Lectures in Intermediate Macroeconomics Taught by Martín Uribe at Columbia University in the Spring of 2026:

Part I Monetary Policy

Part II Fiscal Policy

Part III International Macroeconomics

Assignments and Practice Exams

Homework 1 given at Lecture 5
Homework 2 given at Lecture 7
Homework 3 given at Lecture 9
Homework 4 given at Lecture 12
Practice midterm exam given at Lecture 13
Homework 5 given at Lecture 13
Homework 6 given at Lecture 17
Homework 7 given at Lecture 19
Homework 8 given at Lecture 21
Homework 9 given at Lecture 23
Practice final exam given at Lecture 25

Lecture 1: The Post-Covid Inflation Spike

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Topic 1

Monetary Policy

Introduction

Since the beginning of the 21st century, the global economy has experienced several major macroeconomic events. The world suffered two large crises: the global financial crisis of 2008 and the Covid-19 pandemic. In the aftermath of Covid, the U.S.A. and other advanced economies experienced the largest spike in inflation since the 1980s. More recently, in 2025, the U.S.A. imposed a large increase in import tariffs on almost all goods and on imports from almost all countries.

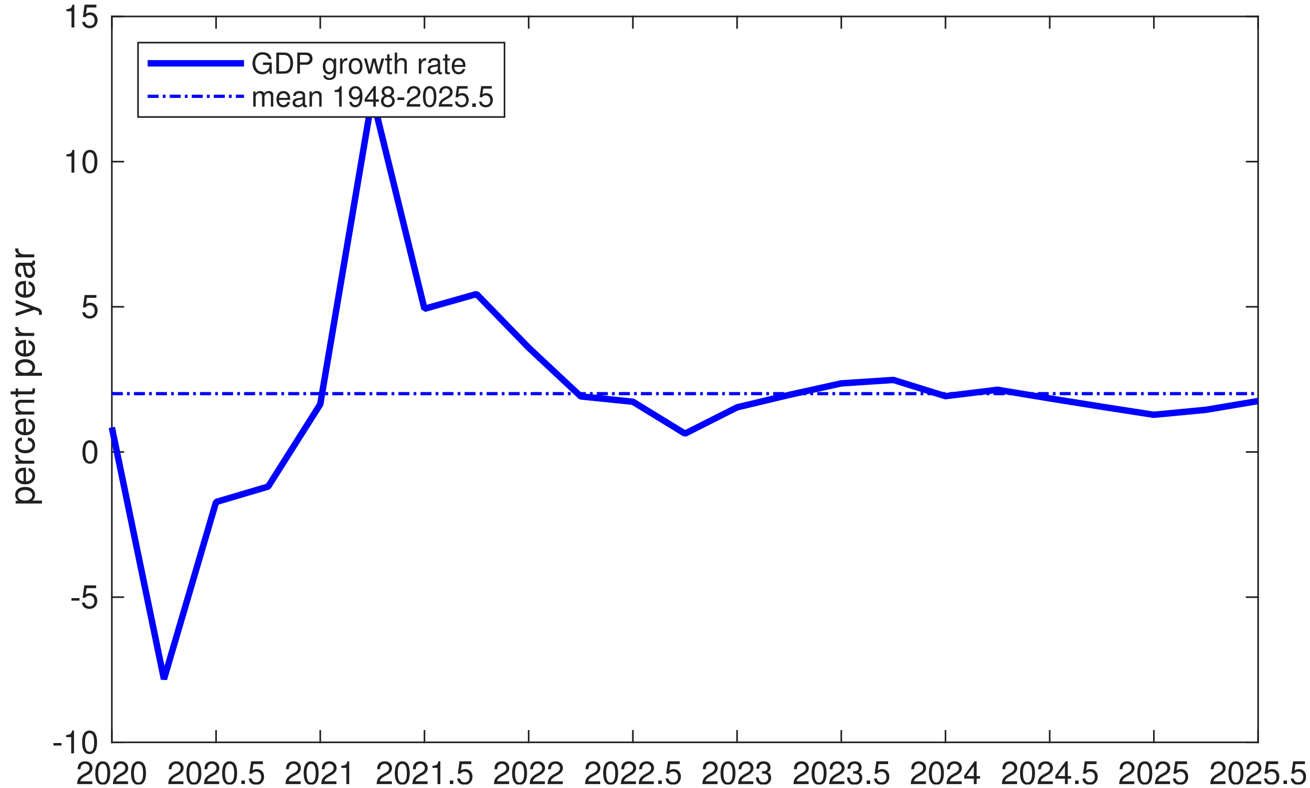
In the next few lectures, we will study a model known as the New Keynesian (NK) model, which will help us understand the policy options available to the central bank.

This model provides answers to questions such as:
What should a central bank that aims to achieve price stability and full employment do in a recession?
What should it do during an economic crisis?
What should the central bank do during a boom in which the economy is overheated?
What are the limits of monetary policy?
What should the central bank do when it runs out of conventional policy tools?
Should the central bank respond to changes in import tariffs, or should it look through them?

Today, we will limit ourselves to examining recent data on output, inflation, and interest rates, with particular emphasis on the pandemic and post-pandemic years.

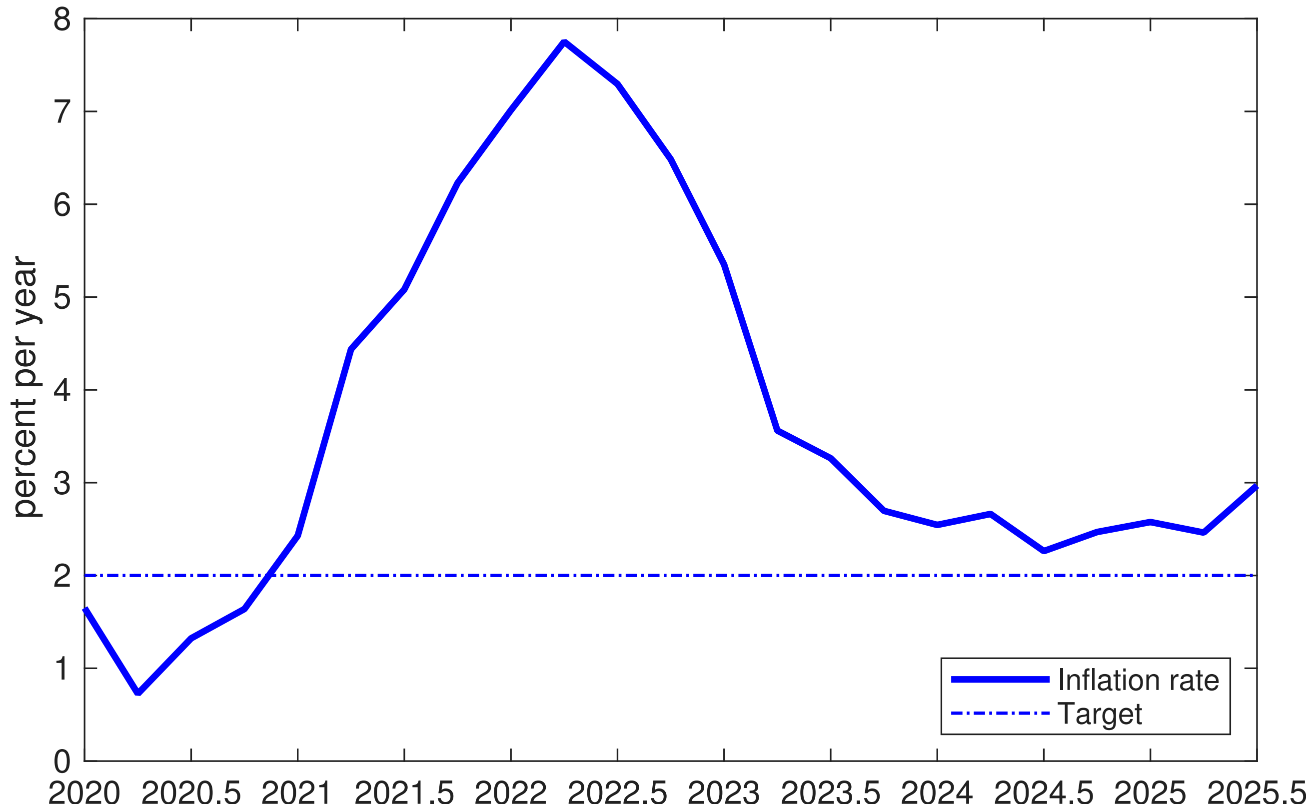
Output, Inflation, and Monetary Policy During the Pandemic

Growth Rate of Real U.S. GDP per Capita
2020:Q1 to 2025:Q3, percent per year



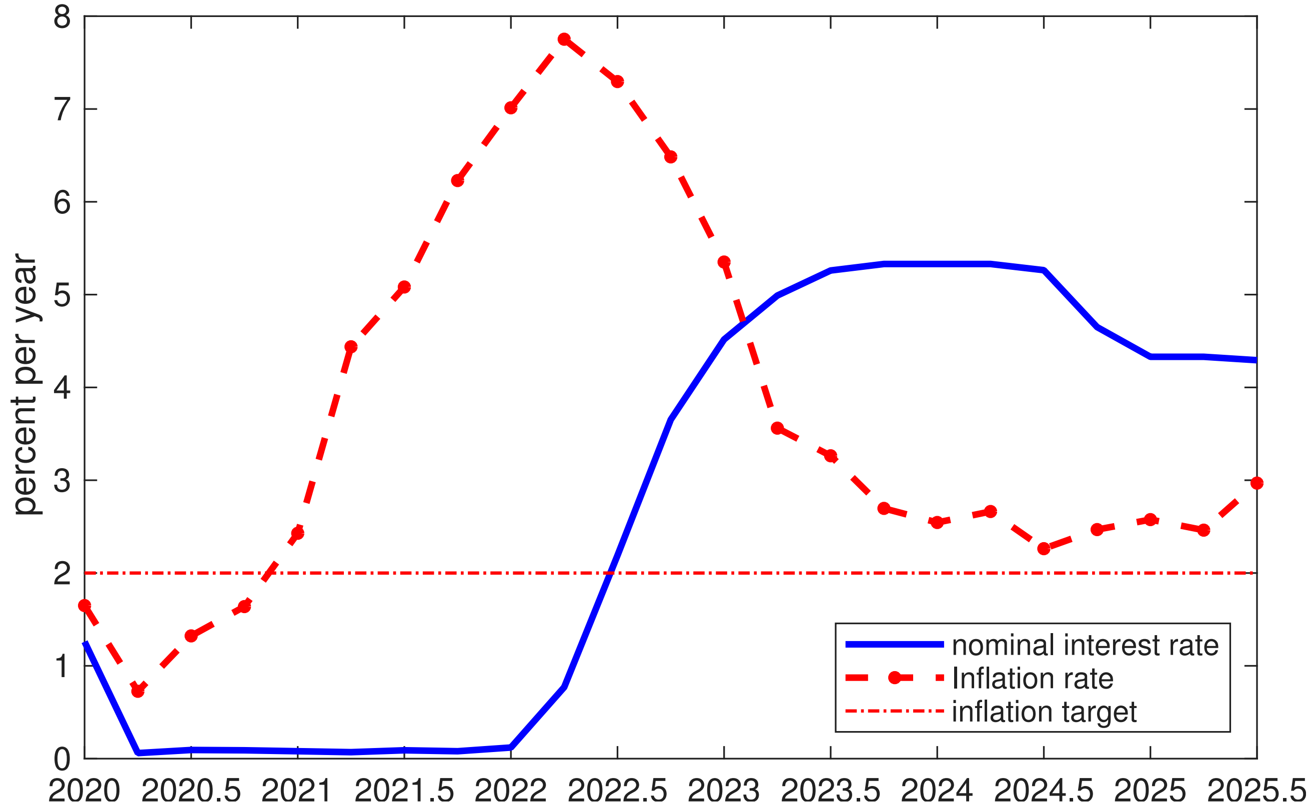
Source: FRED. Year-over-year rate.

U.S. Inflation
2020:Q1 to 2025:Q3, percent per year



Notes. Inflation is measured as the growth rate of the GDP deflator. Year-over-year rate. Source: FRED.

U.S. Nominal Interest Rate
2020:Q1 to 2025:Q3, percent per year



Notes. The nominal interest rate is measured by the federal funds rate. Source: FRED.

What Do These 3 Figures Tell Us?

• The Covid-19 pandemic was extremely contractionary: GDP per capita fell by an annual rate of 8 percent in the second quarter of 2020.

• But it was a short-lived contraction: GDP per capita increased by about 10 percent in the third quarter of 2020. And after that, the growth rate of output was within normal values (about 2 percent),

• The Covid-19 pandemic was highly inflationary: inflation reached 9.4 percent in the second quarter of 2022.

• But the inflation spike started after the economy had recovered, not during the contraction or even the recovery.

• The Fed understandably lowered the interest rate near its lowest possible value of 0 during the contraction, and kept it low for a while.

• But there are good reasons to believe that the Fed waited too long to normalize rates: It started to tighten only in the second quarter of 2022, even though by mid 2021 there were clear signs that inflation had started to get out of control.

Policy Questions

- Was the post-Covid inflationary spike due to demand pressures (one stimulus program too many: (ARP=1.9trillion, IIJA=1.2trillion, etc.) or to supply pressures (global supply chain disruptions, contraction is labor force participation).

- Did the Fed wait too long to react?

- What are the consequences of not reacting quickly enough?

Starting next class, we will try to address these and other related questions. But we must build the NK model first...

Lecture 2: The Phillips Curve

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Topic 1

Monetary Policy

The New-Keynesian (NK) Model

Building Blocks of the NK Model

(1) The Phillips curve

(2) The IS curve

(3) Monetary policy specification

In this lecture, we will introduce the Phillips curve.

The Phillips Curve

The Phillips curve illustrates how current or expected supply-side pressures influence inflation. Intuitively, it suggests that when the economy operates near or above full employment, factor markets–like the labor market–become tight. This tightness drives up wages and the costs of other production factors (rents, etc). Firms, in turn, pass these higher costs onto consumers through higher prices, leading to increased inflation.

Formally, the Phillips curve says that current inflation is an increasing function of the output gap, of expected inflation, and of exogenous cost-push shocks:

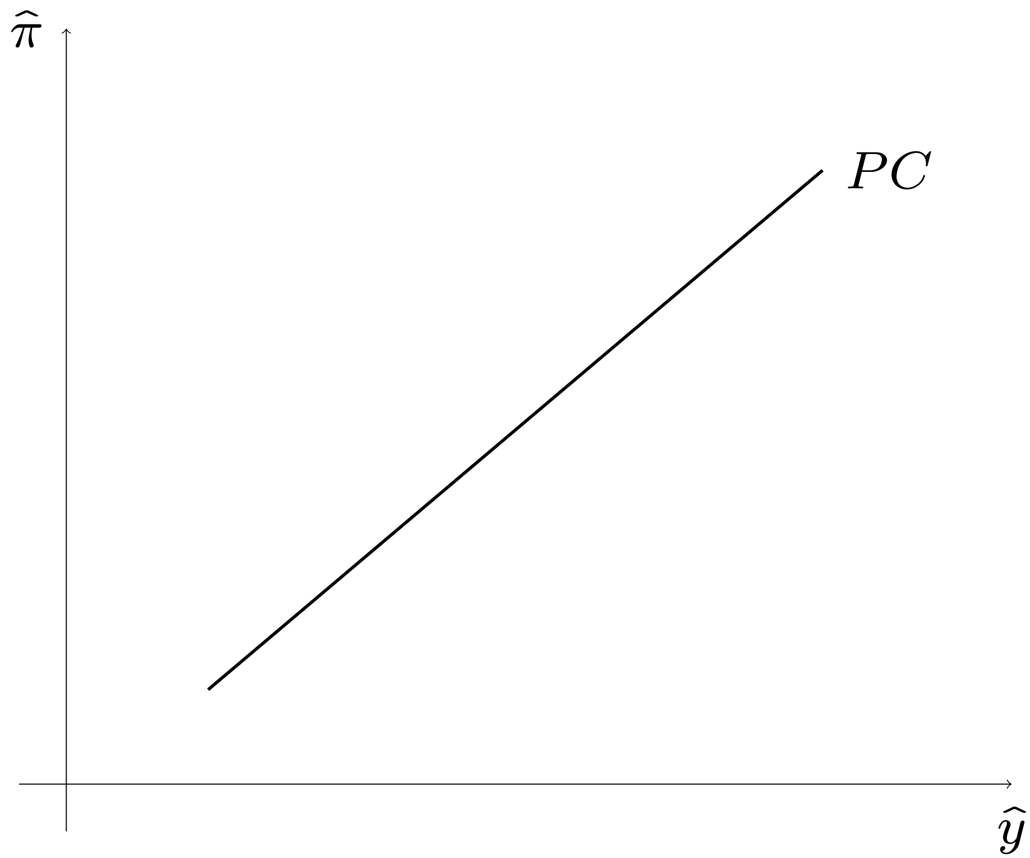
$$\widehat{\pi} = \beta\widehat{\pi}^e + \kappa\widehat{y} + \epsilon^{cp}$$

where
$\widehat{\pi} \equiv \pi - \bar{\pi}$ is the deviation of inflation (π) from the central bank's inflation target ($\bar{\pi}$). For example, in the United States, the Fed's official inflation target is 2 percent per year ($\bar{\pi} = 2$). In December of 2025, inflation in the United States was 2.7 percent ($\pi = 2.7$), so inflation is 0.7 percentage points above the intended target, or $\widehat{\pi} = 0.7$.
$\widehat{\pi}^e \equiv \pi^e - \bar{\pi}$ is the deviation of future expected inflation (π^e) from the inflation target ($\bar{\pi}$). For example, if people expect that next year inflation will be 1.7 percent, then $\widehat{\pi}^e = 1.7 - 2 = -0.3$ percent. $\widehat{y} = \frac{y-\bar{y}}{\bar{y}}$ is the output gap, defined as the relative deviation of output (y) from the full-employment level of output ($\bar{y}$).
ϵ^{cp} is a cost-push term, reflecting changes in the price of oil, disruptions in the global supply chain, etc.
β and κ are positive parameters. The parameter β is known as the *subjective*

discount factor and is less than 1. The parameter κ is known as the slope of the Phillips curve. It measures the sensitivity of inflation to changes in the output gap. We will talk more about β and κ shortly.

The next figure plots the Phillips curve. After the figure, we explain the economic meaning of each term in the Phillips curve.

The Phillips Curve



The figure depicts the function $\widehat{\pi} = \beta\widehat{\pi}^e + \kappa\widehat{y} + \epsilon^{cp}$ in the space $(\widehat{y}, \widehat{\pi})$. The Phillips curve is an upward sloping curve. All else equal, an increase in the output gap $(\widehat{y}\uparrow)$ is associated with higher inflation $(\widehat{\pi}\uparrow)$.

Why is the Phillips Curve Upward Sloping?

Recall that the output gap, $\hat{y}$, is the relative deviation of output, y, from full-employment output, $\bar{y}$. Suppose that initially y is below $\bar{y}$, so the output gap is negative ($\hat{y} < 0$). As y increases and gets closer to $\bar{y}$, the economy begins to heat up. Factor markets, such as the labor market and the commercial and industrial real estate markets, become tighter, and wages and rents start to go up. Thus, the cost of producing goods goes up and, as firms pass these costs on to consumers, prices increase at a faster rate, that is, inflation (π) goes up.

What Is Full-Employment Output, $\bar{y}$?

Full-employment output, $\bar{y}$, is the level of output, y, at which all factors of production are employed, up to some *frictional* or *natural* amount of unemployment. What is frictional or natural unemployment? Take the labor market, for example. For the economy to be at full employment, it is not necessary that every single worker be employed, but that there is roughly as many vacancies as people searching for a job. Businesses are created and destroyed all the time. Also, businesses expand and contract. New businesses and expanding businesses create vacancies, and destroyed and contracting businesses lay off workers. Also, every day new workers enter the labor market and some exit it (because of retirement or to pursue other activities, such as studying). It takes time for new workers or laid off workers from destroyed or shrinking businesses to find their way into the vacancies created by new or expanding businesses. For a job to be created, workers and firms must search for a suitable match. Until that happens, searching workers are unemployed. That is, we have a situation in which there are as many jobs as workers, but, because of these frictions, some workers are unemployed and some jobs are not filled. This type of unemployment is called frictional or natural. When unemployment is of a frictional or natural type, we say that the economy is at full employment. In the United States, the natural or frictional rate of unemployment is about 4 percent. A similar situation can happen with the real estate market: full employment does not occur when all buildings are occupied, but when roughly there are as many people looking to rent or buy as people offering units for rent or sale.

Can the output gap be positive($\widehat{y} > 0$)? Yes, this is a situation in which the economy is overheated, so output is above the level of full-employment output, $y > \bar{y}$. In the labor market, for example, this is reflected in situations in which the number of vacancies exceeds the number of unemployed workers, so the market is tight. In terms of numbers, this would happen when the unemployment rate is below 4 percent or so. A similar situation can take place in the real estate market.

Why Does Expected Inflation Enter the Phillips Curve?

Notice that in the Phillips curve, $\widehat{\pi}$ depends positively on $\widehat{\pi}^e$. That is, all else being equal, an increase in future expected inflation ($\pi^e \uparrow$) is associated with an increase in current inflation ($\pi \uparrow$). Why? An increase in expected inflation reflects firms' anticipation that, in the future, the output gap $\widehat{y}$ will be larger–meaning that output will be closer to or further above full-employment levels–causing the economy to be more overheated. In response to this expectation, firms begin raising prices more rapidly today, leading to an increase in $\widehat{\pi}$.

But why would firms increase inflation today and not wait until the expected increase in the output gap actually occurs in the future? The reason is that changing prices quickly is costly, so when firms anticipate that they will have to increase prices in the future, they prefer to start increasing them already today to avoid a large increase all at once in the future. Why are large price increases costly? One reason is that a large increase in prices can make customers angry. Thus, for example, if a supermarket anticipates that the price of a dozen eggs will have to increase from 6 to 10 dollars over the next year, it might prefer to implement 4 smaller increases than to go from 6 to 10 at once. Thus, it might prefer to increase the price to 7 today, to 8 next quarter, and so on.

When firms face costs of changing prices, like in the economy we are describing here, we say that prices are *sticky* or that there is *nominal price rigidity*. Price stickiness is at the core of the new-Keynesian model.

Why Does the Cost-Push Term ϵ^{cp} Enter in the Phillips Curve?

The Phillips curve postulates that inflation (π)is an increasing function of the cost push term ϵ^{cp}. What does this capture?

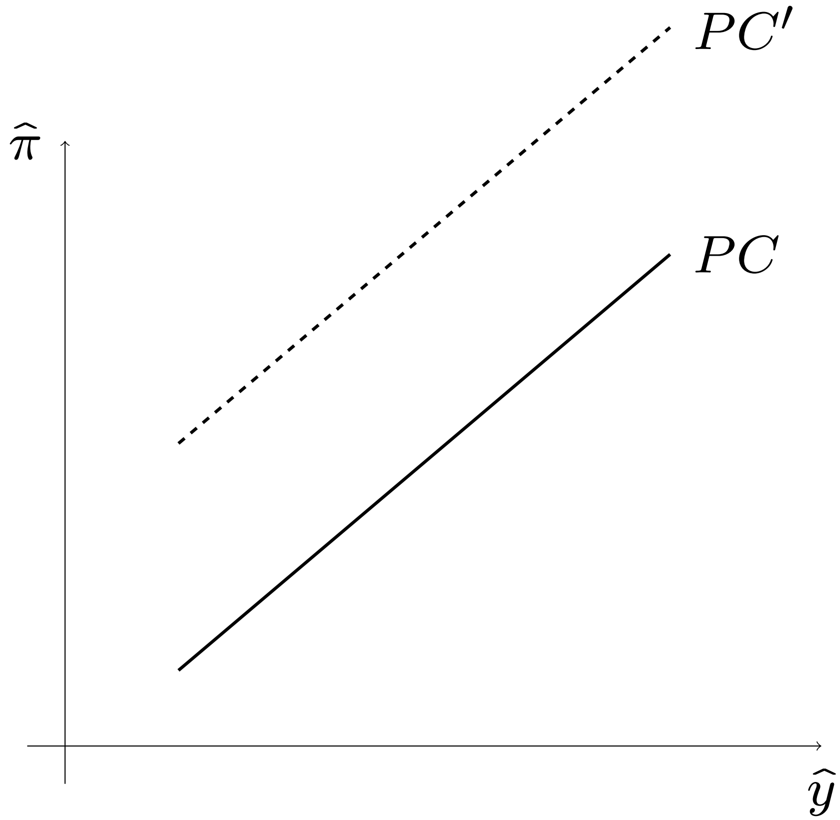
The cost push term ϵ^{cp} reflects factors that increase either the cost of production or the degree of concentration in the marketplace that induces firms to increase prices. For example:

• An increase in the price of oil increases the cost of production of firms that use oil as an input directly or indirectly (e.g., electricity generated with fossil fuel).

• A disruption in the global supply chain that increases the cost of transporting intermediate materials within the country or around the world, rasing firms' cost of production. During the Covid-19 pandemic, for example, ports around the world did not have enough workers to operate, generating large bottlenecks and reducing the normal supply of materials necessary to produce final goods.

• An increase in market power can cause an increase in prices even if the cost of production is unchanged. There can be situations in which firms decide to increase markups of prices over cost of production. This can happen, for example, if large firms collude and agree to all set higher prices or merge and thereby gain the necessary market power to raise profit margins.

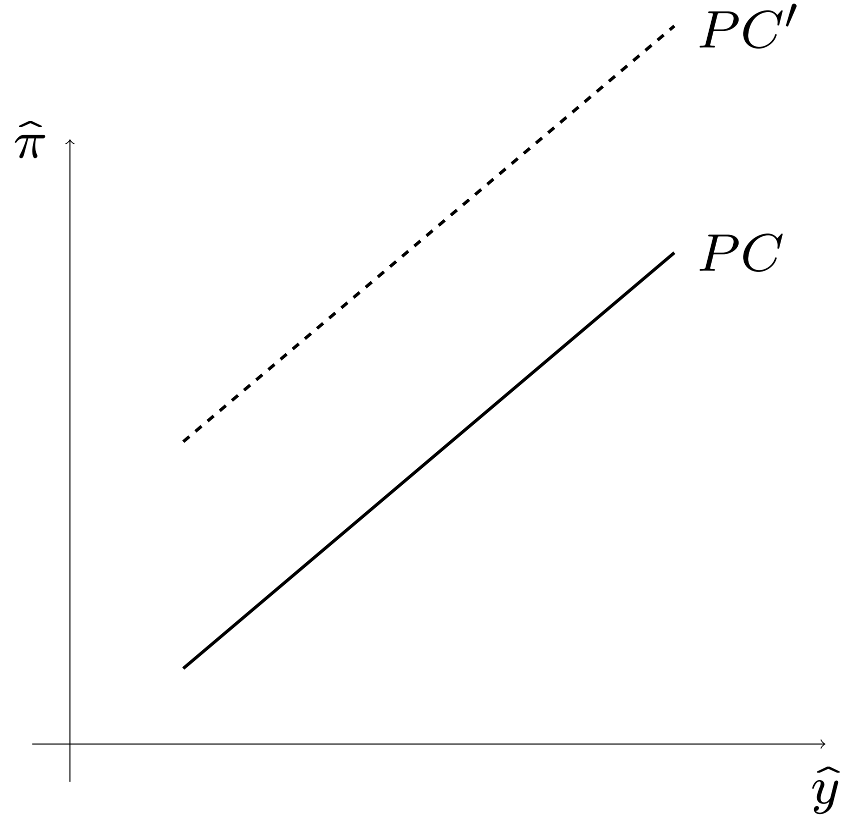
Shifters of the Phillips Curve: An increase in Expected inflation



The Phillips curve is given by the expression $\widehat{\pi} = \beta\widehat{\pi}^e + \kappa\widehat{y} + \epsilon^{cp}$. An increase in expected inflation ($\widehat{\pi}^e \uparrow$) shifts the Phillips curve up and to the left. To see this, note that if $\widehat{\pi}^e$ goes up, then for any given level of the output gap, $\widehat{y}$, the deviation of inflation from target increases, $\widehat{\pi} \uparrow$. In the figure, the Phillips curve depicted with a dashed line and labeled PC' corresponds to a higher future expected inflation rate than the Phillips curve drawn with a solid line and labeled

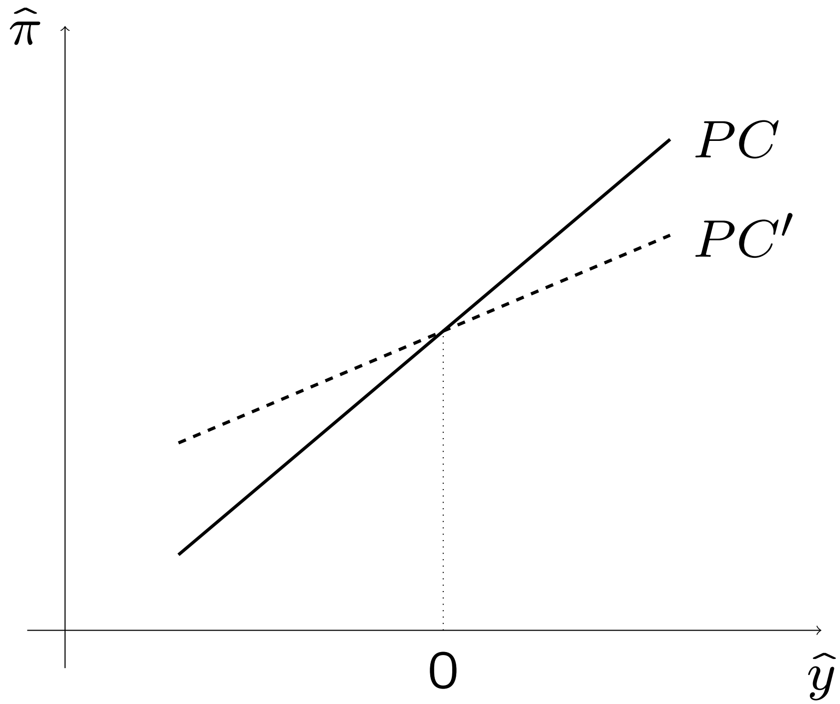
PC. Similarly, a fall in expected inflation ($\widehat{\pi}^e \downarrow$, not shown) would shift the Phillips curve down and to the right.

