New-Keynesian Macroeconomics

• Disagree with classical assumption that prices and wages are perfectly flexible.
  - Classical view: If the Fed increases M, price level P rises immediately and proportionally.
  - Implicit: immediate increase in nominal wages to keep real wage unchanged.

• Observation: most consumer prices and nominal wages change slowly.
  - Firms try to satisfy high demand without raising prices. Firms try to avoid price
cuts when demand is low. Called: **Sticky Prices**; similarly, have sticky wages.
  - Key implication: P does not jump around in response to changes in M.
  - However: Prices and nominal wages adjust eventually – flexible in the long run;
  and they may respond quickly to changes in costs.

• Questions: How does an economy work when prices and wages are sticky? How
does monetary policy work in such an economy?
Conceptual Overview of New-Keynesian Analysis

• Three new elements:
  1. **Short-run aggregate supply curve** (*AS-curve*): inflation increases when output is greater than potential output (Mishkin ch.22).
  2. **Liquidity Effect**: with sticky prices, higher money supply reduces nominal and real interest rates; lower money supply raises interest rates (Mishkin ch.5).
    => Central banks can control interest rates in the short run.
  3. **Taylor principle** (*MP-curve*): central banks should set interest rates so that the real interest rate increases with inflation (Mishkin ch.21).

• Three elements in common with classical analysis – remain unchanged:
  - Demand for goods = $Y^d(r)$, with new Keynesian label: called *IS-Curve*.
  - Supply of goods in the long run is determined by capital and labor; called Potential Output $Y = Y^P$ and graphed as vertical *LRAS*-curve
  - Demand for money relationship: $M^d = L(i,Y) \cdot P$.

**Item #1: Short-run supply.**

**New-Keynesian Short-Run Aggregate Supply**

- Basic idea: each firm varies production to satisfy the demand for its goods.
  1. Recognize prevailing inflation: if demand is normal, each firm raises prices as much as it expects others to raise prices: set $\pi = \pi^e$ when $Y = Y^P$.
  2. Adjust prices up or down in response to excess demand: $\pi$ is an increasing function of the output gap $Y - Y^P$. Responses are small in the short run but more aggressive if excess demand persists.
  3. Respond quickly to disturbances in production – changes in cost

- Aggregate supply of goods – summing over all firms: $\pi = \gamma (Y - Y^P) + \pi^e + \rho$
  - with slope $\gamma > 0$ to describe responses to aggregate demand ($Y$).
  - Graph as **AS-curve** in a $(Y, \pi)$ diagram – upward sloping line.
  - Curve shifts up when $\pi^e$ rises and/or when $\rho > 0$ (e.g. oil shocks).

- Question: If supply depends on aggregate demand, what determines demand?
  - As before: $Y^d(r)$ depends on $r$. Next question: What determines $r$?
  - To show: with sticky prices, the central bank has the power to control $r$. 

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Item #2: How can the central bank control interest rates?

The Liquidity Effect

- **Open Market Operations** = Purchases/sales of bonds for new money.
  - Recall market for money:
    \[ M = L(i,Y) \cdot P \quad \text{or equivalently} \quad M \cdot V(i) = Y \cdot P \]
  - Suppose M increases: How can the market remain in equilibrium?
  - Classical answer: Price level must jump up – cannot happen with sticky prices.
  - Keynesian answer: Interest rate \( i \) must decline, so \( L(i,Y) \) increases; \( V(i) \) declines
    - Real interest rate also declines because \( \pi^e \) is unchanged (or even rises).

=> **Higher money supply reduces interest rates** (while prices are sticky)

- Bond market perspective:
  - More demand for bonds => higher bond prices => lower bond yields.
  - Graphical analysis in Mishkin ch.5: Liquidity preference framework

- Liquidity effect applies to asset allocation in the very short run: At a moment in time, investors allocate wealth between money & bonds (and other assets)
The Liquidity Preference Diagram
Demand curve is downward sloping for given (P.Y). Supply is vertical.

With excess supply, the interest rate falls to $i^*$. With excess demand, the interest rate rises to $i^*$. 

New-Keynesian Macro
Main application: Changes in Money Supply
Higher money supply reduces nominal interest rates

- Money demand curve remains unchanged because prices are sticky
- Central bank can control interest rates by varying money supply.
Complication: Money demand may shift

- Source of shifts: changes in output; changes in the price level; disturbances.
- To control interest rates, the central bank must adjust $M$. Implicit Keynesian assumption: *Money supply varies endogenously to meet interest rate targets.*
Digression: Liquidity Preference and the Bond Market

• Mishkin ch.5 presents Liquidity Preference in a bond market context.
• Perspective: Decisions to hold money are about allocating wealth.
  - Choice of money versus other assets in the very short run, taking wealth as given.
    Insightful because money has special features:
    - **Supply** is controlled by the central bank – directly relevant for economic policy.
    - **Demand** is driven by transaction motives – positive $M^d$ even at low expected returns.

