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 (and wage).
  - Key implication: P does not jump around in response to changes in M$.
  - However: Prices/wages adjust eventually – flexible in the long run; and prices 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. New-Keynesian short-run aggregate supply curve (\textit{AS-curve}): inflation increases when output is greater than potential output (Mishkin ch.22).
  2. The Liquidity Effect: with sticky prices, higher money supply reduces short-term nominal and real interest rates (Mishkin ch.5).
     => Central banks can influence or even “set” interest rates.
  3. Taylor principle (\textit{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 valid:
  - Demand for goods: \( Y^d(r) \), with new name: \textit{IS-Curve}.
  - Supply of goods: \( Y^s(r) \) applies in the long run; called \textit{LRAS-curve}.
     Simplification: assume \( Y^P = Y^s(r) \) is vertical, called Potential Output.
  - Demand for money relationship \( M^d = L(i,Y) \cdot P \).

• Overall: New assumptions about the \textit{short-run}. Classical answers remain valid for the \textit{long run}. In between: adjustment dynamics.
Item #1: Supply.

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

- Basic idea: firms vary production to satisfy demand for their goods.
  1. Raise/reduce prices in response to excess demand – slowly in the short run but more aggressively if excess demand persists.
  2. Recognize prevailing inflation: if demand is normal, each firm raises prices as much as it expects other to raise prices: set $\pi = \pi^e$ when $Y = Y^P$.
  3. Respond quickly to increases in production costs

- 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 $(Y, \pi)$ diagram -- upward sloping line.
  - Curve shifts up when $\pi^e$ rises and/or when $\rho > 0$ (e.g. oil shocks).

- Next question: What determines aggregate demand?
  - Answer: $Y^d(r)$ depends on $r$, as in the classical model; can be shown in in $(Y, r)$ diagram; but $Y^s(r)$ does not apply => So what determines $r$?
  - To show next: with sticky prices, central bank has power to set $r$. 

New-Keynesian Macro
Item #2: How can the central bank set interest rates?

**The Liquidity Effect**

- **Open Market Operations** = Purchases/sales of bonds for new money.
  - Recall market for money:
    \[ M = L(i,Y) \cdot P \] or equivalently \[ M \cdot V(i) = Y \cdot P \]
  - 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).

\[ \Rightarrow \text{Higher money supply reduces interest rates} \] (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

Interest Rate, $i$ (%)

With excess supply, the interest rate falls to $i^*$. With excess demand, the interest rate rises to $i^*$.
Application #1: Higher Money Supply

- Graphical argument why higher money supply reduces interest rates
- Take money demand as constant – assumes unchanged price level.
Liquidity Preference in general

• Financial markets issue: allocation of wealth in the very short run:
  \[ \text{Wealth} = \text{Money} + \text{Other Assets} \]

  Simplified in Mishkin: Other Assets summarized as “Bonds”

• Money treated as a financial asset with special features:
  - **Demand** for transaction purposes even if the return is below other financial assets.
  - Easiest comparison of relative returns is between *money* and *bonds*. (Both are safe.)
  => In equilibrium, liquidity of money must compensate for interest on bonds.
  - **Supply** controlled by the central bank => directly relevant for economic policy.
  - **Equilibrium**: interest rate so the public wants to hold the existing M; otherwise individual attempts to buy/sell bonds would change i.

• Change in money supply: more M ⇔ more central bank demand for bonds.
  Result: Bond prices up => i down. Graph: Move along M^d-function.

• Other application: shifts in money demand. At given wealth, desire to increase or reduce money holdings would require selling bonds or other assets.
  - Higher M^d ⇔ less demand for bonds. Result: Bond prices down => i up.
  - Graph: Shift of M^d-function (illustration next slide)
Application #2: Higher Money Demand
(Sources: output up; price level up; structural change.)

Interest Rate, $i$

$M^s$

$M^d_2$

$M^d_1$

$i_1$

$i_2$

Quantity of Money, $M$

New-Keynesian Macro
Item #3: How do (or should) central banks set interest rates?

**New-Keynesian Monetary Policy**

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

- Taylor Principle: central banks raise/reduce \( r \) when inflation is high/low.
  - Formalized by MP-function: \( r = \bar{r} + \lambda \cdot \pi \) with positive slope \( \lambda > 0 \).
    - move along the curve if \( r \) changes because of inflation.
    - shift the curve if policy changes at a given inflation.

- Interpret monetary policy as setting 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 \( \lambda \).
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
New-Keynesian Analysis
(With Math)

• Three equations for output, inflation, and the real interest rate in the 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 \[ Y = Y^d(r,...) = \bar{Y} - \bar{d} \cdot r, \] with negative slope. Draw as linear for simplicity. (Details in Mishkin ch.20 – optional reading.)