Shifters of the Phillips Curve: A Cost-Push Shock



The Phillips curve is given by the expression $\widehat{\pi} = \beta\widehat{\pi}^e + \kappa\widehat{y} + \epsilon^{cp}$. An increase in the cost-push term ($\epsilon^{cp} \uparrow$) shifts the Phillips curve up and to the left: if (ϵ^{cp} increases, for any given level of the output gap, $\widehat{y}$, the deviation of inflation from target is higher, $\widehat{\pi} \uparrow$. In the figure, the Phillips curve depicted with a dashed line corresponds to a higher cost-push term. We refer to an increase in ϵ^{cp} as a cost-push shock. Similarly, a fall in the cost-push term($\epsilon^{cp} \downarrow$) (not shown) would shift the Phillips curve down and to the right.

Flattening of the Phillips Curve



The Phillips curve is given by $\widehat{\pi} = \beta\widehat{\pi}^e + \kappa\widehat{y} + \epsilon^{cp}$. The Phillips curve flattens when the parameter κ becomes smaller. This can occur if prices become stickier: A given change in the output gap causes a smaller change in inflation. Note that when κ falls, the Phillips curve rotates clockwise around a zero output gap (i.e., around $\widehat{y} = 0$). Can you see this? Similarly, if κ increases, the Phillips curve becomes steeper. This can happen if prices become more flexible. If prices are fully flexible, the Phillips curve is vertical at $\widehat{y} = 0$, and the economy is always at full employment. This makes sense. If prices (including the price of labor, that is, the wage rate) can adjust frictionlessly, then they can go up or down as needed to eliminate excess demand or supply in all markets, including the labor market. If all markets are in equilibrium all the time, there cannot be unemployment (except for frictional unemployment) and the economy operates permanently at full employment. If prices are sticky, market disequilibria, including in the labor market, can occur, causing the economy to be depressed or overheated.

Summing Up

• The new-Keynesian model has three building blocks: the Phillips curve, the IS curve, and a specification of monetary policy.

• Today's class was dedicated to presenting the Phillips curve. It is a positive relationship between the output gap ($\widehat{y}$) and the deviation of inflation from the inflation target ($\widehat{\pi}$). In the space ($\widehat{y}, \widehat{\pi}$), the Phillips curve is an upward sloping curve.

• An increase in expected inflation ($\widehat{\pi}^e \uparrow$) shifts the Phillips curve up and to the left. if $\widehat{\pi}^e$ increases, then at any given level of the output gap, the inflation rate is higher than before the change in $\widehat{\pi}^e$.

• A cost-push shock ($\epsilon^{cp} \uparrow$) shifts the Phillips curve up and to the left. if ϵ^{cp} increases, then at any given level of the output gap, the inflation rate is higher than before the change in ϵ^{cp}.

• The Phillips curve flattens when the parameter κ becomes smaller. This can happen if prices become stickier.

Lecture 3
The IS Curve

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Topic 1

Monetary Policy

The New-Keynesian (NK) Model

Let's Recap: The Building Blocks of the NK Model

(1) The Phillips curve

(2) The IS curve

(3) The monetary policy specification

We have already presented the Phillips curve. This lecture continues by introducing the IS curve.

The IS Curve

The core of the IS curve is the households optimal decision between consuming today and saving today in order to consume in the future. (The name "IS" stands for investment–saving.) Naturally, the decision to consume or save is governed by the interest rate.

All else equal, a higher interest rate strengthens the incentive to save today and postpone current consumption in favor of future consumption. Formally,

$$\frac{c-\bar{y}}{\bar{y}} = -\gamma(\hat{i} - \hat{\pi}^e) + \epsilon^d \tag{1}$$

where
c is consumption;
$\frac{c-\bar{y}}{\bar{y}}$ is the relative deviation of consumption from full-employment output;
i is the nominal interest rate;
$\hat{i} = i - \bar{i}$ is the deviation of the nominal interest rate from its normal level, $\bar{i}$;
π^e is expected future inflation;
$\hat{\pi}^e = \pi^e - \bar{\pi}$ is the deviation of expected inflation from the inflation target ($\bar{\pi}$);
$i - \pi^e$ is the *real* interest rate;
$\hat{i} - \hat{\pi}^e$ is the deviation of the real interest rate from its normal value;
ϵ^d is a demand shock;
γ is a positive parameter known as the intertemporal elasticity of consumption substitution.

Thus, the IS curve states that when the real interest rate, $i - \pi^e$, increases, consumers reduce current consumption. The intuition is that a higher real interest rate makes it more attractive to postpone consumption, save more to take advantage of the higher return, and consume more in the future.

In equilibrium, consumption (the demand for goods) must equal output (the supply of goods), so

$$c = y.$$

Combining this equilibrium condition with equation (1), we obtain the final form of the IS curve:

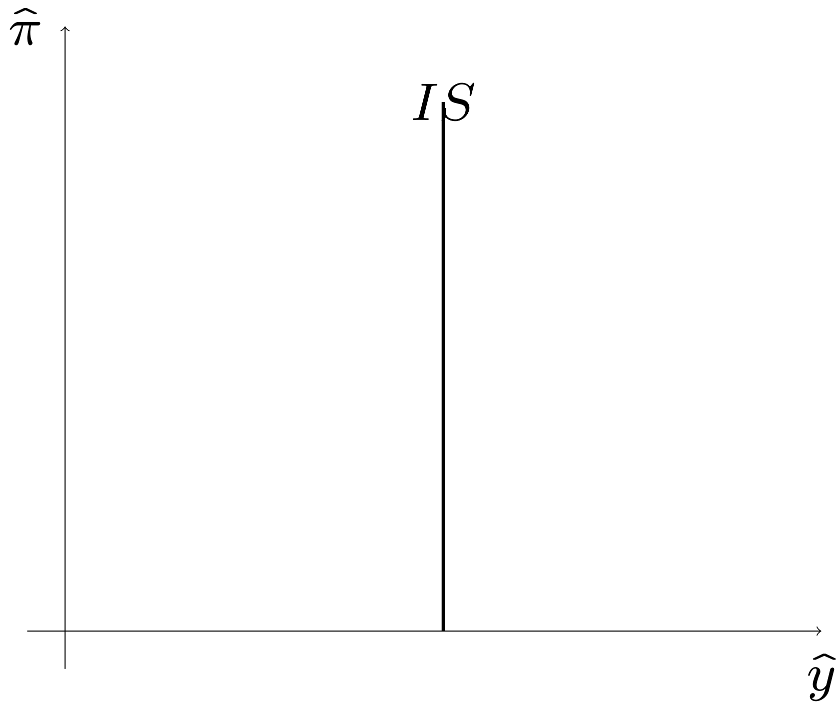
$$\widehat{y} = -\gamma(\widehat{i} - \widehat{\pi}^e) + \epsilon^d,$$

where $\widehat{y} = \frac{y - \bar{y}}{\bar{y}}$ is the output gap, that is, the relative deviation of output from its full-employment level.

The IS curve states that the output gap, $\widehat{y}$, is a decreasing function of the real interest rate, $\widehat{i} - \widehat{\pi}^e$. It also states that the output gap increases when the economy experiences positive demand shocks ($\epsilon^d \uparrow$).

We now plot the IS curve in the space $(\widehat{y}, \widehat{\pi})$.

The IS Curve



The figure depicts the function $\widehat{y} = -\gamma(\widehat{i} - \widehat{\pi}^e) + \epsilon^d$ in the space $(\widehat{y}, \widehat{\pi})$. The IS curve is a vertical line because the output gap does not depend on inflation.

Nominal Versus Real Interest Rate

In equation (1), consumption depends negatively on the real interest rate $i - \pi^e$, not on the nominal interest rate i.* Why? Consider the following two hypothetical cases:

Case 1: The nominal interest rate is 10 percent, $i = 10$, and expected inflation is 8 percent, $\pi^e = 8$. Suppose you save 100 dollars today. Next period you receive 110 dollars. However, you expect prices to increase by 8 percent, so something that costs 100 dollars today is expected to cost 108 dollars next period. Thus, with your savings of 100 dollars today, you expect to be able to buy about 1.02 units of the good next period, since $1.02 \approx 110/108$.

In this example, the bank pays you a 10 percent return, but inflation reduces the purchasing power of money by 8 percent. As a result, your purchasing capacity increases by only 2 percent between today and next period. The *real* interest rate is only 2 percent.

*Strictly speaking, consumption depends on $\widehat{i} - \widehat{\pi}^e$, but since $\widehat{i} = i - \overline{i}$ and $\widehat{\pi}^e = \pi^e - \overline{\pi}$ are deviations of i and π^e from the constants $\overline{i}$ and $\overline{\pi}$, when discussing changes in the real interest rate what ultimately matters is $i - \pi^e$.

Case 2: Suppose now that the nominal interest rate is half as high as in Case 1, namely 5 percent, or $i = 5$. Suppose also that expected inflation is very low, 1 percent, or $\pi^e = 1$. Then the 100 dollars you save today yield 105 dollars next period, and something that costs 100 dollars today is expected to cost 101 dollars next period. Thus, next period you will be able to buy about 1.04 units of the good, since $1.04 \approx 105/101$.

In this second example, the bank pays you 5 percent in interest, and inflation reduces the purchasing power of your investment by 1 percent. Consequently, your purchasing capacity increases by 4 percent between today and next period. The *real* interest rate is 4 percent.

In which case do you have a stronger incentive to save today? Clearly, it is in the second case, even though the nominal interest rate i is lower. The reason is that in Case 1 inflation is expected to erode much of the real value of your savings. In Case 2, the nominal interest rate i is low, but inflation is expected to be very low as well, so the increase in prices during the saving period does not substantially reduce the real value of your investment.

Put differently, although the *nominal* interest rate is lower in Case 2, the *real* interest rate is higher.

Conclusion: what matters for the decision of how much to consume and save today is not the nominal interest rate i, but the real interest rate, $i - \pi^e$, that is, the nominal interest rate net of expected inflation

What is the Demand Shock ϵ^d?

The demand shock ϵ^d captures factors, other than the real interest rate $\hat{i} - \hat{\pi}^e$, that induce households to change their demand for goods. Such factors include, for example:

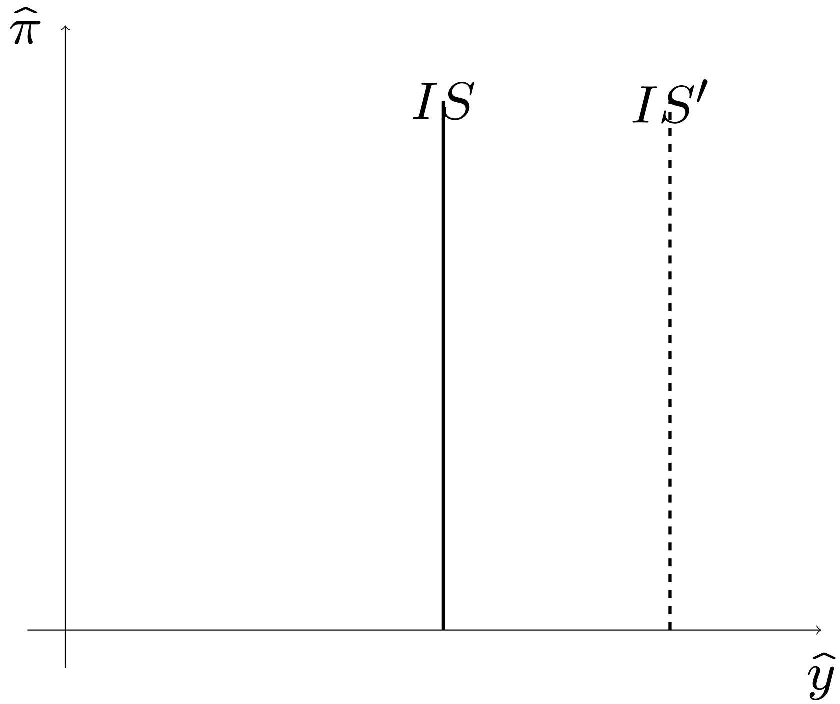
– Changes in preferences for consuming today versus consuming in the future: changes in people's outlook about the future (pessimism, optimism, fear of a future crisis, etc.) can induce people to postpone or front load consumption.

– Fiscal Policy: Changes in taxes, for example, can alter the aggregate demand for goods. Consider, for example, a policy in which the government cuts consumption taxes today and announces an increase in consumption taxes in the future. This policy induces households to increase consumption today. As another example, assume that the government raises taxes on the rich, whose marginal propensity to consume is low, and cuts taxes on the middle class and the poor, whose marginal propensity to consume is higher. This fiscal policy can induce an increase in aggregate consumption.

Why is γ Called the Intertemporal Elasticity of Consumption Substitution?

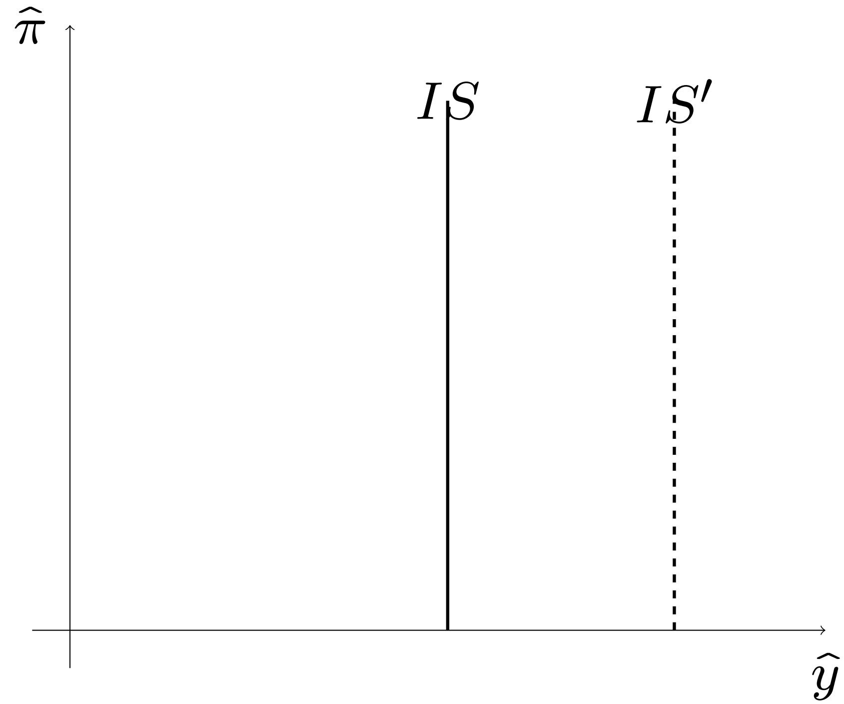
Because γ indicates the percent decrease in aggregate consumption in response to a 1 percentage point increase in the real interest rate. Such a decrease in consumption implies that households save more today, which allows them to consume more in the future. Thus, a change in the real interest rate induces households to *substitute* future consumption for present consumption. This substitution is intertemporal, because it involves present and future consumption– as opposed to, for example, an increase today in the relative price of oranges in terms of apples, which induces an *intratemporal* substitution of apples for oranges. The larger is γ, the more sensitive (or elastic) present consumption will be to changes in the real interest rate.

Shifters of the IS Curve: An Interest Rate Cut ($\widehat{i}\downarrow$)



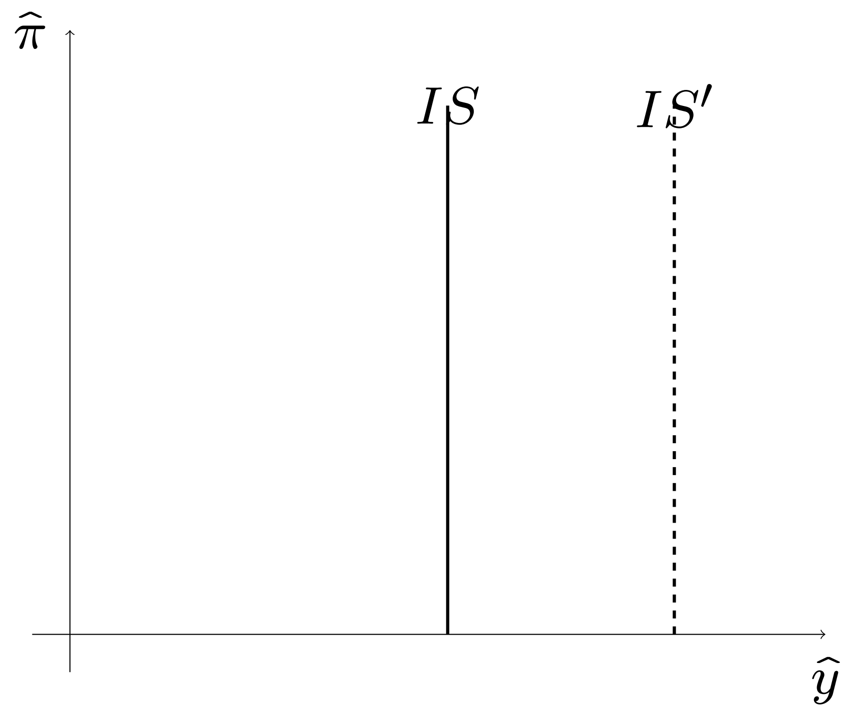
The IS curve is $\widehat{y} = -\gamma(\widehat{i} - \widehat{\pi}^e) + \epsilon^d$. A fall in the nominal interest rate ($\widehat{i}\downarrow$) shifts the IS curve to the right in a parallel fashion, as shown by the dashed line. The reason is that, all else equal, a fall in the nominal interest rate represents a fall in the real interest rate (recall that we are holding constant $\widehat{\pi}^e$), which induces households to expand current consumption. Similarly, an increase in the nominal interest rate ($\widehat{i}\uparrow$) causes a parallel shift in the IS curve to the left (not shown).

Shifters of the IS Curve: An Expansionary Demand Shock ($\epsilon^d \uparrow$)



The IS curve is given by $\widehat{y} = -\gamma(\widehat{i} - \widehat{\pi}^e) + \epsilon^d$. A positive demand shock ($\epsilon^d \uparrow$) shifts the IS curve to the right in a parallel fashion, as shown by the dashed line. Such a shock could be caused, for example, by a temporary tax cut or by an increase in optimism about the functioning of the economy, which, for a given real interest rate, induces households to increase consumption. Similarly, a negative demand shock ($\epsilon^d \downarrow$) causes a parallel shift of the IS curve to the left (not shown).

Shifters of the IS Curve: An Increase in Expected Inflation ($\widehat{\pi}^e \uparrow$)



The IS curve is $\widehat{y} = -\gamma(\widehat{i} - \widehat{\pi}^e) + \epsilon^d$. An increase in future expected inflation ($\widehat{\pi}^e \uparrow$) shifts the IS curve to the right in a parallel fashion, as shown by the dashed line. The reason is that, all else equal, an increase in expected inflation represents a fall in the real interest rate (recall that we are holding constant $\widehat{i}$), which induces households to expand current consumption. Similarly, a fall in future expected inflation($\widehat{\pi}^e \downarrow$) causes a parallel shift in the IS curve to the left (not shown).

Summing Up

• The new-Keynesian model has three building blocks: the Phillips curve, the IS curve, and a specification of monetary policy.

• Today's class was dedicated to presenting the IS curve. The origin of the IS curve is the optimal decision of households to reduce present consumption in response to increases in the real interest rate. In the space $(\widehat{y}, \widehat{\pi})$, the IS curve is a vertical line.

• A fall in the nominal interest rate $(\widehat{i} \downarrow)$ shifts the IS curve to the right in a parallel fashion. This is because, all else equal, an interest rate cut reduces the real interest rate, which induces households to expand present consumption.

• An increase in expected inflation $(\widehat{\pi}^e \uparrow)$ shifts the IS curve to the right in a parallel fashion. This is because, all else equal, an increase in expected inflation reduces the real interest rate, stimulating current consumption.

• A positive demand shock $(\epsilon^d \uparrow)$ shifts the IS curve to the right in a parallel manner.

Lecture 4 Monetary Policy in the New KeynesianModel

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Let's Recap: The Building Blocks of the NK Model

(1) The Phillips curve

(2) The IS curve

(3) Monetary policy specification

We have already presented the Phillips Curve and the IS curve. This lecture continues by specifying the monetary policy, characterizing the equilibrium, and analyzing the ability of the central bank to stabilize the economy in response to a variety of shocks.

Monetary Policy: Instruments and Objectives

We assume that the central bank sets the nominal interest rate i to achieve two goals: price stability and full employment. Many central banks around the world have this dual mandate, including the Federal Reserve in the United States.

• *Price stability:* When a central bank states that one of its goal is price stability, it does not mean zero inflation, but an inflation rate as close as possible to a target. In the United States, the inflation target is 2 percent. The same is true for other developed countries. In emerging countries, the inflation target tends to be higher, about 3 percent. In the notation of the model we are studying, the goal of price stability means attaining an inflation rate as close as possible to $\bar{\pi}$.

• *Full employment:* In the context of the NK model we have developed, this goal means achieving a level of output as close as possible to the level of full-employment output $\bar{y}$, or a zero output gap, $\hat{y} = 0$. We assume that the central bank dislikes deviations of y from $\bar{y}$ in either direction: When y is below $\bar{y}$, the economy suffers involuntary unemployment, and when y is above $\bar{y}$, the economy is overheating, and both outcomes are undesirable.

Note that the central bank has two objectives (price stability and full employment) but only one instrument (the nominal interest rate i). As we will see next, this may or may not create a conflict, depending on the shocks buffeting the economy.

Equilibrium in the NK Model

Recall that the Phillips curve and the IS curve are given, respectively, by

$$\widehat{\pi} = \beta\widehat{\pi}^e + \kappa\widehat{y} + \epsilon^{cp}$$

and

$$\widehat{y} = -\gamma(\widehat{i} - \widehat{\pi}^e) + \epsilon^d$$

Consider a tranquil situation in which the economy is not hit by cost-push or demand shocks, $\epsilon^{cp} = \epsilon^d = 0$. Suppose further that inflationary expectations are anchored at the inflation target, that is, $\widehat{\pi}^e \equiv \pi^e - \bar{\pi} = 0$.

In this case, examining the Phillips curve and the IS curve, we can deduce that the central bank can achieve its two objectives, $\widehat{\pi} = 0$ and $\widehat{y} = 0$, by setting the nominal interest rate at its normal value $\bar{i}$, that is, by setting $\widehat{i} = 0$.

To see this more formally, note that if $\epsilon^{cp} = \epsilon^d = \widehat{\pi}^e = \widehat{i} = 0$, then the Phillips curve and the IS curve become

$$\widehat{\pi} = \kappa\widehat{y}$$

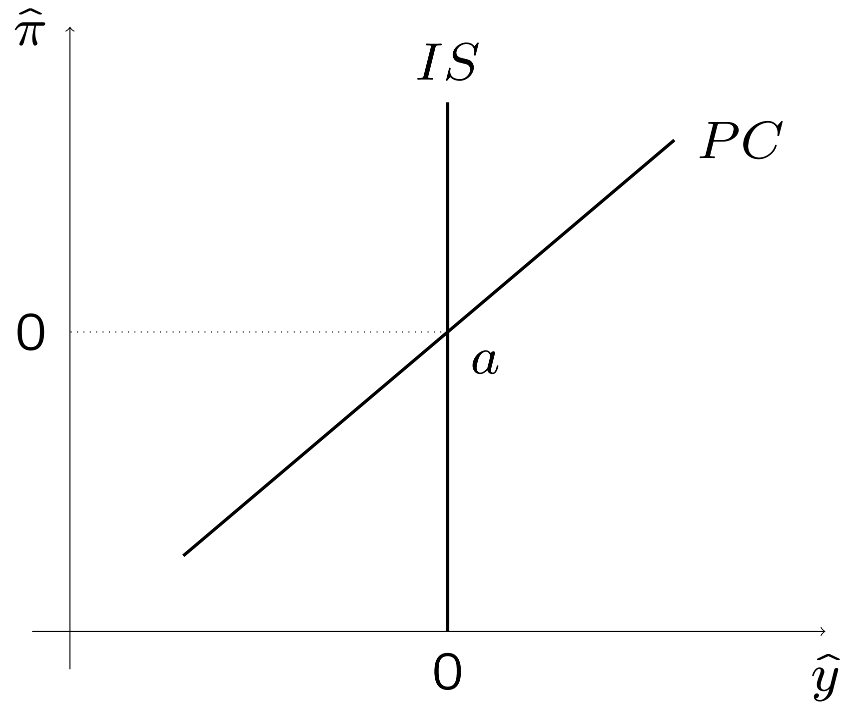
and

$$\widehat{y} = 0$$

The solution of these 2 equations in 2 unknowns, $\widehat{\pi}$ and $\widehat{y}$, is clearly $\widehat{\pi} = \widehat{y} = 0$.

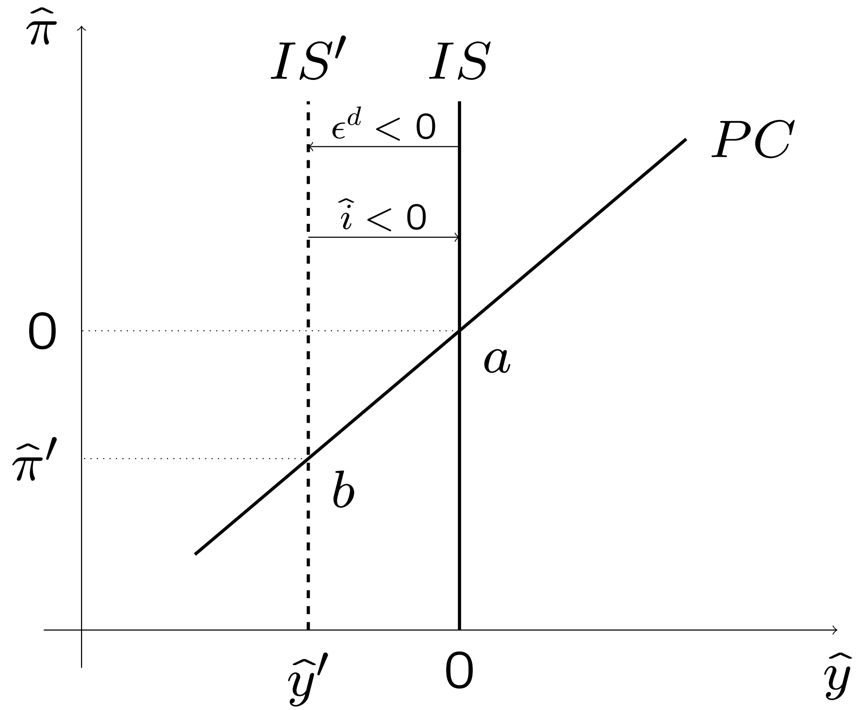
The next figure illustrates this situation.

Equilibrium



The Phillips curve is the upward-sloping line labeled PC, and the IS curve is the vertical line labeled IS. If the economy is not hit by cost-push shocks ($\epsilon^{cp} = 0$) and inflation expectations are anchored ($\widehat{\pi}^e = 0$), the Phillips curve implies that when output is at its full-employment level ($\widehat{y} = 0$), inflation equals its intended target ($\widehat{\pi} = 0$), as shown in the figure. Likewise, if the economy is not subject to demand shocks ($\epsilon^d = 0$), inflation expectations are anchored ($\widehat{\pi}^e = 0$), and the nominal interest rate is at its normal level ($\widehat{i} = 0$), the IS curve is a vertical line intersecting the horizontal axis at $\widehat{y} = 0$. The equilibrium is therefore at point a, where the Phillips curve and the IS curve intersect. At this equilibrium, output and inflation are both at their intended values ($\widehat{y} = \widehat{\pi} = 0$). It follows that, in the absence of cost-push and demand shocks ($\epsilon^{cp} = \epsilon^{d} = 0$) and with anchored inflation expectations ($\widehat{\pi}^{e} = 0$), the central bank can achieve price stability and full employment without active monetary policy intervention, simply by keeping the nominal interest rate at its normal level, $\widehat{i} = 0$.

