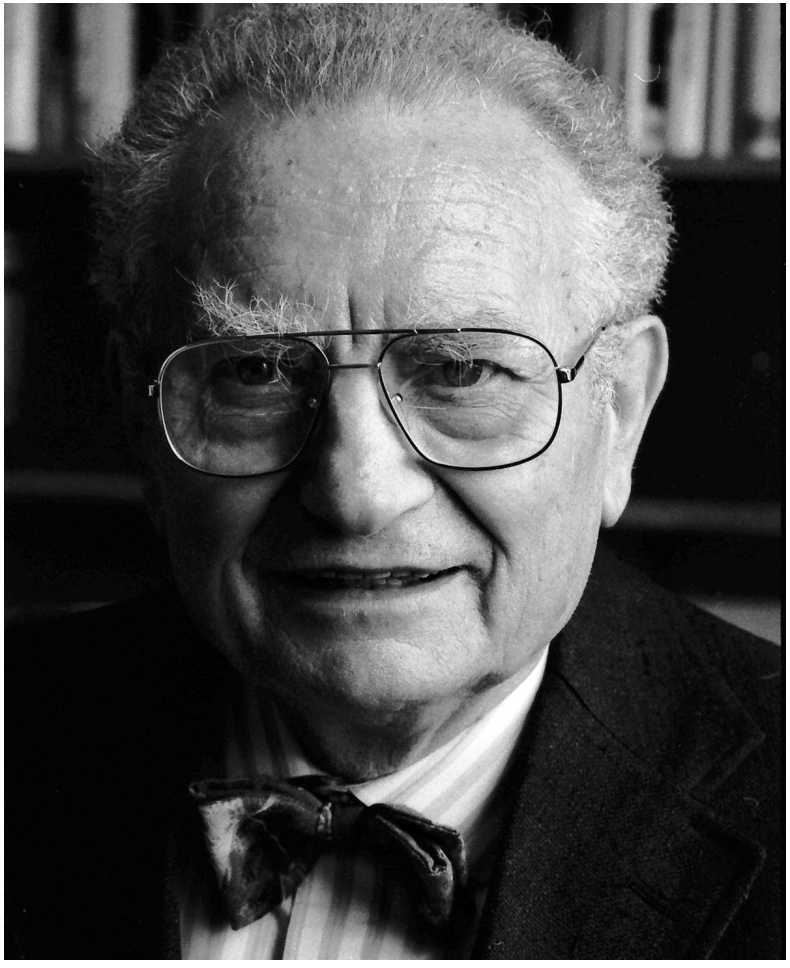


- **James Tobin**
- (1918 - 2002)
- Further developed the ideas of Keynesian economics
- Nobel Prize (1981)
- Two-regime model of the economy
  1. Markets clear (normal times) – Output is **supply constrained**
  2. Keynesian situation – Output is **demand constrained**



- From the two regime model
- In periods of **recession**, demand is sub-optimally low
- Resources in the economy are not fully employed
- This is because of **slow nominal adjustment**
- In these demand constrained times – need particular view of supply curve
  - Normal times – supply curve **vertical**
  - Demand constrained – supply curve **upward sloping**

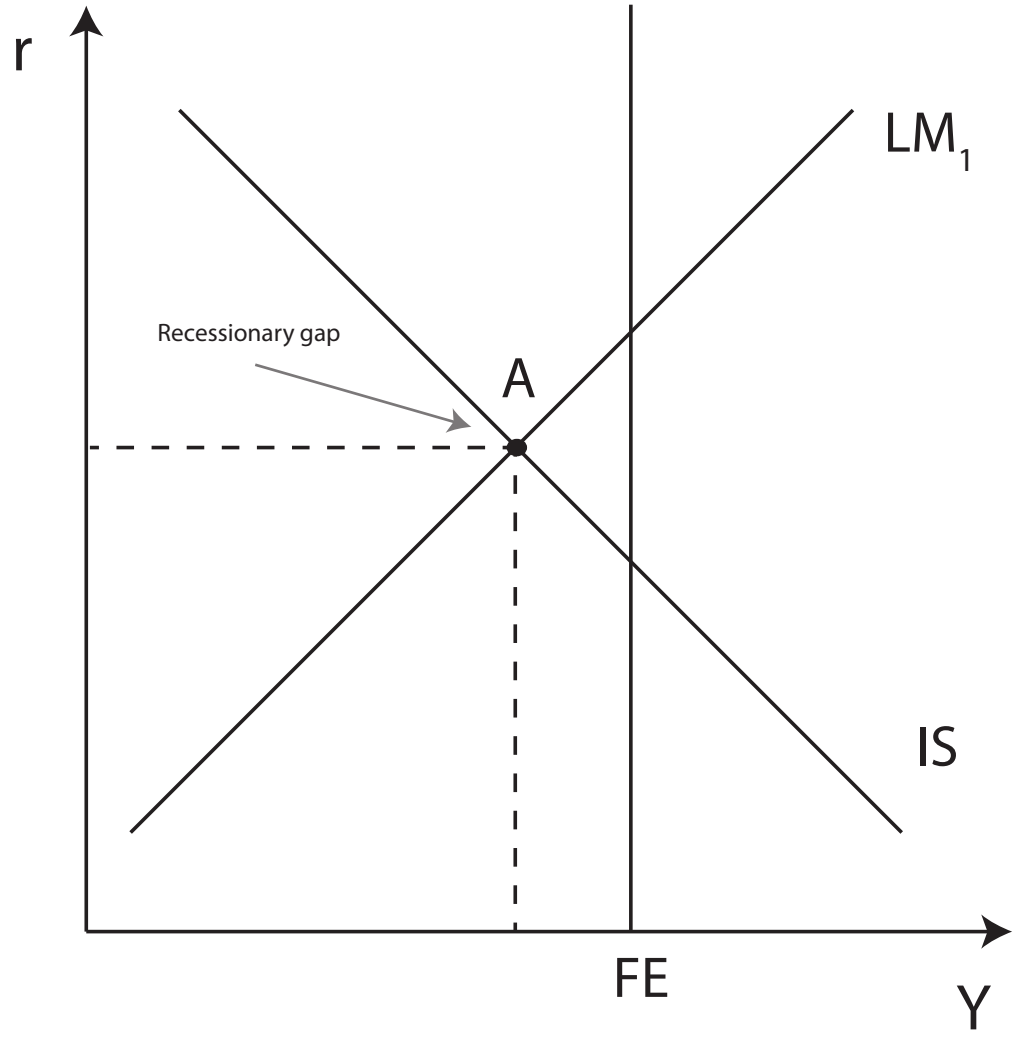
- Tremendously influential Keynesian economist
- **John Hicks**
- (1904 - 1989)
- Significant contributions to consumer demand theory (Hicksian demand, Kaldor-Hicks)
- Responsible for **IS-LM** model (with **Alvin Hansen**)
- Nobel prize (1972) with **Kenneth Arrow** (GE and welfare theory)
- Famous book – **Value and Capital (1939)**



- Another giant of macroeconomics
- **Paul Samuelson**
- (1915 - 2009)
- Unification and clarification of economics through mathematics
- Believed economists had been practicing “mental gymnastics of a particularly depraved type”
- Nobel prize (1970) – **First American**
- Famous book – **Foundations of Economic Analysis (1947)**
- Full professor at **MIT** by 32

