Goals in this Chapter

- Construct a real intertemporal model that will serve as a basis for studying money and business cycles in Chapters 10-12.

- Understand the investment decision of the firm.

- Show how macroeconomic shocks affect the economy.

- Focus on the implications of future expectations for current macroeconomic performance, and the difference between temporary and permanent shocks.
Model Ingredients

- Current and future periods.
- Representative Consumer - labour/leisure choice consumption/savings decision
- Representative Firm - hires labour and invests in current period, hires labour in future
- Government - spends and taxes in present and future, and borrows on the credit market.
Definition: Competitive Equilibrium

A competitive equilibrium is a set of endogenous quantities \((C, C', N, N', Y, Y', T, T', B)\) and endogenous prices \((w, w', r)\) such that, given exogenous variables \((z, K, G, G')\), the following holds:

1. For the representative consumer, given \((w, w', r, T, T', \pi, \pi')\), the bundle \((C, C', N^s, N'^s, S^p)\) maximizes the consumer’s utility subject to his/her present value budget constraint.

2. For the representative firm, given \((w, w', r, K)\), labour demand \((N^d, N'^d)\) and investment \((I)\) maximizes present value profits.

3. The government present value budget constraint holds.

4. Markets clear:
   - Labour markets: \(N = N^s = N^d\) and \(N' = N'^s = N'^d\)
   - Goods markets: \(C + G + I = Y\) and \(C' + G' = Y' + (1 - d)K'\)
   - Credit market: \(S^p = B + I\)
Outline

Construct Output Supply \((r, Y^s)\) and Demand \((r, Y^d)\)

- Current Labour Market and Output Supply Curve
- Current Goods Market and Output Demand Curve

Experiments Using the Real Intertemporal Model

- \(G\) increases temporarily.
- \(G\) increases permanently.
- \(K\) decreases.
- \(z\) increases.
- \(z'\) increases.
## Outline

**Output supply and demand**
- Current Labour Market and Output Supply Curve
- Current Goods Market and Output Demand Curve

**Experiments Using the Real Intertemporal Model**
- Government Consumption
- Total Factor Productivity
Given an interest rate, $r$,

- The intersection of the current labour supply and labour demand curve determines the current real wage, $w^*$, and current employment, $N^*$.

- The production function then determines aggregate output, $Y^*$. 
Construction of the Output Supply Curve

- If the interest rate increases to, \( r_2 > r_1 \), the current labour supply curve shifts to the right because we assume that the substitution effect dominates the income effect.
- Employment increases to \( N_2 > N_1 \) and the wage decreases to \( w_2 < w_1 \).
- Output increases to \( Y_2 > Y_1 \).
- The output supply curve is an upward sloping curve consisting of a real interest rate - real current output pairs \( (r, Y) \) such that the labour market clears.
Effect of increased government spending

Given an interest rate, \( r \),

- If \( G \) or \( G' \) increases, the present value of taxes, \( T + \frac{T'}{1+r} \), increases.
- Since leisure is a normal good, it decreases and \( N^s \) shifts to the right, employment increases and wages fall.
- Output increases to \( Y_2 > Y_1 \).
- Hence, the output supply curve shifts to the right.
Effect of increased TFP or initial capital

Given an interest rate, $r$,

- If $z$ or $K$ increases, increases the marginal product of current labour.
- The labour demand curve, $N^d$ shifts to the right, employment increases and wages increase.
- The production function shifts up and output increases to $Y_2 > Y_1$.
- Hence, the output supply curve shifts to the right.
Outline

Output supply and demand
  Current Labour Market and Output Supply Curve
  Current Goods Market and Output Demand Curve

Experiments Using the Real Intertemporal Model
  Government Consumption
  Total Factor Productivity
Output demand

Total demand for output equals

- demand for consumption goods
- plus demand for investment goods,
- plus demand for goods from government

\[ Y^d = C^d(Y, r) + I(r) + G \]
Equilibrium in the current goods market, given $r$

\[ Y^d = C^d(Y, r) + I(r) + G = Y \]
Construction of Output Demand Curve

An increase in the real interest rate to $r_2 > r_1$:

- Decreases demand for current consumption, $C^d(Y, r_1) > C^d(Y, r_2)$ for every level of current income, $Y$ ($C^d(Y, r)$ as a function of $Y$ shifts down)
  - “Lenders” want to save more (substitution effect dominates)
  - “Borrowers” want to borrow less
  - Representative consumer saves more

- Decreases investment, $I(r_1) > I(r_2)$
  - Present value Marginal Benefit of extra $K$ decreases.
  - Firms want to decrease $K'$ by decreasing $I$
  - This way firms equalize $MP'_K = r + d$

Hence, the Output Demand Curve is decreasing in $r$. 