A Negative Demand Shock ($\epsilon^d < 0$)



Suppose that initially the economy is not being hit by any shock and inflationary expectations are anchored ($\epsilon^d = \epsilon^{cp} = \widehat{\pi}^e = 0$). Suppose also that the central bank sets the interest rate at its normal level, $\widehat{i} = 0$. The Phillips curve and the IS curve are the solid lines labeled PC and IS in the figure. The initial equilibrium is at point a, where the economy is at full employment and the inflation rate is at the intended target ($\widehat{y} = \widehat{\pi} = 0$). Suppose now that the economy is hit by a negative demand shock ($\epsilon^d < 0$). This disturbance shifts the IS curve to the left, as shown by the dashed vertical line labeled IS'. The negative demand shock can represent an increase in people's pessimism about the economy, or contractionary fiscal policy, such as an increase in taxes or a reduction of government transfers to low income households. Such a shock induces households to consume less at any level of the real interest rate.

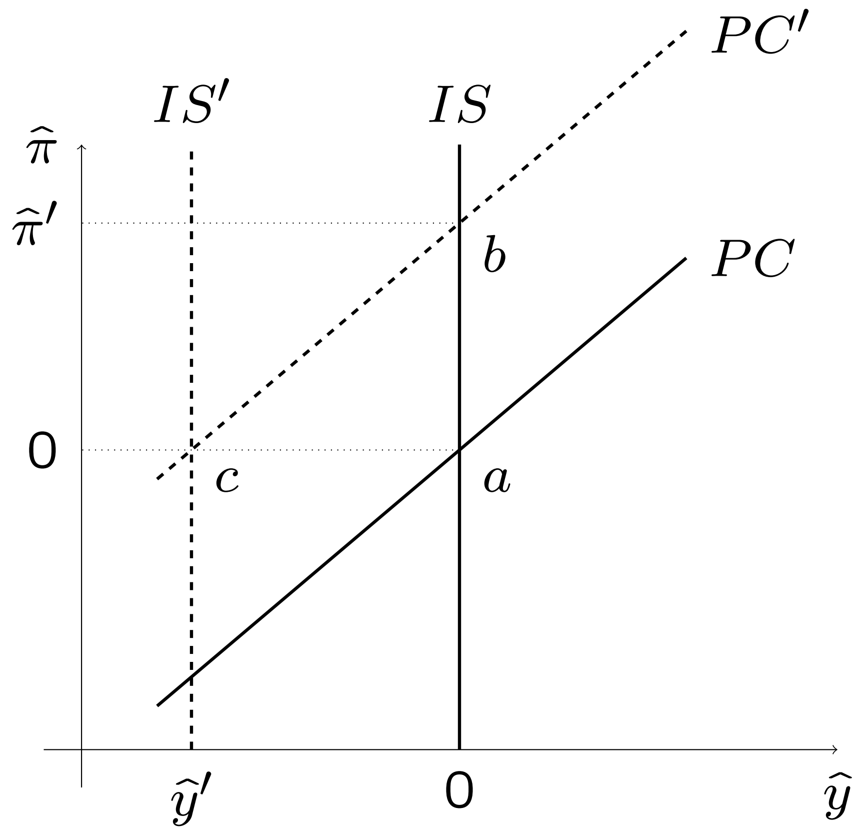
The new equilibrium is at point b, where the economy suffers unemployment ($\widehat{y}' < 0$) and inflation is below target ($\widehat{\pi}' < 0$).

The intuition behind this effect is as follows: By the IS equation, the exogenous fall in aggregate demand $\epsilon^d < 0$, requires a fall in the real interest rate, $\widehat{i} - \widehat{\pi}^e$, to restore the aggregate demand for goods to its original level, namely, $\bar{y}$. But expected inflation is given and so is the nominal interest rate, so the real interest rate, $\widehat{i} - \widehat{\pi}^e$, cannot change. With weaker demand, firms are forced to cut production, and the output gap becomes negative ($\widehat{y} < 0$). Then, by the Phillips curve, the negative output gap induces firms to increase prices at a pace lower than the inflation target, $\widehat{\pi} < 0$.

To restore the original equilibrium, the central bank must lower the interest rate ($\widehat{i} < 0$). Given inflationary expectations, the monetary easing lowers the real interest rate, which stimulates consumption. In the figure, this is reflected in a shift of the IS to the right in a parallel fashion. If the interest rate cut is of the right size, the central bank can restore full employment and keep the inflation rate at its target level.

Policy tradeoff: Note that in this case the central bank faces no conflict between its inflation and employment goals. At point b the inflation rate and output are both below target, and an interest rate cut boosts both. We conclude that in response to demand shocks, the central bank does not face a tradeoff between stabilizing prices and stabilizing aggregate activity.

A Cost-Push Shock ($\epsilon^{cp} > 0$)



Initially, the economy is at point a. There are no shocks ($\epsilon^d = \epsilon^{cp} = 0$), inflation expectations are anchored ($\widehat{\pi}^e = 0$), and the nominal interest rate is at its normal level, $\widehat{i} = 0$. As a result, inflation is at its intended target, $\widehat{\pi} = 0$, and the output gap is zero, $\widehat{y} = 0$.

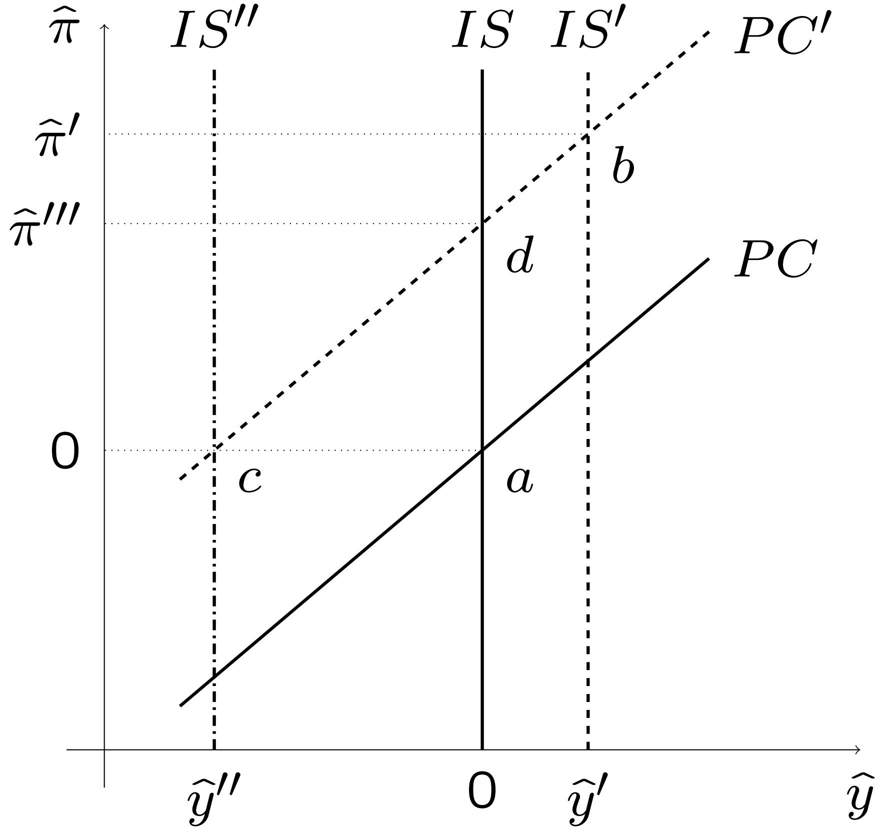
Suppose now that the economy is hit by a cost-push shock, $\epsilon^{cp} > 0$. This shock could represent an increase in the price of oil (an intermediate input used in the production of final goods), an increase in market power, a disruption in supply chains, etc. At any given level of the output gap, the cost-push shock raises inflation. As a result, the Phillips curve shifts up and to the left, as shown by the upward-sloping dashed line labeled PC'. The new equilibrium is at point b, where inflation is higher, $\widehat{\pi}' > 0$.

At this point, the central bank must decide how to respond. If it chooses to do nothing (in monetary jargon, to "look through the shock"), the economy remains at full employment, but inflation stays above its intended target. At the other extreme, the central bank can act to bring inflation back to target, $\widehat{\pi} = 0$. To do so, it must tighten monetary policy by raising the nominal interest rate, $\widehat{i} > 0$. This policy shifts the IS curve to the left. To fully offset the inflationary effect of the shock, the interest rate increase must be large enough for the new IS curve to intersect the shifted Phillips curve at point c.In the figure, this IS curve is shown as the dashed vertical line labeled IS'. At point c, inflation is back at target, $\widehat{\pi} = 0$, but output is below full employment, $\widehat{y}' < 0$. With this hard policy stance, the central bank achieves price stability at the cost of a recession.

A third option lies between these two extremes. The central bank can raise the interest rate by less than required to fully stabilize inflation. In this case, the IS curve (not shown) shifts to a position between the vertical lines labeled IS and IS', and the equilibrium lies on the dashed Phillips curve between points b and c. Under this policy, the central bank tolerates some inflation and some unemployment. The combination of elevated inflation and depressed output is known as *stagflation*.

It follows that when the economy is hit by a cost-push shock, the central bank faces a tradeoff between stabilizing inflation and stabilizing aggregate activity: moving closer to one objective necessarily implies moving farther away from the other.

An Increase in Expected Inflation ($\widehat{\pi}^e \uparrow$)



Consider now an increase in expected inflation ($\widehat{\pi}^e \uparrow$). The figure depicts this situation. The initial equilibrium (before the change in $\widehat{\pi}^e$) is at point a. Prior to the change in inflation expectations, the economy is at full employment ($\widehat{y} = 0$) and inflation is at its intended target ($\widehat{\pi} = 0$).

When expected inflation is above or below the inflation target, we say that inflation expectations are unanchored. An increase in expected inflation ($\widehat{\pi}^e > 0$) shifts the

IS curve to the right to IS' (see the figure above). It also shifts the Phillips curve up and to the left to PC'. The IS curve shifts to the right because, given the nominal interest rate, the increase in expected inflation lowers the real interest rate, $\widehat{i} - \widehat{\pi}^e$, which stimulates aggregate demand. The Phillips curve shifts up and to the left because, for any given output gap, an increase in future expected inflation causes an increase in current inflation. The new equilibrium is at point b, with inflation above the target ($\widehat{\pi}' > 0$) and output above full employment ($\widehat{y}' > 0$). At point b, the economy is overheatted.

The central bank can intervene to improve the situation by tightening monetary conditions. Specifically, an increase in the nominal interest rate $\widehat{i} \uparrow$ can bring both inflation and the output gap down, placing the economy closer to the intended equilibrium, point a in the figure. But monetary policy cannot bring the economy quite to point a. The central bank faces a conflict or a tradeoff between inflation and output. If it chooses to bring inflation all the way down to its target level $\bar{\pi}$, it must implement an aggressive interest rate hike ($\widehat{i} \uparrow$) to shift the IS curve to IS'' (shown with a dash-dotted line in the figure). The resulting equilibrium is at point c, where the inflation rate is at its target level ($\widehat{\pi} = 0$), but the economy is in recession ($\widehat{y}'' < 0$). Under this policy, the increase in the nominal interest rate is very high and so is the contraction in aggregate demand. So the economy goes from being overheatted to suffering a recession.

Alternatively, the central bank could choose to keep the economy from overheating and bring output down to its full-employment level ($\widehat{y} = 0$). This requires a smaller interest rate hike than the policy that brings inflation down to its target level. Under this policy, the IS curve shifts to the left to its initial position (the solid line labeled IS). The new equilibrium is at point d. At this equilibrium, output is at full employment ($\widehat{y} = 0$). However, the inflation rate is above its target $\bar{\pi}$ ($\widehat{\pi}''' > 0$).

A third policy alternative for the central bank is an intermediate approach, where it tolerates some inflation and some unemployment. In this case (not shown in the figure), the economy would settle at a point on the Phillips curve PC', between points c and d. The exact position on the Phillips curve PC'–closer to c or to d–depends on the central bank's policy preferences. A dovish central bank, which prioritizes reducing unemployment and is more tolerant of higher inflation, would steer the economy closer to point d. Conversely, a hawkish central bank, which emphasizes controlling inflation even at the cost of higher unemployment, would aim for a position nearer to point c.

Our assumption of a dual mandate for the central bank of aiming for full employment and inflation at the inflation target only guarantees that the central bank will intervene by rasing the interest rate to a level at least as high as the one consistent with an equilibrium at point d. That is, the Fed will not pick a point between b and d. The reason is that at any point between b and d the central bank can reduce both inflation and get closer to full employment, so there is no policy conflict. The tradeoff between inflation and aggregate activity occurs only between points c and d. Similarly, the central bank will not want to place the economy at a point on PC' southwest of point c, because in this range it can improve on both the inflation and the output fronts by lowering the interest rate.

Summing Up

• This lecture uses the NK model developed in previous lectures to understand the macroeconomic effects of different shocks and to study the policy options for the central bank in response to such shocks.

• We assumed that, as in the United States and other countries, the central bank has a dual objective of price stability (inflation as close as possible to the inflation target) and full employment.

• An expansionary demand shock ($\epsilon^d \uparrow$) causes an increase in inflation and output. An appropriate increase in the nominal interest rate ($\widehat{i} \uparrow$) can restore full employment and price stability. In this case, the central bank does not face a conflict between its two policy goals.

• A cost-push shock (ϵ^{cp}) is inflationary. If the central bank tightens, it can reduce inflation, but at the cost of some unemployment. So in this case the monetary authority faces a tradeoff between stabilizing inflation and maintaining full employment. If the central bank chooses to tolerate some inflation and some unemployment, the economy would suffer stagflation.

• An increase in future inflation expectations ($\widehat{\pi}^e \uparrow$) causes an increase in inflation and an expansion in aggregate activity. The central bank can eliminate some of the overheating and some of the excess inflation by tightening monetary policy ($\widehat{i} \uparrow$). But the central bank cannot eliminate undesired inflation completely without causing unemployment. As a result, beyond a certain degree of tightening, the central bank faces a tradeoff between further reducing inflation and causing unemployment.

Lecture 5: Limits to Monetary Easing

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

The Zero Lower Bound on Nominal Interest Rates and Its Macroeconomic Implications

The Zero Lower Bound (ZLB) on the Nominal Interest Rate

The nomninal interest rate is the key policy instrument of the central bank. We saw, for example, that if the economy is hit by a negative demand shock ($\epsilon^d < 0$), then the monetary authority can restore both price stability ($\widehat{\pi} = 0$) and full employment ($\widehat{y} = 0$), by an appropriate cut in interest rates, or monetary easing ($\widehat{i} \downarrow$).

The larger the negative demand shock is, the larger the cut in interest rate required to stabilize the economy will be. If the negative shock is sufficiently large, the required cut in the interest rate caould be so large that its level, i, could be negative.

The problem is that the nominal interest rate cannot be negative. This restriction is known as *the zero lower bound on interest rates* or, in the monetary economics jargon, the ZLB.

Why can't the nominal interest rate be negative? Because if the central bank allowed you to borrow at a negative interest rate, you would borrow an infinite amout of money. To see this, consider the following example. Suppose the interest rate was -4%. Then, you could borrow 1 million dollars and simply wait for one year. At the end of the year, you pay bak your loan, 1 million, plus interest, -40 thousand. That is, you have to pay back to the central bank only 960 thousand dollars. In other words, you made a pure profit of 40 thousand dollars by just sitting on the money you borrowed and without taking any risk. Instead of a million dollars, you could borrow 1 trillion, and you would make even larger profits. In fact, the optimal decision would be to borrow and infinite amount of money. And everybody else would do the same. This is clearly an unsustainable situation for the central bank.

So there is a limit to how low the nominal interest rate, i, can go, and the limit is zero:

$$i \geq 0$$

Since $\widehat{i} = i - \overline{i}$, where $\overline{i}$ is the normal, or long-run, value of i, the ZLB implies that $\widehat{i}$ cannot gove below $-\overline{i}$. So we can express the zero lower bound on i equivalently as

$$\widehat{i} \geq -\overline{i}$$

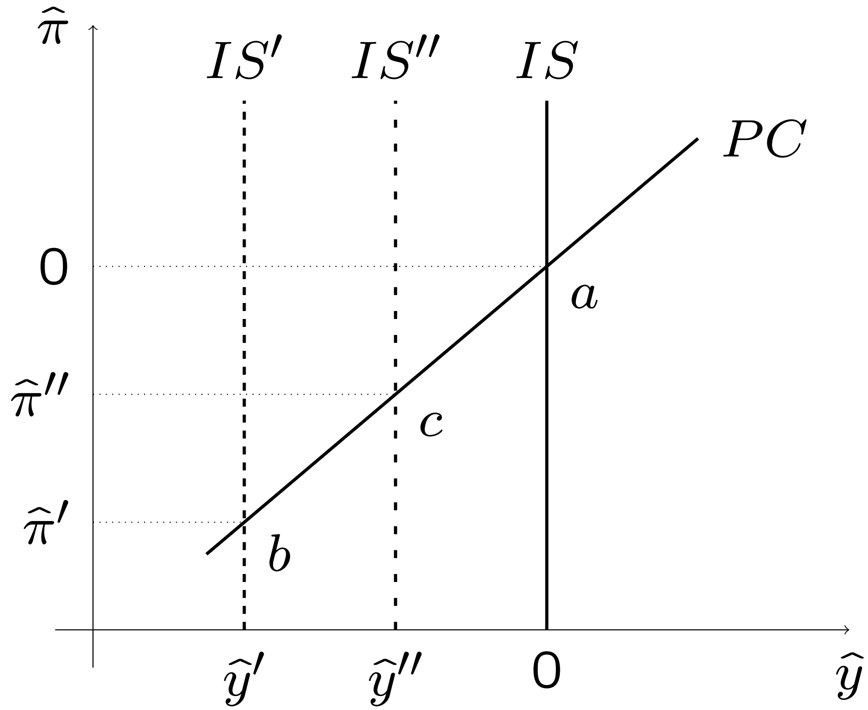
The above two expressions are equivalent, they convey the same restriction.

What are the Macroeconomic Consequences of the ZLB?

The key implication of the zero lower bound on interest rates is that it imposes a limit to the central bank's ability to stabilize the economy.

Consider the case of a large negative demand shock ($\epsilon^d < 0$). For example, the global financial crises of 2008 was arguably triggered by a collapse of prices in the housing market, which caused a large contraction in aggregate demand (more on the GFC later). The situation is depicted in the next figure.

A Large Negative Demand Shock ($\epsilon^d < 0$)



Initially, the economy is at point a, where inflation is at the intended target ($\widehat{\pi} = 0$) and output is at full employment ($\widehat{y} = 0$). Assume that the nominal interest rate is at its normal level ($\widehat{i} = i - \overline{i} = 0$).

Suppose now that the economy is hit by a negative demand shock ($\epsilon^d < 0$). This shock shifts the IS curve to the left to IS', and the new equilibrium is at point b. In the new equilibrium, inflation is below target ($\widehat{\pi}' < 0$) and the economy suffers unemployment ($\widehat{y} < 0$).

The central bank can boost aggregate demand by cutting interest rates ($\widehat{i} < 0$). Monetary easing shifts the IS curve to the right. If the cut in the interest rate is correctly calibrated, the IS curve will return to its original position, IS, and the intended equilibrium a will be restored. However, suppose that the negative demand shock was so large that the interest rate required to attain the intended equilibrium a is negative ($i < 0$ or $\widehat{i} < -\overline{i}$). In this case, the central bank is forced to make a smaller interest rate cut. Specifically, the best the central bank can do is to set the interest rate at zero ($i = 0$ or $\widehat{i} = -\overline{i}$).This smaller cut in the interest rate shifts the IS curve to the right, but not all the way to its original position. In the figure, the IS curve associated with a zero interest rate is labeled IS'',and is located between IS' and IS. After the central bank intervention, the equilibrium is at point c, where the inflation rate is below target ($\widehat{\pi}'' < 0$) and output is below full employment ($\widehat{y} < 0$). In a situation like this, we say that the economy is stuck at the ZLB or that the economy is suffering a *liquidity trap*. A liquidity trap is a situation in which the central bank is making monetary conditions as laxed as possible by setting the interest rate at zero, and nonetheless the economy suffers unemployment and the inflation rate is below the inflation target and possibly negative.

A Numerical Example

Let the Phillips curve be

$$\hat{\pi} = \beta\hat{\pi}^e + \kappa\hat{y} + \epsilon^{cp}$$

and the IS curve be

$$\hat{y} = -\gamma(\hat{i} - \hat{\pi}^e) + \epsilon^d$$

Suppose that
- $\beta = 0.75$, $\kappa = 1$, and $\gamma = 0.5$.
- There are no cost-push shocks, $\epsilon^{cp} = 0$.
- Inflationary expectations are anchored, $\hat{\pi}^e = 0$.
- The normal level of the nominal interest rate is 3 percent, $\bar{i} = 3$.
- The economy suffers a large negative demand shock of 10 percent, $\epsilon^d = -10$.
- Before the shock, the nominal interest rate is at its normal level, $\hat{i} = 0$, or, equivalently, the nominal interest rate is 3 percent, $i = 3$.

Let's calculate the equilibrium values of output, inflation, and the nominal interest rate under 2 alternative policy responses:

(1) The central bank does not intervene.

(2) The central bank intervenes to get as close as possible to its dual goal of price stability and full employment.

1. No policy intervention

Under no intervention, we have that $\widehat{i} = 0$.

From the IS curve, we then have that
$\widehat{y} = -\gamma(\widehat{i} - \widehat{\pi}^e) + \epsilon^d = \epsilon^d = -10$.
The negative demand shock generates a large economic contraction of 10 percent of output.

From the Phillips curve, we have that
$\widehat{\pi} = \beta\widehat{\pi}^e + \kappa\widehat{y} + \epsilon^{cp} = \kappa\widehat{y} = 1 \times (-10) = -10$.
The contraction in aggregate demand causes a large fall in inflation, bringing it 10 percentage points below the intended target.

The results we obtain are in line with those derived with the graphical approach. A negative demand shock causes recession and a fall in inflation.

2. The central bank intervenes to try to achieve Its dual Goal

In performing this calculation, we must be careful and check whether, in trying to bring about price stability and full employment, the central bank is or is not constrained by the ZLB. To this end, we will first calculate the nominal interest rate that brings about price stability and full employment, without considering the ZLB. If the resulting interest rate is positive, then we are done. If it is negative, we will need to set $i = 0$ and recompute the equilibrium.

(a) Equilibrium Not Taking the ZLB Into Account
We know that if we don't take the ZLB into account, the central bank can achieve both price stability and full employment ($\widehat{\pi} = \widehat{y} = 0$). Let's compute the value of $\widehat{i}$ that achieves this outcome. If $\widehat{y} = 0$, then the IS curve implies that
$0 = -\gamma(\widehat{i} - \widehat{\pi}^e) + \epsilon^d = -0.5(\widehat{i} - 0) - 10 \Rightarrow \widehat{i} = -20$.
The central bank must set the interest rate 20 percentage points below its normal value, $i - \bar{i} = -20$. Since the normal value of the interest rate is 3 percent, we have that the level of the interest rate is $i = -20 + \bar{i} = -20 + 3 = -17 < 0$.

Thus, achieving the central bank's dual goal requires setting the nominal interest rate below zero, which violates the ZLB. So this cannot be the equilibrium.

(b) Equilibrium with the ZLB Binding

The best the central bank can do in this situation is to set the interest rate at its minimum possible value.
So let's set $i = 0$ so that $\widehat{i} = i - \bar{i} = 0 - 3 = -3$. Then, from the IS curve, we have
$\widehat{y} = -\gamma(\widehat{i} - \widehat{\pi}^e) + \epsilon^d = -0.5(-3 - 0) - 10 = -8.5$ The negative demand shock generates a large contraction in aggregate activity of 8.5 percent, and the central bank cannot avoid it, because it has its hands tied by the ZLB. The contraction, though, is somewhat smaller than the one that occurs in the absence of central bank intervention.

To obtain the inflation rate, use the Phillips curve
$\widehat{\pi} = \beta\widehat{\pi}^e + \kappa\widehat{y} + \epsilon^{cp} = 1 \times (-8.5) = -8.5$.
The central bank cannot achieve its goal of price stability, as the equilibrium rate of inflation is 8.5 percentage points below its intended target. The central bank would like to further ease monetary conditions, but it is limited by the zero bound on nominal interest rates. The fall in inflation, though, is not as large as in the absence of intervention.

Summing Up

• In general, in response to negative demand shocks, the central bank can achieve both price stability and full employment by lowering interest rates. So one instrument suffices to achieve both goals.

• But if the negative demand shock is too large, the required interest rate cut might bring the nominal interest rate below zero, which is impossible. In this case, the ZLB binds.

• When the ZLB is binding, the central bank cannot achieve its dual goal, and both inflation and output fall below their intended targets. An equilibrium in which the nominal interest rate is 0 and nevertheless the economy is in recession and inflation is below target is called *a liquidity trap.*

Lecture 6
The ZLB and the inflation target

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Let's Recap

Last class we established that, in general, when faced with negative demand shocks, the central bank can simultaneously ensure price stability and full employment by reducing the interest rate. However, we also showed that if the demand shock is sufficiently severe, then the necessary rate cut may push the nominal interest rate below zero, which is not feasible. In this situation, the zero lower bound (ZLB) becomes a binding constraint. We showed that when the ZLB is binding, the central bank is unable to fulfill its dual mandate, leading to both inflation and output falling short of their targets.

We said that an equilibrium in which the nominal interest rate is as low as it can be (that is, the central bank is providing liquidity as cheaply as possible) and nonetheless the economy remains in recession and inflation is below target is known as a *liquidity trap.*

In this lecture we begin by examining an important episode of a liquidity trap: the global financial crisis of 2008.

We then ask how much room the central bank has to lower interest rates and what factores determine this room.

The Global Financial Crisis of 2008

Starting in the fourth quarter of 2007, the U.S. economy suffered a large financial crisis, which then spread around the world. Arguably, the crisis was triggered by a significant boom-and-bust cycle in the housing market. The boom was largely fueled by the development of the "subprime" market in the early 2000s. This market provided people with weak creditworthiness access to cheap mortgage loans. These new types of mortgage contracts included, among other soft terms, low or even negative down payments and "teaser" rates (i.e., adjustable interest rates that started low but increased after a few years).

During this period, lenders did not perceive subprime mortgages as risky because house prices were expected to continue rising. Since the collateral of a mortgage contract is the house itself, loans appeared to be safe assets in a context of increasing house prices.

An additional problem arose from a financial innovation that consisted in bundling these low-quality loans with other mortgage loans to create new assets that were difficult to price accurately but that, during the boom, were traded as safe assets: Small banks issued subprime mortgages and sold them to larger financial institutions, which bundled them and sold the resulting mortgage-backed securities (MBS) to other financial entities. MBS were highly rated due both to the perceived ever-increasing strength of the real estate market and to the belief that pooling many mortgages diversified away the risk of individual borrower defaults.

In 2007, however, many borrowers with adjustable-rate loans could no longer afford their payments as interest rates on these obligations began to rise. Recall that many mortgage contracts featured very low initial teaser rates that reset to higher levels after a few years; these resets began to take effect around 2007. This development led to a wave of property sales and triggered a collapse in the housing market.

Thus, ex post, default risk in mortgages turned out to be systemic rather than idiosyncratic, and MBS became highly risky assets. Many financial institutions that had invested heavily in MBS faced severe distress. Fearing that these institutions would be unable to meet their obligations, depositors began to withdraw funds en masse.

In September 2008, Lehman Brothers (which held a large portfolio of MBS) went bankrupt, generating panic in global financial markets. Several other major financial institutions also failed (Washington Mutual, IndyMac Bank, among others), while others had to be rescued by the government to avoid collapse (Bear Stearns, AIG, Fannie Mae, and Freddie Mac, among others).

Macroeconomic Consequences of the GFC

The three figures below display the evolution of U.S. output growth, inflation, and the nominal interest rate during the global financial crisis. A number of observations are worth pointing out:

1. The financial meltdown caused a collapse in the aggregate demand for goods and services. As a consequence, the United States fell into a deep recession starting in 2007:Q4. At the trough of the contraction in mid-2009, output per capita fell by 5 percent in year-on-year terms. Recalling that the average growth rate of output is about 2 percent, this is a large contraction (7 percentage points below average).

2. Note that after the trough, output *growth* recovered relatively quickly, but the *level* of output remained below trend. In order for the level of output to return to its pre-crisis trend, the growth rate of output should have been significantly above its average level of 2 percent for several quarters. But this didn't happen. Compare this pattern to the one observed during the Covid recession (Lecture1.pdf), where the level of output did return to its trend path, as output growth was highly negative in 2020:Q2, but highly positive in 2020:Q3.