• Recall condition for equilibrium on financial markets: assets with *relatively* low return must have *relatively* high liquidity and *relatively* low risk.
  - Easiest assessment of money is relative to bonds; since both are safe, the tradeoff is between return and liquidity.
  - Mishkin simplifies and writes: $\text{Wealth} = \text{Money} + \text{Bonds}$. More precisely:
    $\text{Wealth} = \text{Money} + \text{Other Assets}$, and Bonds exemplify Other Assets
  - Useful lessons from Mishkin’s analysis: Excess demand for money $\leftrightarrow$ Insufficient demand for other assets (incl. bonds), and vice versa. Given wealth, the interest rate that equilibrates the market for money is consistent with equilibrium the bond market.
**Item #3: How should central banks set interest rates?**

**New-Keynesian Monetary Policy**

- Central banks have wide discretion to set interest rates, using open market operations and exploiting the liquidity effect.
  - Claim: inflation will be unstable in the long run, unless the central bank raises \( r \) in response to rising inflation. Motivates assumption:

- **Taylor Principle:** Central banks raise/reduce \( r \) when inflation is high/low.
  - Formalized in the MP-function: \( r = \bar{r} + \lambda \cdot \pi \) with positive slope \( \lambda > 0 \).
    - Move along the curve if \( r \) varies because of inflation.
    - Shift the curve if \( \bar{r} \) changes: interpreted as discretionary policy change.

- Interpret monetary policy as setting the intercept and slope of the MP function
  - Decision to cut rates at given \( \pi \) \( \Leftrightarrow \) shift MP down \( \Leftrightarrow \) increase money supply.
  - Decision to raise rates at given \( \pi \) \( \Leftrightarrow \) shift MP up \( \Leftrightarrow \) reduce money supply.
  - Policy on how aggressively to respond to inflation = choice of \( \lambda \).

- **Key assumption in the Keynesian model:** Central banks set interest rates in a way that satisfies the Taylor principle – they do what they should do.
The Monetary Policy Curve (MP)

Autonomous monetary policy tightening shifts the MP curve up.

Autonomous monetary policy easing shifts the MP curve down.

New-Keynesian Macro
**Keynesian Analysis: Solving the Model**

- **Math**: three equations for output, inflation, and the real interest – all short run:
  1. **Short-run AS-curve**: \( \pi = \gamma (Y - Y^p) + \pi^e + \rho \)
     
     Inflation depends on the output gap \((Y - Y^p)\) with slope \(\gamma > 0\), on expected inflation \(\pi^e\), and on price shocks \(\rho\) (e.g. oil shocks).
  2. **IS-curve**: “real” demand \(Y = Y^d(r,...) = \overline{Y} - \overline{d} \cdot r\), with negative slope.
     
     Draw as linear for simplicity. (Details in Mishkin ch.20 – optional reading.)
  3. **MP-curve** for interest rates: \(r = \overline{r} + \lambda \cdot \pi\) with slope \(\lambda > 0\).
     
     Invokes liquidity effect: central bank controls \(r\). Assume target depends on inflation.

- **Technical Note on the class page** has math details. In class use mostly diagrams.

- **Graphical Analysis**:
  - Given: AS curve in \((Y,\pi)\) diagram, IS in \((Y,r)\) diagram; MP in \((r, \pi)\) diagram.
  - Solution: substitute MP into IS to obtain the **AD-curve**
    
    \[ Y = \overline{Y} - \overline{d} \cdot (\overline{r} + \lambda \cdot \pi) = (\overline{Y} - \overline{d} \cdot \overline{r}) - \overline{d} \cdot \lambda \cdot \pi \]
  
    - AD curve has negative slope because \(\pi \uparrow \Rightarrow r \uparrow \Rightarrow Y \downarrow\)
  
    - Combine AD and AS in \((Y,\pi)\) diagram: unique intersection \((Y^*,\pi^*)\)
  
    - Plug \(Y^*\) into IS or \(\pi^*\) into MP to obtain \(r^*\)
**Keynesian Analysis: Applications**

- Common task: **Determine effects of policy shifts or disturbances** (“shocks”).
  - Idea: Disturbances shift curves. Use economic interpretation & knowledge of the model to determine which curves shift in which directions.
  - AS shifts when firms change pricing; IS shifts when aggregate demand changes (C or I or G or NX); MP shifts when monetary policy changes
- Example: Increase in consumer confidence => IS and AD shift right: (Y, π, r) up.