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Construction of Output Demand Curve

\[ c^d = \text{Demand for Current Consumption} \]

\[ y = \text{Current Income} \]

\[ 45^\circ \]

Slope = MPC

\[ r = \text{Real Interest Rate} \]

\[ Y = \text{Current Output} \]

\[ Y^d \]
Shifts in the Output Demand Curve

\[ G \uparrow, \ PV_{\text{taxes}} \downarrow, \ Y' \uparrow, \ z' \uparrow \text{ or, } K \downarrow \]

increase output demand, \( Y^d \), for every \( r \)
The interest rate, \( r^* \), is determined by \( Y^s = Y^d \) and has to be consistent with labour market clearing, \( N^s(r^*) = N^d \).
Experiments Using the Real Intertemporal Model

- $G$ increases temporarily.
- $G$ increases permanently.
- $K$ decreases.
- $z$ increases.
- $z'$ increases.
Output supply and demand
Current Labour Market and Output Supply Curve
Current Goods Market and Output Demand Curve

Experiments Using the Real Intertemporal Model
Government Consumption
Total Factor Productivity
Temporary Increase in Government Purchases

Initial equilibrium: $r_1, w_1, N_1, Y_1$

Effect on $Y^s$

- An increase in $G$, holding $G'$ fixed, implies that PV of taxes increase. Hence, $w$ falls, leisure falls (normal good) and $N^s(r_1)$ shifts right to $N^s_2(r_1)$.
- This causes $Y^s$ to shift right.

Effect on $Y^d$

- $C^d(Y, r)$ shifts down because of increase in PV taxes, but $G$ increases. $Y^d = C^d(Y, r) + l(r) + G$?

- Since $\Delta G = \Delta PV_{taxes}$ and $MPC < 1$ when the effect is temporary and small compared to lifetime income, $Y^d = C^d(Y, r_1) + l(r_1) + G$ shifts right.
Temporary Increase in Government Purchases

The interest rate, $r$, could increase or decrease, but...

- If $\Delta G$ has a small effect on lifetime wealth (since the change in $G$ is temporary), the shift in $N^s$, $Y^s$ and $C^d(Y_1, r_1)$ should be small.

- In addition, it is clear that current output/income increases. This tends to slightly increase current consumption to $C^d(Y_2, r_1) > C^d(Y_1, r_1)$.

- Hence, the shift in $Y^d$ is relatively large so that $r_2 > r_1$.

Good reasons to believe that the interest rate increases.
Temporary Increase in Government Purchases

Effect of increase in $r$

- $N_2^s(r_1)$ shifts right to $N_2^s(r_2)$:
  - employment increases further (move along $Y^s$ curve);
  - real wage decreases to $w_2 < w_1$

- $C^d(Y, r)$ decreases to $C^d(Y_2, r_2) < C^d(Y_2, r_1)$
  Overall effect on current consumption: decrease.

- $I(r)$ decreases to $I(r_2) < I(r_1)$
  Government consumption crowds out private investment!
Temporary Increase in Government Purchases

- Output increases, real interest rate increases, real wage falls, consumption and investment decrease, employment rises.
- Government spending crowds out both consumption and investment.
Permanent Increase in Government Purchases

Initial equilibrium: \( r_1, w_1, N_1, Y_1 \)

Effect on \( Y^s \)

- An increase in \( G \) and \( G' \) such that \( G_2 = G_1 + \Delta G \) and \( G'_2 = G'_1 + \Delta G \), implies that PV of taxes increase. Hence, we falls, leisure falls (normal good) and \( N^s(r_1) \) shifts right to \( N^s_2(r_1) \).
- This causes \( Y^s \) to shift right.
Permanent Increase in Government Purchases

Initial equilibrium: \( r_1, w_1, N_1, Y_1 \)

Effect on \( Y^d \)

- \( C^d(Y, r) \) shifts down because of increase in PV taxes, but \( G \) increases. \( Y^d = C^d(Y, r) + l(r) + G? \)

- Permanent income hypothesis (Milton Friedman): this permanent change in \( G \) decreases lifetime income a lot. As opposed to a temporary change in \( G \), PIH suggests \( MPC \approx 1 \) in this case.