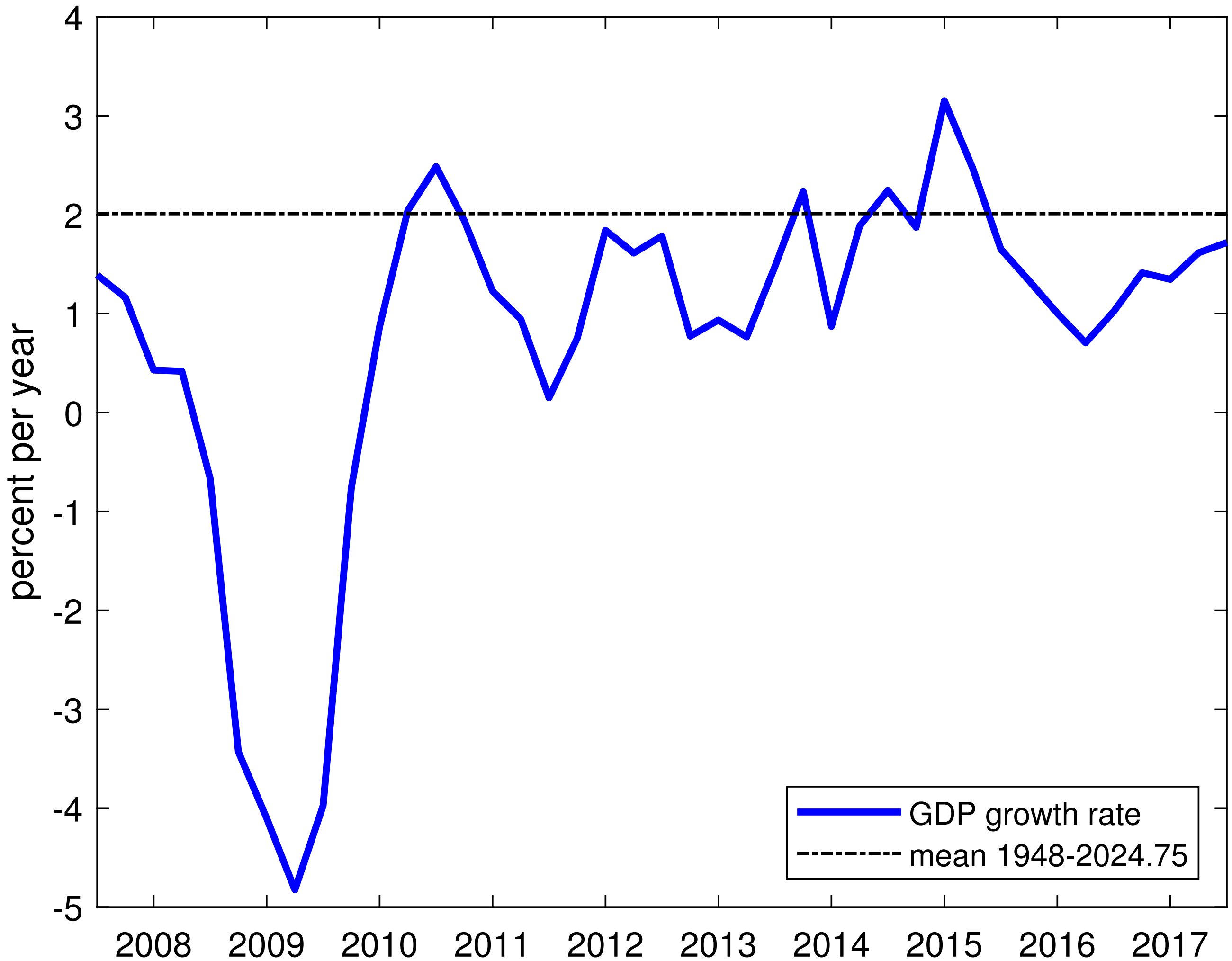
3. The collapse in aggregate demand brought inflation down significantly below the intended target of 2 percent. By late 2010, inflation riched its lowest value of almost 0.

4. The Fed reacted quickly, by bringing the nominal interest rate it targets for policy purposes (called the federal funds rate) drastically down to a level very

close to 0. The ZLB was technically binding. The economy wasin a liquidity trap: output running below trend, inflation way below target, and monetary conditions as laxed as possible.

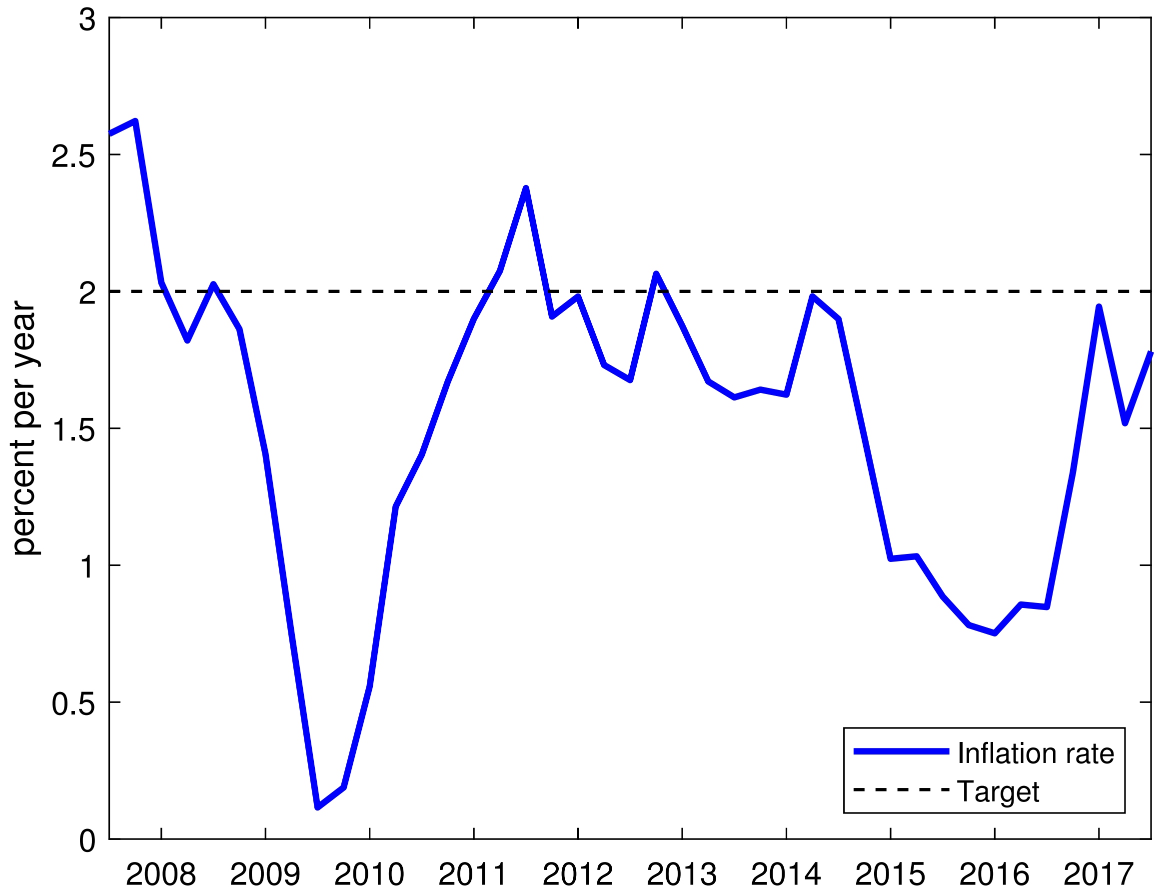
4. The Fed also engaged in other emergency policies called non-conventional monetary policy. We already mentioned that it rescued a number of financial institution that were at the brink of bankrupcy. The Fed also embarked in large-scale asset purchases, a policy commonly referred to as quantitative easing (QE). Among the assets it purchased were Treasury bonds, mortgage-back securities, and bonds issued by government-sponsored enterprises.

Growth Rate of Real U.S. GDP per Capita 2007:Q3 to 2017:Q3, percent per year



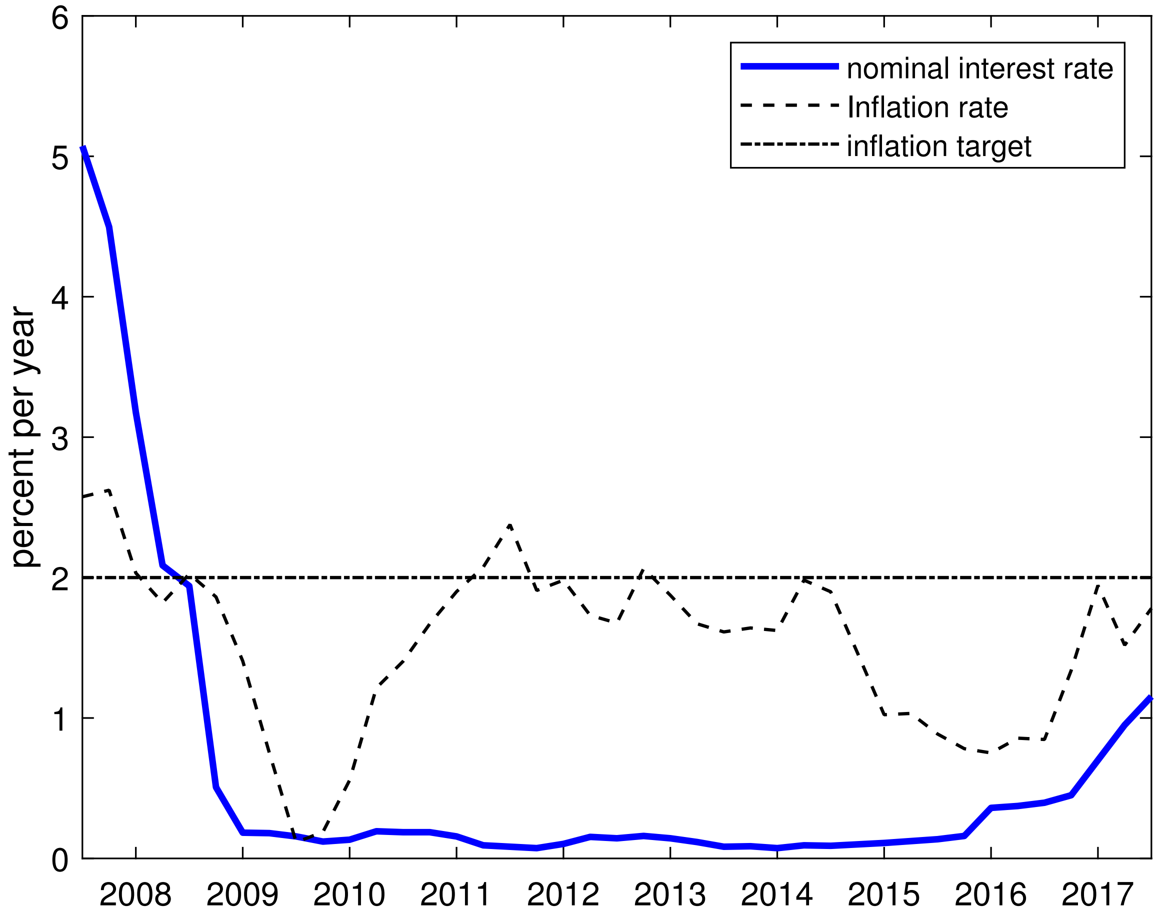
Source: FRED. Year-over-year rate.

U.S. Inflation
2007:Q3 to 2017:Q3, percent per year



Notes. Inflation is measured as the growth rate of the GDP deflator. Year-over-year rate. Source: FRED.

U.S. Nominal Interest Rate
2007:Q3 to 2017:Q3, percent per year



Notes. The nominal interest rate is measured by the federal funds rate. Source: FRED.

How Much Room for Maneuver Does the Central Bank Have?

Start with a situation in which the economy is not being hit by any shock ($\epsilon^d = \epsilon^{cp} = 0$), and inflation expectations are anchored at the inflation target ($\widehat{\pi}^e = \pi^e - \bar{\pi} = 0$). We already established that under these conditions the central bank can achieve the intended equilibrium, $\widehat{\pi} = \widehat{y} = 0$, by setting $\widehat{i} = 0$, that is, by setting the nominal interest rate at its normal value:

$$i = \bar{i}.$$

This means that in this situation, the nominal interest rate is at a distance $\bar{i}$ from the zero lower bound. If the economy is hit by a negative shock, the central bank can cut the nominal interest rate by $\bar{i}$ before hitting the ZLB. It follows that the higher is $\bar{i}$, the larger will be the interest rate cut the central bank can implement in response to a negative shock without being constrained by the ZLB. The question then is what determines the normal nominal interest rate $\bar{i}$?

The Fisher Equation

Under normal circumstances, the nominal interest rate must compensate savers for two things. First, it must protect savings from future expected inflation. Under normal circumstances, inflation expectations are anchored around the central bank's inflation target, that is, $\pi^e = \bar{\pi}$. We then have that the normal level of the nominal interest rate, $\bar{i}$, is at least as high as the inflation target $\bar{\pi}$.

In addition to protecting savers against future expected inflation, the normal interest rate must provide them with real compensation for their willingness to postpone current consumption. We will refer to this compensation as the normal real interest rate and denote it $\bar{r}$. Thus, under normal circumstances, the nominal interest rate will be

$$\bar{i} = \bar{r} + \bar{\pi}. \tag{1}$$

This condition ensures that, under normal circumstances, if you save the equivalent of one unit of goods today, then at the end of the investment period the bank will return to you the equivalent of $1 + \bar{r}$ units of goods.

Example: Suppose you have 100 dollars and that one pizza costs 25 dollars. Then, today you have the equivalent of 4 pizzas. Suppose that the inflation target is 2 percent ($\bar{\pi} = 2$) and that the normal real interest rate is 1 percent ($\bar{r} = 1$). Suppose that the economy is in normal times (no shocks and inflation expectations are anchored). Then people expect that inflation next year will be equal to the inflation target ($\pi^e = \bar{\pi} = 2$), and the interest rate will be equal to its normal level of 3 percent ($\bar{i} = \pi^e + \bar{r} = 2 + 1 = 3$). If you deposit the \$100 in the bank, then next period you will receive \$103. Also, next period a pizza is expected to cost 2 percent more than today, or $25.5. Thus, with your $103 you will be able to buy about 4.04 pizzas, which is about 1 percent more pizzas than you can buy with $100 today. In short, the interest rate not only protects your savings against expected inflation, but it also rewards your willingness to postpone the consumption of pizzas for one year by allowing you to buy a little more pizza next year.

The rlationship stating that under normal circumstances the nominal interest rate is the sum of the real interest rate and expected inflation, $\bar{i} = \bar{r} + \pi^e$, is known as the *Fisher equation*, after the American economist Irving Fisher, who was the first to notice that under normal circumstances the nominal interest rate compensates savers for expected inflation and for postponing consumption.

The Inflation Target and the ZLB

The normal real interest rate $\bar{r}$ is not under the control of the government. It is determined by factors that govern the long-run evolution of the real economy, such as technological progress and demographics. Thus, for the purpose of analyzing business-cycle fluctuations, that is, expansions and contractions in aggregate activity lasting around 6 or seven years from peak to peak (or from trough to trough), we will regard $\bar{r}$ as an exogenous parameter (i.e., as a fixed number determined outside of the NK model).

On the other hand, the inflation target, $\bar{\pi}$, is entirely a decision of the central bank. For example, in 2012, the Fed announced that its official inflation target would be 2 percent. This target remains in place today.

Since the normal interest rate is the sum of the inflation target and the normal real interest rate, $\bar{i} = \bar{\pi} + \bar{r}$, we have that the larger is the inflation target, the larger the normal interest rate will be.

Recalling that the larger is $\bar{i}$, the larger is the cut in the interest rate the central bank can implement in response to a negative shock without hitting the ZLB, it follows that the larger the inflation target $\bar{\pi}$, the less likely it is that the central bank becomes stuck at the ZLB. In fact, one reason (among others) why the Fed set its inflation target at 2 percent rather than at a lower level, such as 0, is that 2 percent gives it more room for monetary policy intervention.

To illustrate this point, suppose, for example, that the normal real interest rate is 1 percent, or $\bar{r} = 1$. Then, if the inflation target were 0 ($\bar{\pi} = 0$), then the normal nominal interest rate would be $\bar{i} = \bar{r} + \bar{\pi} = 1 + 0 = 1$. Thus, starting from a normal situation in which the nominal interest rate equals the normal nominal interest rate, $i = \bar{i} = 1$, in response to a negative shock the central bank could lower the nominal interest rate by only 1 percentage point before being constrained by the zero lower bound. If instead the inflation target were 2 percent, $\bar{\pi} = 2$, then the normal nominal interest rate would be 3 percent, $\bar{i} = \bar{r} + \bar{\pi} = 1 + 2 = 3$. Consequently, again starting from a normal situation in which the interest rate equals the normal interest rate, $i = \bar{i} = 3$, if the economy were hit by a large negative shock, the central bank could lower the interest rate by 3 percentage points before hitting the ZLB.

What Determines the Inflation Target?

If a higher inflation target gives the central bank more room to stabilize the economy, why doesn't it set its inflation target much higher than 2 percent, say 10 percent? The reason is that inflation is bad for the economy in many respects.

For example, inflation erodes the income of those who don't have the ability to protect themselves against it. These are people who don't have adequate access to financial markets (e.g., don't have a bank account or an account in an asset management company like Vanguard) and therefore cannot invest in interest-bearing financial instruments, which provide protection against inflation. These are typically low income families.

Inflation also damages the system of relative prices. In a high inflation environment it is difficult to tell whether a given increase in the price of a good reflects real forces, such as a contraction in supply or an expansion in demand, or is simply the consequence of inflation. This malfunctioning of the price system, in turn, can negatively affect economic performance, because prices represent signals that convey information about the relative scarcity or abundance of factors of production and people's tastes, thereby representing the key mechanism through which the allocation of resources and consumption are organized.

In setting its inflation target, therefore, the central bank must negotiate a tradeoff between having more room to stabilize the economy and minimizing deleterious effects of inflation of the type just discussed.

Summing Up

• How much room the Fed has to implement monetary policy depends on the long run or normal level of the nominal interest rate, $\bar{i}$.

• According to the Fisher equation, $\bar{i}$ is the sum of the normal level of the real interest rate and the normal level of inflation expectations.

• The normal real interest rate $\bar{r}$ is determined by long-run factors, such as technological progress and demographic trends. Thus, for the purpose of analyzing booms and recessions taking place at business-cycle frequency, the normal level of the $\bar{r}$ can be taken as given.

• The long-run or normal level of inflation expectations, if well anchored, are equal to the central bank's inflation target, $\bar{\pi}$.

• Thus, the larger the inflation target, the larger the room for the central bank to lower interest rates without hitting the ZLB.

• In determining its inflation target, the central bank balances the benefit of having more maneuver to lower interest rates in response to negative shocks against the negative effects of inflation on the functioning of the economy.

- When the ZLB is binding, additional policy tools, such as quantitative easing (QE) and forward guidance (i.e., the central bank's commitment that it will keep interest rates low for an extended period to support economic recovery), may be necessary to stimulate the economy.

Lecture 7
Rules Versus Discretion

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

What does rules Versus discretion mean?

Thus far, we have studied the actions of a central bank that, depending on the state of the economy, decides what action to take with respect to its policy instrument, the nominal interest rate i.

In this policy framework, the central bank applies its judgment on a situation by situation basis. This policy arrangement is known as *policy discretion*. A different monetary framework is one in which the central bank follows a rule that stipulates in advance what to do in each situation. Both policy approaches have advantages and disadvantages. The main advantage of following a rule is time consistency and credibility. Adhering to a rule reduces the central bank's temptation to deviate from its mandate. Also, if the public receives a clear message of what the central bank will do under each situation, it helps anchoring inflation around the central bank's target. On the other hand, rules can be too rigid at times. For example, a rule can be designed to work well under regular circumstances, that is, in response to shocks that are not too large. But they might not work well under unusual circumstances when the economy is hit by large shocks, like the collapse of the subprime housing market in 2007, or unknown shocks, like the Covid-19 pandemic. Under this type of situations, applying discretion might be beneficial.

In this lecture, we study how the economy functions when the central bank follows a rule.

The Taylor Rule

The best known rule in monetary economics is the *Taylor rule*. According to this rule, the central bank sets the deviation of the nominal interest rate from its normal value, $\widehat{i}$, as an increasing function of the deviation of the inflation rate from the inflation target, $\widehat{\pi}$, and the output gap, $\widehat{y}$. The rule also allows for the possibility that the central bank deviates from the rule from time to time in a random fashion. These deviations are known as *monetary shocks*.

Formally, the Taylor rule takes the form

$$\widehat{i} = \alpha_\pi \widehat{\pi} + \alpha_y \widehat{y} + \epsilon^m \tag{1}$$

Here, α_π and α_y are positive parameters, and ϵ^m is the monetary shock.

This rule is named after John Taylor, who in 1993 estimated econometrically that it represents well monetary conduct in the United States, especially during the Volcker and Greenspan tenures.

The Inflation Coefficient of the Taylor Rule

Taylor estimated empirically that the inflation coefficient of the Taylor rule is greater than 1,

$$\alpha_\pi > 1.$$

When this condition is satisfied, we say that monetary policy is *active*, and when it is not satisfied ($\alpha_\pi < 1$), we say that monetary policy is *passive*.

Since Taylor's estimation, a large literature has argued on theoretical grounds, i.e., using models, that a value of α_π greater than 1 is indeed conducive to macroeconomic stability. The idea is as follows: Suppose inflation rises above the target, because, say, of a demand shock ($\epsilon^d \uparrow$). If the Fed increases the interest rate by more than the increase in inflation, $\alpha_\pi > 1$, then $i - \pi$, which is a proxy for the real interest rate, increases. In turn, the increase in the interest rate reduces aggregate spending, the economy cools down and inflation falls, which is what the Fed intended.

If instead the Fed increases the interest rate by less than inflation, $\alpha_\pi < 1$, then the proxy for the real interest rate, $i - \pi$, falls instead of increasing, and aggregate demand does not fall to induce a cooling down of the economy and a return of inflation to its intended target.

Note that in this explanation we talk of $i - \pi$ as a proxy for the real interest rate. We use the term "proxy" because the real interest rate is not $i - \pi$, but $i - \pi^e$. So the argument given above for why the condition $\alpha_\pi > 1$ is stabilizing is merely meant to convey the intuition behind this property.

Shortly, we will discuss further the stabilizing properties of a relatively high value of α_π.

The Output Coefficient of the Taylor Rule

The output coefficient of the Taylor rule, α_y, is assumed to be positive. The intuition for why a positive value for α_y is stabilizing is as follows. Suppose that $\widehat{y}$ is positive, that is, output increases above its full employment level. This could be the consequence, again, of a positive demand shock ($\epsilon^d \uparrow$). If upon observing that the economy is overheating, the Fed increases the interest rate, $\alpha_y > 0$, then aggregate demand falls, the economy cools down, and the output gap tends to return to its intended level $\bar{y}$.

A typical parameterization of the Taylor rule is one in which α_π is around 1.5 and α_y is about 0.125. Under this parameter values, the Taylor rule looks like this,

$$\widehat{i} = 1.5\widehat{\pi} + 0.125\widehat{y} + \epsilon^m$$

Monetary Shocks

The term ϵ^m in the Taylor rule is called *monetary shock*. This object is meant to capture deviations from the rule.

These deviations are typically modeled as exogenous and random. They could capture a variety of factors such as

• non-systematic disagreements among members of the board of governors of the central bank.

• random errors measuring $\widehat{\pi}$ or $\widehat{y}$

• The Fed responding to factors that are non-economic in nature, such as local or global political instability.

when ϵ^m is positive, we say that a *contractionary monetary shock has occurred*, because, all else equal, such a shock leads to a monetary tightening ($\widehat{i} \uparrow$). Similarly, if ϵ^m is negative, we say that an *expansionary monetary shock* has occurred.

The three-equation NK model

With the Taylor rule, the NK model becomes a three-equation system:

1. The Phillips curve
$\widehat{\pi} = \beta \widehat{\pi}^e + \kappa \widehat{y} + \epsilon^{cp}$

2. The IS curve
$\widehat{y} = -\gamma(\widehat{i} - \widehat{\pi}^e) + \epsilon^d$

3. The Taylor rule
$\widehat{i} = \alpha_\pi \widehat{\pi} + \alpha_y \widehat{y} + \epsilon^m$

Two features of the three-equation NK model are worth noting: (a) The nominal interest rate is no longer an exogenous variable, but an endogenous one. That is, $\widehat{i}$ is now determined by the model, not outside of the model. Before the introduction of the Taylor rule, the central bank was assumed to have discretion in setting the interest rate, so it applied its own judgment on a case by case basis. Now, the central bank follows a rule, and the nominal interest rate is determined jointly with output and inflation. Thus, now we have three equations in three unknowns, $\widehat{\pi}$, $\widehat{y}$, and $\widehat{i}$.

(b) The three-equation NK model features three shocks. In addition to the demand shock, ϵ^d, and the cost-push shock, ϵ^{cp}, we now have the monetary shock, ϵ^m, given by the non-systematic component of the Taylor rule.

The modified IS curve

Use the Taylor rule to eliminate the nominal interest rate from the IS curve. This yields

$$\widehat{y} = -\gamma(\alpha_\pi \widehat{\pi} + \alpha_y \widehat{y} + \epsilon^m - \widehat{\pi}^e) + \epsilon^d$$

Now collect all terms containing $\widehat{y}$ on the right-hand side and the term containing $\widehat{\pi}$ on the left-hand side. This gives

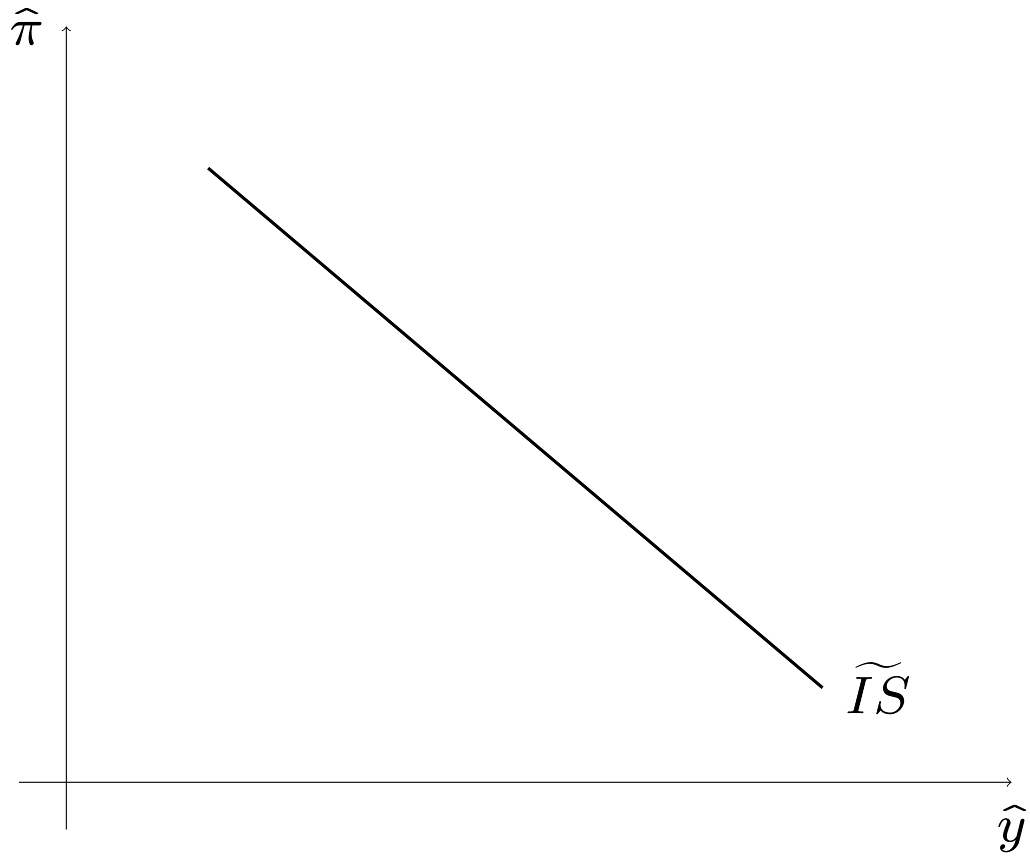
$$\gamma\alpha_\pi \widehat{\pi} = -\widehat{y} - \gamma\alpha_y \widehat{y} + \gamma\widehat{\pi}^e - \gamma\epsilon^m + \epsilon^d$$

Finally. solve for $\widehat{\pi}$ to get

$$\widehat{\pi} = -\frac{1 + \gamma\alpha_y}{\gamma\alpha_\pi}\widehat{y} + \frac{1}{\alpha_\pi}\widehat{\pi}^e - \frac{1}{\alpha_\pi}\epsilon^m + \frac{1}{\gamma\alpha_\pi}\epsilon^d \tag{2}$$

We will call this equation the modified IS curve.