3. **MP-curve** for interest rates: \[ r = \bar{r} + \lambda \cdot \pi \] with slope \(\lambda > 0\). Invokes liquidity effect: central bank controls \(r\). Assume target depends on inflation.

• Dynamics: Expectations adjust until \(\pi^e = \pi\). Shocks wash out, so \(\rho = 0\).
   Then \(\pi = \gamma(Y - Y^P) + \pi \rightarrow Y = Y^P \) → Classical output in the long run: LRAS. Keynesian “Long Run” = long enough for price adjustment.

• Technical Note on the class page has math details. In class use mostly diagrams.
New-Keynesian Analysis  
(With Diagrams)

- Three curves: AS in $(Y,\pi)$ diagram, IS in $(Y,r)$ diagram; MP in $(r,\pi)$ diagram.

- Task in most applications: **Determine responses to 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

- Several options to find the short-run equilibrium in *one* diagram:
  1. Focus on inflation & output – use $(Y,\pi)$ diagram.
     - Substitute MP into IS to obtain the **AD-curve**: negative slope as $\pi \uparrow \Rightarrow r \uparrow \Rightarrow Y \downarrow$
     $$Y = \bar{Y} - \bar{d} \cdot (\bar{r} + \lambda \cdot \pi) = (\bar{Y} - \bar{d} \cdot \bar{r}) - \bar{d} \cdot \lambda \cdot \pi$$
     - Graph together with AS $\Rightarrow$ Determines $\pi$ and $Y$. Insert $\pi$ into MP to obtain $r$.
  2. Focus on interest rates – use $(Y,r)$ diagram.
     - Substitute AS into MP: $r = \bar{r} + \lambda \cdot \gamma (Y - Y^p) + \lambda \cdot \pi^e + \lambda \cdot \rho$; called LM-curve.
     - Graph LM and IS together $\Rightarrow$ Determines $r$ and $Y$. Famous as “IS-LM analysis.”

Here follow Mishkin and mostly use AD-AS.
Graphical Analysis in the New-Keynesian Model

- Short Run solutions: AD-AS. Then use (Y,r) diagram to find r.

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

IS curve: Real interest rates & real output (IS = classic $Y^d(r)$. LM not required)

• Long run solutions: intersection of AD or IS with LRAS.
  - Transition from ST to LR: over time, expected inflation adjusts $\Rightarrow$ AS shift in the direction of the long run equilibrium.
  
• Example: if IS shifts right $\Rightarrow$ (a) AD right $\Rightarrow$ Y up, $\pi$ up; (b) $r$ up because $\pi$ up along MP curve; (c) over time, AS adjusts until Y reaches LRAS.
Main Policy Results

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

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

- Note that higher output => higher employment => lower unemployment rate.
  => 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 $\pi^e \rightarrow \pi$.
  => 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.
Adjustment in the Longer Run: Expected Inflation

• Short-run AS-curve $\pi = \gamma(Y - Y^p) + \pi^e + \rho$ implies that actual inflation differs from expected inflation whenever $Y \neq Y^p$ or $\rho \neq 0$.

• How long does is take for expectations to adjust? (Depends on scenario.)

• Adaptive expectations: learning from experience, looking back (e.g., $\pi^e = \pi_{-1}$).
  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.

• Graphical analysis: 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 $Y^p$.

$=>$ Long run equilibrium is the same as the classical model:
  Money growth is inflationary. Fiscal expansion raises the real interest rate.
Follow-up Question #1: 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.*
Question #2: *What goes wrong when policy violates the Taylor Principle?*

- Suppose a central bank sets $\lambda=0$. Then IS implies $Y = Y^d(\bar{r},...)$. 
  - If $Y^d(\bar{r},...) > Y^P$, obtain cycle of rising inflation as firms try to set $\pi > \pi^e$, expected inflation rising, actual inflation rising $\Rightarrow$ Run-away inflation.
  - If $Y^d(\bar{r},...) < Y^P$, obtain cycle of firms trying to set $\pi < \pi^e$, expected inflation falling, actual inflation falling $\Rightarrow$ Run into ZLB – deflation and low demand.

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

- Contrast to classical recommendation: constant money growth avoids both high inflation and severe deflation, provided velocity is stable.
Question #3: 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

\[ r \]
\[ \Delta \bar{r} \]
\[ r_0 \]
\[ \pi_0 \]
\[ \pi_1 \]

Market for Money

\[ i \]
\[ M^s \]
\[ M^d \]
\[ i_0 \]
\[ i_1 \]

IS curve

\[ IS \]
\[ r_0 \]
\[ Y \]

AD-AS diagram

\[ \pi \]
\[ Y \]

New-Keynesian Macro
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 $i < r_0 + \pi_1$.
Money & Interest Rates in Mishkin ch.5

- Mishkin presents three cases.

**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.