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Macroeconomics

Consumption, Savings, and Investment

Contents:

Introduction

Previously, we developed a model that investigated the production side of the economy; we postulated that levels of capital, labor, and technology determined the level of output in the economy.

Well, stuff produced is demanded, or bought, by someone or something. In this set of notes, we develop a model that investigates the motivations of the buyers of the economy's production. We'll develop a model of aggregate demand, or total desired spending—a model that tells us the major reasons why things are purchased in the economy. And along the way, we'll also develop a model for national savings; this is unavoidable (and fun!), since any income that is not spent on things must be saved--so if we know what determines spending we also know what determines savings.

And now, a caveat: for simplicity, we will ignore foreign trade in our modeling endeavors in this set of notes. In effect, we will be looking at a hypothetical economy closed to foreign trade. (We'll look at foreign trade later in the semester.)

An important simplifying assumption: Output = Income

We know that in reality GDP does not equal national income. But it's a pain in the butt to keep track of the difference between GDP and national income as we develop our model of aggregate demand. So we shall ignore the difference, and we'll assume that GDP = national income in our models. This allows us to use one symbol—Y—to represent both national income and GDP.

Aggregate Demand

Aggregate demand means total desired spending on final goods & services in the economy. We wish to model aggregate demand; that is, we wish to figure out why people, businesses, and governments desire to buy goods and services. Recall that in a real economy we can divide spending into four categories: consumption, investment, government purchases, and net exports. In this set of notes, we will ignore net exports—in effect assuming that the economy is closed to foreign trade.

So we'll focus on Consumption, Investment, and Government Purchases. Let's begin by modeling consumption.

Consumption

Recall that consumption includes all purchases of final goods and services by households, except for housing. What determines the amount of goods and services that consumers will buy; that is, what determines households' desired level of consumption, $\mathbf{C^d}$? Well, consider these possible influences:

1) Income, Y
2) Wealth
3) Expected future income
4) Net taxes, T
5) Expected real interest rates

Let's examine these possible influences on consumption, one by one

1) Income, Y

Economists generally agree that there is a positive relationship between the level of national income, Y, and the level of desired consumption, C^d.

More Y → more desired consumption

Less Y → less desired consumption

2) Wealth

(Wealth is the value of all of the assets that households own (such as houses and stocks), minus households' debt.) Economists generally agree that there is a positive relationship between wealth and the desired level of consumption, C^d.

More wealth → more desired consumption

Less wealth → less desired consumption

3) Expected Future Income

Economists generally agree that an expectation of higher income in the future causes a household to desire to consume more today. (A prime example is the full time college student; she tends to have a high level of spending, despite a low current income, because she believes that she will have a much larger future income than her current income.)

Higher expected future income → more desired consumption now

Lower expected future income → lower desired consumption now

4) Net taxes, T

(Net taxes are the net amount that government takes from individuals. It equals total household tax revenue minus transfer payments.) There is some controversy surrounding the effects of net taxes on desired consumption.

We assume in (4) that government is changing net taxes without changing the level of government purchases.

View 1: A large majority of economists believe that there's an inverse relationship between net taxes and desired consumption. After all, if the government takes more from you in net taxes, then that leaves you with less income to spend; so you spend less—lower desired consumption. The same logic applies for a reduction in net taxes—lower net taxes leaves more income for consumer spending.

Majority view:

Higher net taxes → lower desired consumption

Lower net taxes → higher desired consumption

View 2: A small but influential group of economists believe that changes in net taxes do not change the level of desired consumption. This theory is known as Ricardian Equivalence. The idea is this: consumers view a tax cut as temporary, believing that the government must raise taxes in the future to make up for the tax revenue lost now. So, according to this view, *households save the entirety of a tax cut*, since they believe that they will need the money to pay for higher taxes in the future.

This view is named after economic thinker David Ricardo (who himself did not believe it).

The same logic works for a tax hike; households see this as a temporary tax hike and pay for its entirety by drawing down their savings, believing that they can replenish their savings when taxes fall later.