The modified IS s Curve



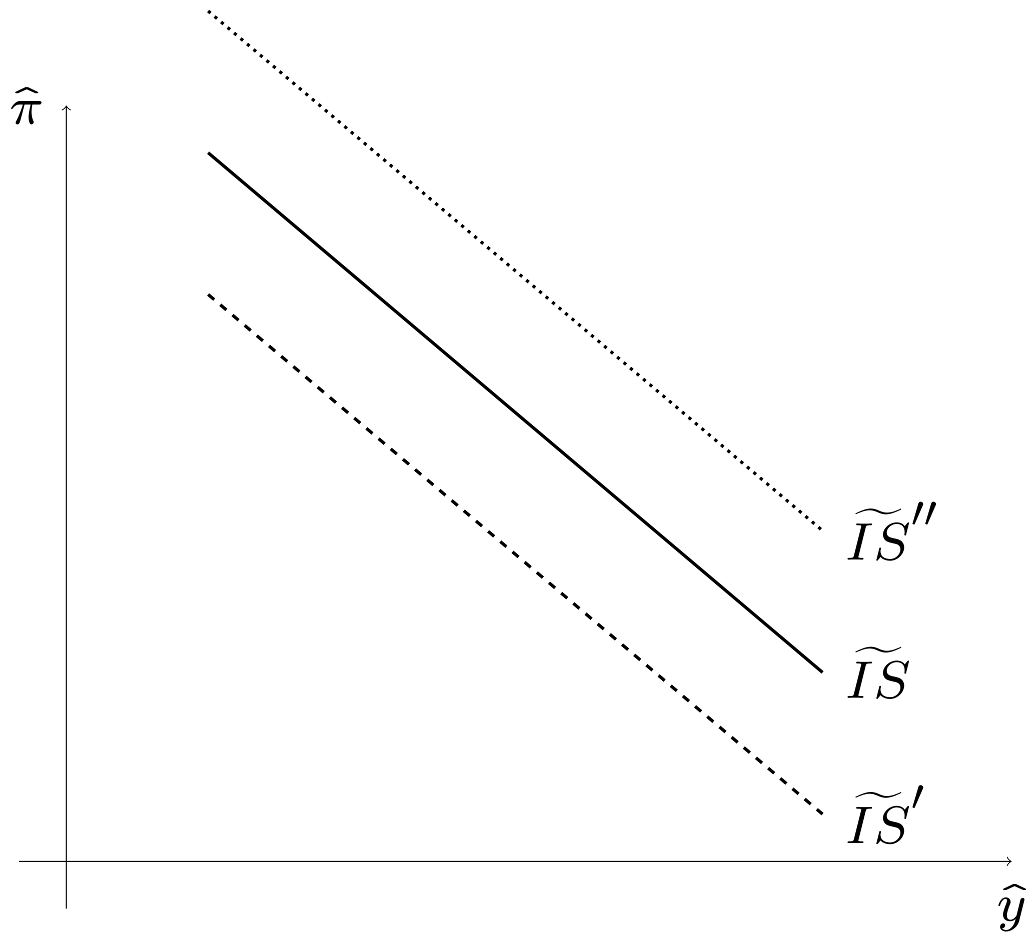
The figure depicts the function $\widehat{\pi} = -\frac{1+\gamma\alpha_y}{\gamma\alpha_\pi}\widehat{y} + \frac{1}{\alpha_\pi}\widehat{\pi}^e - \frac{1}{\alpha_\pi}\epsilon^m + \frac{1}{\gamma\alpha_\pi}\epsilon^d$ in the space $(\widehat{y}, \widehat{\pi})$.

The modified IS curve, labeled $\widetilde{IS}$ in the figure, is a downward sloping curve. All else equal, an increase in the output gap ($\widehat{y}\uparrow$) is associated with lower inflation ($\widehat{\pi}\downarrow$).

The slope of the modified IS curve is the coefficient in front of the output gap, $-\frac{1+\gamma\alpha_y}{\gamma\alpha_\pi}$. The larger is this coefficient in absolute value, the steeper the modified IS curve will be.

Note that both parameters of the Taylor rule, α_π and α_y, enter in the slope of the modified IS curve. The higher is the inflation coefficient of the Taylor rule, α_π, the flatter the Taylor rule will be. Also, the larger the output coefficient of the Taylor rule, α_y, is, the steeper the modified IS curve will be.

Shifters of the modified IS curve (ϵ^m, ϵ^d, and $\widehat{\pi}^e$)



The original modified IS curve is the solid line. A contractionary monetary shock ($\epsilon^m \uparrow$) or a negative demand shock ($\epsilon^d \downarrow$) shifts the modified IS curve down and to the left, as shown by the dashed line labeled $\widetilde{IS}'$. An increase in expected inflation

($\widehat{\pi}^e \uparrow$) shifts the IS curve up and to the right, as shown by the dotted line labeled $\widetilde{IS}''$.

Active monetary policy and the modified IS curve

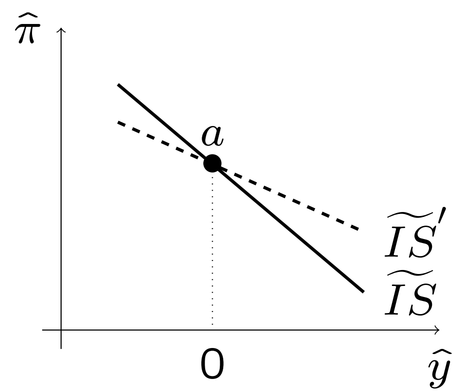
The more active monetary policy is, that is, the higher α_π is, the flatter the modified IS curve will be and the less it will shift in response to demand shocks (ϵ^d), monetary shocks (ϵ^m), or changes in inflationary expectations ($\widehat{\pi}^e$). To see this, let's reproduce the modified IS curve for convenience:

$$\widehat{\pi} = -\frac{1+\gamma\alpha_y}{\gamma\alpha_\pi}\widehat{y} + \frac{1}{\alpha_\pi}\widehat{\pi}^e - \frac{1}{\alpha_\pi}\epsilon^m + \frac{1}{\gamma\alpha_\pi}\epsilon^d \qquad (2)$$

The slope of the modified IS curve is the coefficient in front of $\widehat{y}$,

$$\text{slope of the modified IS curve} = -\frac{1+\gamma\alpha_y}{\gamma\alpha_\pi}$$

The smaller is this coefficient in absolute value, the flatter the modified IS curve will be. Since α_π appears in the denominator of this coefficient, we have that the more active monetary policy is (the larger α_π is), the flatter the modified IS curve will be, as shown in the next figure.



In the figure, the original modified IS curve is the solid line, labeled $\widetilde{IS}$. For simplicity, we assume here that there are no demand or monetary shocks ($\epsilon^d = \epsilon^m = 0$) and that inflationary expectations are anchored ($\hat{\pi}^e = 0$). An increase in α_π causes the modified IS curve to rotate counterclockwise as shown by the dashed line labeled $\widetilde{IS}'$. The rotation occurs at point a, where $\hat{y}$ is nil.

What does it mean that the modified IS curve becomes flatter when α_π increases? It means that the central bank becomes more hawkish—that is, it cares more about inflation—so a given variation in output changes the inflation rate by less. How do we know that a larger α_π means that the central bank is more hawkish? Look again at the Taylor rule (equation (1)). According to the Taylor rule, the larger is α_π the larger will be the increase in the interest rate in response to a given increase in inflation. That is, the larger is α_π, the more the central bank cares about inflation not deviating much from the intended target.

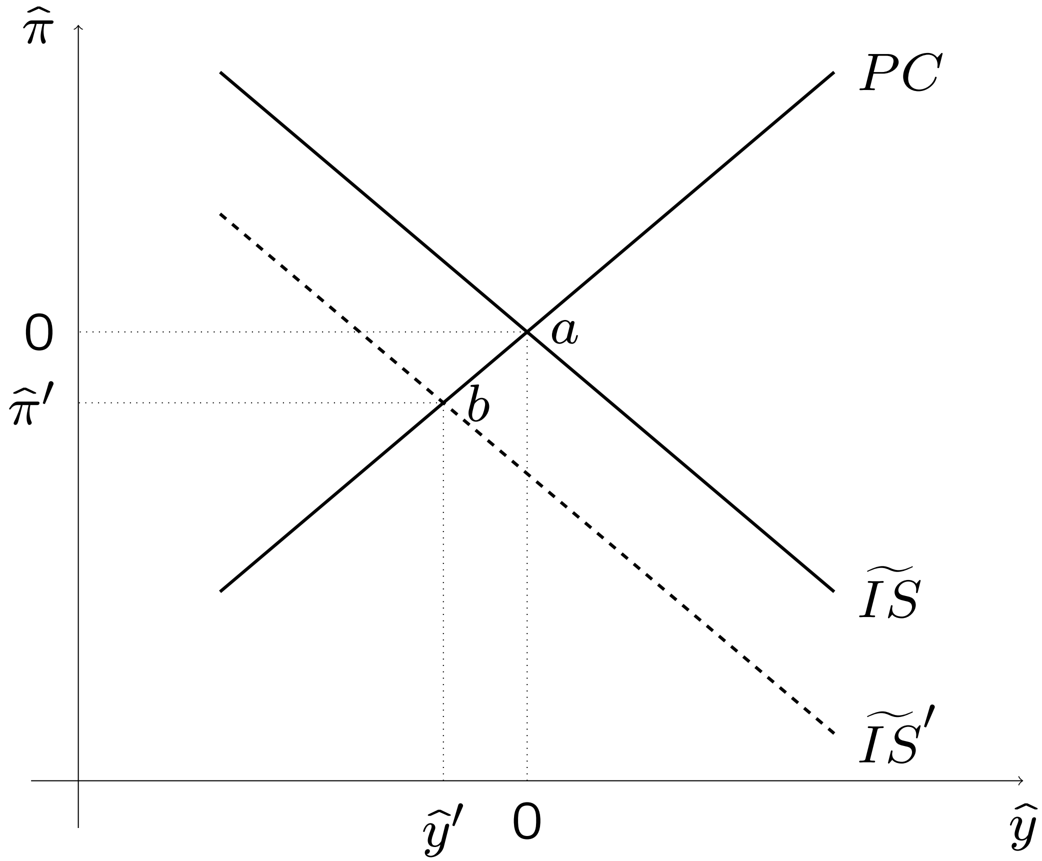
In the extreme case in which $\hat{\pi} \to \infty$, the modified IS curve becomes perfectly flat. In this case, $\hat{\pi}$ becomes independent of $\hat{y}$.

Active Monetary Policy and Shifts in the Modified IS Curve

Take another look at the modified IS curve given in equaiton (2). Note that α_π appears dividing both shocks, the demand shock ϵ^d and the monetary shock ϵ^m. This means that the larger α_π is—that is, the more active monetary policy is—the smaller will be the change in $\widehat{\pi}$ in response to a demand shock or a monetary shock at any given level of $\widehat{y}$. Put differently, a larger value of α_π implies that a given demand or monetary shock causes a smaller shift in the modified IS curve.

In the extreme case in which $\alpha_\pi \to \infty$, all coefficients of the modified IS curve go to zero. As a result, the modified IS curve becomes perfectly flat at $\widehat{\pi} = 0$. In this case, the central bank is so hawkish, that it accepts nothing else but the inflation target.

A negative demand shock ($\epsilon^d \downarrow$)



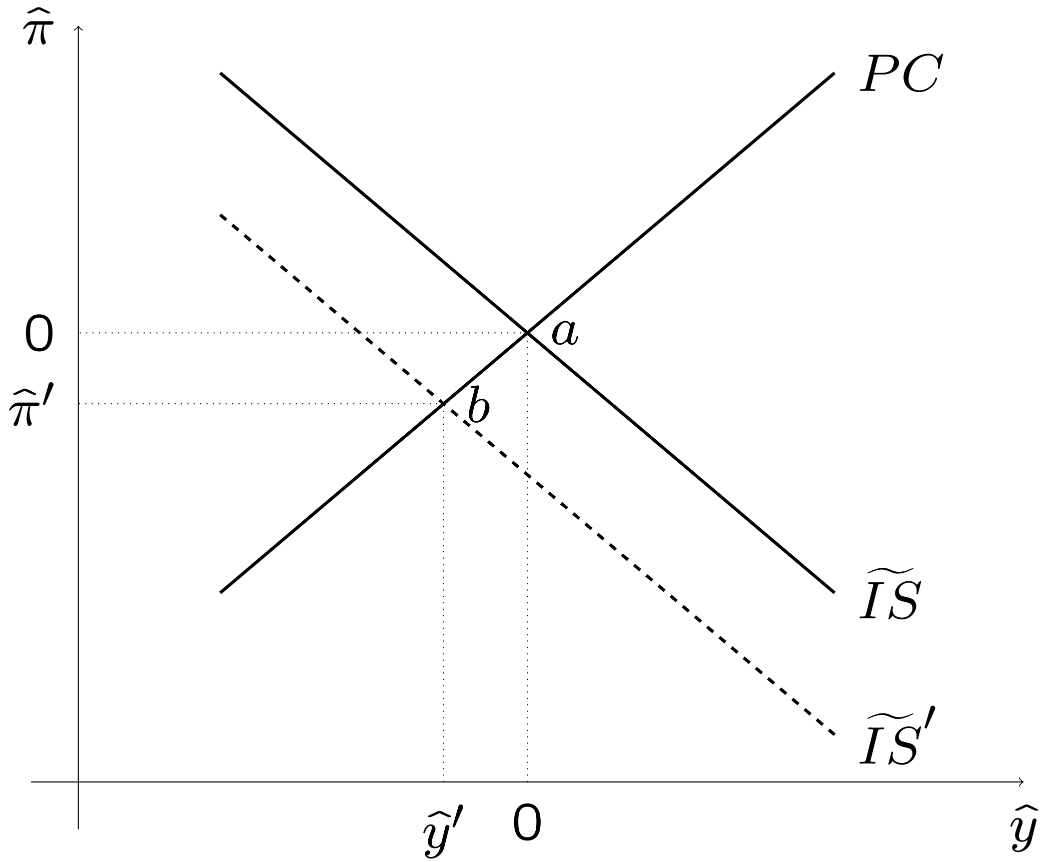
Suppose that initially there are no shocks ($\epsilon^d = \epsilon^m = \epsilon^{cp} = 0$). The original equilibrium is at point a, where the modified IS curve labeled $\widetilde{IS}$ (solid downward sloping line) crosses the Phillips curve labeled PC (solid upward sloping line). At this equilibrium, output is at full employment ($\widehat{y} = 0$) and inflation is at its intended target ($\widehat{\pi} = 0$). Because at point a $\widehat{\pi} = \widehat{y} = 0$ and because there are no monetary shocks ($\epsilon^m = 0$), we know from the Taylor rule given in equation (1) that $\widehat{i} = 0$, that is, the interest rate, i, is at its normal level, $\overline{i}$.

Suppose now that the economy is hit by a negative demand shock ($\epsilon^d < 0$). As we saw, this type of shock can have different origins, such as a pessimistic turn in people's economic outlook or the bursting of a housing market bubble. The negative demand shock shifts the modified IS curve down and to the left to $\widetilde{IS}'$ (dashed downward sloping line) . The modified IS curve shifts to the left because due to the negative demand shock, at any value of the inflation rate, people demand less goods. The new equilibrium is at point b, where the new modified IS curve, $\widetilde{IS}'$ intersects the Phillips curve, PC.

At the new equilibrium, the economy suffers a recession, $\widehat{y}' < 0$, and inflation is below the inflation target, $\widehat{\pi}' < 0$. Note that the central bank does loosen monetary conditions by lowering the interest rate, $\widehat{i} < 0$. We know this because by the Taylor rule (1), if $\widehat{\pi} < 0$, $\widehat{y} < 0$, and $\epsilon^m = 0$, then $\widehat{i} < 0$. However, the monetary easing is not enough to bring the economy back to the intended equilibrium ($\widehat{\pi} = \widehat{y} = 0$). In this regard, a central bank acting with discretion achieves a better outcome, because, as we saw in previous lectures, it can implement an interest rate cut large enough to restore full employment and price stability.

We conclude that following a rule has the advantage of facilitating commitment, credibility, and transparency, but at the cost of the central bank not being able to always implement the best possible monetary intervention.

A contractionary monetary shock ($\epsilon^m \uparrow$)



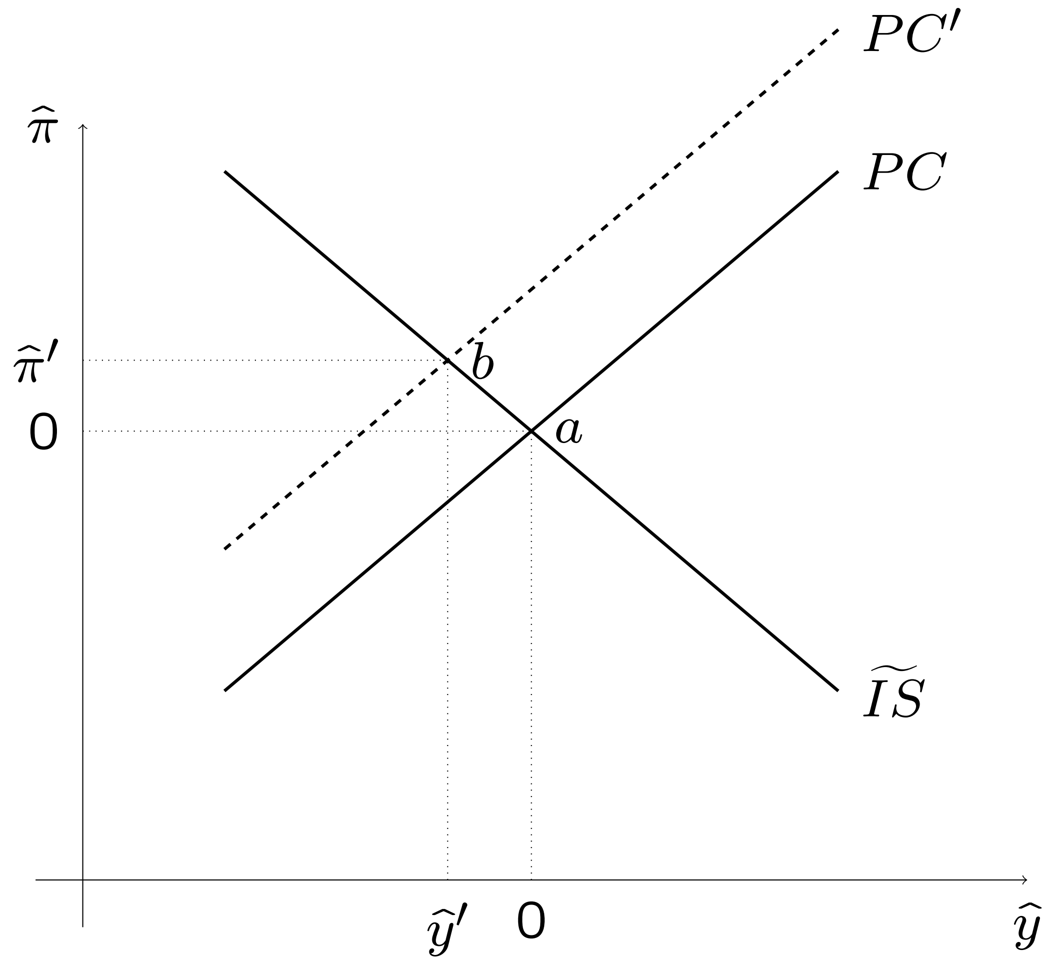
Take a look at the modified IS curve given in equation (2). It is clear that a contractionary monetary shock ($\epsilon^m \uparrow$) has qualitatively the same effect as a negative demand shock ($\epsilon^d \downarrow$). Thus, starting with an initial situation without shocks ($\epsilon^d = \epsilon^m = \epsilon^{cp} = 0$), we have that the original equilibrium is at point a, where the modified IS curve crosses the Phillips curve labeled PC. The economy enjoys full employment ($\widehat{y} = 0$), inflation is at the target ($\widehat{\pi} = 0$), and the interest rate is at its normal level $\widehat{i} = 0$.

A contractionary monetary shock shifts the modified IS curve down and to the left to $\widetilde{IS}'$ (dashed downward sloping line). Intuitively, given inflationary expectations, the monetary tightening ($\epsilon^m \uparrow$) causes an increase in the real interest rate and a contraction in aggregate demand. Thus, at any level of the inflation rate, output is lower. The new equilibrium is at point b, where the new modified IS curve, $\widetilde{IS}'$ intersects the Phillips curve, PC.

At the new equilibrium, the economy suffers a recession, $\widehat{y}' < 0$, and inflation is below the inflation target, $\widehat{\pi}' < 0$.

At the new equilibrium (point b), the interest rate is higher than initially (point a). We know this because the only reason why aggregate demand is lower in this situation is that the interest rate increased (recall that there are no demand or cost-push shocks, $\epsilon^d = \epsilon^{cp} = 0$). By the Taylor rule, the fall in $\widehat{\pi}$ and $\widehat{y}$ tend to lower the interest rate, but the monetary shock, $\epsilon^m \uparrow$, tends to increase it. This latter effect dominates and the interest rate ends up increasing, $\widehat{i} \uparrow$.

A cost-push shock ($\epsilon^{cp} \uparrow$)



Suppose that initially there are no shocks ($\epsilon^d = \epsilon^m = \epsilon^{cp} = 0$). The original equilibrium is at point a, where the modified IS curve labeled $\widetilde{IS}$ (solid downward sloping line) crosses the Phillips curve labeled PC (solid upward sloping line).

At this equilibrium, output is at full employment ($\widehat{y} = 0$) and inflation is at its intended target ($\widehat{\pi} = 0$). Because at point a $\widehat{\pi} = \widehat{y} = 0$ and because there are no monetary shocks ($\epsilon^m = 0$), we know from the Taylor rule given in equation (1) that $\widehat{i} = 0$, that is, the interest rate, i, is at its normal level, $\overline{i}$.

Suppose now that the economy is hit by a cost-push shock ($\epsilon^{cp} > 0$). This type of shock can reflect, for example, an increase in oil prices or a disruption in the global supply chain.

The cost-push shock shifts the Phillips curve up and to the left to PC' (dashed upward sloping line) . The new equilibrium is at point b, where the modified IS curve intersects the new Phillips curve, PC'.

At the new equilibrium, the economy suffers a recession, $\widehat{y}' < 0$, and inflation $\widehat{\pi}' > 0$, that is, the cost-push shock causes stagflation.

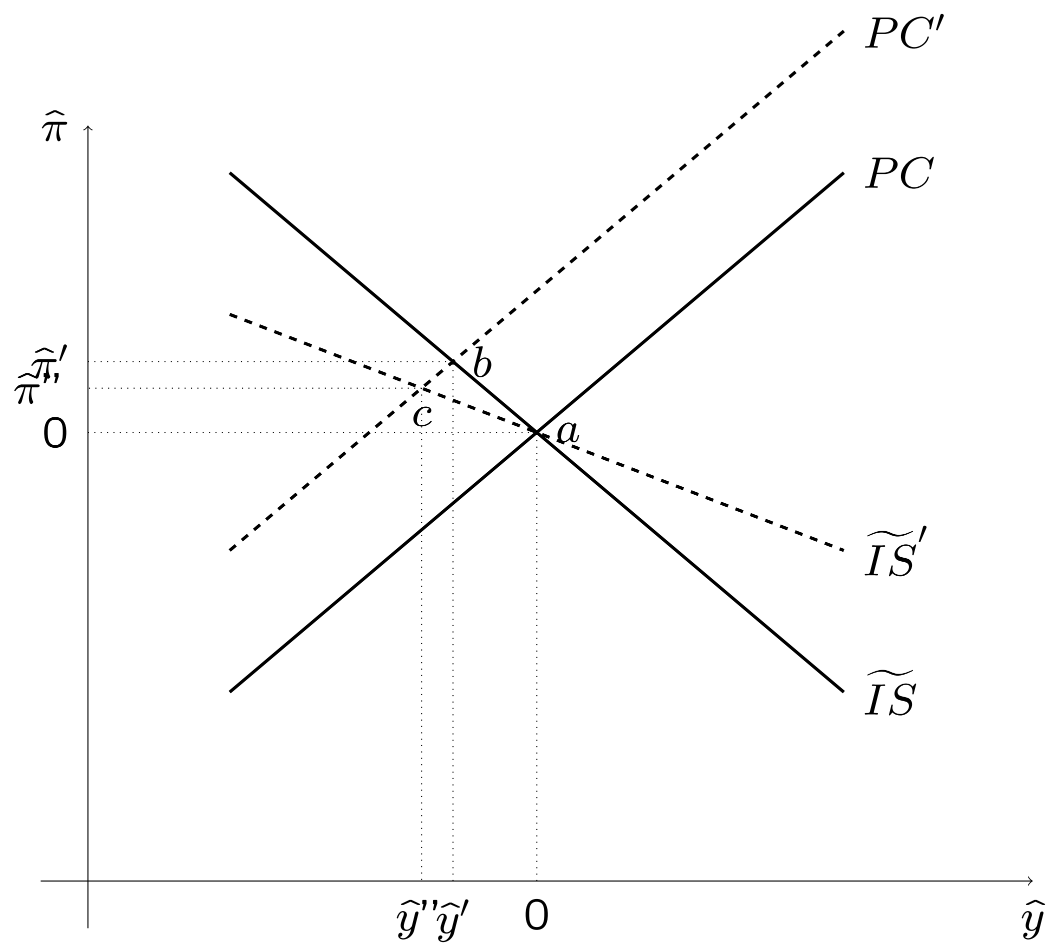
Through the Taylor rule, the central bank increases the interest rate $\widehat{i} > 0$. How do we know this? Recall from previous lectures that if the central bank does not intervene, $\widehat{i} = 0$, a cost-push shock causes inflation but the economy remains at full employment. The fact that here the economy suffers unemployment indicates that the central bank does intervene by raising the interest rate. So the Taylor rule is more hawkish than an ultra dovish central bank that does not intervene (i.e., a central bank that prefers to preserve full employment at the cost of a relatively large spike in inflation).

At the same time, the central bank that follows a Taylor rule is more dovish than the ultra hawkish central bank that prefers to maintain inflation at its target level ($\widehat{\pi} = 0$) at the expense of a relatively large recession. In sum, the Taylor rule represents the taste of a central bank that in response to a cost-push shock decides to tolerate some inflation and some unemployment.

Active Monetary Policy and the Inflation-Unemployment Trade-off

We just saw that in response to a cost-push shock, a central bank that follows a Taylor rule tolerates some inflation ($\widehat{\pi} > 0$) and some unemployment ($\widehat{y} < 0$). But how much of each is it willing to tolerate? The answer depends on how active monetary policy is, that is, how large the inflation coefficient of the Taylor rule α_π is.

We saw earlier that an increase in α_π flattens the modified IS curve. The next figure shows the effect of a cost-push shock for two values of the inflation coefficient α_π.



The original position is at point a. The modified IS curve and the Phillips curve are displayed with solid lines and labeled $\widetilde{IS}$ and PC, respectively. At the original equilibrium inflation is at the intended target and output is at full employment ($\widehat{\pi} = \widehat{y} = 0$). As we saw, the cost-push shock shifts the Phillips curve up and to the left to PC' (dashed upward sloping line), and the new equilibrium is at point b, where the economy suffers stagflation, $\widehat{\pi} > 0$ and $\widehat{y} < 0$.

Consider now a more hawkish central bank, that follows a Taylor rule with a larger inflation coefficient α_π. For this economy, the original equilibrium is also point a. However, the modified IS, depicted with a thick dotted lined denoted $\widetilde{IS}'$, is flatter. The cost-push shock now places the economy at point c, where $\widetilde{IS}'$ and PC' intersect. At this equilibrium, the economy also suffers stagflation ($\widehat{\pi} > 0$ and $\widehat{y} < 0$). However, at point c the increase in inflation is smaller and the contraction in output is larger than at point b. The reason is that the central bank with a larger α_π is more hawkish and favors an equilibrium where inflation deviates less from the target, and output falls more sharply.

Summing Up

• Under discretion, the central bank intervenes on a situation by situation basis. Advantage: interventions are more precise and adapted to the shock being addressed, so more ability to keep the economy at full employment and price stability. Disadvantage:prone to time inconsistencies and deviations from promises or commitments.
• Under a rule, he central bank has an automatic response to each possible situation. Advantage: transparency, time consistency, easier to stick to commitments. Disadvantage: can be too rigid; interventions do not always achieve the best possible outcome.
• The Taylor rule is a rule whereby the interest rate is set as an increasing function of the inflation rate and the output gap. A monetary shock is given by exogenous deviations of the interest rate from this rule.
• Under a Taylor rule, the NK model has 3 equations, and the nominal interest rate is an endogenous variable.
• The IS curve and the Taylor rule jointly give rise to a modified IS curve that is downward sloping in the space $(\widehat{y}, \widehat{\pi})$.
• A negative demand shock ($\epsilon^d < 0$) or a contractionary monetary shock ($\epsilon^m < 0$) both shift the modified IS curve down and to the left. Both shocks cause recession and a fall in inflation. Through the Taylor rule, the central bank lowers the interest rate, but not enough to bring about full employment and price stability. Under discretion. the central bank does cut interest rates enough to achieve these goals. Thus, the rule induces a less desirable outcome than discretion. It follows that gaining credibility, transparency, and commitment through a rule can come at a cost of less desirable outcomes in terms of output and inflation.