Undergrad IS/LM representation

- How does the **automatic adjustment mechanism** work?
- **Example:** Going from **recessionary gap** to full employment
- Motivation for activist stabilisation policy?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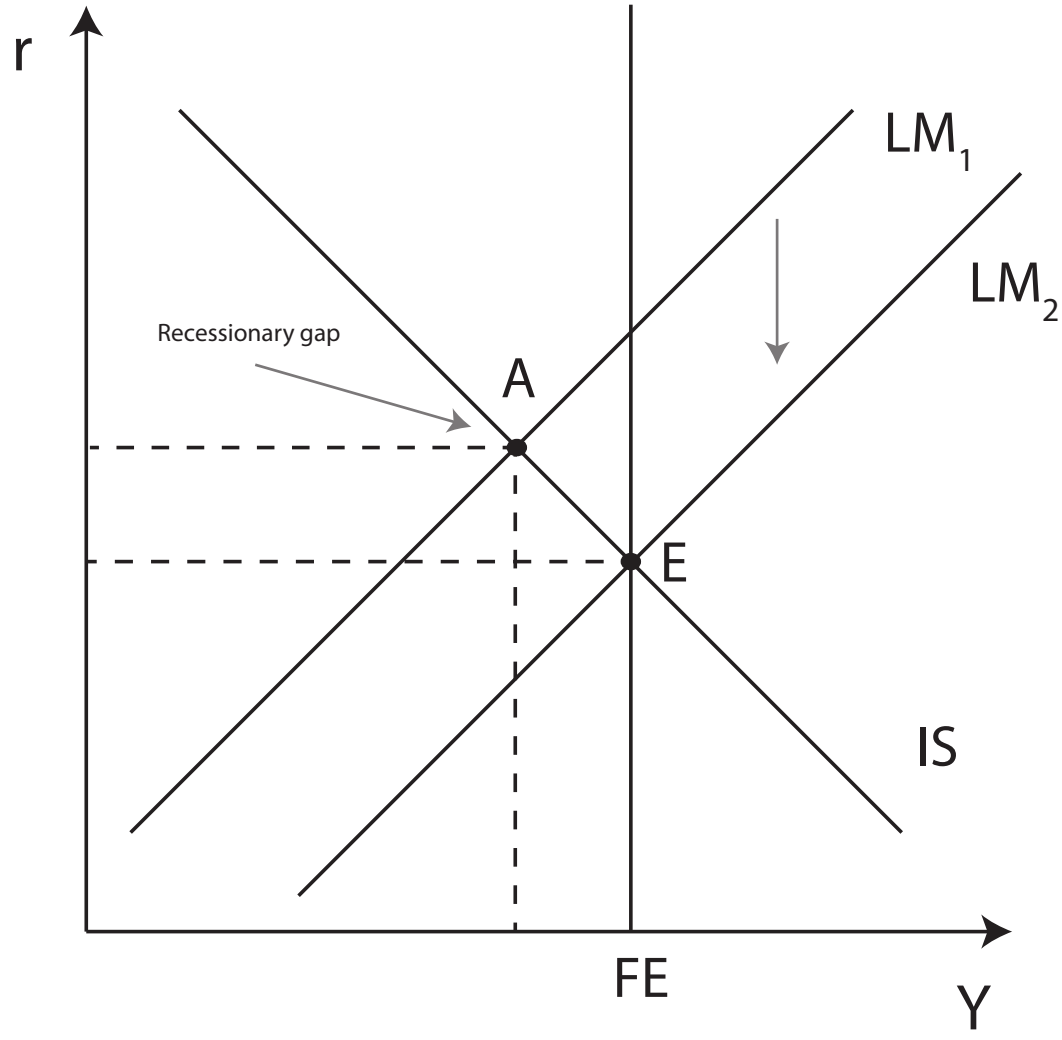
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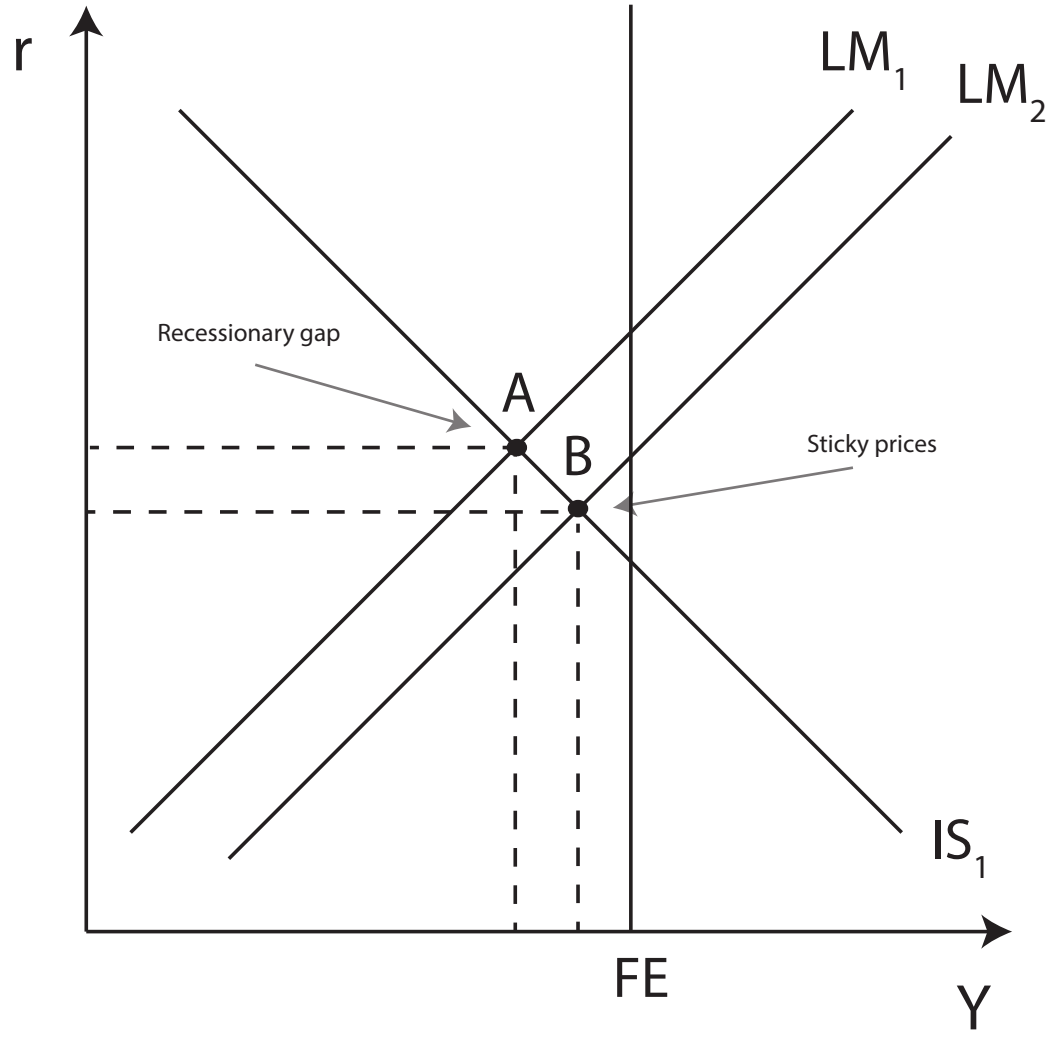
Undergrad IS/LM representation

- Reaction to recessionary gap (at point **A**) is a **drop in the overall price level** so that real money supply $(M/P) \uparrow$
- As the price drops the **LM** $\downarrow$ and the interest rate $\downarrow$
- Lower interest rate **raises aggregate demand** (through investment)
- Production rises in response to increased expenditure – think about the Keynesian cross (ala **Samuelson**)
- Economy moves along the **IS** curve
- **Adjustment process** continues until the economy reaches full employment (at point **E**)

Classicals vs. Keynes

- The **classical view** is that prices are completely flexible
  - Adjustment process is **rapid**
  - LM curve moves back, unencumbered, to full employment equilibrium
- The **Keynesian view** is that prices adjust slowly
  - Adjustment process is **sluggish**
  - Could potentially prevent full employment equilibrium from being obtained

- Short- vs long-run **money neutrality**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Sticky prices
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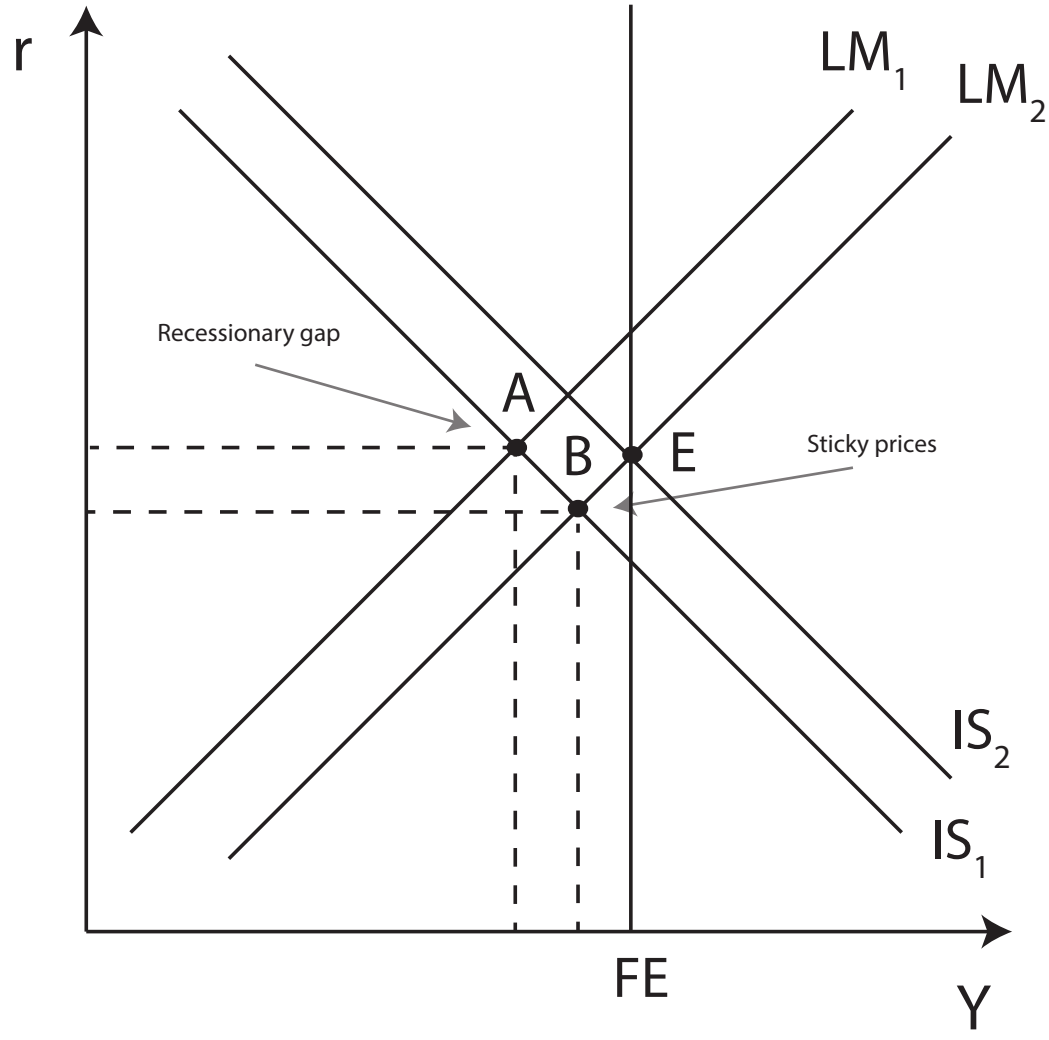
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Disclaimer

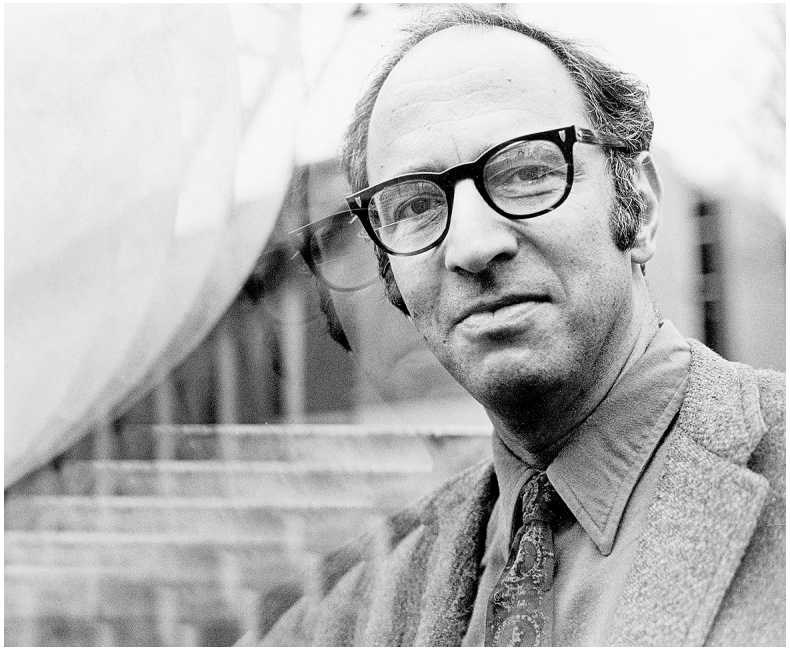
Bertrand Russell once noted that he would rather his ideas be defended by his fiercest professional critic than by his closest friend ‘innocent of philosophy’

Introduction to Keynesian economics

- **Tobin**, **Keynes** and many others, cite the Great Depression as motivating factor for their research

  *The crisis triggered a fertile period of scientific ferment and **revolution** in economic theory* – (**Tobin**)