**AD-AS Diagram: Inflation & real output (Key diagram)**

**IS curve: Real interest rate & real output**

New-Keynesian Macro
Adjustments in the Longer Run

- Output vs. potential: if $Y \neq Y^P$ firms have idle capacity or struggle to meet demand => incentive to reduce or raise prices => shift AS down or up
- Actual vs. expected inflation: AS-curve $\pi = \gamma(Y - Y^P) + \pi^e + \rho$ implies that expectations are wrong whenever $Y \neq Y^P$ or $\rho \neq 0$ => expectations will adjust.

- Conclude: Keynesian model has intrinsic dynamics
  - AS curve shifts over time until $\pi = \pi^e$ and $Y = Y^P$. (Shocks are unexpected so $\rho = 0$ in expectation.). Line $Y = Y^P$ is vertical = LRAS curve
- Example with IS shift. After AS adjusts, return to $Y = Y^P$, higher ($\pi$, $r$).
**Key Policy Results**

- **Short-run effects of expansionary fiscal policy:**
  - Higher $G$ increases aggregate demand $\Rightarrow$ IS shifts right, AD shifts right. 
  - Higher output, higher inflation, higher real interest rate.
  - Lower taxes may increase consumption. Then higher aggregate demand $\Rightarrow$ IS shifts right, AD shifts right. $\Rightarrow$ Output/inflation/real interest rate all higher.

- **Short-run effects of expansionary monetary policy:**
  - Monetary policy sets interest rates: Lower $\bar{r}$ $\Rightarrow$ MP shifts down, AD shifts right $\Rightarrow$ Higher output, higher inflation, but reduced real interest rate.

- **Note that higher output $\Rightarrow$ higher employment $\Rightarrow$ lower unemployment rate.**

$\Rightarrow$ **New-Keynesian analysis implies that fiscal & monetary policy can influence real output and the unemployment rate.**

- **Limitation:** Sticky-price effects vanish in the long run: AS shifts up as $\pi^e \rightarrow \pi$.

$\Rightarrow$ **The effects of monetary and fiscal policy on real output and employment apply only for as long as prices are sticky – not in the long run.**

- **Also practical limitations:** Effective interventions require good information and quick decision-making. Fiscal stimulus implies rising public debt.
Note on Time Horizons

1. How long does it take for the AS curve to adjust? (A: Depends on scenario.)
   - Adaptive expectations: learning from experience, looking back (e.g., $\pi^e = \pi_{t-1}$).
     Commonly assumed for AS-curve; implies slow adjustment.
   - Rational expectations: exploiting all available information, looking forward.
     Commonly assumed for financial markets (more in Mishkin ch.7)
   - Standard assumptions: On good and labor markets, expectations adjust gradually, so the full adjustment of prices and wages takes several years.
   - General principles: AS curve shifts up over time if $\pi > \pi^e$ (down if $\pi < \pi^e$).
     - Equilibrium $(Y, \pi)$ move along AD curve to intersection of AD and $Y^p$.
     - Equilibrium $(Y, r)$ move along IS curve to intersection of IS and $Y^p$.
     $\Rightarrow$ Long run equilibrium is the same as the classical model

2. Think of SR and LR as key markers on a continuous adjustment process
   - Macro short run ~ 1-2 years. Macro long run ~ 5-10 years.
   - Financial markets respond much more quickly; e.g. Liquidity effect.
   - Stocks of government debt, external debt, physical capital accumulate more slowly—typically ignored in the Keynesian model, even in “LR”
Application: *How does monetary policy affect interest rates over time?*

- Task: Reconcile Classical and Keynesian reasoning.
  
  Combine Liquidity Preference diagram, MP-curve, and AD-AS diagram.

- Keynesian monetary reasoning is framed in terms of interest rates:
  - Money supply is in the background: set M in whatever way needed so the nominal interest rate is consistent with the desired MP curve.
  - Market for money equilibrium $M \cdot V(i) = Y \cdot P$ still applies.