• In response to a cost-push shock ($\epsilon^{cp} > 0$), the Taylor rule delivers an equilibrium that is in between the one that obtains under an ultra dovish central bank (full employment and a relatively large inflation hike) and the one that obtains under an ultra hawkish central bank (inflation at the intended target and a relatively large recession). In the resulting equilibrium, the central bank tolerates some inflation and some recession (stagflation). To induce this situation the central bank (always through the Taylor rule) raises interest rates after the cost-push shock.

• The split between inflation and unemployment after a cost-push shock depends on how hawkish or dovish the central bank is, which is governed primarily by the inflation coefficient of the Taylor rule, α_π. The larger is this parameter, the less inflation the central bank will tolerate, at the expense of more unemployment.

Lecture 8
Interference with Central Bank Independence: Two Examples

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Central Bank Independence

Central banks have mandates, typically centered on full employment and price stability, with the latter often understood as maintaining an inflation target.

To achieve these mandates, a central bank must be able to conduct monetary policy independently, free from pressure by the executive branch (e.g., the president or the secretary of the treasury), other branches of government, or external individuals and organizations.

Independence does not imply a lack of communication with, for example, the executive branch, nor does it preclude coordination in certain circumstances. For instance, during the 2007 global financial crisis, both the U.S. Treasury and the Federal Reserve implemented a range of unconventional policies to prevent the collapse of the financial sector from triggering a major depression. Since many of these policy measures were novel and had the potential to overlap, coordination was necessary to avoid duplication.

However, there are instances where the executive branch attempts to pressure the central bank into implementing policies that conflict with its mandates. A common example occurs when a president, particularly in an election year, seeks to influence the central bank to loosen monetary policy to boost employment, even if doing so contradicts the central bank's policy stance. Another example, often observed in high-inflation emerging economies such as Argentina, is when the treasury department runs chronic fiscal deficits and pressures the central bank to finance the shortfall by printing money–despite the central bank's recognition that such actions fuel inflation.

Two Examples of Presidents Meddling with Monetary Policy

We will study two episodes in which the president of the United States interfered with the actions of the Fed.

One example occurred in the early 1970s during the first Nixon administration, and the other more recently during the first Trump administration. (This saga, of course, resumed in his second term, with the same protagonists.)

In both cases, the president put pressure on the chairman of the Fed to ease monetary conditions against the advise of the latter.

In one case the president was able to twist the arm of the Fed chairman and in the other he was not. But in both episodes the pressure exerted by the President on the Fed had significant economic effects.

The papers documenting the two examples employ different research techniques: The paper on the Nixon interference uses a narrative approach, and the paper on the Trump interference uses a high-frequency econometric approach.

How Nixon Pressured Burns*

• The protagonists
Arthur Burns, chairman of the Fed since 1970, appointed by Nixon (former Professor at Columbia, also got there his BA and PhD).
Richard Nixon: president seeking reelection in 1972.

• The state of the economy
Just out of a recession, but unemployment still lingering.

• Source:
Nixon tapes since October 1971.

• The conflict
Richard Nixon demanded and Arthur Burns supplied an expansionary monetary policy and a growing economy in the run-up to the 1972 election.

• Consequences
Nixon won reelection by a landslide.
Inflation rose to two-digit numbers in 1973 and 1974. Arguably, the Nixon interference caused an unanchoring of inflationary expectations.

---

*The discussion of the Nixon interference with monetary policy is based on the paper entitled "How Richard Nixon Pressured Arthur Burns: Evidence from the Nixon Tapes," by Burton A. Abrams, *Journal of Economic Perspectives 20*, Fall 2006, 177-188. Also, listen to an episode of the NPER podcast Planet Money based on this article that aired in 2025.

Three Pieces of Evidence

- Conversations between Nixon and Burns.
- Deliberations of the Fed's Federal Open Market Committee (FOMC).
- Conversations of Nixon with close advisors about Burns.

Evidence of Interference from Conversations Between Nixon and Burns

• **October 10, 1971, Nixon and Burns in the Oval Office**

Nixon: "I don't want to go out of town fast . . . this will be the last Conservative administration in Washington . . . [the liquidity problem [is] just bullshit."
Burns: [monetary policy has produced] "lots of liquidity"
Nixon: "Does this mean we're stuck then with a recession next year?"
Burns: "No, I predict recovery"

• One Month Later, November 10, 1971, One Year Before Election Day, Nixon and Burns on the phone.
Burns: "Look, I wanted you to know that we are reducing the discount rate today."

• **One Month Later, December 10, 1971, Nixon and Burns on the phone.**

Burns: "I wanted you to know that we lowered the discount rate . . . got it down to 4.5 percent"
Nixon: "Good, good, good"
Burns: "[I want to] put them [the FOMC] on notice that through this action that I want more aggressive steps taken by that committee on next Tuesday."
Nixon "Great. Great, . . . you can lead 'em. You can lead 'em. You always have, now. Just kick 'em in the rump a little."
Burns: "Time is getting short. We want to get this economy going."

Evidence of Interference from FOMC Deliberations

The discussions at the FOMC of December 14, 1971) reveal that the policy easing was not regarded as sound policy by its members (governors of the fed and selected regional Fed presidents).

Although the vote was unanimous, the opinions voiced in the meeting reveal something different:

• President of the Kansas City Fed: voted "reluctantly."

• Board member J. L. Robertson: voted with "considerable reluctance [and] serious doubts."

• President of the New York Fed (Alfred Hayes): "All of this suggests the need for great caution in moving in the direction of any greater monetary ease."

Evidence of Interference from Conversations of Nixon with Close Advisors

• **December 24, 1971, phone conversation with Office of Management and Budget Director George Shultz**

Nixon: "Do you feel, as far as Arthur [Burns] and the money supply, we got that about as far as we can turn it right now, have we? I mean as far as my influence on him, that's what I'm really asking."

Shultz: "Yeah. Well, you know he said that he, that they voted to increase it [the money supply]."

Nixon: "I know. And he said, 'I . . .' What was his view, his words?"

Shultz: "'And I'm on the line on that."'

Nixon: "Well, you watch it and remind me. If I have to talk to him again, I'll do it. Next time I'll just bring him in."

Shultz: "I'm sure we'll have to keep after him on it, but I think you hit it just about right, the other day. He was heading for the Virgin Islands [Nixon laughs] and wasn't going to do any good anyway to . . . because he wasn't going back to his Board at all."

Nixon: "Right."

Shultz: "I think it was good to have that discussion about the procedures for appointment [to the Fed's Board] so that he sees that he doesn't have complete control."

Nixon: "Well, he's just got to realize that it's, uh, like it is with [Supreme Court Chief Justice Warren] Burger . . . I'm not going to let him name his people."

Shultz: "Well, it's been quite a year, Mr. President..."

The Data

The next two figures display U.S. output growth, inflation, and the nominal interest rate around the reelection of Nixon in the fourth quarter of 1972.

Nixon's interference took place between the fourth quarter of 1971 (one year before the election date) and the first quarter of 1972.

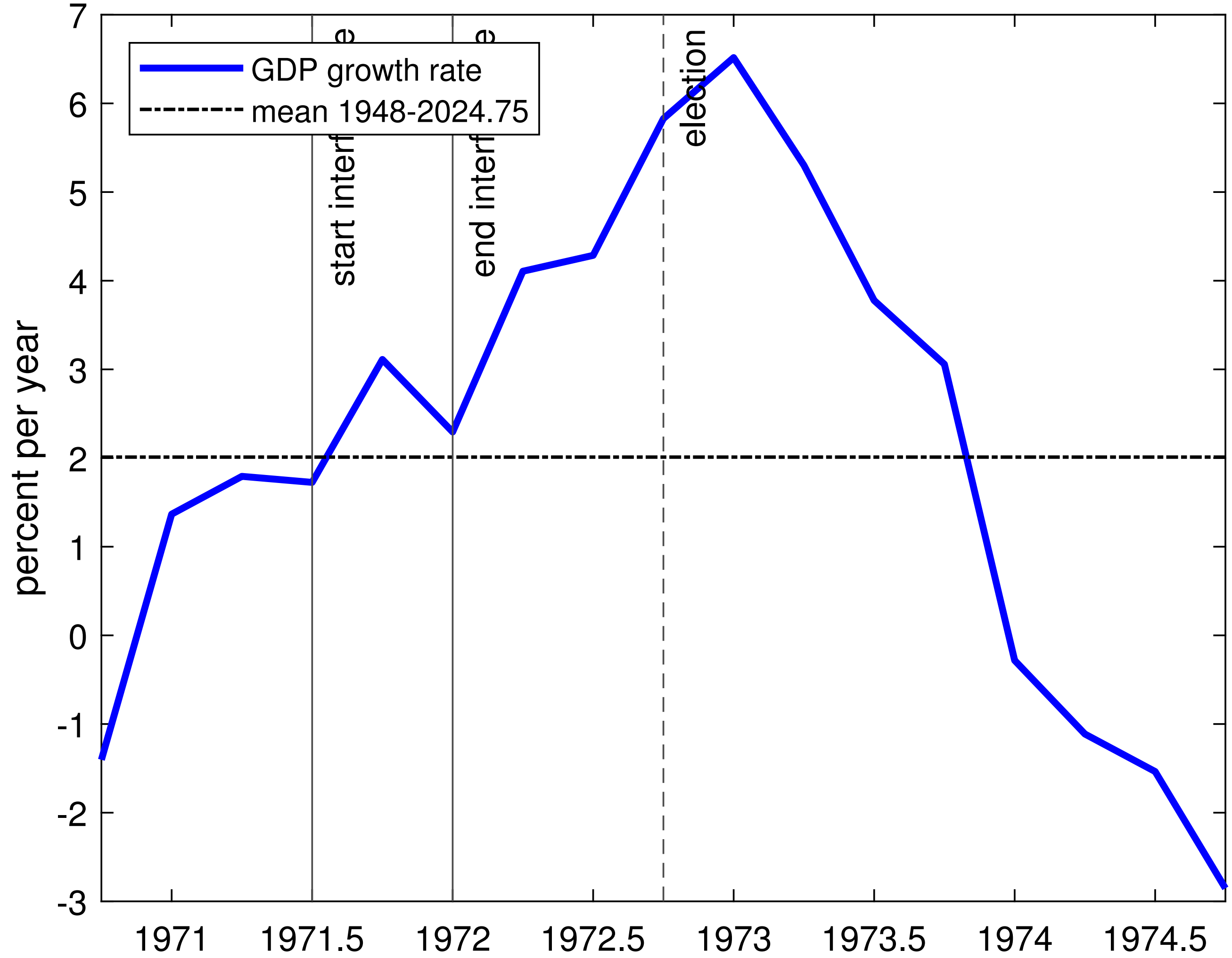
The first figure displays a positive association between interference and output growth, which is consistent with Nixon's rationale for pressuring Burns to ease monetary policy.

The second figure shows that during the interference period, the Federal Funds rate fell, in spite of the inflation rate being quite high at around 5 percent (nothing compared to what was coming, but the actors at the time did not know it).

Why did Nixon stop interfering with monetary policy in the second quarter of 1972, if the election was still two quarters away?

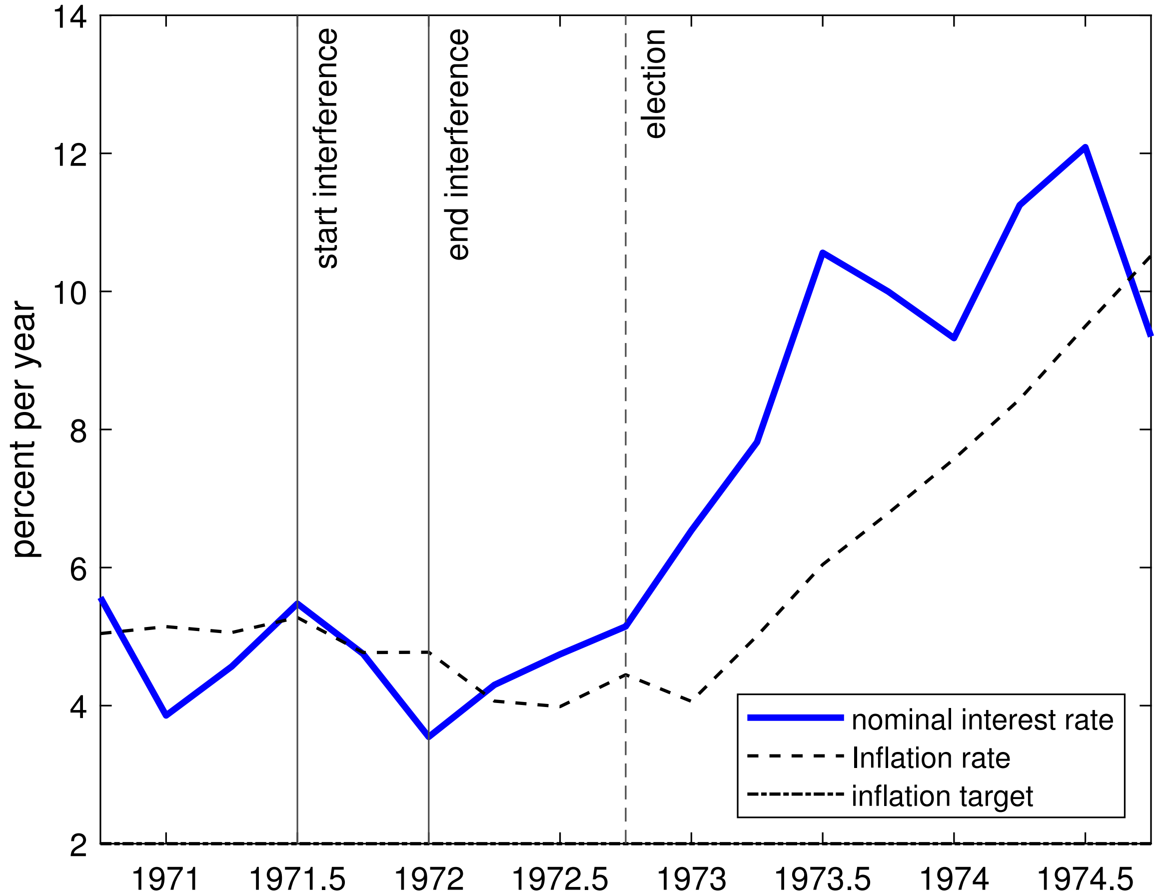
Nixon was quite aware that monetary policy has lags. So he cut a deal with Burns that the latter could do whatever he wanted with monetary policy since April 1972.

**Figure 1: Growth Rate of Real U.S. GDP per Capita
1970:Q4 to 1974:Q4, percent per year**



Source: FRED. Year-over-year rate.

Figure 2: U.S. Inflation and Nominal Interest Rate
1970:Q4 to 1974:Q4, percent per year



Notes. Year-over-year rates. The inflation rate is measured by the growth rate of the GDP deflater, and the nominal interest rate is measured by the federal funds rate. Source: FRED.

Why Did Nixon Stop interfering Two Quarters Before the 1972 Election

Look again at the seond figure. The interest rate stops falling after 1972:Q1, and actually begins to rise. The election is in November. So why did Nixon allow this?

Abrams's paper suggests that Nixon was convinced that the effects monetary policy occur with a lag of at least six months, so he thought that nothing the Fed could do between April and November could affect unemployment:

February 14, 1972, conversation between Nixon and Burns (and reportedly Ehrlichman, who doesn't speak)
Nixon: "You say it's coming along, and we had this six-month period of an awful dry spell, and I guess I'm not sure we may have hurt us irreparably."
Burns: "No."
Nixon: "You don't think so?'
Burns: "Ah, no. How could it Mr. President?"
Nixon: "Well, as my memory . . . [garbled]. You know the problem with it; you've always spoken of that time lag."
Burns: "No, but you see, uh . . ."
Nixon: "I don't much, I really don't care what you do in April, but between now and April . . . [garbled] that can hurt us . . . [garbled] in November."

Consequences

• Nixon wins reelection in 1972 in a landslide.

• Output growth peaks around reelection but then the economy decelerates sharply.

• After reelection, inflation rises rapidly from its already high level pre-election and reaches 2-digit figures, in spite of the fact that the Fed steadily raised interest rates.

• Many observers, including Abrams in the paper discussed here, characterize the post-election period as one in which inflationary expectations became unanchored. The unanchoring occurred, the argument goes, because the Fed showed lack of commitment to price stability when, yielding to political pressure, it eased monetary conditions in spite of high inflation

• The next graph shows that the "unanchoring" view is consistent with the predictions of the 3-equation NK model. Specifically, it shows that an increase in $\widehat{\pi}^e$ can cause simultaneously:
(a) an increase in inflation ($\widehat{\pi}\uparrow$),
(b) a recession ($\widehat{y}\downarrow$),
(c) in the context of rising interest rates ($\widehat{i}\uparrow$).

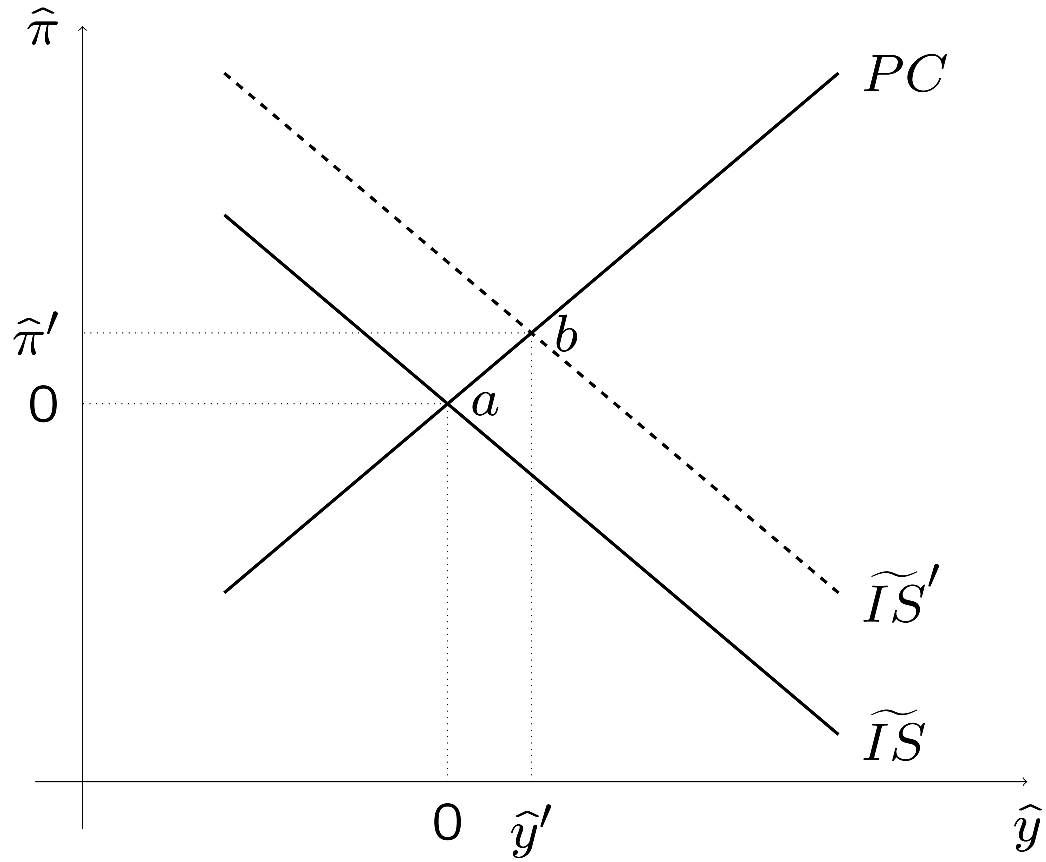
Nixon-Burns Through the Lens of the NK Model

Let's divide the interference episode in two subperiods:

- The interference proper (pre 1972 election): An expansionary monetary shock.

- The Aftermath (post 1972 election): unanchoring of inflationary expectations.

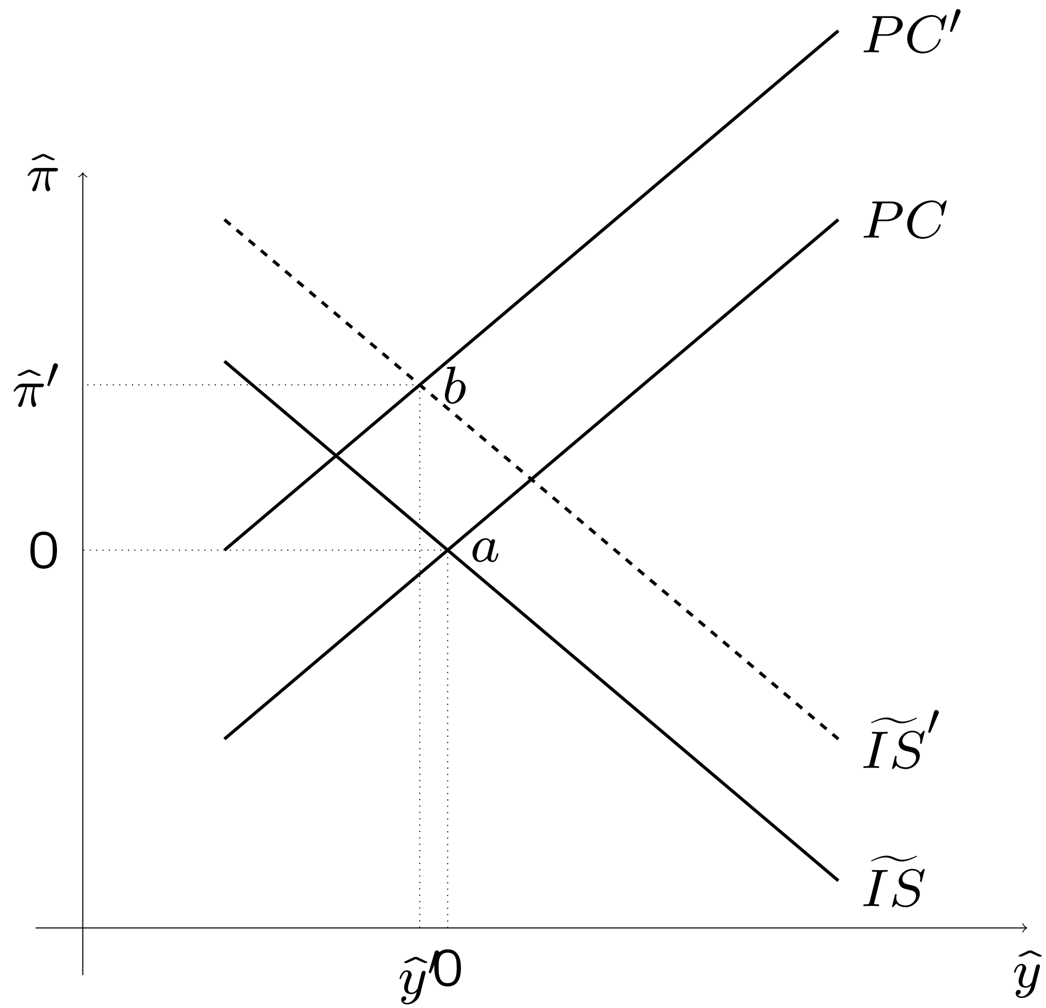
The interference proper: An expansionary monetary shock ($\epsilon^m \downarrow$)



The public (and even FOMC members other than Burns, as documented above) interpreted the interest rate cuts that Nixon and Burns agreed upon behind doors as unwarranted given the economic conditions at the time. Inflation was running high and output growth was about its average of 2 percent per year, so a cut in interest rates was not what people were expecting. The interest rate-cuts did spur economic growth, but also caused inflation (or prevented inflation from falling). To understand this, take a look at the figure above. To make things simple, we will assume that before Nixon's interference, the economy is at full employment and inflation is at its target level. This is a benevolent view of things, because we see in the data that inflation was high, but we adopt it for simplicity. So in the graph the initial equilibrium is point a. If $\widehat{y} = 0$ and $\widehat{\pi} = 0$, an interest rate cut is unnecessary. But Nixon talked Burns into doing it.

This surprise cut in the interest rate can be interpreted as an expansionary monetary shock, that is, $\epsilon^m < 0$. Recall that ϵ^m is the exogenous component of the Taylor rule. This shock shifts the modified IS curve up and to the right as shown by the downward sloping dashed line. The intuition behind this shift is that, given expected inflation π^e, the cut in the interest rate represents a cut in the real interest rate, so consumption increases at any level of inflation. The Phillips curve does not shift. The new equilibrium is at point b. At the new equilibrium, the economy is overheated: output is above full employment and inflation is above its desired level. Nixon is happy with this outcome, because he thinks that a high level of employment will help him win the November election. But Burns (and the members of the FOMC) are unhappy for 2 reasons: first, the expansionary monetary shock created inflation; and second, the policy move send the signal to the public that the Fed does not care about inflation.

The aftermath: Unanchoring of inflationary expectations ($\widehat{\pi}^e \uparrow$)



Look at Figure 2. After the 1972 election, inflation rose to two-digit numbers, in spite of the fact that the Fed tightened significantly. One interpretation that many observers maintain is that during this period inflationary expectations became unanchored. Because of the unwarranted loosening of monetary conditions forced by Nixon and agreed by Burns before the election, the Fed had lost credibility. People stop believing that it cared about price stability. Through the lens of the NK model, this can be interpreted as an increase in $\widehat{\pi}^e$. The situation is depicted in the diagram above. For simplicity, we again assume that the initial situation is at full employment and inflation at the inflation target ($\widehat{y} = \widehat{\pi} = 0$).

The increase in inflationary expectations, $\widehat{\pi}^e > 0$, causes the modified IS curve to shift up and to the right to $\tilde{IS}'$ (downward sloping dashed line). The reason is that, given the nominal interest rate, the increase in inflationary expectations lowers the real interest rate, so aggregate demand expands,and at any given level of inflation output is higher. The Phillips curve shifts up and to the left to PC' (upward sloping dashed line), because firms pass part of the increase in expected inflation to prices today.

The new equilibrium is at point b, where inflation is unambiguously higher. The effect on output is ambiguous. It depends on the size of the vertical shifts in the modified IS curve and the Phillips curve. It is clear from the figure that if the Phillips curve shifts vertically by more than the modified IS curve, then output falls, otherwise it increases. The vertical shift in the modified IS curve is equal to $\Delta\widehat{\pi}^e/\alpha_\pi$, where Δ denotes change, and α_π is the inflation coefficient of the Taylor rule. To see that this is the vertical shift in the modified IS curve, recall that the coefficient in front of $\widehat{\pi}^e$ in the modified IS curve is precisely $1/\alpha\pi$. The vertical shift in the Phillips curve is $\beta\Delta\widehat{\pi}^e$, where β is the subjective discount factor. To see this, recall that the coefficient in front of $\widehat{\pi}^e$ in the Phillips curve is β.

Thus, in response to the unanchoring in inflationary expectations, $\Delta \widehat{\pi}^e > 0$, output increases if $\beta < 1/\alpha\pi$ and decreases if $\beta > 1/\alpha_\pi$. In calibrations of the NK model at quarterly frequency, the subjective discount factor is typically assumed to be around 1 percent, or $\beta = 0.99$. The inflation coefficient of the Taylor rule is typically calibrated at 1.5, that is, $\alpha_\pi = 1.5$. It follows that under a typical calibration, $\beta > 1/\alpha_\pi$, the unanchoring of inflationary expectations causes recession. Thus the economy suffers stagflation ($\widehat{y}' < 0$ and $\widehat{\pi}' > 0$), which is what was observed after the 1972 election in the United States.

Note that, consistent with the data, the interest rate at point b is higher than at point a, that is, $\widehat{i} > 0$. To see this, examine the IS curve, $\widehat{y} = -\gamma(\widehat{i} - \widehat{\pi}^e)$. I omitted ϵ^d because we are not considering a demand shock ($\epsilon^d = 0$). We know that output falls, $\widehat{y} < 0$, and that inflationary expectations increased, $\widehat{\pi}^e > 0$. It follows immediately from the IS curve that $\widehat{i} > 0$. So in spite the fact that the Fed is tightening, inflation is increasing, just as observed in the post 1972 election period (Figure 2). The unanchoring of inflationary expectations sets in motion an inflationary process that the Fed cannot stop even if it reacts aggressively to inflation, α_π large.

How Trump Pressured Powell*

• The protagonists
Jerome Powell, chairman of the Fed since February 2018, (former member of the board of governors of the Fed) appointed by Trump.
Trump: U.S. president facing midterm elections in November 2018 and seeking reelection in November 2020.

• The state of the economy.
The tweets against Fed policy started in April 2018. At the time, the growth rate of output per capita was 0.7 percentage points above its historic average of 2 percent, and the inflation rate was about 0.5 percentage points above its intended target of 2 percent. See the next two figures.

• Data Sources
tweets by president Trump and high-frequency data on federal funds futures (which are used to estimate future values of the Federal Funds Rate by market participants).

• The conflict
Trump wanted the Fed to cut interest rates. The Fed, instead tightened several times in 2018.