  *I believe myself to be writing a book on economic theory which will largely **revolutionize** – not, I suppose at once but in the course of the next ten years, the way the world thinks about economic problems* (**Keynes** on writing the General Theory)



- This one is not an economist. . .
- Philosopher of science
- Wrote the Structure of Scientific Revolutions
- Introduced the idea of a **paradigm shift**

Intellectual revolution

- **Thomas Kuhn** claimed that normal science is puzzle solving
- Puzzles are tests of the scientist, not the theory
- Solving puzzles requires a framework, called a **paradigm**
- When **anomalies** accumulate and become serious, the paradigm enters a crisis
- If there is a rival paradigm the science could enter a period of extraordinary science – a **revolution**
- This model has been used to describe the **Keynesian revolution**

Alan Blinder's summary of Keynesian economics

- You can read his summary of the **six principal tenets** of Keynesian economics @ EconLib
- First three tenets describe **how the economy works**
  - **Aggregate demand** influenced by many decisions – both public (G_t) and private ($C_t + I_t$)
  - Short run effects on quantities **rather than prices**
  - Self adjusting mechanism of the market works poorly
- What distinguishes Keynesians is their belief in the following three tenets about **economic policy**
  - Unemployment perceived to be too high and too variable
  - Arguments for **active stabilisation policy**
  - Some are more concerned with unemployment than inflation

Alan Blinder's summary of Keynesian economics

- Some **essential features** in modern macroeconomics are missing from traditional Keynesian models
- Keynesian models before the 1970's did not include explicit **optimising decision makers**
- Relationships were often **static**, only concerned with partial equilibrium results
  - In the selected cases where dynamics were introduced they were often *ad hoc*
- Focus on **one-time changes** to exogenous variables
  - Does not capture dynamic and stochastic processes

Keynesian Fallacies (Gregory Mankiw)

- Reading the *General Theory* is the best way of learning about the macroeconomy
- Lessons of **classical economics** are not helpful in understanding how the world works
- Excessive savings threatens recession (paradox of thrift), requires a bout of deficit spending to cure
- Fiscal policy is more powerful than monetary policy as stabilisation tool
- Inflation is the **cost of low unemployment**, we must accept the trade-off
- Policymakers should **avoid rules** in favour of discretion

Why introduce nominal rigidities / imperfections?

- **RBC** models $\rightarrow$ monetary shocks are not responsible for propagating cyclical fluctuations
- In other words, they don't have **real effects** (no impact on real prices or quantities)
- Markets clear instantaneously $\rightarrow$ monetary change results in proportional change in the price level
- Standard in the literature to include **nominal imperfections** $\rightarrow$ barriers to changes in prices or wages
- Is this realistic? What do you think? **Examples**?

Why introduce nominal rigidities / imperfections?

- We will have to introduce **microfoundations**
- Luckily, we will start slow, with small (often static) business cycle models
- Some **questions for today**
  1. How do we introduce barriers to price change?
  2. What effect do barriers to nominal adjustment have?
  3. Do these barriers lead to aggregate nominal rigidity?

Model assumptions

- We start with a baseline case (there will be **four cases in total**)
- Some important **structural assumptions**, which will hold unless otherwise specified, are,
  - No government
  - Closed economy (i.e. **no international trade**)
  - Prices are fixed
  - Discrete time model (**for now**)

Assumptions: Firms

- Assume that the **horizon for the model** is such that we are not interested in capital
- Output is only a function of labour
- The implication is that aggregate output will equal consumption
- In other words, we consume all our output (**nothing is saved**)

$$Y = F(L), \quad F'(\bullet) > 0, \quad F''(\bullet) \leq 0$$

Assumptions: Households

- A fixed number (normalized to 1) of infinitely lived **identical households**, that obtain utility from
  1. Consumption: C_t
  2. Real money balances: M_t/P_t
  3. Disutility from (time spent) working: L_t
- The representative household's objective function is,

$$H = \sum_{t=0}^{\infty} \beta^t \left[U(C_t) + \Gamma\left(\frac{M_t}{P_t}\right) - V(L_t) \right], \quad 0 < \beta < 1$$

- Some important properties are,

$$\begin{aligned} U'(\bullet) > 0, \quad U''(\bullet) \leq 0 \qquad & \downarrow \text{MU in consumption} \\ \Gamma'(\bullet) > 0, \quad \Gamma''(\bullet) \leq 0 \qquad & \downarrow \text{MU in money holdings} \\ V'(\bullet) > 0, \quad V''(\bullet) \geq 0 \qquad & \uparrow \text{MU in labour} \end{aligned}$$

Assumptions: Households

- We impose a specific functional form with respect to consumption and money holdings (**we won't look at labour**)
- Doing this will give us constant relative risk aversion (**CRRA**) interior functions for the variables in question

$$U(C_t) = \frac{C_t^{1-\theta}}{1-\theta}, \quad U'(C_t) = C_t^{-\theta}, \quad \theta > 0$$

$$\Gamma\left(\frac{M_t}{P_t}\right) = \frac{(M_t/P_t)^{1-\chi}}{1-\chi},$$

$$\Gamma'(m_t) = (m_t)^{-\chi}, \quad \chi > 0$$

- For simplicity of notation, we will use $m_t = M_t/P_t$ going forward.

Avoiding parameter confusion...

- Students (**myself included**) often struggle to provide an intuitive account of parameter changes
- Especially confusing is the distinction between,
  - discount factor (β)
  - discount rate (ρ)
  - coefficient of relative risk aversion (θ)
  - elasticity of substitution ($1/\theta$)
- Let's try to make this **easier to grasp**

Avoiding parameter confusion. . . Discounting

- The discount factor (β) is the rate at which you **discount future consumption** (C_{t+1})
- Lower the value of β, the more we value consuming today
- Also referred to as the **degree of impatience** $\rightarrow$ i.e. it has to do with **time preference**
- Discount factor is related to the discount rate in the following way,

$$\beta = \frac{1}{1+\rho}$$

- The greater the value for ρ the less the household values future consumption relative to today (**more impatient**)

Avoiding parameter confusion. . . Smoothing

- Coefficient of relative risk aversion (θ) relays the households willingness to **shift consumption** between periods
- When the value is small, **marginal utility** falls more slowly as consumption rises $\rightarrow$ household is more willing to allow its consumption to vary over time
  - Can potentially **take advantage** of differences between discount rate and the rate of return on savings
- Has to do with **consumption smoothing**
- Changes in stable present consumption versus a potential windfall in future
- No uncertainty in the model, so household's attitude toward risk is irrelevant
  - Normally, lower value of $\theta \rightarrow$ less risk averse
- **Elasticity of intertemporal substitution** in CRRA is $1/\theta$

Assumptions: Financial assets and evolution of wealth

- There are two assets in the model,
  - Non-interest bearing money (M_t)
  - Interest bearing bonds (B_t) at interest rate (i_t)
- The household has an *initial endowment* of **financial wealth** A_t,
  - i.e., financial wealth at the beginning of period t: $A_t = M_{t-1} + B_{t-1}$
- From period t to $t+1$ the household holds the following **bonds**

$$B_t = A_t + W_t L_t - P_t C_t - M_t$$

- Financial wealth at the beginning of period $t+1$ is then

$$\begin{aligned} A_{t+1} &= M_t + (B_t) \cdot (1 + i_t) \\ A_{t+1} &= M_t + (A_t + W_t L_t - P_t C_t - M_t) \cdot (1 + i_t) \end{aligned}$$

- This equation describes the evolution of wealth.
- Note: similar to real money balances, we will use $w_t = W_t / P_t$ for real wages for ease of notation.

Assumptions: Household's decision

$$A_{t+1} = M_t + (A_t + W_t L_t - P_t C_t - M_t) \cdot (1 + i_t)$$

- The household takes the paths of P_t, W_t and i_t as given
- It chooses the paths of C_t and M_t to maximize its lifetime utility subject to its flow budget constraint and a no-Ponzi-game condition.

Assumption 1

Because we want to allow for the possibility of nominal wage rigidity and of a labour market that does not clear, for now we do not take a stand concerning whether the household's labour supply, L, is exogenous to the household or a choice variable. For now, we make no assumption about how firms choose L.

Assumption 2

The path of M is set by the central bank. Thus, although households view the path of i as given and the path of M as something they choose, in general equilibrium the path of M is exogenous and the path of i is determined endogenously.

Household behaviour

- **Romer** uses calculus of variations to solve this problem
- A small decline in C_t by dC frees up nominal funds worth $P_t \cdot dC$
- These are saved in bonds earning interest rate i_t
- In period $t+1$, nominal payoff is $(1+i_t) \cdot P_t \cdot dC$
- Real purchasing power in $t+1$ becomes:

$$(1+i_t) \cdot P_t \cdot dC \,/\, P_{t+1} = (1+r_t) \cdot dC$$
$$\Rightarrow (1+r_t) = (1+i_t) \cdot (P_t/P_{t+1})$$

- **Fisher equation:** $(1+r_t) = (1+i_t)/(1+\pi_{t+1})$
- In equilibrium the (discounted) marginal utilities of these consumption changes have to be equal

$$C_t^{-\theta} = \beta \mathbb{E}_t \left[C_{t+1}^{-\theta} \cdot (1+r_t) \right] = (1+r)\beta C_{t+1}^{-\theta}, \text{ (certainty equiv.)}$$

- This method is intuitive and quick, but let's also look at the full setup (**Lagrangian**)

Alternative Approach: Lagrangian

- We can also solve the problem with a Lagrangian setup – or even a Bellman equation (Dynamic Theory)
- This means we have to rewrite the budget equation
- Given **financial wealth** at the beginning of period t is defined as $A_t = M_{t-1} + B_{t-1}$, we can write:

$$M_t + B_t = M_t + (M_{t-1} + B_{t-1} + W_t L_t - P_t C_t - M_t) \cdot (1 + i_t)$$

$$\therefore \frac{M_t}{P_t} + C_t + \frac{B_t}{(1+i_t)P_t} = \frac{B_{t-1}}{P_t} + \frac{M_{t-1}}{P_t} + \frac{W_t L_t}{P_t}$$

- Rewrite this in **intensive form** as

$$m_t + C_t + \frac{b_t}{(1+i_t)} = \frac{b_{t-1} + m_{t-1}}{(1+\pi_t)} + w_t L_t$$

- where $1 + \pi_t = P_t / P_{t-1}$
- note: we can think of bonds having a discount price $Q_t \equiv 1/(1+i_t)$

