LECTURE 19
SAVING AND INVESTMENT IN THE LONG RUN
April 2, 2020

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LECTURE 19
Saving and Investment in the Long Run

April 2, 2020
Midterm 2 Reminders

• Please make sure you’ve read the long email we sent last Sunday (the slides at the start of Lecture 18 and the recording of the Q&A at the end of that lecture may also be useful).

• Tuesday, April 7, 2:00–3:30 p.m. (PDT).

• If you would prefer to take it 10:00 – 11:30 p.m. (PDT), email Todd Messer (messertodd@berkeley.edu) by 5 p.m (PDT) tomorrow (April 3).
Midterm 2 Reminders

- The exam will be distributed and submitted through Gradescope.

- We will do a trial run this weekend: We will distribute a short assignment through Gradescope. You need to do the assignment and upload it to Gradescope by 5 p.m. (PDT) Monday (April 6).

- Doing the trial run is required!

- DSP students: If you do not receive an email from Todd Messer by April 3, please contact him.
Midterm 2 Ground Rules

• Open book and open note: You may use official class resources (book, slides, problem set answer sheets, and your notes).

• Not open internet: You may not use anything else—you may not confer with other students in any way, or use any non-class-provided resources.

• *Study and prepare just as you would for a traditional, closed-note exam!*
Announcements

• The answer sheet to Problem Set 4, Part 2 will be posted this evening.
I. Overview
Aggregate Production Function

(1) \[
\frac{Y^*}{\text{POP}} = \frac{Y^*}{N^*} \cdot \frac{N^*}{\text{POP}}
\]

(2) \[
\frac{Y^*}{N^*} = f \left( \frac{K^*}{N^*}, T \right)
\]

(3) \[
\frac{Y^*}{\text{POP}} = f \left( \frac{K^*}{N^*}, T \right) \cdot \frac{N^*}{\text{POP}}
\]
Where We’re Headed: The Long-Run Saving and Investment Diagram

Here S is saving, I is investment, and r is the real interest rate (and * denotes a long-run value).
II. REVIEW OF THE INVESTMENT DEMAND CURVE
The Nominal vs. the Real Interest Rate

- Recall: The interest rate is the percentage increase in your balance if you didn’t make any deposits or withdrawals.

- The *nominal* interest rate is just the conventional or stated interest rate—the percentage increase in the balance in dollars.

- The *real* interest rate is the percentage increase in your balance *measured in terms of purchasing power (that is, adjusted for changes in prices)* if you didn’t make any deposits or withdrawals.
The Nominal vs. the Real Interest Rate (cont.)

• If the inflation rate is $\pi$ percent, the first $\pi$ percentage points of whatever the nominal interest rate is just makes up for inflation. Only the remainder increases the real value of your balance.

• Thus, the real interest rate ($r$) satisfies:

$$r = i - \pi$$

• Example: If inflation is 2% and the nominal interest rate is 3%, the real interest rate is:

$$r = 3\% - 2\% = 1\%$$
The Profit-Maximizing Level of Investment

• Firms want to purchase capital up to the point where:

\[
\text{PV(Stream of MRP}_K\text{'s)} = \text{Purchase Price}
\]

• Why it’s the present value of the Stream of MRP\(_K\text{'s: the firm receives the MRP}_K\text{'s in the future.}

• Why the firm needs to use the real interest rate to compute the present value: think of measuring the MRP\(_K\text{'s in real (or inflation-adjusted) terms.}
Why It’s the Real Interest Rate That Affects Investment Demand—Example

• A competitive firm in year \( t \) is thinking of buying a machine that will have a marginal physical product of 1 in year \( t+1 \) and in year \( t+2 \), and 0 thereafter.

• Suppose, \( \pi \) and \( r \) are both 0.

• Then \( i = 0 \).

• \( \pi = 0 \) implies \( P_{t+2} = P_{t+1} = P_t \). (\( P_t \) is the price of the good sold by the firm in period \( t \).)

• So, \( PV(\text{Stream of } \text{MRP}_K's) = \frac{P_{t+1}}{1+i} + \frac{P_{t+2}}{(1+i)^2} = P_t + P_t \).
• Suppose instead inflation is 100%, still with \( r = 0 \).