*The discussion of the Trump interference with monetary policy is based on the paper entitled "Threats to central bank independence: High-frequency identification with twitter," by Francesco Bianchi, Roberto Gómez-Cram, Thilo Kind, and Howard Kung, *Journal of Monetary Economics 135*, 2023, 3754.

- Consequences

The Fed did not yield to the Fed's pressures.
But Trump's tweets had significant effects on expected interest rates, bond prices, and stock shares.

Macroeconomic Indicators During the Trump Interference

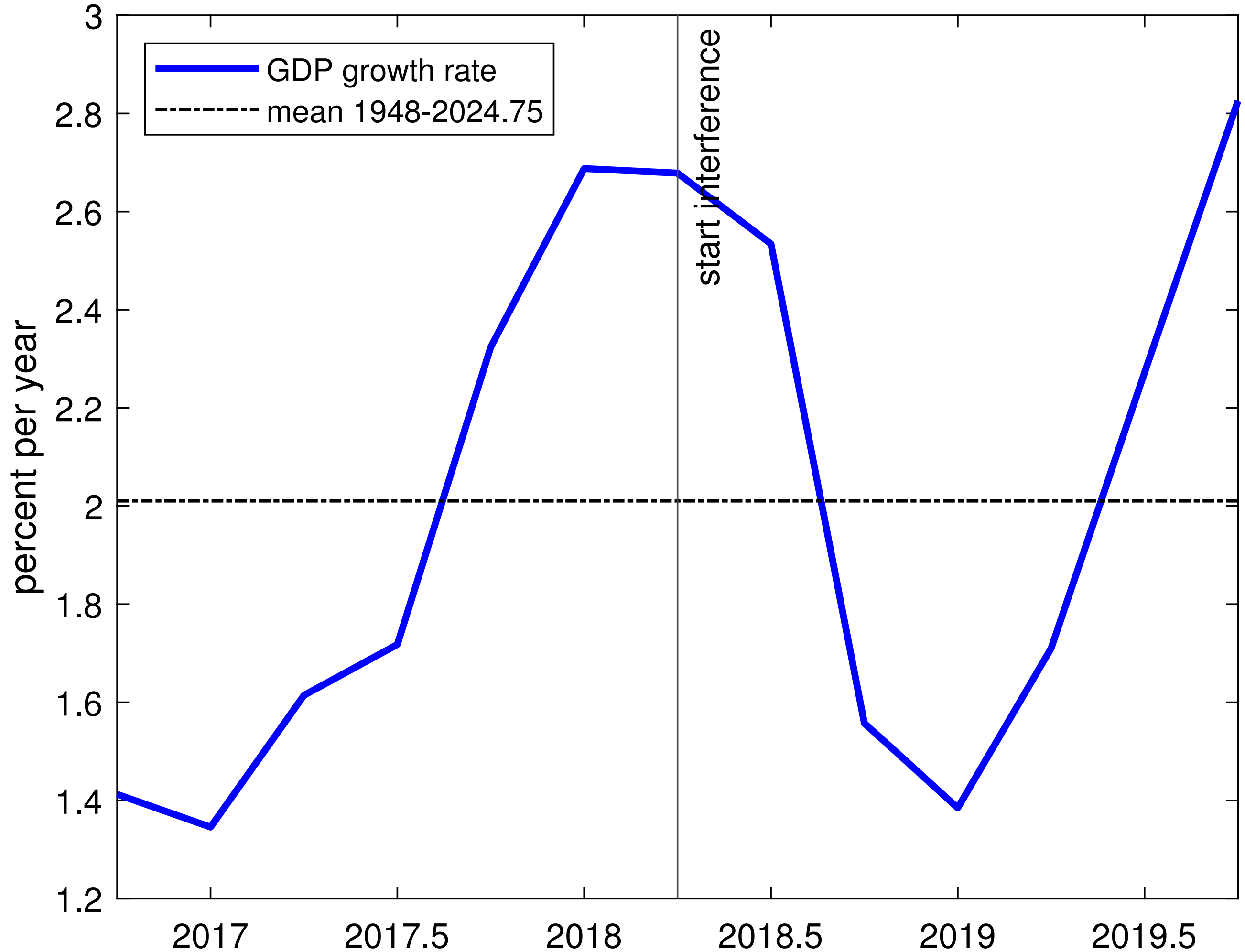
The next two figures display U.S. output growth, inflation, and the nominal interest rate around the interference of Trump with monetary policy in 2018.

I cut the sample before 2020:Q1, to avoid the Covid-19 period, because the magnitude of the economic effects of the pandemic would distort the scale of the plots.

The economy had left the GFC of 2008 behind. Accordingly, the Fed had started to normalize the interest rate in 2015 through a number of tightenings.

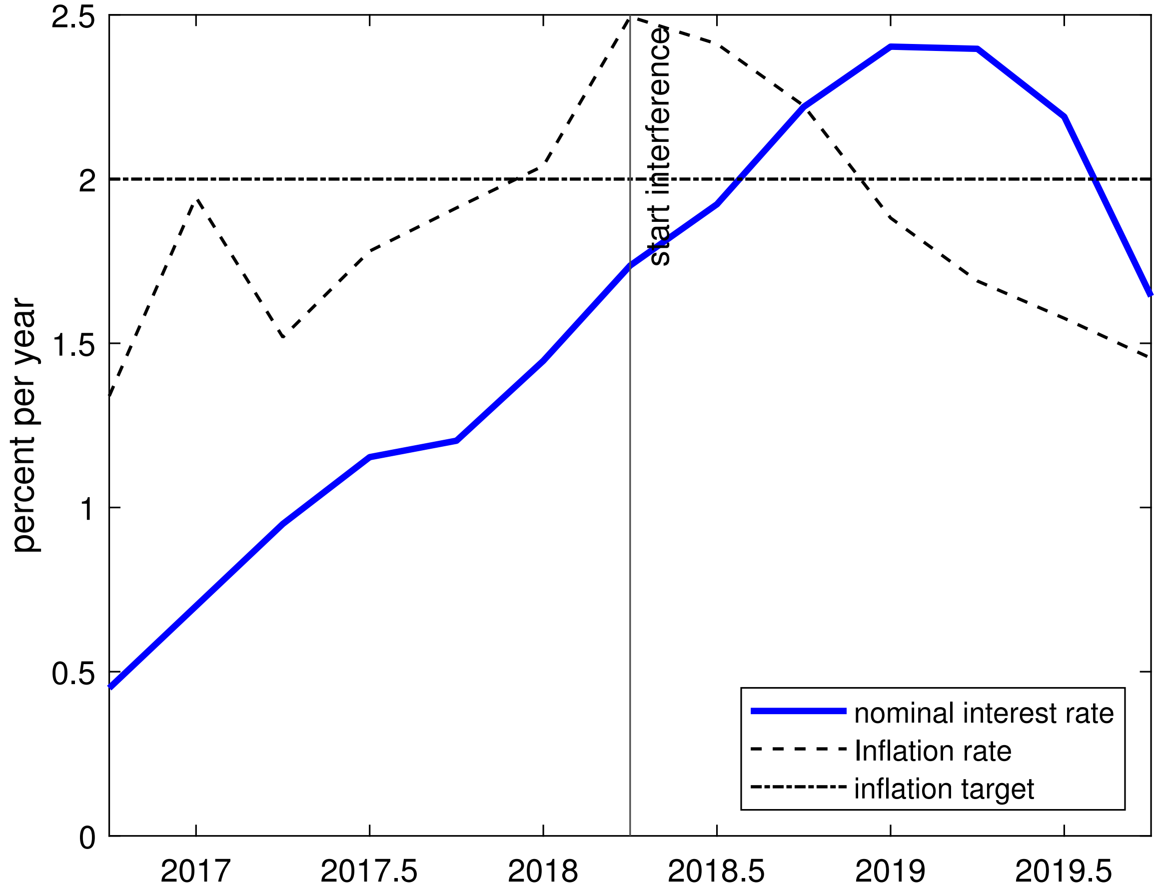
When the President's twitter attacks started, the Fed was more concerned with inflation (which was above target) than with output (which was growing at an above-average rate.

Figure 3: Growth Rate of Real U.S. GDP per Capita 2016:Q4 to 2019:Q4, percent per year



Source: FRED. Year-over-year rate.

Figure 4: U.S. Inflation and Nominal Interest Rate 2016:Q4 to 2019:Q4, percent per year



Notes. Year-over-year rates. The inflation rate is measured by the growth rate of the GDP deflater, and the nominal interest rate is measured by the federal funds rate. Source: FRED.

The president's tweets: Two examples

The first tweet by Trump criticizing the Fed was sent in April 2018 and stated: *"Russia and China are playing the Currency Devaluation game as the U.S. keeps raising interest rates. Not acceptable."*

On October 1, 2019, Trump tweets: *As I predicted, Jay Powell and the Federal Reserve have allowed the Dollar to get so strong, especially relative to ALL other currencies, that our manufacturers are being negatively affected. Fed Rate too high. They are their own worst enemies, they don't have a clue. Pathetic!*

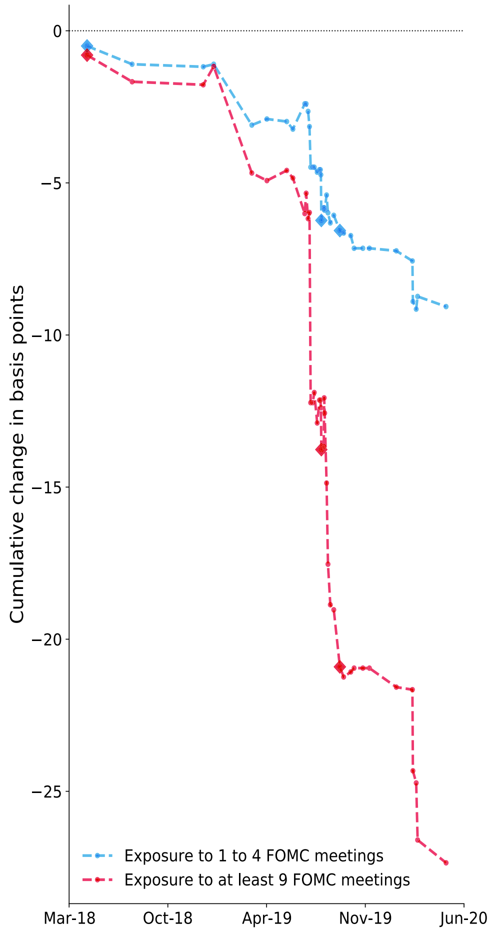
High-Frequency Identification

To identify the effect of the president's tweets on a given variable, ,for example, expected values of the Federal Funds Rate, the technique proceeds as follows:
(1) Use federal fund futures rate (FFF) to compute the expected value of the federal funds rate (FFR). There are FFFs with different maturities, so one can compute the expected value of the FFR over different time horizons. Example, one can calculate what market participants believe the FFR will be in one months from now, three months from now, nine months from now, etc. FFFs are traded continuously, so data is available at high frequency.
(2) scrape Trump's twitter (now X) account for tweets that exclusively relate to the Federal Reserve which unequivocally advocate looser monetary policy. This is a valid indicator of the president's opinion and a good instrument for identification, because
(a)at the time he used twitter extensively,
(b) this platform represented his primary tool of public communication, and
(c) one can easily obtain the exact time at which the tweet was published.
(3) Compute the change in the FFF before and after a tweet, within a small time window around it. The baseline analysis uses a window 0.1 minutes before and 5 minutes after each tweet.

Why does this procedure identify the effect of the president's tweets on (in this case) the expected FFR?
Because within such a small time window, it is unlikely that any other shock could have hit the economy.
Interpretation of Results

If the FFF at the beginning of the time window and the FFF at the end of the time window are roughly equal, we conclude that the Fed is well isolated from presidential interference.

Figure 5: Tweets and the Expected Federal Funds Rate



(a) Cumulative Plot

Cumulative jumps in the expected FFR associated with Trump's tweets estimated using high-frequency identification, in basis point. Blue line: short-horizon FFF contracts (exposed to 1-4 FMMC MEETINGS). Red line: long-horizon FFF contracts (exposed to at least 9 FOMC meetings). Source: Bianchi et al. (JME, 2023, Figure 1(a)).

Results

Trump's tweets did have a significant effect on relevant economic variables:
- The average effect of the tweets across all FFF contracts is around -0.26 bps per tweet.
- This effect grows with the time horizon, with a peak of -0.64 bps at the longest horizon.

Figure 5 displays the cumulative changes in the expected FFR following Trump's tweets. For long-horizon FFF contracts (red line), the cumulative effect is a fall of more than 25 basis points, which is the typical cut performed by an FOMC meeting.
- Similar results using Eurodollar futures (EDF) to measure expected interest rates.
- Extending the event window to a day increases the magnitude of the estimates up to a factor of eight.
- Treasury yields fall within minutes around Trump tweets at each maturity up to 30 years, with the peak effect around ten years.
- The stock market level increases significantly within minutes of Trump tweets.
- In spite of these effects, unlike in the Nixon-Burns episode, Trump's interference did not appear to have damaged the Fed's credibility, because it did not yield to pressure. The fall in inflation associated with tighter policy in 2018 (see the second figure) is consistent with this conclusion.

Summing Up

• Central bank independence is crucial for maintaining stable inflation and full employment, free from political pressures.

• Presidential interference has occurred in the past, notably under Nixon (197172) and Trump (2018), both pressuring the Fed for looser monetary policy.

• Nixon and Burns: Nixon successfully pressured Fed Chair Arthur Burns to ease monetary policy before the 1972 election, leading to short-term growth but long-term inflation.

• Trump and Powell: Trump publicly criticized Fed Chair Jerome Powell via Twitter, demanding lower interest rates. Though the Fed did not yield, markets reacted strongly.

• High-frequency identification using Federal Funds Futures and Trump's tweets shows that presidential statements significantly lowered expected interest rates and bond yields, and boosted stock prices.

• Policy Implications: These episodes suggest that political interference has a significant effect on important economic variables and highlight the risks it carries for inflation and potential credibility loss for central banks.

Lecture 9
Macroeconomic Effects of Import Tariffs

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Liberation Day

On April 2, 2025, President Trump announced the imposition of import tariffs on most products from nearly all trading partners.

Tariffs applied mostly to manufactured goods, including automobiles, steel, aluminum, machinery, electronics, and other industrial products.

Across products, import tariffs ranged from 10% to over 100%, with the highest tariffs imposed on Chinese imports, particularly in electronics and machinery.

Across countries, the average import tariff ranged from 10% to 50%, with Cambodia among the most heavily taxed at about 49% and the United Kingdom among the least taxed at about 10%.

Questions

Liberation Day triggered a number of questions:

How can we measure the average tariff in the United States across all goods and all trading partners?

How large are import tariffs in the United States?

What are the macroeconomic effects of an increase in import tariffs? Is it inflationary? Does it cause a recession?

Does it matter whether the increase in import tariffs is perceived as permanent or transitory by consumers and firms?

What if the increase in tariffs is anticipated by consumers and firms (through news leaks, say)?

How to measure the aggregate import tariff rate?

Before turning to how to embed import tariffs into our model, let's look at some tariff data.

The tariff schedule is complex, with over 20,000 goods categories, and then for a given good, the import tariff may differ by country of origin.

One simple measure of the aggregate import tariff rate is the effective or trade-weighted tariff rate.

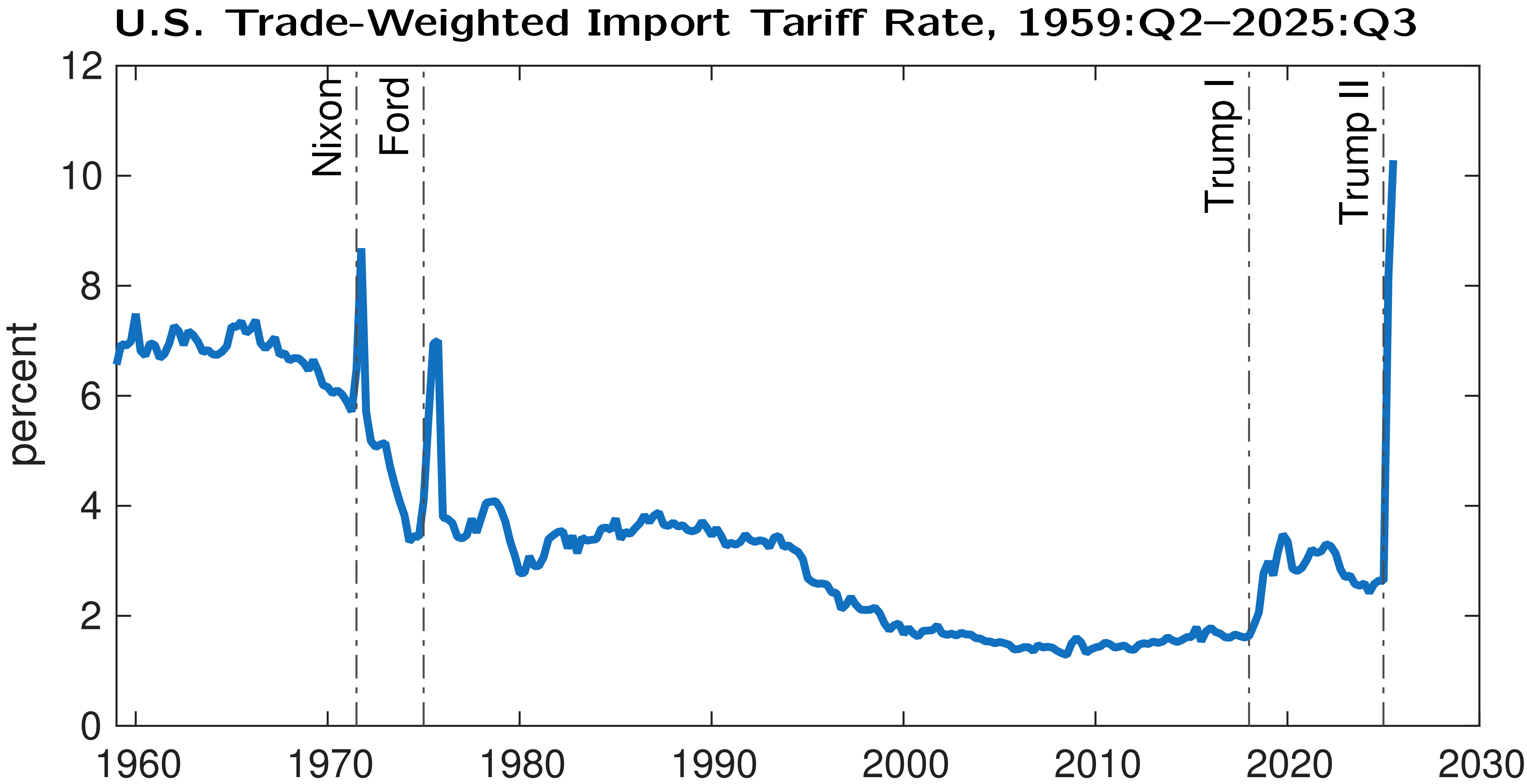
$$\tau_t = \frac{d_t}{m_t}$$

$d_t =$ customs duties (NIPA Table 3.5U); $m_t =$ value of imports of goods (excluding duties) (NIPA Table 1.1.5).

By definition $d_t = \sum_i d_{it}$, where $d_{it} = \tau_{it} m_{it} =$ customs duties on good i in period t, τ_{it} = import tariff rate on good i in period t, and m_{it} = imports of good i in period t. The symbol $\sum_i$ sands for sum over all goods i. Also by definition, $m_t = \sum_i m_{it}$.
Rearrange:

$$\tau_t = \frac{d_t}{m_t} = \frac{\sum_i d_{it}}{m_t} = \frac{\sum_i m_{it}\tau_{it}}{m_t} = \sum_i s_{it}\tau_{it}; \qquad \text{where} \qquad s_{it} \equiv \frac{m_{it}}{m_t}$$

That's why this measure is called the 'trade-weighted' import tariff rate.



Notes. Vertical lines mark the start of the main import tariff episodes in the sample: Nixon 1971:Q3, Ford 1975:Q1, Trump 2018:Q1, and Trump 2025Q1. Data Sources: NIPA Tables 3.5U and Table 1.1.5, see also Schmitt-Grohé and Uribe (2026).

What Does the Figure Show?

• Until the first Trump tariff increase in 2018 (Trump I), the tariff rate displayed a negative trend. It fell from about 7% in the late 1950s to about 2% just before Trump I.

• Since the late 1950s, there are four major tariff-increase episodes:

– The 1971:Q3 Nixon import surcharge: a 10-percentage-point tariff on all imported goods. It was temporary (rescinded four months later).

– The 1975:Q1 Ford oil tariff increase: a $2-per-barrel tax on oil imports, at a time when oil prices were about $11 per barrel. It was temporary (revoked within the same year).

– The 2018:Q1 Trump tariff increase (Trump I): imposed on roughly 15 percent of imported goods, mainly from China. More persistent: unlike the earlier episodes, these tariffs remained in place for years and were largely maintained by the Biden administration.

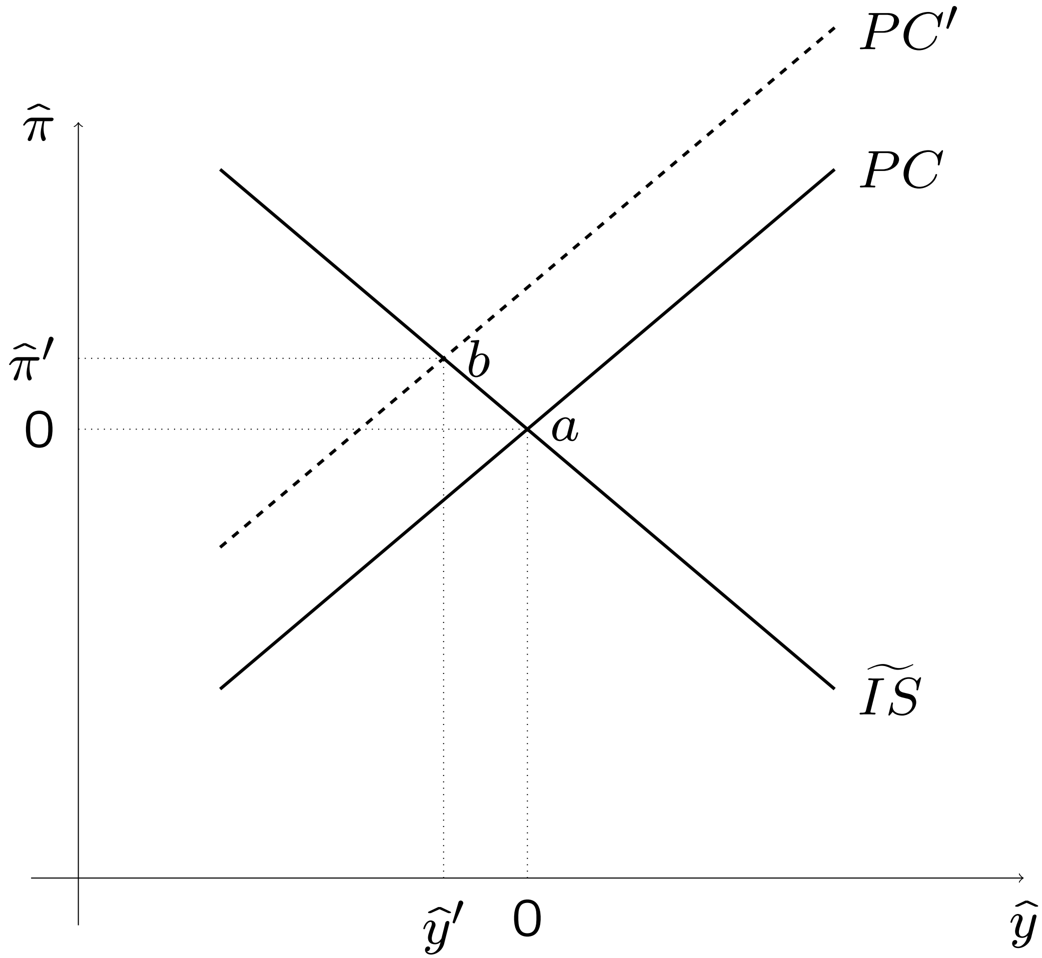
– The tariff increase of 2025:Q2 (Trump II) . is the largest tariff increase since 1959, exceeding the Nixon increase by almost 3 percentage points. Is it transitory or persistent? Time will tell.

Macroeconomic Effects of Import Tariff Increases

A Persistent Tariff Increse

An increase in import tariffs raises the cost of intermediate materials for firms. In the context of the NK model, we can think of a tariff increase as a cost-push shock ($\epsilon^{cp} \uparrow$). The figure on the next page illlustrates how output and inflation adjust to this shock.

Effect of a Persistent Import Tariff Increase



Suppose that initially there are no shocks ($\epsilon^d = \epsilon^m = \epsilon^{cp} = 0$). Assume further that inflation expectations are anchored ($\widehat{\pi}^e = 0$). The initial equilibrium is at point a, where the modified IS curve labeled $\widetilde{IS}$ (solid downward sloping line) crosses the

Phillips curve labeled PC (solid upward sloping line). At this equilibrium, output is at full employment ($\widehat{y} = 0$) and inflation is at its intended target ($\widehat{\pi} = 0$). Because at point a $\widehat{\pi} = \widehat{y} = 0$ and because there are no monetary shocks ($\epsilon^m = 0$), the Taylor rule, $\widehat{i} = \alpha_\pi \widehat{\pi} + \alpha_y \widehat{y} + \epsilon^m$ stipulates that the interest rate, i, is at its normal level, $\overline{i}$, or $\widehat{i} = 0$.

Suppose now that the government increases import tariffs, so that now $\epsilon^{cp} > 0$. Firms pass the increase in costs on to prices, so inflation increases for any level of output. Graphically, the import tariff increase shifts the Phillips curve up and to the left to PC' (dashed upward sloping line) .

The new equilibrium is at point b, where the modified IS curve intersects the new Phillips curve, PC'. Comparing points a and b, we have that as a result of the import tariff increase, the economy suffers a recession, $\widehat{y}' < 0$, and an increase in inflation $\widehat{\pi}' > 0$ (stagflation).

At the new equilibrium, the nominal interest rate is higher than at the initial equilibrium, $\widehat{i} \uparrow$. To see that the interest rate increases, recall that the IS holds, that is, $\widehat{y} = -\gamma(\widehat{i} - \pi^e) + \epsilon^d$ (why does the IS curve hold? because the modified IS curve was derived starting from the IS curve). Now, we know that the tariff increase causes $\widehat{y}$ to fall, that is, the left-hand side of the IS curve falls. So something must change on the right-hand side of the IS curve. But $\widehat{\pi}^e = \epsilon^d = 0$. It follows immediately that $\widehat{i}$ must increase.

However, this tightening of monetary conditions is not large enough to prevent an increase in inflation. Keeping the inflaition rate at the inflation target would require a larger tightening and a deeper recession. A central bank that follows a Taylor rule with finite coefficinets (α_π and α_y) dislikes such an extreme outcome.

In short, a persistent import tariff increase causes an increase in inflation, a fall in output, and a monetary tightening.

A Transitory Import Tariff Increase

Consider now the effects of a transitory or temporary import tariff increase. Like the persistent tariff increase, a temporary tariff increase raises the cost of imported materials for firms. Thus, we can treat it as a cost-push shock ($\epsilon^{cp} > 0$, just as in the persistent case.