Alternative Approach: Lagrangian

$$\max_{C_t, m_t, b_t} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[U(C_t) + \Gamma(m_t) - V(L_t) \right]$$
$$+ \lambda_t \left[\frac{b_{t-1} + m_{t-1}}{(1+\pi_t)} + w_t L_t - C_t - m_t - \frac{b_t}{(1+i_t)} \right]$$

- Relevant first order conditions for this problem are,

$$(\partial C_t) \qquad \beta^t u'(C_t) = \lambda_t$$
$$(\partial b_t) \qquad \mathbb{E}_t \frac{\lambda_{t+1}(1+i_t)}{(1+\pi_{t+1})} = \lambda_t$$

- **Fisher equation**: $(1+i_t)/(1+\pi_{t+1}) = (1+r_t)$
- Combining these gives us the same equation as before,

$$C_t^{-\theta} = \beta \mathbb{E}_t \left[C_{t+1}^{-\theta} \cdot (1+r_t) \right]$$

Household behaviour

- $C_t^{-\theta} = (1+r)\beta C_{t+1}^{-\theta}$ is a **multiplicative** equation, often difficult to make sense of these
- Take logs on both sides to simplify $\rightarrow$ makes it an **additive** equation

$$-\theta \ln C_t = \ln(1+r_t)\beta - \theta \ln C_{t+1}$$

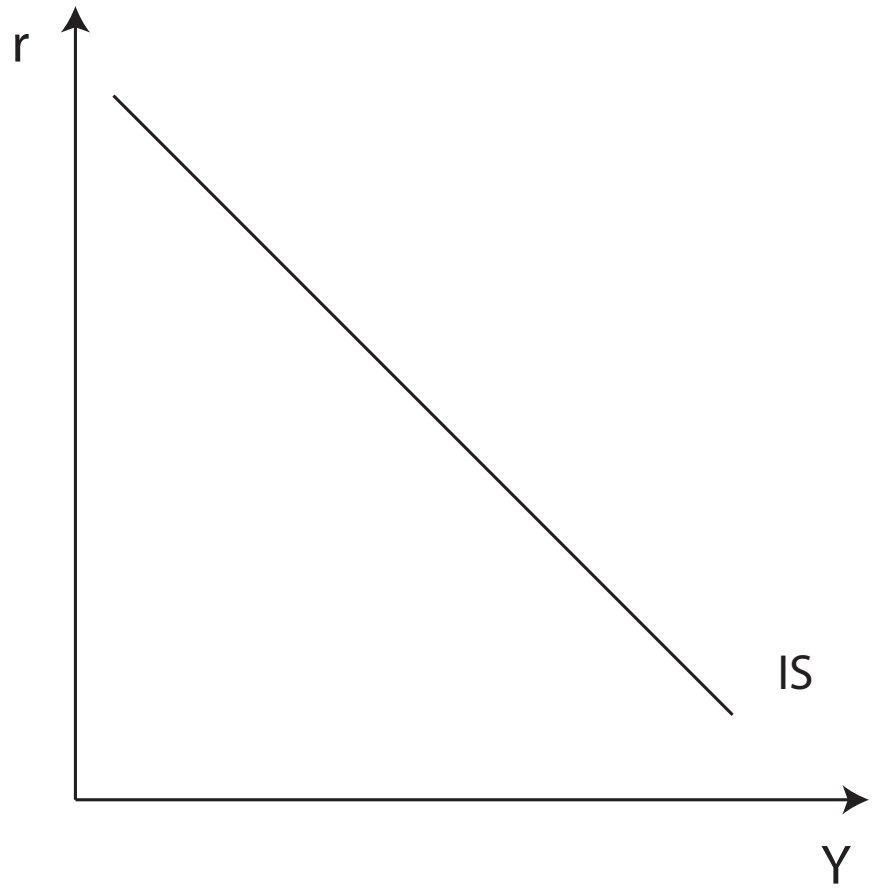
$$\therefore \ln C_t = \ln C_{t+1} - \frac{1}{\theta} \ln[(1+r_t)\beta]$$

- We can now implement some simplifying assumptions: $Y_t = C_t$; $\ln(1+r) \approx r$ for small r. This gives:

$$\ln Y_t = a + \ln Y_{t+1} - \frac{1}{\theta} r_t \tag{1}$$

where $a \equiv -(1/\theta) \ln \beta > 0$.

- Eq. (1) is the new Keynesian IS curve (under certainty).



- **New Keynesian IS curve**

$$\ln Y_t = a + \ln Y_{t+1} - \frac{1}{\theta} r_t$$

- Key feature: is the **negative relation** between output and the real interest rate
- Based on **microfoundations**
- Main difference to traditional *IS*-curve is Y_{t+1} on the RHS $\rightarrow$ important later on ...

Household behaviour contd. . .

- What about money holdings . . . again, we follow Romer at first . . .
- Remember that the evolution of wealth is then given by

$$
\begin{aligned}
A_{t+1} &= M_t + (A_t + W_t L_t - P_t C_t - M_t) \cdot (1 + i_t) \\
\frac{A_{t+1}}{(1+i_t)} &= \frac{M_t}{(1+i_t)} + A_t + W_t L_t - P_t C_t - M_t \\
\frac{A_{t+1}}{(1+i_t)P_t} &= \frac{M_t}{(1+i_t)P_t} + \frac{A_t}{P_t} + \frac{W_t L_t}{P_t} - C_t - \frac{M_t}{P_t} \\
\therefore \frac{A_{t+1}}{(1+i_t)P_t} &= \frac{M_t(i_t)}{(1+i_t)P_t} - C_t + \frac{A_t}{P_t} + \frac{W_t L_t}{P_t} \\
\therefore a_{t+1}\frac{(1+\pi_t)}{(1+i_t)} &= m_t \frac{i_t}{(1+i_t)} - C_t + a_t + w_t L_t
\end{aligned}
$$

  where $a_t = \dfrac{A_t}{P_t}$ and using Romer's assumption: $(1 + \pi_t) = P_{t+1}/P_t$.

- Now consider a balanced budget change in M_t/P_t and C_t

Household's decision contd. . .

- From the evolution of wealth we determined that,

$$a_{t+1}\frac{(1+\pi_t)}{(1+i_t)} = m_t\frac{i_t}{(1+i_t)} - C_t + a_t + w_t L_t$$

- Household raises $M_t/P_t = m_t$ by dm and lowers C_t by $[i_t/(1+i_t)]dm$
- The household's real bond holdings therefore fall by $\{1 - [i_t/(1+i_t)]dm\}$ OR $[1/(1+i_t)dm]$
- This change has **no effect** on wealth at the beginning of period $t+1$
- At the margin, if the household is optimising, this change must not affect utility

Household's decision contd. . .

- The utility benefit of the change is $\Gamma'(M_t/P_t)dm$, and the utility cost is $U'(C_t)[i_t/(1+i_t)]dm$
- The first-order condition for optimal (real) money holdings is therefore

$$\Gamma'\left(\frac{M_t}{P_t}\right) = \frac{i_t}{(1+i_t)}U'(C_t)$$

- Since $U'(\bullet)$ and $\Gamma'(\bullet)$ are given and $C_t = Y_t$ implies

$$\begin{aligned} m_t^{-\chi} &= \frac{i_t}{(1+i_t)}Y_t^{-\theta} \\ \therefore m_t &= Y_t^{\theta/\chi}\left(\frac{1+i_t}{i_t}\right)^{1/\chi} \end{aligned} \tag{2}$$

- Money demand Eq. (2) is increasing in output and decreasing in the nominal interest rate.

Alternative Approach: Lagrangian

$$\max_{C_t, m_t, b_t} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[U(C_t) + \Gamma(m_t) - V(L_t) \right]$$
$$+ \lambda_t \left[\frac{b_{t-1} + m_{t-1}}{(1+\pi_t)} + w_t L_t - C_t - m_t - \frac{b_t}{(1+i_t)} \right]$$

- Relevant first order conditions for this problem are,

$$(\partial C_t) \qquad \beta^t U'(C_t) = \lambda_t$$
$$(\partial b_t) \qquad \mathbb{E}_t \frac{\lambda_{t+1}(1+i_t)}{(1+\pi_{t+1})} = \lambda_t$$
$$(\partial m_t) \qquad \Gamma'(m_t) + \mathbb{E}_t \frac{\lambda_{t+1}}{(1+\pi_{t+1})} = \lambda_t$$

Alternative Approach: Lagrangian

- Combining the FOC for bonds and real money holdings gives us,

$$\Gamma'(m_t) + \frac{\lambda_t}{(1+i_t)} = \lambda_t$$

- Substituting λ_t using the FOC for consumption gives,

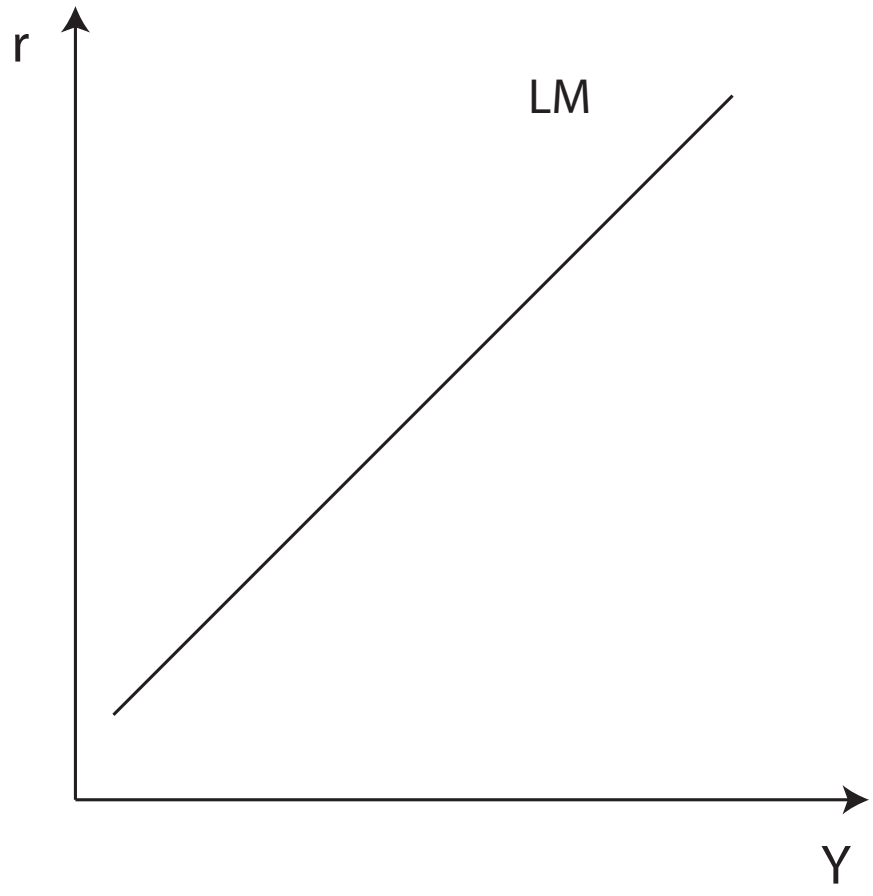
$$\Gamma'(m_t) + \frac{C_t^{-\theta}}{(1+i_t)} = C_t^{-\theta}$$

$$\therefore \quad \Gamma'(m_t) = C_t^{-\theta} - \frac{C_t^{-\theta}}{(1+i_t)}$$

$$\therefore \quad m_t^{-\chi} = C_t^{-\theta}\frac{i_t}{(1+i_t)}$$

$$\therefore \quad m_t^{-\chi} = Y_t^{-\theta}\frac{i_t}{(1+i_t)} \quad \Rightarrow \quad Y_t = C_t$$

$$\therefore \quad m_t = Y_t^{\theta/\chi}\left(\frac{1+i_t}{i_t}\right)^{1/\chi}$$