Ricardian equivalence view:

Higher net taxes → no change in desired consumption

Lower net taxes → no change in desired consumption

5) Expected real interest rates, r

One might think that higher interest rates induce higher savings (and hence lower current consumption), since the reward for each dollar saved is higher. But there is a countervailing effect; higher interest rates cause faster asset accumulation, requiring one to save less (and hence consume more) to accumulate the same dollar amount of assets over time. So:

Higher expected real interest rate: Maybe a little bit lower consumption

Lower expected real interest rate: Maybe a little bit higher consumption

The Algebra of Consumption

Sometimes the level of desired consumption spending in the economy is modeled using a Keynesian consumption function. A common general form is:

$$C^d = c_0 + c_y(Y-T) \qquad \text{where } c_0 \text{ and } c_y \text{ are constants}$$

Here's a specific form of the Keynesian consumption function, for a hypothetical specific economy:

$$C^d = 100 + .8(Y-T)$$

Note: c_y (and the .8 in our specific example) is known as the marginal propensity to consume, defined as the amount by which consumption rises when spendable income rises by \$1.

Example:

Suppose an economy has GDP equal to 1000 and a consumption function $C = 50 + .8(Y-T)$. Suppose further that $T = .5Y$ (where the ".5" is sometimes called the net income tax rate). How much is consumption?

Answer: $C = 50 + .8(Y-.5Y) \rightarrow C = 50 + .4Y \rightarrow C = 50 + .4(1000) \rightarrow C = 450$

Well, we've finished modeling consumption. Now let's model the second type of spending—investment.

Investment, I

Most investment involves purchases of physical capital by firms—machinery, buildings, and the like. Thus there is a link between I and K. Investment adds to the economy's existing capital stock.

So, to understand what motivates investment, we need a model that helps us determine the profit-maximizing size of the capital stock. The idea is: firms will invest more if they wish to increase the capital stock, and they will invest less if they wish to decrease the capital stock.

The Desired Capital Stock is the profit-maximizing size of the capital stock. We shall theorize that this is determined by comparing the benefit of an extra unit of capital to the cost of an additional unit of capital.

Intuition:

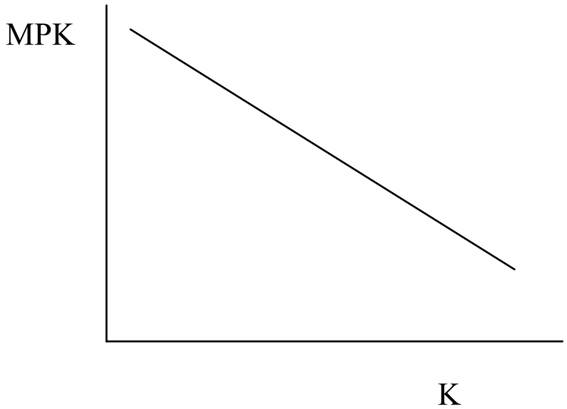
1) If the benefit of employing an additional unit of capital exceeds the cost, then firms will want to employ more capital.
2) If, on the other hand, the cost of employing one more unit of capital exceeds the benefit, then firms will want to employ less capital.
3) The implication if (1) combined with (2) is that:

The desired capital stock is reached when the benefit of an additional unit of capital equals the cost of an extra unit of capital.

Let's formalize this theory. First, we need a more specific definition of the benefit of an extra unit of capital and the cost of an extra unit of capital.

<u>Benefit of an extra unit of capital: Marginal Product of Capital, MPK</u>

Hey, we already have a definition of the benefit of employing an extra unit of capital—it's the marginal product of capital. As you recall, this equals the increase in production made possible by employing one extra unit of capital. We also know that it is realistic to assume diminishing returns to capital—each additional unit of capital adds successively less to total output, Y. We can see this on a graph:



The expected future marginal product of capital, **MPK^f**

We're trying to figure out what causes investment today. We argue that it adds to the capital stock and allows the firm to produce more stuff. But it's just slightly more complicated. Usually, a unit of investment this year does not show up in the capital stock this year. There is a lag between investment and an increase in the capital stock. (Consider an auto firm that begins building a new assembly line today; it won't be able to produce cars for a couple of years.) So the benefit of investing today is some future marginal product of capital. Let's define this as the *expected future marginal product of capital*, and abbreviate it MPK^f.

Example:

The single producer in an economy expects that next year the economy's production function will be:

$$Y = 20K^{.4}L^{.6}$$

What is the equation representing next year's expected marginal product of capital?

Answer: $MPK^f = 8K^{-.6}L^{.6}$ (using the MPK formula in the notes file macro-productivity)

Ok, so we've defined the benefit of employing an extra unit of capital. But what's the cost of an extra unit of capital?