- **Example of Monetary Expansion:**
  - Start with $Y = Y^P$, $\pi = \pi_0$, $r = r_0 = \bar{r} + \lambda \pi_0$.
  - In market for money: $M^d$ and $M^s$ shift to the right at rate $\% \Delta M = \pi_0$ with intersections at $i = r + \pi^e = r_0 + \pi_0$ (To simplify, assume no growth in Y and V.)
  - Suppose the central bank decides to shift the MP curve down: $\bar{r} \downarrow$.
  - How? Implemented by open market purchase => Extra shift in $M^s$ right, so $i$ declines by $\Delta i = \Delta \bar{r}$. *The Liquidity Effect.*
  - Time horizon: Instantaneous. Macroeconomy still unchanged.
  - Macro implications?
Monetary Expansion Example: Graphs

MP curve

![MP curve graph]

Market for Money

![Market for Money graph]

IS curve

![IS curve graph]

AD-AS diagram

![AD-AS diagram graph]
Monetary Expansion Example: Economic Reasoning

- Macro Short run: MP curve down => AD curve shifts right => $Y \uparrow$, $\pi \uparrow$.
  - In market for money:
    (a) $Y \uparrow$ => Extra shift in $M^d$ to the right, raising $i$: The Income Effect.
    (b) $\pi \uparrow$ => $P$ increases more quickly => Shift in $M^d$ more: The Price Effect.
  - Time horizon: Macroeconomic “short run” ~ several months.
  - How big are these effects? Use long run as benchmark…

- Macro Long run: AS curve shifts up until $Y = Y^P$ at inflation rate $\pi = \pi_1$
  - Note unchanged IS curve => Real interest rate must return to $r = r_0$.
  - Return to $r = r_0$ on MP curve => $\Delta \bar{r} + \lambda \Delta \pi = 0$, $\pi_1 - \pi_0 = (-\Delta \bar{r})/\lambda > 0$.

  => No real changes $(Y,r)$ in the long run. Money is neutral.
  - Expectations adjust, so $i = r_0 + \pi_1$ increases: The Expected Inflation Effect.
  - Note that $\Delta i = \Delta \pi = \Delta \pi^e$: Fisher effect.
  - Graph in market for money: $M^d$ and $M^s$ shift to the right at rate $\% \Delta M = \pi_1$ with 
    intersections at $i = r + \pi^e = r_0 + \pi_1$. Shift in MP = Change in money growth.

- Compare SR and LR: $Y > Y^P$ in short run implies $r < r_0$, $\pi < \pi_1$ and $i < r_0 + \pi_1$. 

New-Keynesian Macro
Lessons from macroeconomics:

1. Money is neutral in the long run:
   - Real rate returns to initial value
   - Rules out case (a)

2. Sticky prices imply a Liquidity effect: i down in short run
   - Rules out case (c)

3. Money growth causes inflation
   - Fisher effect in the long run:
     \[ \%\Delta M = \Delta \pi = \Delta \pi^e = \Delta i \]
   - All other “effects” must cancel.

• Conclude: only case (b) is consistent with liquidity effect & LR-neutrality.
**Critical Question #1:**

**What goes wrong when central banks violate the Taylor Principle?**

- Suppose a central bank sets $\lambda=0$. Then $Y = Y^d(\bar{r},...) \Rightarrow$ vertical AD curve
  - If $Y^d(\bar{r},...) > \bar{Y}^P$, obtain cycle of rising inflation as firms try to set $\pi > \pi^e$, expected inflation rising, actual inflation rising $\Rightarrow$ Run-away inflation.
  - If $Y^d(\bar{r},...) < \bar{Y}^P$, obtain cycle of firms trying to set $\pi < \pi^e$, expected inflation falling, actual inflation falling $\Rightarrow$ deflation and zero nominal interest rate.

- Keynesian model assumes well-working, responsible central banks.

- Contrast to classical recommendation: constant money growth avoids both high inflation and severe deflation (provided velocity is stable).
Critical Question #2: How does monetary policy work when i=0?

Macroeconomics at the Zero Lower Bound

- Nominal interest rates cannot be negative if money can be held at zero cost.
  => Nominal interest rates have a zero lower bound (ZLB): \( i \geq 0 \).
  => The real interest rate is bounded by minus expected inflation: \( r \geq -\pi^e \)
    
    [Practical detail: for large investors holding money safely is costly => Nominal interest rates can be slightly negative, bounded by the cost of holding money—small, approximate by zero.]

- Problem: If \( \pi^e \) is low or negative, ZLB conflicts with market equilibrium.

1. Argument for Keynesian fiscal stimulus: ZLB limits central banks’ ability to reduce \( r \). If \( Y < Y^p \) and \( i = 0 \), only fiscal stimulus can raise output.
   Caveat: Rising government debt => expectations of future taxes.

2. Argument for “unconventional” Fed policy: Expand the money supply. Rely on rational investors to know that money growth is inflationary in the long run.
   Holding \( i = 0 \) constant, higher \( \pi^e \) reduces the real interest rate.
   Caveat: Uncertainty when and by how much expectations will respond.