• Then \( i = 100\% \).

• \( \pi = 100\% \) implies \( P_{t+1} = (1 + \pi)P_t = 2P_t \), and \( P_{t+2} = (1 + \pi)^2P_t = 2^2 = 4P_t \).

• So, \( PV(\text{Stream of MRP}_k's) = \frac{P_{t+1}}{1+i} + \frac{P_{t+2}}{(1+i)^2} \)  
  \[
  = \frac{2P_t}{2} + \frac{4P_t}{2^2} 
  = P_t + P_t.  
  \]
Why It’s the Real Interest Rate That Affects Investment Demand—Example (continued)

• Suppose instead $r$ is 100%, with $\pi = 0$.

• Then $i = 100\%$.

• $\pi = 0$ implies $P_{t+2} = P_{t+1} = P_t$.

• So, $PV(\text{Stream of MRP}_K's) = \frac{P_{t+1}}{1+i} + \frac{P_{t+2}}{(1+i)^2}$

  $$= \frac{P_t}{2} + \frac{P_t}{2^2}$$

  $$= \frac{3}{4} P_t.$$
Why It’s the Real Interest Rate That Affects Investment Demand—Example (concluded)

• The first case (a different \( i \), but the same \( r \)) did not affect \( \text{PV} \text{(Stream of MRP}_K\text{'s)} \).

• The second case (a different \( r \)) did affect \( \text{PV} \text{(Stream of MRP}_K\text{'s)} \).

• These two cases illustrate the general point: We need to use the real interest rate to compute \( \text{PV} \text{(Stream of MRP}_K\text{'s)} \).
The Real Interest Rate and Investment

• The firm purchases capital up to the point where:

\[
\frac{\text{Real MRP}_{K_1}}{(1 + r)^1} + \frac{\text{Real MRP}_{K_2}}{(1 + r)^2} + \cdots + \frac{\text{Real MRP}_{K_n}}{(1 + r)^n}
\]

= Purchase Price,

where \( r \) is the real interest rate (and \( n \) is the lifespan of the capital good).

• If \( r \) rises, PV(Stream of MRP\(_K\)’s) falls.

• To restore the condition for profit-maximization, the firm reduces its investment (which increases MRP\(_K\)’s).
The Relationship between Normal Investment and the Normal Real Interest Rate
Example: New Investment Goods Are More Productive

Real Interest Rate \((r)\)

Investment \((I)\)
III. SAVING AND INVESTMENT
Where We’re Headed: The Long-Run Saving and Investment Diagram

Here S is saving, I is investment, and r is the real interest rate (and * denotes a long-run value).
The Uses of Potential Output

- Consumption ($C^*$)
- Investment ($I^*$)
- Government purchases ($G$)
- Net Exports ($NX^*$)

Stars denote normal, long-run values.

For now, we will assume that $NX^* = 0$. 
Equilibrium Condition

\[ Y^* = C^* + I^* + G \]

We can rearrange this as:

\[ Y^* - C^* - G = I^* \]

- \( Y^* - C^* - G \) is normal national saving supply (\( S^* \)).
- \( I^* \) is normal investment demand.
- Thus, equilibrium requires \( S^* = I^* \).
Private and Public Saving

\[ S^* = Y^* - C^* - G \]
\[ = Y^* - C^* - G + (T - T) \]
\[ = (Y^* - T - C^*) + (T - G) \]
(Private Saving + Public Saving)

Thus, we can write the equilibrium condition as:

\[ Y^* - C^* - G = I^* ; \text{ or as} \]
\[ S^* = I^* ; \text{ or as} \]
\[ (Y^* - T - C^*) + (T - G) = I^* . \]
IV. NATIONAL SAVING AND THE REAL INTEREST RATE
The Supply of Saving

• Recall: Normal national saving \((S^*) = Y^* - C^* - G\).

• \(Y^*\) is determined by \(K^*/N^*\), technology, and \(N^*/POP\).

• We take \(G\) as given.