The User Cost of Capital, **uc**

Suppose that you buy a new pizza oven for $10,000 for your restaurant that you expect will last 10 years. This is a piece of capital! The benefit of this oven this year is the pizzas that it will help you produce. But what is the cost of using this piece of capital this year—what is the user cost of capital?

All dollar values and interest rates are adjusted for inflation in this example.

Is it $10,000--the purchase price of the oven? NO! You could sell the oven at the end of the year (let's say for $9,500).

Is it $500—the difference between the purchase price and the oven's worth after a year of use? (By the way; this reduction in the oven's value is called depreciation.) NO! Because the purchase of the oven tied up $10,000 of your money for a year—and you could have earned interest on that money (let's say 8%).

So, if there are no taxes or subsidies involved here,

user cost of capital = lost interest + depreciation

Let's abbreviate: uc for user cost of capital, r for expected real interest rate, p_k for the real purchase price of the oven:

$$uc = rp_k + \text{depreciation}$$

Now let's assume that all capital loses value at a constant rate per year, relative to its purchase price p_k. Let's call this depreciation rate d:

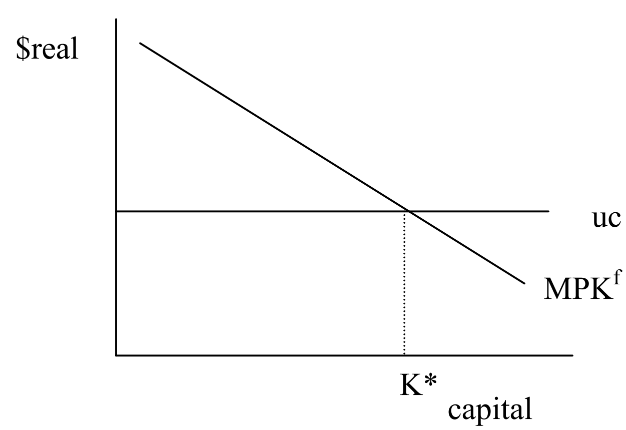
$$uc = rp_k + dp_k$$

or

$\mathbf{uc = (r + d)p_k}$ ←it's the user cost of capital equation! (Assumes no taxes)

So, we've figured out the benefit of an extra unit of capital, and we've figured out the cost of an extra unit of capital. The desired capital stock is where these two are equal. Let's look at this equilibrium graphically:

Equilibrium: The Desired Capital Stock, K* (no taxes)



Algebraically, K* occurs where $MPK^f = uc$

But wait! What about taxes! The tax system is very complicated in the real world and affects the desired capital stock in many ways. Let's simplify and say that taxes reduce the marginal product of capital by an effective tax rate, τ

After tax benefit to an extra unit of capital = $MPK^f(1-\tau)$

So the new algebraic condition for the desired capital stock is

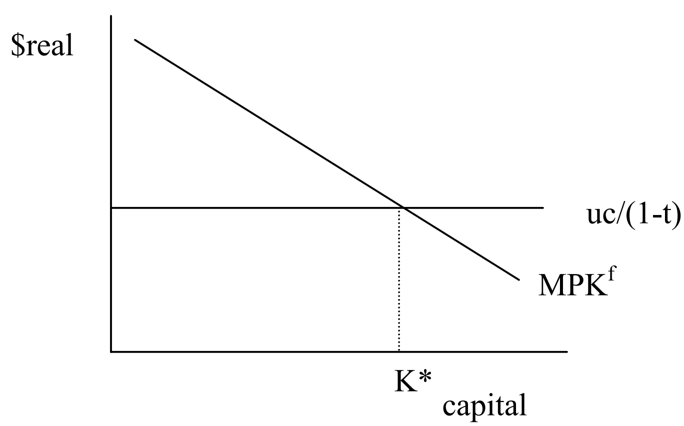
$MPK^f(1-\tau) = uc$

It is customary to divide both sides of this equation by (1-t):

$\mathbf{MPK^f = uc/(1-\tau)}$ ←This is the algebraic condition for the desired capital stock, with taxes

And, by the way, the term $uc/(1-\tau)$ is known as the tax-adjusted user cost of capital.