- This means that \( \Delta C^d(Y, r) \approx -\Delta G \) and \( Y^d \) doesn’t move.
Permanent Increase in Government Purchases

The interest rate, \( r \), decreases, because...

- If \( \Delta G \) has a large effect on lifetime wealth (since the change in \( G \) is permanent), \( N^s \) and \( Y^s \) increase while \( Y^d \) remains stable because government consumption almost fully crowds out private consumption.

- Hence, the shift in \( Y^s \) is relatively large so that \( r_2 < r_1 \).

Good reasons to believe that the interest rate decreases.

Book (edition 3) assumes shift in \( Y^d \) equal shift in \( Y^s \) so that \( r \) unchanged.
Permanent Increase in Government Purchases

Effect of decrease in $r$ (if any, relevant for editions before 3)

- $N^s_2(r_1)$ shifts left to $N^s_2(r_2)$:
  - employment decreases (move along $Y^s$ curve)
  
  Since output must increase to $Y_2 > Y_1$, this leftward shift in $N^s(r)$ is smaller than the original rightward shift. Thus, employment increases to $N_2 > N_1$
  
- real wage decreases to $w_2 < w_1$

- $C^d(Y, r)$ increases to $C^d(Y_2, r_2) > C^d(Y_1, r_1)$
  
  Overall effect on current consumption: uncertain.

- $I(r)$ increases to $I(r_2) > I(r_1)$
Permanent Increase in Government Purchases

To summarize according to Williamson, edition 3:

- Current output increases
- Current private consumption unchanged
- Current private investment unchanged
- Current employment increases
- Current real wage rate decreases
- Real interest rate unchanged
Outline

Output supply and demand
  Current Labour Market and Output Supply Curve
  Current Goods Market and Output Demand Curve

Experiments Using the Real Intertemporal Model
  Government Consumption
  Total Factor Productivity
Increase in Current TFP, $z$

Initial equilibrium: $r_1, w_1, N_1, Y_1$

Effect on $Y^s$

- An increase in $z$, implies that current labour productivity is higher. Hence, $N_1^d$ shifts to the right to $N_2^d$.

- This causes $Y^s$ to shift right.

Effect on $Y^d$

- Holding the interest rate fixed, nothing happens to consumption, investment and government consumption.

- The $Y^d$ curve is unaffected.

Hence employment, wages and output increase while the interest rate falls.
Increase in Current TFP, $z$

The interest rate, $r$, decreases, which has the following effects.

- $N^s_2(r_1)$ shifts left to $N^s_2(r_2)$:
  - employment decreases (move along $Y^s$ curve)
  - Since output must increase to $Y_2 > Y_1$, this leftward shift in $N^s(r)$ is smaller than the rightward shift in $N^d(r)$.
  - Overall employment increases to $N_2 > N_1$
  - real wage increases further to $w_2 > w_1$

- $C(Y, r)$ increases to $C(Y_2, r_2) > C(Y_1, r_1)$

- $I(r)$ increases to $I(r_2) > I(r_1)$
Increase in Future TFP, $z'$

Initial equilibrium: $r_1, w_1, N_1, Y_1$

Effect on $Y^s$

- Holding the interest rate fixed, nothing happens to labour supply and demand.
- The $Y^s$ curve is unaffected.

Effect on $Y^d$

- An increase in future TFP $z'$, implies that firms want to invest more because the future marginal product of capital increases for every amount of $K'$.
- This shifts the $Y^d$ curve to the right.

Hence, current output and the interest rate increase.
Increase in Future TFP, $z'$

The interest rate, $r$, increases, which has the following effects:

- $N^s(r_1)$ shifts right to $N^s(r_2)$:
  - employment increases (move along $Y^s$ curve) to $N_2 > N_1$
  - real wage decreases to $w_2 < w_1$

- $C^d(Y, r)$ decreases to $C^d(Y_1, r_2) < C^d(Y_1, r_1)$ but the increase in income causes $C^d(Y, r)$ to increase to $C^d(Y_2, r_2) > C^d(Y_1, r_2)$
  Overall current consumption may increase or decrease.

- $I(r)$ decreases to $I(r_2) < I(r_1)$
  Overall investment must increase because this increase is what drove the initial increase in output demand.
Think about

- What is the effect of a permanent increase in TFP ($z$ and $z'$ increase)?
- What is the effect of a war which destroys the current capital stock, $K$?
- What are the likely effects of Alistair Darling’s budget for the crisis? What does the real intertemporal model have to say? What realities are missing in the model/are assumed away?