• So: To understand what determines \(S^*\), we need to understand what determines \(C^*\).
The Real Interest Rate and the Opportunity Cost of Current Consumption

• Think of a household trying to maximize its utility from consumption today and consumption in the future.

• If the real interest rate rises, the opportunity cost of consuming today rises: What you give up to consume today is higher because the real return you would earn on saving is higher than before.

• That is, the real interest rate is a component of the opportunity cost of current consumption.
The Real Interest Rate and Saving

• The condition for utility maximization between consumption today and consumption in the future:

\[
\frac{\text{MU}_{\text{current}}}{P_{\text{current}}} = \frac{\text{MU}_{\text{future}}}{P_{\text{future}}}
\]

• If the real interest rate rises, the relative price (opportunity cost) of current consumption rises.

• To maximize utility, the household therefore needs to consume less today.

• That is, it needs to save more.
The Supply of Saving

Recall: \( S^* = Y^* - C^* - G \)
How a Change in $Y^* - T$ Affects Consumption and Private Saving

- When a household’s current $Y^* - T$ rises, its budget constraint between current and future consumption shifts out.
- A utility-maximizing household will therefore increase both its current and future consumption.
- To increase its future consumption, it needs to increase its saving.
- So, the household’s saving rises, but by less than the increase in $Y^* - T$.
- Note: This is just about the behavior of *private* saving.
Example: A Tax Cut

Recall: $S^* = Y^* - C^* - G$
A Note on How We Model the Government

• Recall: We take G as given.

• This means that we assume it doesn’t respond to other variables.

• So, for example, when we consider the effects of a change in T, we assume G doesn’t change.

• Aside: This is just a specific example of *ceteris paribus* from early in the semester.
Example: A Tax Cut

Recall: \( S^* = Y^* - C^* - G \)
Private and Public Saving and a Tax Cut

• When $Y^* - T$ rises, $C^*$ is higher at a given $r$, but by less than the amount of the rise in $Y^* - T$.

• Recall:  
  \[ S^* = (Y^* - T - C^*) + (T - G) \]

  Private Saving  Public Saving

• Suppose there is a tax cut. At a given $r$:
  • $T - G$ falls by the full amount of the tax cut.
  • $Y^* - T - C^*$ rises, but by less than the amount of the tax cut (because $C^*$ rises).
  • So $S^*$ falls at a given $r$. 
V. The Determinants of Investment and the Real Interest Rate in the Long Run
The Long-Run Saving and Investment Diagram
U.S. Fiscal Developments in 2018 and 2019

- There was a large tax cut and a large increase in government purchases.
- Most observers think that output was close to potential ($Y \approx Y^*$) when those changes occurred.
A Tax Cut and “Crowding Out”
A New Technology That Raises Future MRP$_K$’s
VI. STOCK PRICES
Physical Capital versus Financial Capital

- **Physical capital** refers to aids to the production process that were made in the past: machines, buildings, trucks, computers.

- **Financial capital** refers to the funds used to purchase, rent or build physical capital.
Two Ways to Raise Financial Capital

• **Issue bonds**: borrow funds in return for a promise to repay later with interest.

• **Issue stocks**: sell people a share of the company. In return, they are entitled to a share of future profits (that is what a dividend is).
What should someone be willing to pay for a stock?

Stock price =

$\text{PV}(\text{Stream of Expected Future Dividends})$
What moves stock prices?

• A change in the interest rate.
  • Lower interest rates, all else equal, are likely to be associated with higher stock prices.

• A change in expected future dividends.
  • If something makes people expect lower future dividends, that should be associated with a lower stock price.
  • The lower expected dividends could apply to a particular firm or to firms in general.
The Recent Behavior of Stock Prices

Source: FRED.
What Firms’ Stock Prices Might Have Gone Up Recently?

Market Summary > Zoom Video Communications Inc

106.88 USD  Feb 26, 2020

Google Finance - Yahoo Finance - MSN Money
Stock Prices Respond Almost Instantly to News

Facebook stock price and news of privacy breach

Google Finance - Yahoo Finance - MSN Money
Efficient Markets Hypothesis

• It is difficult to make money off news in the stock market because information is processed very quickly.