What's this look like? See below:



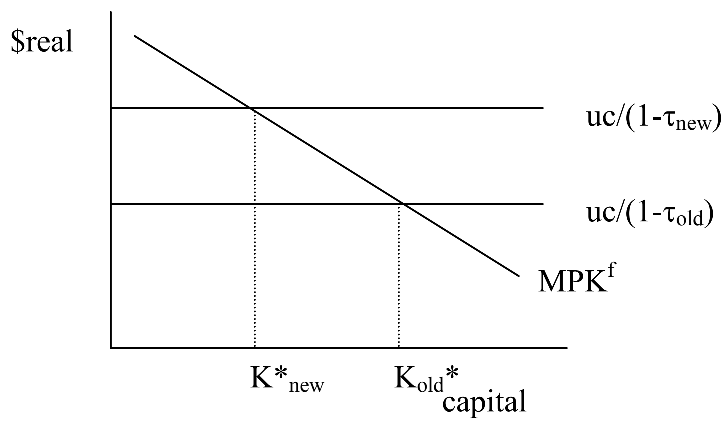
Events that change the desired capital stock:
Perhaps you can see from the above graph that these categories of things can change the desired capital stock:

--an event that changes MPK^f
--an event that changes uc
--an event that changes τ

What can change MPK^f? Well, better technology can make each unit of capital more productive, shift the MPK^f curve right, and increase the desired capital stock. (In a Cobb-Douglas production function, better technology would increase the "A" parameter.)

What can change uc? Mainly a change in the expected real interest rate, r. For example, a lower r would reduce uc, shift the user cost of capital curve down, and increase the desired capital stock.

What can change τ? Politicians altering tax law changes τ. For example, an increase in corporate taxes causes a higher τ, shifts the user cost curve up, and reduces the desired capital stock. Here's a graph of this phenomenon:



Example:
In a hypothetical economy the $MPK^f = 100 – 5K$, the expected real interest rate is 25%, the rate of depreciation is 10%, the effective tax rate is 30%, and the real price per unit of capital is \$20. What is the desired capital stock?

Answer:
$MPK^f = uc/(1-\tau) \rightarrow 100 – 5K = uc/.7 \rightarrow 100 – 5K =[(.25 + .10)20]/ .7 \rightarrow 100 – 5K = 10$

$\rightarrow 90 = 5K \rightarrow K^* = 18$

Well, we've looked carefully at the desired capital stock. Now let's look carefully at the link between investment and the desired capital stock:

Investment adds to the future capital stock—we know that. We also know that depreciation—the wear and tear of the existing capital stock—reduces the future capital stock. Let's simplify this relationship so that we can express it in our model. Let's assume:

Warning! The textbook uses the same letter, t, to represent the income tax rate and to represent a time period (as in year t). I use the same symbols as the textbook.

1) Investment in any year (say, year t), adds to the capital stock in the next year (say, year t + 1)

2) Depreciation in any year (year t) reduces the size of the capital stock next year (year t+1)

These two assumptions imply the following equation:

$$K_{t+1} = K_t + I_t - dK_t$$

Interpretation: next year's capital stock equals this year's, plus new investment in capital, minus depreciation of capital.

But wait: the producers want next year's capital stock to be of profit-maximizing size; that is, they want it to equal the desired capital stock, K*. So let's substitute:

$$K^* = K_t + I_t - dK_t$$

Let's rearrange the above equation, solving it for I_t. This is our goal, after all, in this section of the notes: to figure out what motivates firms to invest.

$$\mathbf{I_t = K^* - K_t + dK_t}$$

Notice: When K* rises, I_t rises. When K* falls, I_t falls. What does this mean? It means:

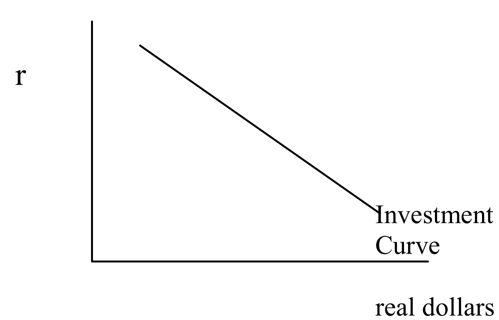
Events which increase the desired capital stock cause investment spending to rise. Events which decrease the desired capital stock cause investment spending to fall.

What are these events? Well, we went over some at the top of page 8:

--a change in technology
--a change in the expected real interest rate
--a change in the effective business tax rate.