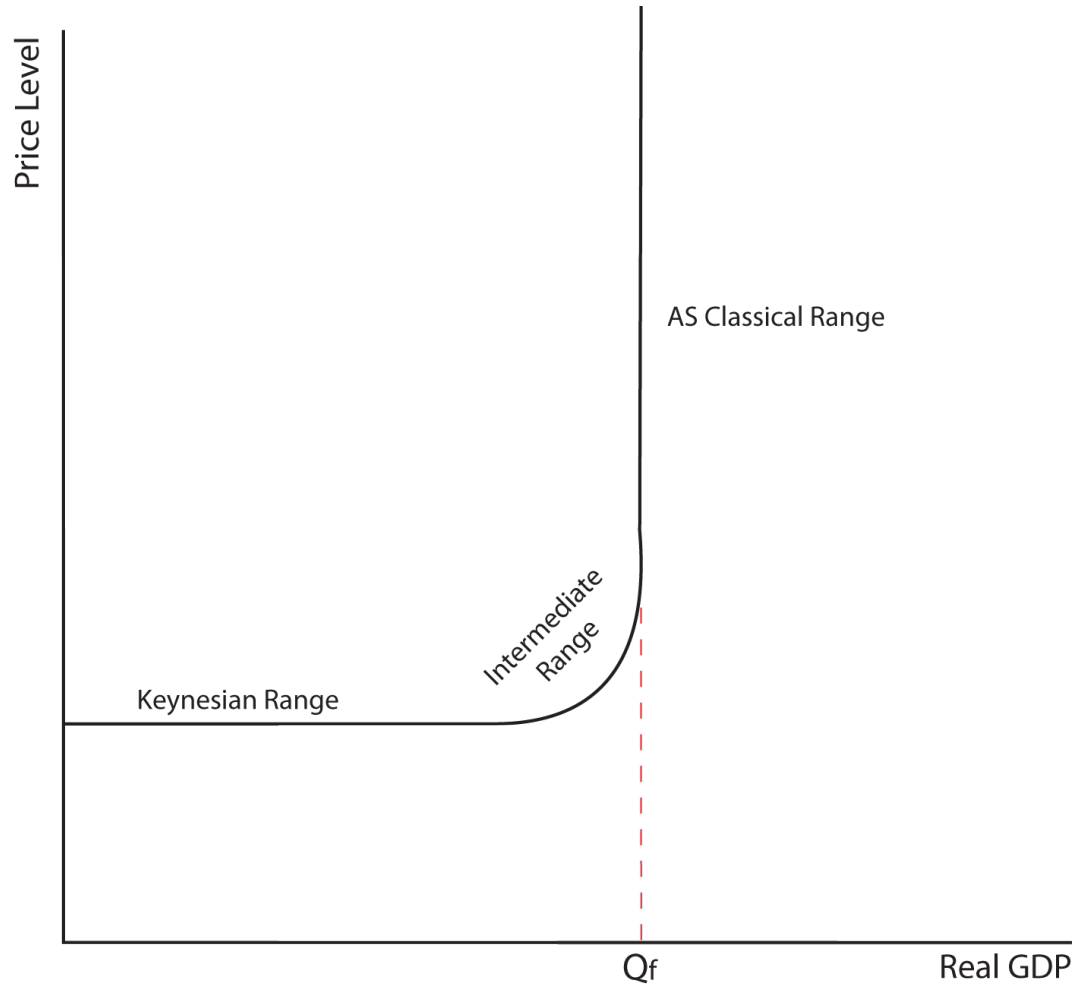
- **New Keynesian LM curve**

$$m_t = Y_t^{\theta/\chi} \left(\frac{1 + i_t}{i_t} \right)^{1/\chi}$$

- *Real* money demand m_t is,
  - Increasing in output Y_t
  - Decreasing in the nominal interest rate i_t

Aggregate Supply

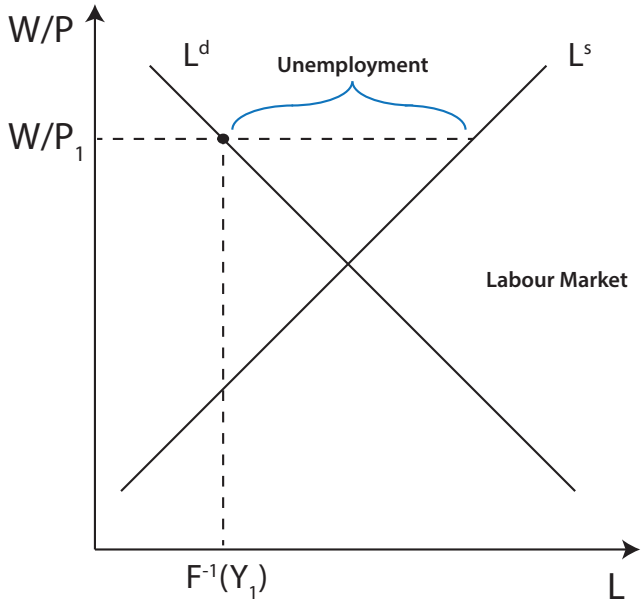
- We are done with the **aggregate demand** (AD) side for now
- **Long run** $\rightarrow$ all factors of production are variable
- **Short run** $\rightarrow$ only labour is variable (capital, land, etc. are fixed)
- Consider four ways of finding a **nonvertical** short run AS curve
  - i.e. a positive response of output to increase in *aggregate* goods price level
- Variations based on assumptions, not derived from microfoundations

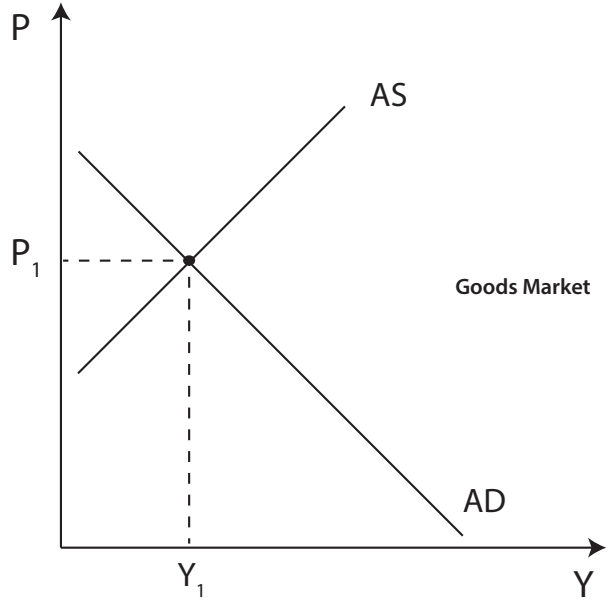

Price Level
AS Classical Range
Intermediate Range
Keynesian Range
Qf
Real GDP

	Prices	Goods Market	Wages	Labour Market	Implications
Case 1	**Flexible**	**Competitive**	**Fixed**	**Starts in surplus**	
Case 2	**Fixed**	**Monopolistic**	**Flexible**	**Competitive**	
Case 3	**Fixed**	**Monopolistic**	**Flexible**	**Real imperfections**	
Case 4	**Flexible**	**Monopolistic**	**Fixed**	**Real imperfections**	

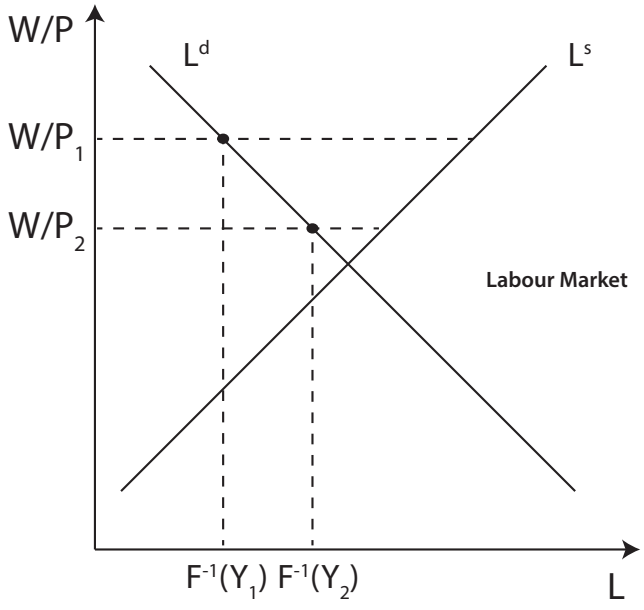
Case 1: Keynes's Model

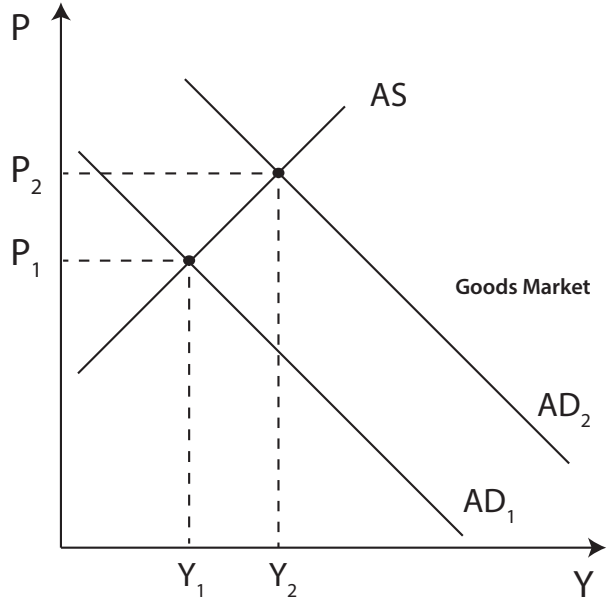
- **Kenyes** proposes a short run aggregate supply (**SRAS**) curve
- Shows how labour responds to shifts in **AD**
- Upward sloping schedule in (P, y) space
- This Keynesian **AS** model requires nominal imperfections
  - Typically an imperfection in the labour market
  - More recent **New Keynesian** work also introduces rigidities in goods market