Investment Spending and the Investment Curve

Now we know what motivates investment spending. It is sometimes useful to display this knowledge graphically using what is known as an investment curve:

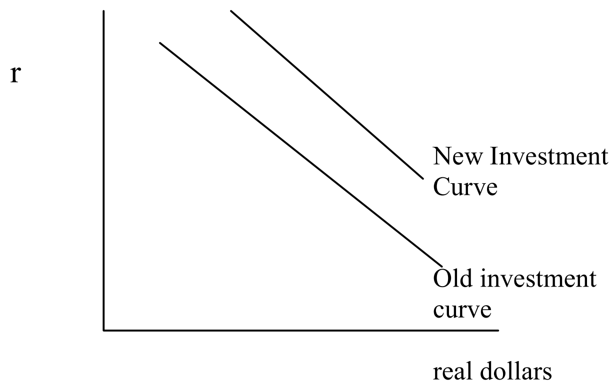


Notes about the investment curve:

1) A change in r causes a movement along the curve

2) A change in technology or the effective business tax rate or anything that causes a change in investment spending (except for r) causes the investment curve to shift. A rightward shift means higher desired investment spending; a leftward shift means lower desired investment spending.

Example: Politicians reduce the effective business tax rate:



Investment Equation:

One can also represent desired investment spending with an equation. Here's a simple example:

$$I^d = 2000 - 100r$$

This equation does not change when r changes. The equation does change when anything else affects investment spending.

Example: Using our example above, if politicians reduce the effective tax rate, then the new investment equation might be $I^d = 2500 - 100r$

Well, now we've finished modeling C and I. Let's move on to G.

Government Purchases, G
We assume that the level of government purchases is *exogenous*; that is, G is set by government officials, and nothing within our economy will change it. The only way to change G is if we, the modelers, decide to change G to simulate an act by government officials.

We can represent government purchases with an equation such as this one:

$$G = 500$$

You can see that G only changes if we, the modelers, change the number ourselves.

We are done with modeling G.

(Reminder: G does not include transfer payments such as Social Security and unemployment compensation. Instead, transfer payments are relevant to net taxes, T.)

Aggregate Demand, $C^d + I^d + G$
Total spending in our closed economy is the sum of desired consumption, desired investment, and government purchases:

$$AD = C^d + I^d + G$$

Example:
In a hypothetical closed economy,
$C^d = 200 + .8(Y\text{-}T)$, $I^d = 2000 - 100r$, $G = 500$, and $T = .25Y$

What is aggregate demand?

Answer:
$$AD = C^d + I^d + G$$
$$AD = 200 + .8(Y - .25Y) + 2000 - 100r + 500$$
$$AD = 2700 + .6Y - 100r$$

From Desired Spending to Desired National Savings

Since income is either spent or saved, we have, believe it or not, in our development in a model of desired spending, already developed a model of desired national savings. I'll show you:

First, recall what we learned in the notes macro-measure about national savings:

$$S = Y + NFP - C - G$$

Second, note that in our closed economy model, there are no net factor payments from abroad, since there's no abroad. We can restate our equation with NFP = 0:

$S = Y - C - G$

Third, let's replace S and C with their desired values, S^d and C^d:

$$\mathbf{S^d = Y - C^d - G}$$

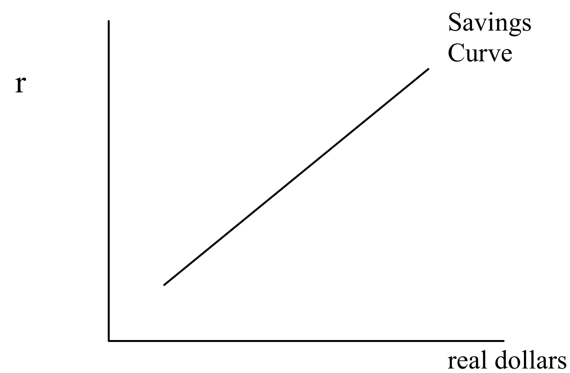
Interpretation of the above equation:

1) Desired savings equals the portion of national income neither spent by government nor desired to be spent by households.

2) If government officials change G, then desired national savings will change. Higher G leads to lower national savings. Lower G leads to higher national savings.