- **Case 1: Keynes**
- Fixed wage (short run) $\rightarrow W = \bar{W}$
- Firms hire labour up to the point where the marginal product equals the real wage (L^d)
  - $\text{MP}_L = F'(L) = W/P$
- L^s derived from marginal disutility from hours worked
- Firms keep labour on their demand curve
  - Labour need **NOT** be on its supply curve
- **Keynes** assumes that the starting point is in **disequilibrium**
  - Labour market with above equilibrium real wage





- **Case 1: Keynes**
- Aggregate demand increase
  - Money supply shock
  - Firms meet the increase in demand
  - Hire more labour as a result of increased production
  - Price and cost increases (*diminishing* MP_L)

- **Implications**?
  - Counter-cyclical real wages
  - Involuntary unemployment

	Prices	Goods Market	Wages	Labour Market	Implications
Case 1	**Flexible**	**Competitive**	**Fixed**	**Starts in surplus**	• Counter-cyclical real wages • Involuntary unemployment
Case 2	**Fixed**	**Monopolistic**	**Flexible**	**Competitive**	
Case 3	**Fixed**	**Monopolistic**	**Flexible**	**Real imperfections**	
Case 4	**Flexible**	**Monopolistic**	**Fixed**	**Real imperfections**	

Case 2: Sticky Prices, Flexible Wages, and a Competitive Labour Market

- This case focuses on imperfections in the **goods market**
- Assume no imperfections in the labour market (competitive)
  - Labour remains on its **supply curve**
- Auxiliary assumption about **imperfect competition** (i.e. pricing power)
  - Needed to allow for quantity adjustments
  - Striving for a justification of nominal imperfections (due to price setting)

Derivation of Labour Supply

$$\max_{C_t, m_t, b_t, L_t} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[U(C_t) + \Gamma\left(\frac{M_t}{P_t}\right) - V(L_t) \right]$$
$$+ \lambda_t \left[\frac{M_t}{P_t} + C_t + \frac{B_t}{(1+i_t)P_t} - \frac{B_{t-1}}{P_t} - \frac{M_{t-1}}{P_t} - \frac{W_t L_t}{P_t} \right]$$

- Relevant first order condition for this problem is,

$$(\partial L_t) \quad \lambda_t \frac{W_t}{P_t} = V'(L_t)$$
$$\therefore \quad C_t^{-\theta} \frac{W_t}{P_t} = V'(L_t)$$

Derivation of Labour Supply

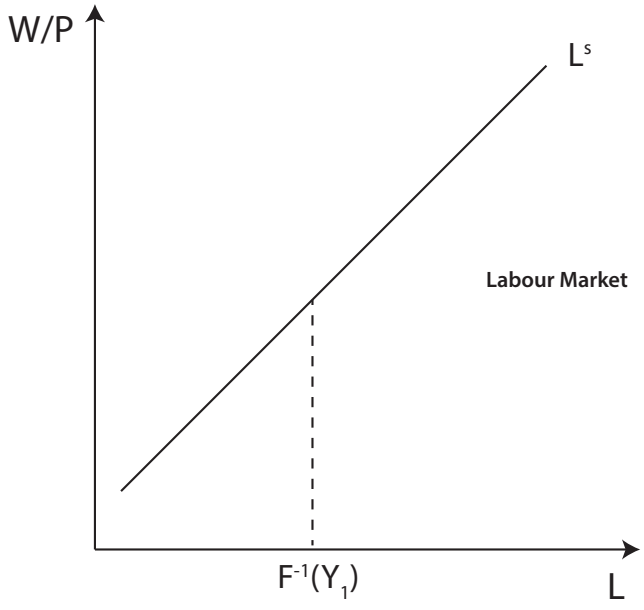
- At this point we can drop the time subscript. In equilibrium, $C = Y = F(L)$, which implies,

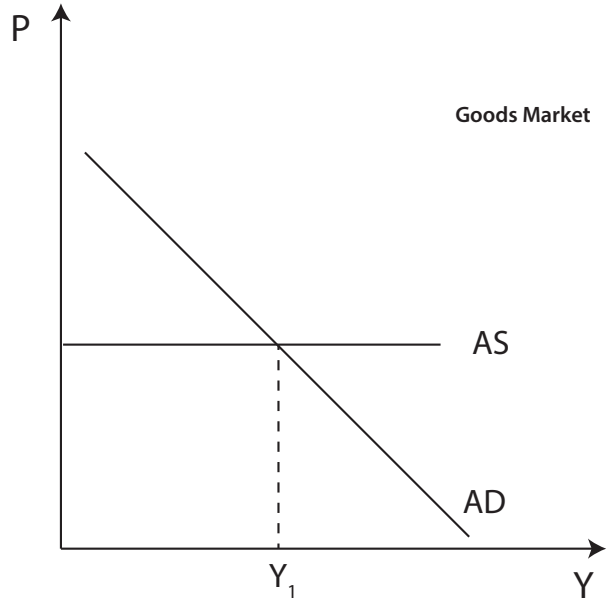
$$\frac{W}{P} = [F(L)]^{\theta} V'(L)$$

- This equation implicitly defines L as an increasing function of the real wage,

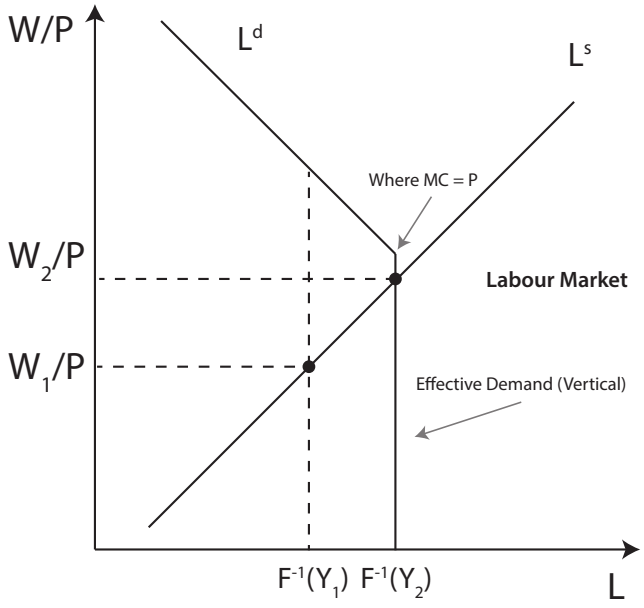
$$L = L^s \left(\frac{W}{P} \right), \quad L^{s\prime}(\bullet) > 0$$

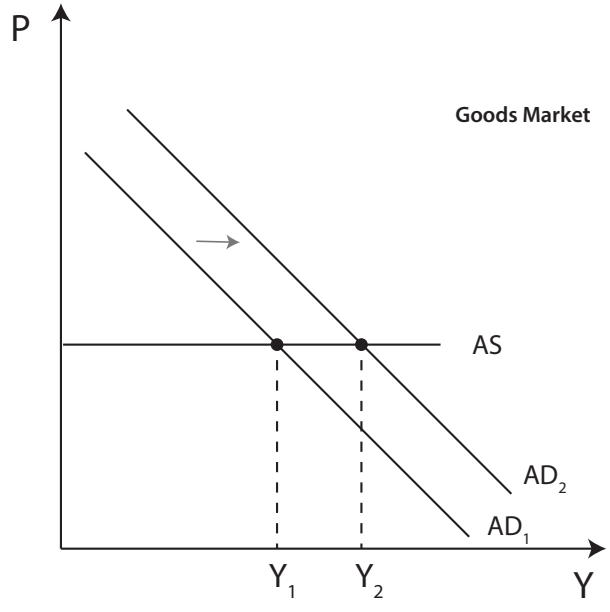
- Markup is defined as $\mu = \dfrac{P}{W/F'(L)}$





- **Case 2**
- Prices are **fixed** $\rightarrow P = \bar{P}$
- When $\bar{P} >$ MC the labour market clears (L^d **vertical**)
- Assume that price is **above** marginal cost
- **Markup** over marginal cost $\rightarrow$ pricing power
- Supply curve is **flat** over some relevant range
- Output completely demand determined
- Firms are **demand constrained**
  - Up to $Y^{\text{max}} \rightarrow$ where marginal product equals real wage
  - i.e. $F'(L) = W/P$

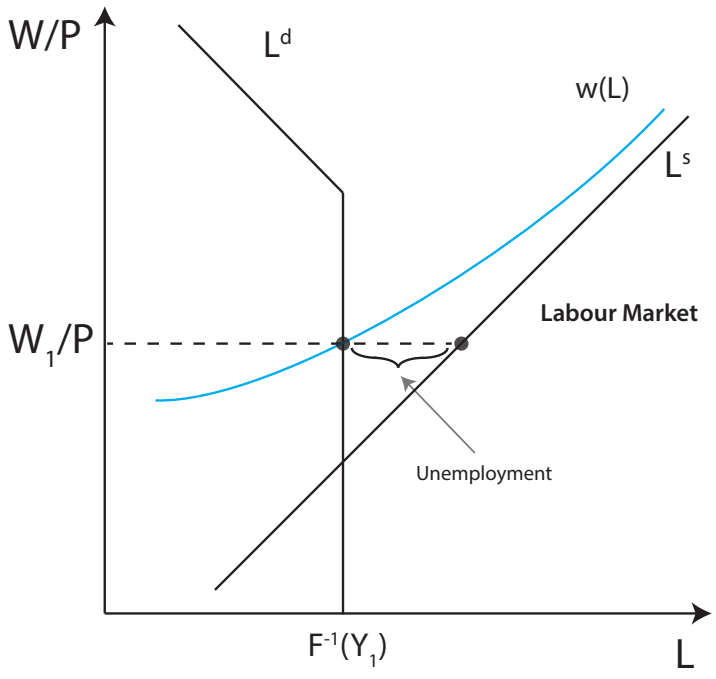




- **Case 2**
- If aggregate demand increases
  - Profitable to **expand production** to meet demand
  - Increase wage $\rightarrow$ hire more workers
  - If real wage does not increase beyond **effective demand** curve $\rightarrow$ continue to produce
  - Absorbs increase in cost through lower **markup**
- **Implications**?
  - Pro-cyclical real wages
  - Counter-cyclical markup
  - NO involuntary unemployment

	Prices	Goods Market	Wages	Labour Market	Implications
Case 1	**Flexible**	**Competitive**	**Fixed**	**Starts in surplus**	• Counter-cyclical real wages • Involuntary unemployment
Case 2	**Fixed**	**Monopolistic**	**Flexible**	**Competitive**	• PC real wages • CC markup • NO involuntary unemployment
Case 3	**Fixed**	**Monopolistic**	**Flexible**	**Real imperfections**	
Case 4	**Flexible**	**Monopolistic**	**Fixed**	**Real imperfections**	

Case 3: . . . labour market rigidity



- **Case 3** adds *real labour market imperfections* ('rigidity') to **Case 2**
- Non-Walrasian
  - Real wage remains above the level where $L^d = L^s$
  - Efficiency wage (Romer 10.2) – **Examples**?
- Failures other than the price system

$$\frac{W}{P} = w(L) > F'(L), \quad w'(\bullet) \geq 0$$

- **Implications**?
  - Same as before, but **WITH** involuntary unemployment!