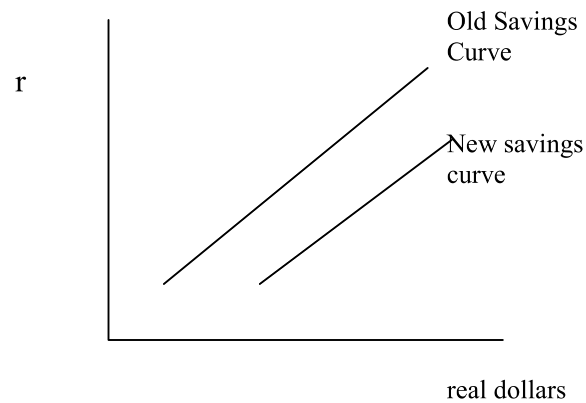
3) Events which change desired consumption will change desired savings. Events that cause higher desired consumption reduces desired savings. Events that cause lower desired consumption increases desired savings. Earlier in these pages, we listed things that may affect desired consumption. Therefore, these things also affect desired savings:
--household wealth
--household income
--expected future household income
--net taxes (maybe, under one view)
--expected real interest rates (a little bit)

<u>The Savings Curve</u>
Note that higher interest rates, by reducing consumption a bit, also probably increase desired savings a bit. Hence we can represent our model of desired savings with this upward-sloping savings curve:



Note: If r changes then one doesn't shift the savings curve—one moves along it. If, however, any of those other things that we mentioned earlier that affect desired savings change, then the savings curve shifts—to the right means more desire savings, and to the left means less desired savings.

Example: Household wealth falls



Savings = Investment: Equilibrium and interest rates

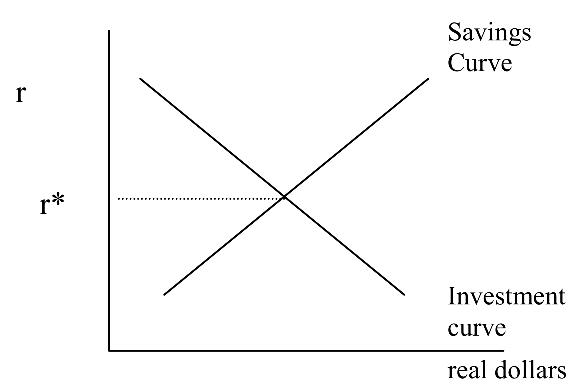
Recall from the notes macro-measure:

$$S = I + CA$$

Well, in a closed economy, CA (the current account balance) is zero, so we have this:

$$S = I$$

We can display this equilibrium on a graph:



We have graphed equilibrium in the market for loanable funds! National savings—the combined savings of individuals and government—is the amount of money available to be loaned out—the supply of loanable funds. Investors need to borrow this money to invest—they demand loanable funds. The equilibrium between savings—the supply of loanable funds—and investment—the demand for loanable funds—determines the equilibrium price of loanable funds—the real interest rate!

Notice how this model came out of our examination of the causes of spending in the economy. This is very important to remember; our spending habits help to determine the interest rate.

Events that change the equilibrium expected real interest rate

As you can see from the loanable funds graph above, if some event causes either the savings curve or the investment curve (or both) to shift then the equilibrium real interest rate will change. What causes these shifts? Well, we went over many causes earlier in these notes. Here's a recap:

These things cause the expected real interest rate to change by changing desired savings:

--Government officials change G
--Household wealth changes
--Household income changes
--Household expected future income changes
--Household net taxes change

These things cause the expected real interest rate to change by changing desired investment:

--Technology or some other event changes the marginal product of capital
--Government changes the effective business tax rate

The Algebra of the Loanable Funds Market: Example

In a hypothetical closed economy,
$C^d = 200 + .8(Y\text{-}T)$, $I^d = 2000 - 100r$, $G = 500$, and $T = .25Y$. We also hypothesize that the full employment level of GDP is 5000.

What is the full employment expected real interest rate?

Answer: We need equations for the savings curve and the investment curve

We already have the investment curve equation: $\mathbf{I^d = 2000 - 100r}$

Now let's get the savings curve:
$S^d = Y - C - G$
$S^d = 5000 - (200 + .8(Y\text{-}T)) - 500$
$S^d = 4300 - .8(5000 - .25Y)$
$S^d = 4300 - 4000 + .2(5000)$
$\mathbf{S^d = 1300}$

In this economy, notice that the interest rate does not affect the level of savings

Now let's set savings equal to investment to get the expected real interest rate:

$S^d = I^d$

$1300 = 2000 - 100r$

$100r = 700$

$r = 7$