	Prices	Goods Market	Wages	Labour Market	Implications
Case 1	**Flexible**	**Competitive**	**Fixed**	**Starts in surplus**	• Counter-cyclical real wages • Involuntary unemployment
Case 2	**Fixed**	**Monopolistic**	**Flexible**	**Competitive**	• PC real wages • CC markup • NO involuntary unemployment
Case 3	**Fixed**	**Monopolistic**	**Flexible**	**Real imperfections**	• Same as Case 2 **WITH** • Involuntary unemployment
Case 4	**Flexible**	**Monopolistic**	**Fixed**	**Real imperfections**	

Case 4: Sticky Wages, Flexible Prices, and Imperfect Competition

- Extends **Case 1** by adding real imperfections in the goods market
- Monopolistic firms charges a markup ($\mu(L)$) over marginal cost,

$$P = \mu(L)\frac{W}{F'(L)}, \quad MC = \frac{W}{F'(L)}$$

- This implies that the real wage is,

$$\frac{W}{P} = \frac{F'(L)}{\mu(L)}$$

- **Implications**?
  - If the markup is **constant** the real wage remains **counter-cyclical** $\rightarrow$ downward-sloping MP_L
  - However, if the markup is sufficiently counter-cyclical, then the real wage is acyclical (or slightly procyclical)

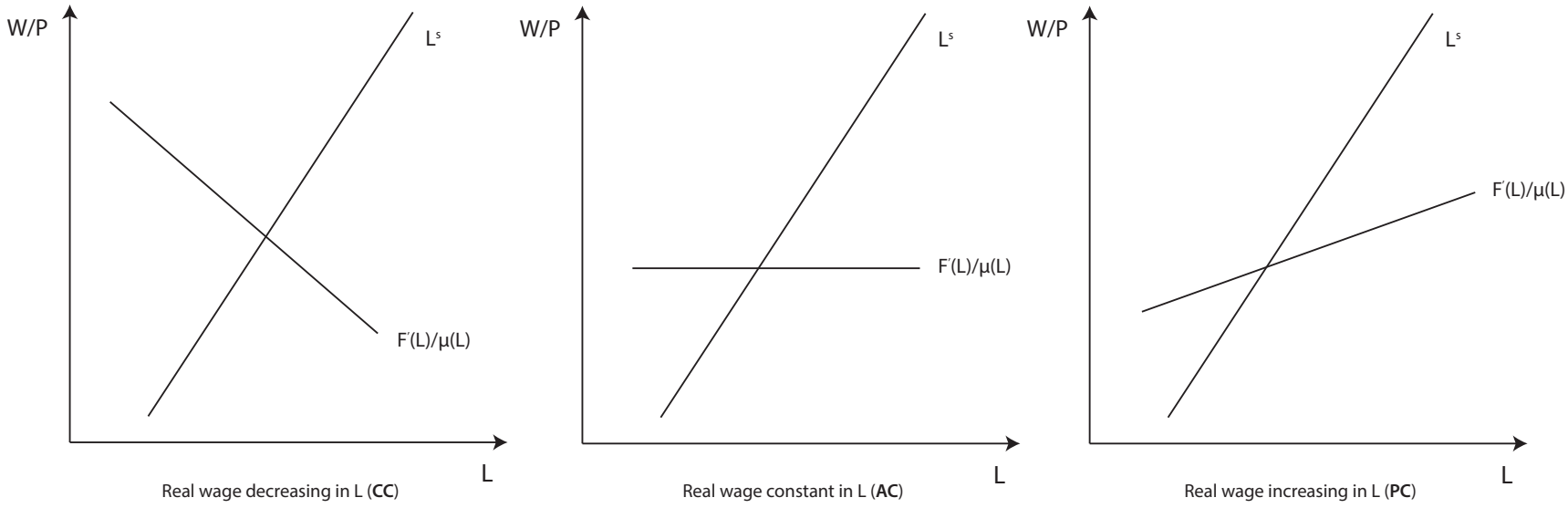


Figure: The labour market with sticky wages, flexible prices, and an imperfectly competitive goods market

Phillips Curve

- Accessible papers on the history of the Phillips curve by Robert Gordon

- Developed by A.W. Phillips in **1958**
- Low unemployment was associated with high inflation
- A **1960** study by **Solow** and **Samuelson** replicated these findings for the US
- Phillips curve **tradeoff** became basis for discussion of macroeconomic policy
- **Tradeoff**: Lower unemployment could be achieved, but at the cost of higher inflation

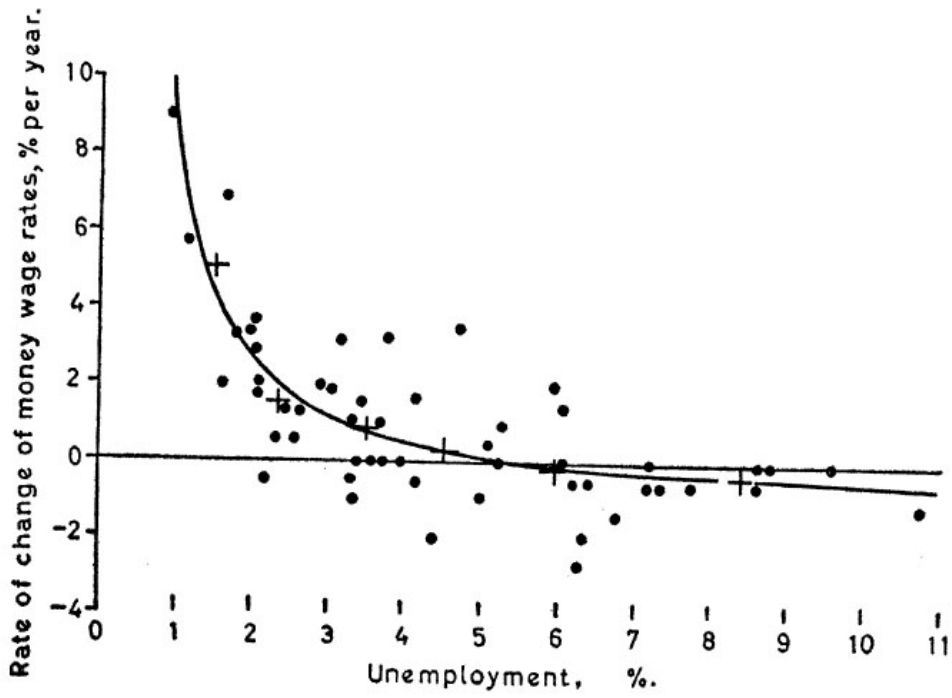


Fig.1. 1861 – 1913

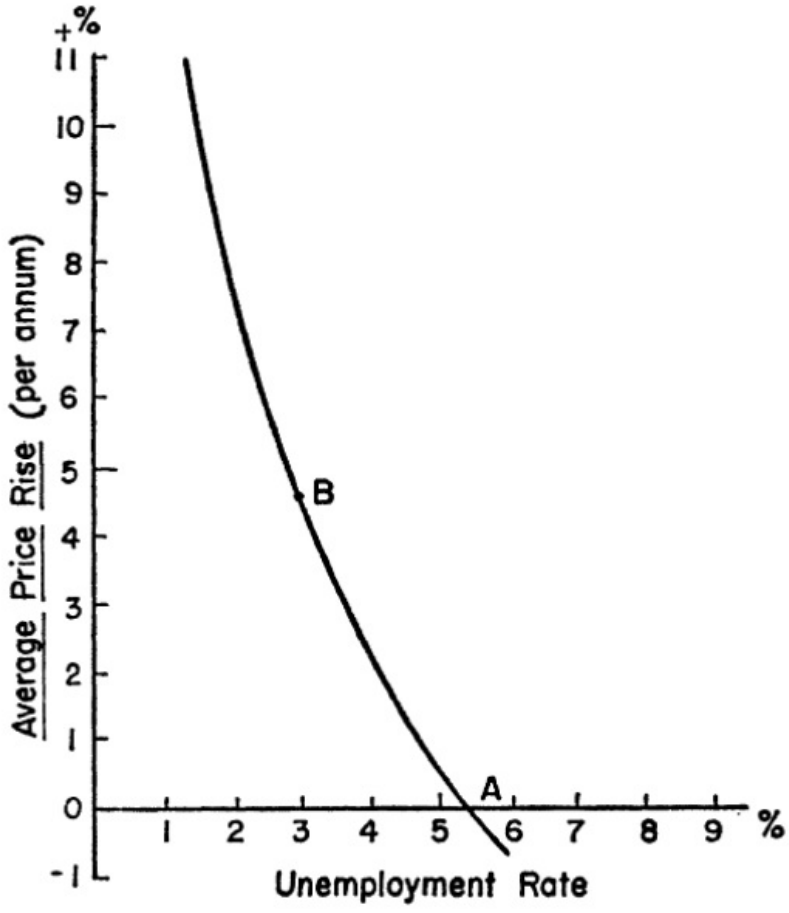


FIGURE 2

MODIFIED PHILLIPS CURVE FOR U.S.

This shows the menu of choice between different degrees of unemployment and price stability, as roughly estimated from last twenty-five years of American data.

Phillips Curve: Basic Theoretical model

- Assume wages are given, but proportional to the price level in the previous period,

$$W_t = AP_{t-1}, \quad A > 0$$

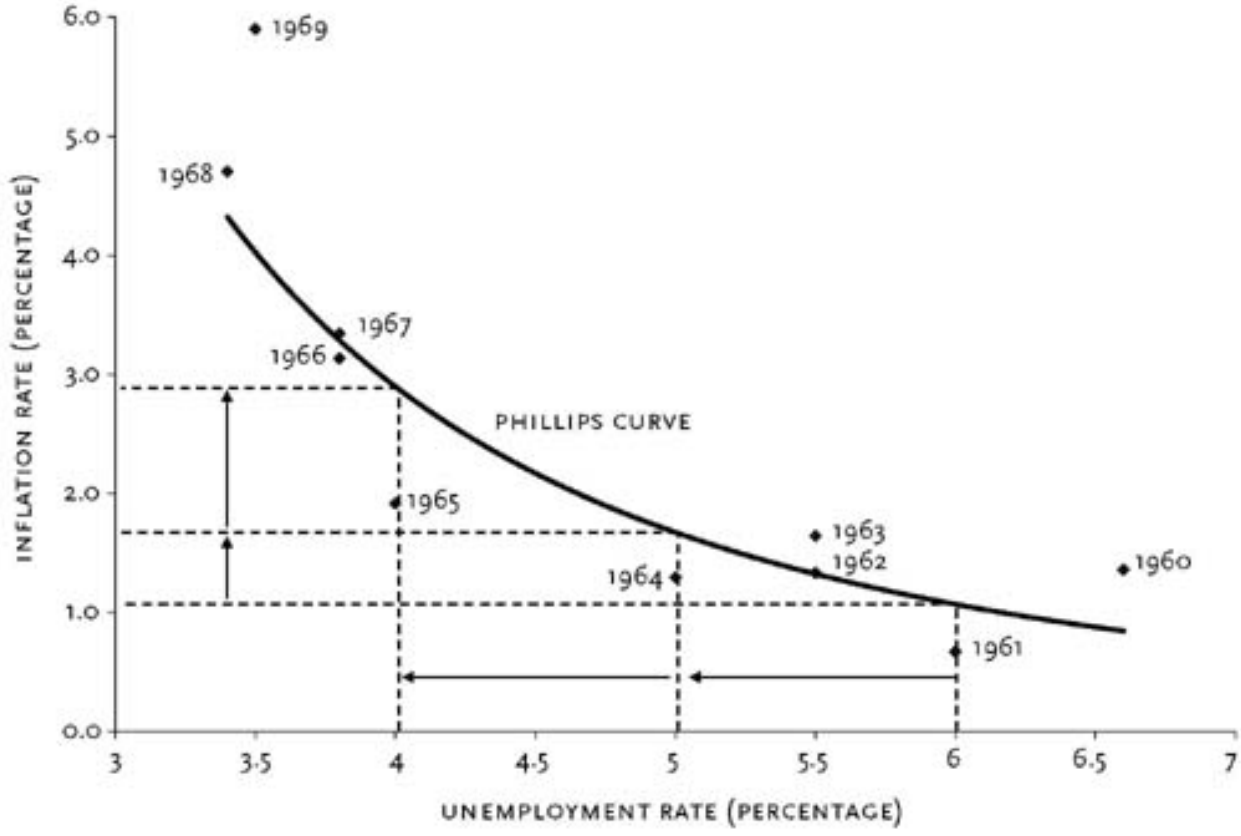
- As before, demand for labour is determined by the point where the real wage is equal to the marginal product of labour,

$$\frac{W_t}{P_t} = F'(L_t)$$

- The combination of these to gives us the permanent tradeoff between output and inflation,

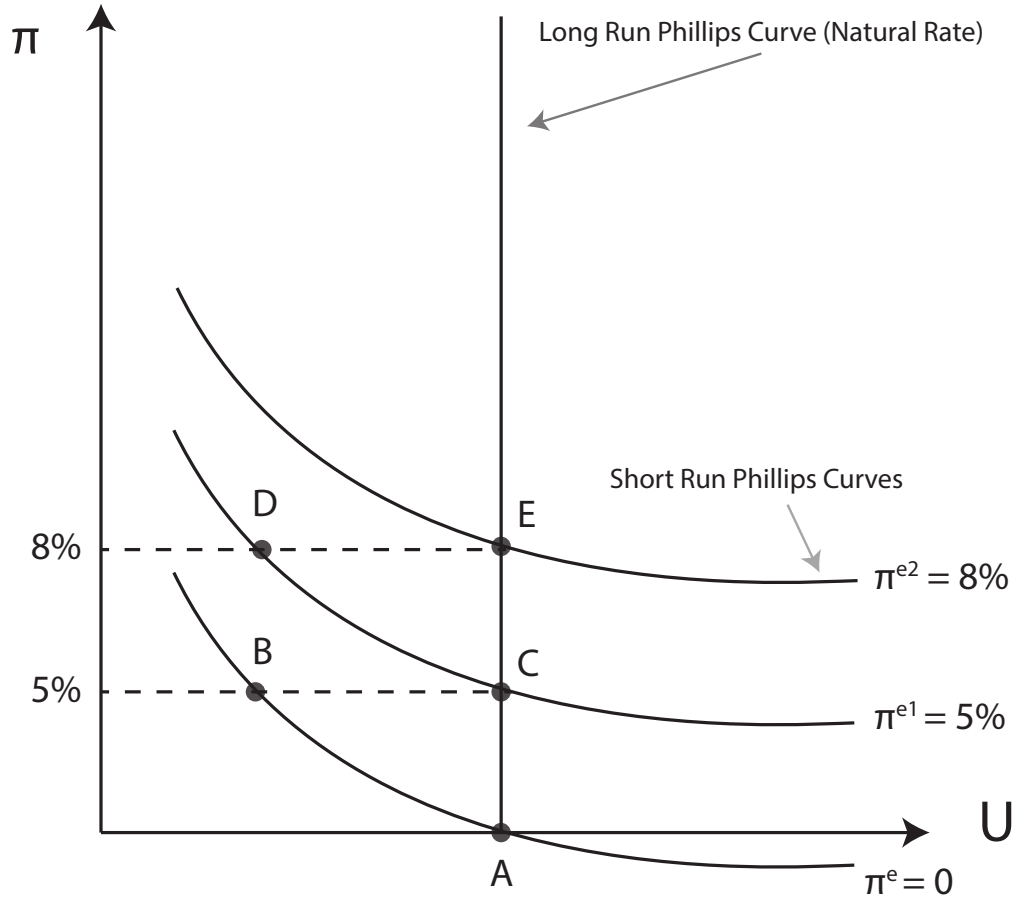
$$F'(L_t) = \frac{A_t P_{t-1}}{P_t} = \frac{A}{1+\pi_t}$$

- Treated as menu of policy options


6.0
5.0
4.0
3.0
2.0
1.0
0.0
INFLATION RATE (PERCENTAGE)
1969
1968
1967
1966
PHILLIPS CURVE
1965
1963
1962
1964
1960
1961
3
3·5
4
4·5
5
5·5
6
6·5
7
UNEMPLOYMENT RATE (PERCENTAGE)

Breakdown of the Phillips Curve

- **Supply shocks** negate Phillips curve result (e.g. 1970's)
  - Unemployment ↑, Inflation ↑
- **Edmund Phelps** and **Milton Friedman** independently challenged the theoretical underpinnings
  - Natural rate hypothesis → some normal or natural rate of unemployment
  - Policy cannot keep unemployment below this level indefinitely
  - No single Phillips curve, but rather series of short-run and one long run curve
- Let's look at the graph by **Brad DeLong** and a graph in **R**


π
Long Run Phillips Curve (Natural Rate)
Short Run Phillips Curves
D
E
8%
B
C
5%
A
U
$\pi^{e2} = 8\%$
$\pi^{e1} = 5\%$
$\pi^{e} = 0$

Theoretical failure I: Expectations

- The long run of unemployment is a **real variable**
  - Determined by other real factors
  - Labour productivity, capital:labour ratio, etc.
- Unexpected rise in prices could lead to temporarily lower real wages
  - Raising quantity of labour demand
  - Bumping labour of it's supply curve schedule
- The **result**?
  - Temporarily lower unemployment
  - Nominal wage adjustment
  - Return to natural rate of unemployment (but at higher inflation rate)

Expectations augmented Phillips curve

$$\pi_t = \pi_t^* + \lambda(\ln Y_t - \ln \bar{Y}) + \varepsilon_t^s$$

- Where π_t^* is **core inflation** and ε_t^s represents **supply shocks**
- Underlying inflation π_t^* is what would prevail if output Y_t is at it's potential $\bar{Y}$ (or natural rate)
- The term $\lambda(\ln Y_t - \ln \bar{Y})$ implies an upward sloping relationship between output and inflation
- Core inflation does not seem to be a function of the rest of the economy in this equation

Accelerationist Phillips Curve

- **Friedman** believed that inflation expectations were determined *adaptively*
  - **Adaptively** $\rightarrow$ people use last year's inflation rate π_{t-1} as a guide to what to expect this year
- Set $\pi_t^* = \pi_{t-1}$ which means the expectations augmented Phillips curve becomes,

$$\pi_t = \pi_{t-1} + \lambda(\ln Y_t - \ln \bar{Y}) + \varepsilon_t^s$$

- This relates the change in inflation to the gap between output and its natural rate
- When output is above its natural rate, inflation will be increasing (vice versa)
- Output above natural rate $\rightarrow$ **accelerating price level**

Expectations augmented Phillips curve

- When there are many longer lasting inflationary shocks, core inflation will vary
- In these cases an alternative Phillips curve specification seems appropriate

$$\pi_t = \pi_t^e + \lambda(\ln Y_t - \ln \bar{Y}) + \varepsilon_t^s$$

- Friedman pointed out that if policymakers tried to exploit an apparent Phillips curve tradeoff,
  - Public would get used to high inflation and come to expect it
  - π_t^e would drift up and the tradeoff between inflation and output would worsen
- In the long-run you can't fool the public ($\pi_t^e \approx \pi_t$)
- Can't keep output away from it's natural rate ($Y_t \approx \bar{Y}$)

Theoretical failure II: Rational expectations

- Rational expectations $\rightarrow$ model consistent behaviour
- Public will foresee attempts to move along the Phillips curve (**Goodhart's Law, Lucas Critique**)
- Policy ineffectiveness position (**Sargent** and **Wallace**)
- Only **unanticipated** inflation (non-systematic policy) could succeed in the short run
  - Is this a useful scientific policy result?
  - Is non-systematic policy an oxymoron?
- Important lesson about differential effect **expected and unexpected** changes