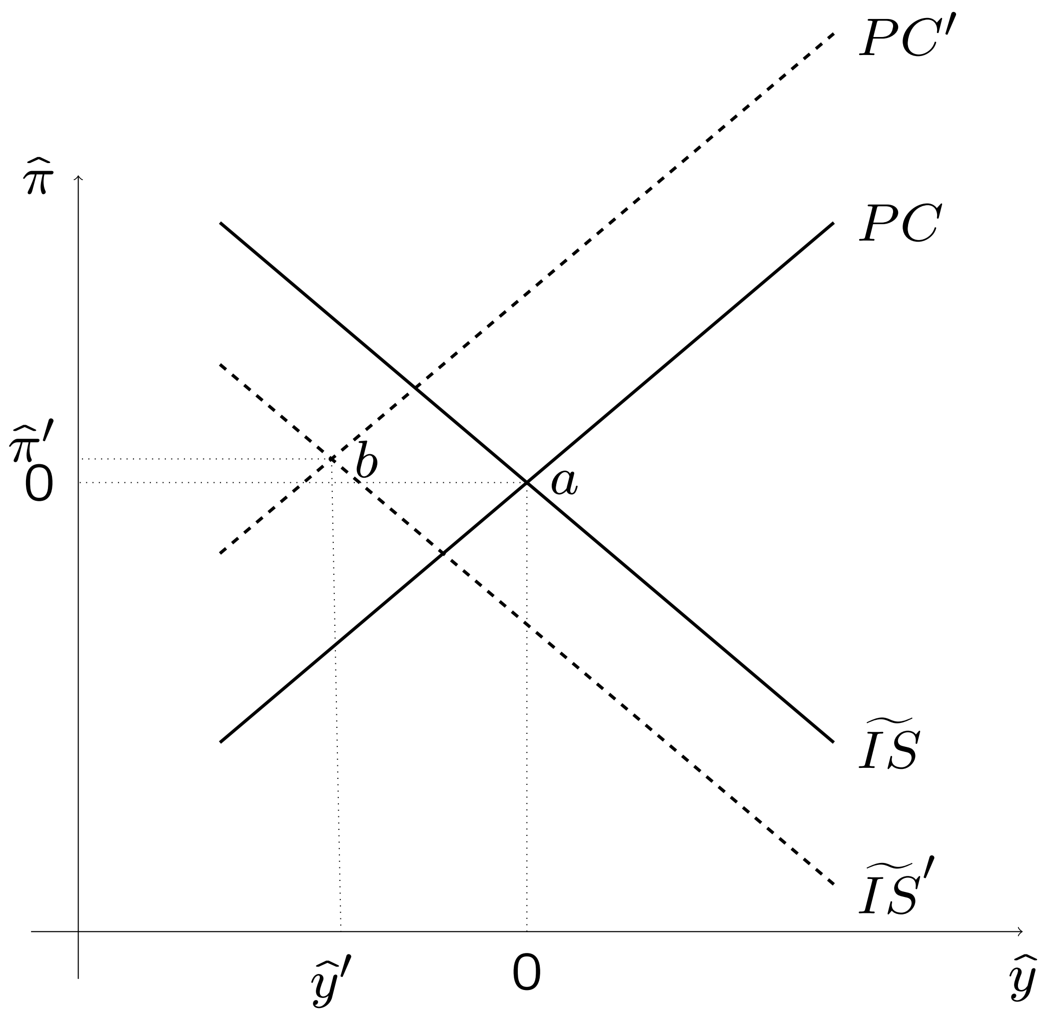
But a temporary tariff increase also has implications for the aggregate demand for goods. The transitory increase in import tariffs makes consumption goods more expensive, but only temporarily. So households have an incentive to cut consumption today in favor of higher consumption in the future, when import tariffs fall back to their normal values. For example, if you were planning to buy a new car and you learn that this year cars have an import tariff of 50% and that the tariff will go down to 0% next year, it might be optimal for you to postpone the purchase for one year. If this behavior is generalized across goods and people, we have a fall in aggregate demand.

Why would the cut in consumption be generalized across all goods and not limited to imported goods? Almost no good is purely imported or purely domestic. Take an extreme example: a hair cut. This is a service produce in yur local hair saloon. But your hair dresser might use imported inputs. The hair clipper, for example, could be imported from China, spray could be imported from Europe, and so on.

The generalized cut in present consumption in favor of future consumption caused by a temporary increase in import tariffs represents a negative demand shock, $\epsilon^d < 0$.

The effects of a temporary increase in import tariffs on output and inflation is illustrated in the next figure.

A Temporary Import Tariff Increase



The economy is initially at point a, where inflation is at the intended target ($\hat{\pi} = 0$) and output is at the full-employment level ($\hat{y} = 0$).

The imposition of a transitory import tariff represents a cost-push shock ($\epsilon^{cp} \uparrow$), which shifts the Phillips curve up and to the left. The new Phillips curve is the upward sloping dashed line labeled PC'.

The transitory import tariff shock also represents a negative demand shock $\epsilon^d \downarrow$, because it induces a substitution of future for present consumption. This negative demand shock shifts the modified IS curve down and to the left, as shown by the downward sloping dashed line labeled $\widetilde{IS}'$.

The new equilibrium is at point b. The temporary import tariff shock is unambiguously contractionary ($\widehat{y} \downarrow$): both the cost-push shock and the negative demand shock cause output to fall.

The effect of the temporary tariff increase on inflation is ambiguous. It depends on the strength of the two shocks. Inflation can go up (if the cost-push shock is relatively strong) or down (if the negative demand shock is relatively strong). In the figure, inflation goes up slightly.

Summarizing, a transitory increase in import tariffs is more contractionary than a persistent one, but also less inflationary.

The central bank's intervention is also ambiguous. The monetary authority follows a Taylor rule. The negative demand shock lowers output and inflation, which calls for a cut in interest rates. The cost-push shock is contractionary, which also calls for an interest rate cut, but it is also inflationary, which calls for an increase in the interest rate.

An Anticipated Import Tariff Increase

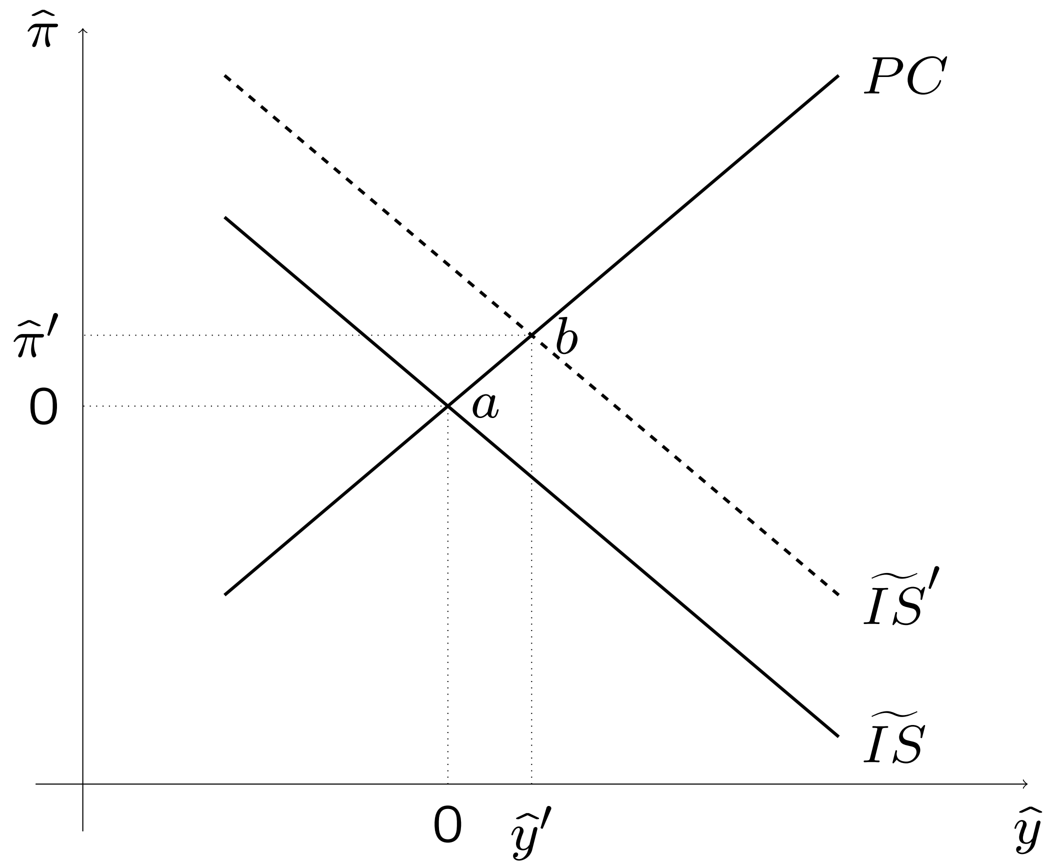
Suppose that households and firms learn that the government will increase import tariffs next year.

Households expect that consumption goods will become more expensive in the future, so they increase consumption today, before import tariffs go up. This represents a positive demand shock, $\epsilon^d \uparrow$.

Tariffs don't increase today, so firms don't experience an increase in the cost of materials. So, unlike in the case of a tariff increase today, (persistent or transitory), when the import tariff increase is anticipated, there is no cost-push shock ($\epsilon^{cp} = 0$).

The next figure illustrates how output and inflation adjust to an anticipated import tariff increase.

Effects of an Anticipate Increase in Import Tariffs



Initially, the economy is at point a, where inflation is at its target level, $\widehat{\pi} = 0$, and output is at full employment, $\widehat{y} = 0$.

The anticipation of an increase in tariffs next year induces households to front-load demand. This is represented by a positive demand shock, $\epsilon^d \uparrow$, which shifts the modified IS curve up and to the right as depicted by the downward sloping dashed line labeled $\tilde{IS}'$ in the figure.

The Phillips curve does not change position, because the tariff increase has not occurred yet, so firms do not experience an increase in costs.

The new equilibrium after agents learn about the government's plan to increase import tariffs next year is at point b.

The increase in aggregate demand causes an economic expansion, $\widehat{y} \uparrow$, and an increase in inflation, $\widehat{\pi} \uparrow$.

The central bank, which follows a Taylor rule, raises interest rates (recall that if output and inflation go up, the Taylor rule calls for a tightening of money conditions). The tightening, however, is not large enough to prevent overheating and inflation.

In short, an anticipated increase in import tariffs is inflationary and expansionary.

Summing Up

• The U.S. trade-weighted tariff rate trended downward from about 7% in the late 1950s to around 2% just before the 2018 Trump tariffs.

• Since 1959 there have been four main tariff-increase episodes: Nixon (1971), Ford (1975), Trump I (2018), and Trump II (2025). The earlier two were temporary, while the Trump I tariffs were much more persistent.

• The 2025 tariff increase (Trump II) is the largest in the sample, exceeding the Nixon surcharge. It applies broadly across products and countries, with tariffs ranging from about 10% to over 100% across goods.

• A persistent tariff increase acts as a cost-push shock: it raises inflation, lowers output (stagflation), and induces the central bank to tighten monetary policy.

• A transitory tariff increase combines a cost-push shock with a negative demand shock, because households postpone consumption. Output falls more, while the effect on inflation is ambiguous.

• An anticipated future tariff increase creates a positive demand shock today, as households front-load consumption. Output and inflation rise, and the central bank responds by raising interest rates.

Lecture 10

The Quantity Theory of Money

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Short- Versus Long-Run Monetary Analysis

Until now, we have studied the short-run determinants of inflation, output, and the interest rate. We focused on movements in these variables over periods of, say, two years or so. The NK model was designed for this type of analysis.

Today we change gears. We are interested in understanding the determinants of inflation in the long run, say over a period of 10 or 20 years.

To conduct this type of analysis, we must look at the data from a different perspective and use a completely different model. The model we will study today is called the Quantity Theory of Money (QTM).

It's not that one model is right and the other is wrong. Each is designed to explain monetary phenomena at different horizons. Just as classical mechanics works well at everyday scales while quantum mechanics is needed at very small scales, short-run monetary models (the NK model) emphasize nominal rigidities, whereas long-run analysis (the QTM) abstracts from them and focuses on monetary fundamentals.

The Money Supply

Intuitively, the money supply is the total quantity of dollars available in the economy at a point in time, currency in circulation plus bank deposits and other instruments that can easily be used for payments.

We use the following notation:

$$M_t = \text{ money supply in period } t$$

A period is the unit of time considered. Today, a period will be one year.

M_t is a nominal variable, because it is measured in current dollars.

Let's talk more precisely about how to measure the money supply.

How Do We Measure the Money Supply, M_t?

For the purpose of the analysis in this lecture, the money supply consists of assets that people and firms use to perform transactions. Empirically, economists typically use three alternative measures of money:

$M0$
A relatively narrow definition of money is known as the monetary base. The monetary base is the sum of currency in circulation (bills and coins in the hands of people or firms) and bank reserves (money that banks keep in their vaults or deposited at the central bank). The monetary base is also called high-powered money or $M0$. These three names are used indistinctly.

$M1$
The second definition of money is $M1$, which consists of the sum of currency in circulation (bills and coins) plus demand deposits (checking accounts).

$M2$
A third measure of money is called $M2$ and is broader than $M1$. $M2$ consists of $M1$ (that is, currency in circulation plus demand deposits) plus deposits in savings accounts, small time deposits, and retail money market funds.

Data on $M0$, $M1$, and $M2$ can be found, for example, by visiting the website of the Board of Governors of the Federal Reserve System.

The Growth Rate of the Money Supply

The growth rate of the money supply plays a central role in the model we will study today, the Quantity Theory of Money, or QTM.

Let μ_t denote the growth rate of the money supply between period $t-1$ and period t. Then, μ_t is given by

$$\mu_t = \frac{M_t}{M_{t-1}} - 1$$

where, as mentioned before, M_t is the money supply in period t

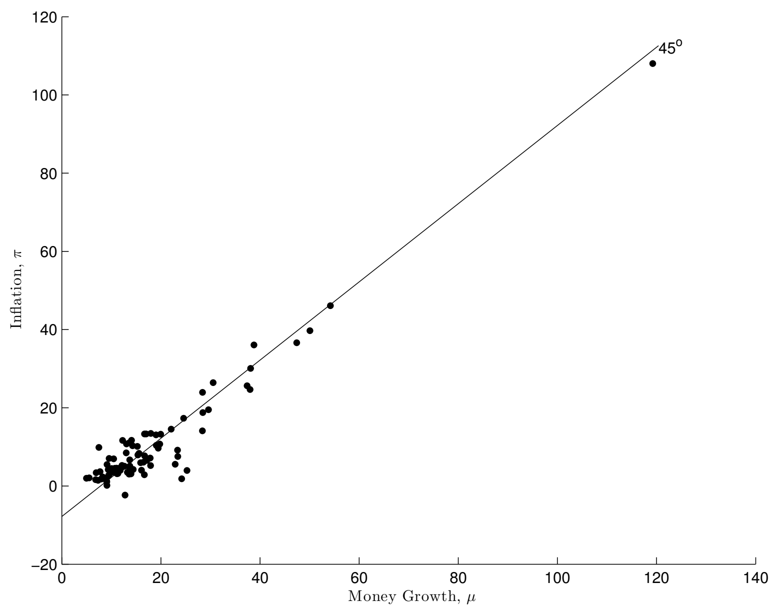
Two Long-Run Empirical Regularities

(a) In the long run, average inflation moves nearly one-for-one with the average growth rate of the money supply.

(b) In the long run, the average growth rate of output is unrelated to the average growth rate of the money supply. This fact is known as *long-run money superneutrality.*

(a) Empirical Evidence on Money Growth and Inflation

Money Growth and Inflation Across Countries: 1960 to 2014



Source: Own calculations based on data from the IMF-IFS database.

What is in the figure? On the vertical axis is the average annual inflation rate between 1960 and 2014, denoted π, expressed in percent. To compute inflation, we used the GDP deflator, which is a price index of all final goods and services produced in the economy. Letting P_{1960} and P_{2014} denote the GDP deflator index in 1960 and 2014, respectively, π is computed as

$$\pi = \left[\left(\frac{P_{2014}}{P_{1960}} \right)^{1/54} - 1 \right] \times 100. \tag{1}$$

On the horizontal axis is the average annual growth rate of the quantity of money, denoted μ, expressed in percent. The empirical measure of the quantity of money used in the plot is M2. If M_{1960} and M_{2014} are the quantities of money in 1960 and 2014, respectively, then

$$\mu = \left[\left(\frac{M_{2014}}{M_{1960}} \right)^{1/54} - 1 \right] \times 100. \tag{2}$$

Each dot in the figure represents a different country, and there are 93 countries in the sample. For each of the 93 countries, the figure displays with a dot the pair (μ, π).*

*For some countries the available sample is shorter than 1960-2014, but for all countries the sample is at least 10 years long.

The central message of the figure is that when we consider a relatively long period of time, in this case 54 years, then average inflation moves one-for-one with the average growth rate of the money supply. The cloud of points lies roughly on a line with slope 1, suggesting a high correlation between money growth and inflation in the long run. For the 93 observations in the figure, the correlation between inflation and money growth is 0.95.

This high correlation obtains independently of the level of income. For instance, the correlation between π and μ is 0.96 among the group of OECD countries, which includes some of the richest countries in the world, and 0.96 among Latin American countries, a group that includes both middle and low income countries.

The type of empirical evidence shown in the figure motivated the prominent economist Milton Friedman (1912-2006) to claim that "Inflation is always and everywhere a monetary phenomenon." '*

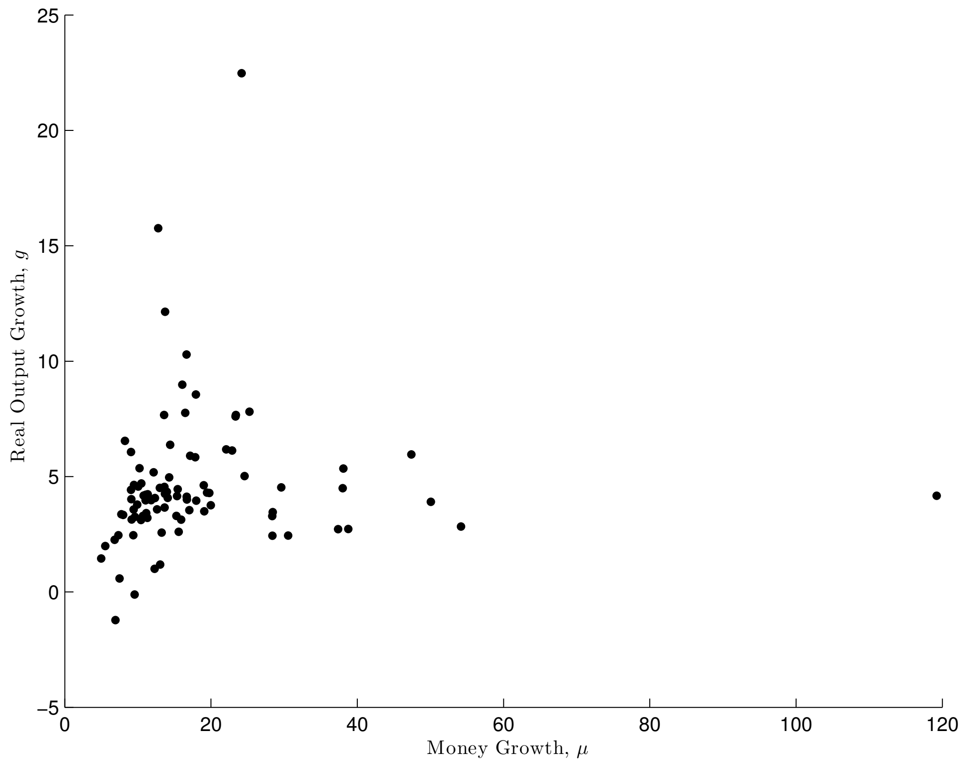
*Milton Friedman is one of the most influential economists of the twentieth century. He received the Nobel Prize in 1976.

Deflation at Very Low Levels of Money Growth

Take another look at the figure. What is the rate of inflation associated with very low growth rates of money? The figure suggests that the cloud of points intersects the vertical axis at a value slightly below zero. This suggests that when the money growth rate is nil for a long period of time, the associated average rate of inflation is negative.

(b) Empirical Evidence On Money Growth and Economic Growth

Money Growth and Output Growth Across Countries: 1960 to 2014



Source: Own calculations based on data from the IMF-IFS database.

The figure displays the average growth rate of money and the average growth rate of output over the period 1960 to 2014 for 100 countries. The vertical axis measures g, the average annual growth rate in real GDP in percent. If we denote real output in 1960 and 2014 by Y_{1960} and Y_{2014}, respectively, then g is given by

$$g = \left[\left(\frac{Y_{2014}}{Y_{1960}} \right)^{1/54} - 1 \right] \times 100.$$

The horizontal axis measures the average annual growth rate of money, μ. The figure displays with dots the pairs (μ, g) for 100 countries.

Observations On The Figure

The message conveyed by the figure is that, in the long run, there is no clear relation between output growth and money growth.

This empirical fact is known as *long-run monetary superneutrality*.

Definition of Monetary Superneutrality: changes in the money growth rate have no effect on real variables (e.g., real GDP, real consumption, the real interest rate).

Summary of Empirical Regularities

We have documented two long-run empirical regularities involving money growth:

(a) In the long run, average inflation moves one-for-one with the average growth rate of the money supply.

(b) In the long run, the average growth rate of output is unrelated to the average growth rate of the money supply. This fact is known as *long-run money superneutrality.*

Any sound monetary theory must capture facts (a) and (b). It is important to keep in mind that (a) and (b) are facts concerning the long-run relationship between money growth and inflation and economic growth.

The Quantity Theory of Money

The Quantity Theory of Money asserts that a key determinant of the price level and inflation is the quantity of money issued by the central bank and its growth rate.

The Demand for Money

According to the Quantity Theory of Money (QTM), agents hold a stable fraction of their income in the form of money. What does this mean? Let M_t^d be the demand for nominal money balances, that is, people's desired holdings of money. People need money to perform transactions, such as purchases and sales of goods and services, payments of wages and rents, for example.

According to the QTM, the higher is output, measured in dollars, the larger is the number of transactions made each period, and therefore the larger is the amount of money agents need to hold to perform those transactions. In its simplest version, the QTM postulates that the demand for money is a constant fraction of nominal output:

$$M_t^d = \frac{1}{\bar{v}} P_t Y_t, \tag{3}$$

where P_t is the price level (dollars per unit of good) and Y_t is real full-employment output (amount of good). So $P_t Y_t$ is full-employment output measured in dollars. We assume that in the long-run the economy is always at full employment. Since the QTM is concerned with the long-run, in the QTM output is always at full employment. Unlike the NK model, the QTM is not concerned with explaining deviations of output from full employment. The main concern of the QTM is to explain what determines inflation in the long run.

$\bar{v}$ is a parameter, that is, a number determined outside of the QTM model. $\bar{v}$ is known as *money velocity.*

To grasp the intuition why $\bar{v}$ is called money velocity, rearrange equation (3) to get $\bar{v} = \frac{P_t Y_t}{M_t^d}$. This says that each dollar of money is used to perform $\bar{v}$ transactions. If $\bar{v} = 2$, for example, then each dollar is used to perform 2 transactions each period. In this case, we say that money velocity is 2. The higher $\bar{v}$ is, the faster money will have to circulate in the economy.

Equilibrium

Let's continue to denote by M_t the money supply. Equilibrium in the money market requires that the supply of money equals the demand for money, or

$$M_t = M_t^d. \tag{4}$$

Combining (3) and (4) we get

$$M_t = \frac{1}{\bar{v}} P_t Y_t.$$

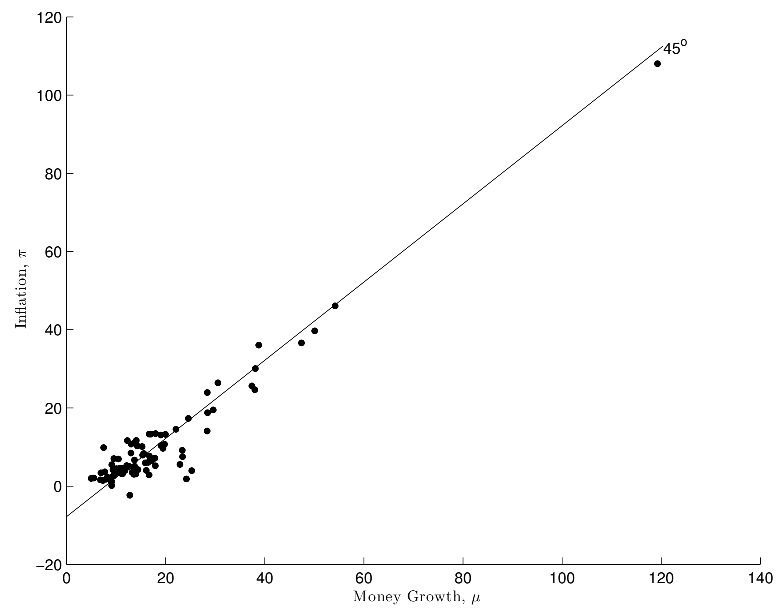
Rearranging this expression yields

$$P_t = \bar{v} \frac{M_t}{Y_t}. \tag{5}$$

This expression says that, given output, the price level is determined by the money supply. It also says that, given output, an increase in the money supply is associated with a proportional increase in prices.

Empirical Regularity (a) and the QTM

Recall the graph relating inflation and the growth rate of the money supply across countries between 1960 and 2014:



What does the quantity theory predict for the relationship between the long-run growth rate of the money supply and the long-run growth rate of prices? In other words, assuming that the quantity theory is true, what would the scatter plot of the previous slide look like?

Start with equation (5):

$$P_t = \bar{v}\frac{M_t}{Y_t}$$

This expression also holds in period $t-1$

$$P_{t-1} = \bar{v}\frac{M_{t-1}}{Y_{t-1}}$$

Divide these expressions term by term to obtain

$$\frac{P_t}{P_{t-1}} = \frac{M_t}{M_{t-1}} \frac{Y_{t-1}}{Y_t}$$

Note that money velocity, $\bar{v}$, disappeared, because, by assumption, it does not change over time. Using our notation for inflation and money and output growth,* we can write this expression as

$$1 + \pi_t = \frac{1 + \mu_t}{1 + g_t}.$$

Taking logs and using the approximation $\ln(1 + x) \approx x$ yields:

$$\pi_t = \mu_t - g_t$$

*Here we express π_t, μ_t and g_t in per one. Earlier in this lecture we did express them in percent.

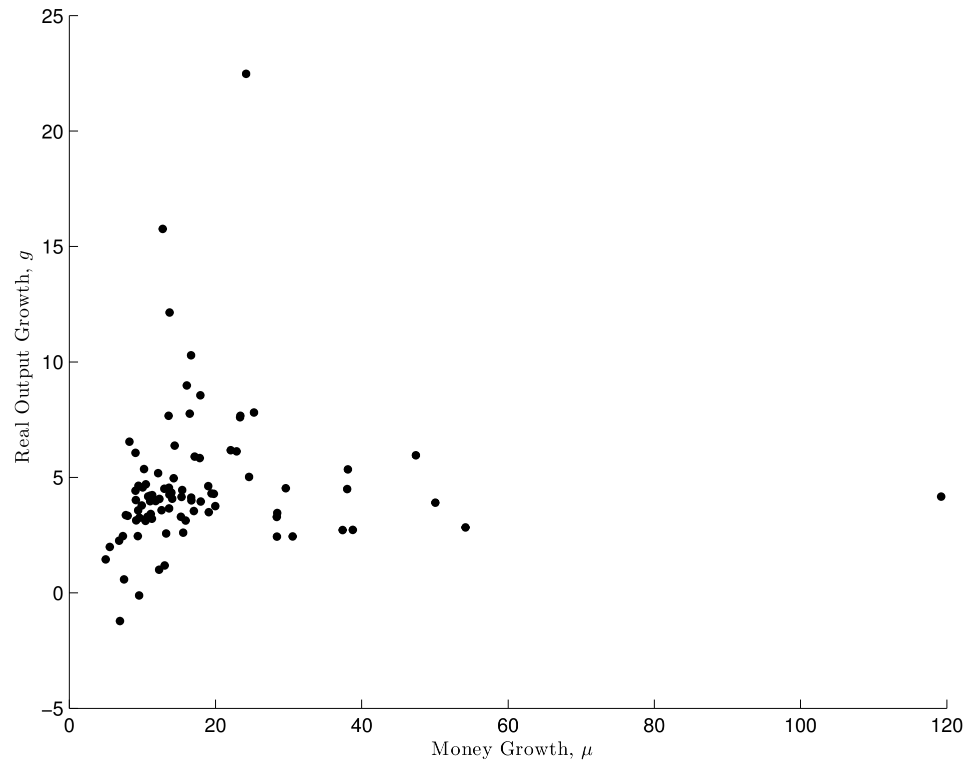
Now taking averages over a long period of time, we have that the quantity theory of money predicts that the average inflation rate is equal to the average money growth rate minus the average output growth rate. Formally,

$$\pi = \mu - g,$$

where variables without a time subscript denote long-run averages. This expression says that, holding g constant, if we plot π against μ, we should get a line with unit slope and a negative intercept equal to $-g$. So, holding constant the growth rate of output, inflation should move one-for-one with the money growth rate. This prediction of the QTM is consistent with empirical regularity (a) (see graph above). It is also consistent with Milton Friedman's claim that "inflation is always and everywhere a monetary phenomenon." Indeed, Milton Friedman was a prominent advocate of the QTM.

Empirical Regularity (b) and the QTM

Recall the graph (reproduced below) suggesting no relationship between the money growth rate and real output growth in the long run:



What does the QTM say about the long-run relationship between the growth rate of money and the growth rate of real output?

According to the QTM, the long-run growth rate of real output is independent of the amount of money printed by the central bank. Instead, the QTM maintains that in the long run, real output is determined by real factors, such as population growth, technological progress, taxes, and openness to trade.

It follows that the QTM predicts no long-run relation between the money growth rate, μ_t, and the growth rate of real output, g_t. That is, the QTM is consistent with empirical fact (b). In other words, the QTM predicts that money is superneutral in the long run.

Admittedly, in this particular regard, there's little, if any, gentlemanly distance between model assumptions and model predictions.

The Quantity Theory of Money and Monetary Policy

Question: According to the Quantity Theory of Money, what should a central bank do to ensure price stability in the long run?

Answer: Control the growth rate of the money supply.

How does monetary policy affect inflation according to the QTM? Earlier in this lecture, we deduced the following prediction of the QTM:

$$\pi_t = \mu_t - g_t. \tag{6}$$

It remains to specify the monetary policy adopted by the central bank. We will consider a number of different monetary-policy regimes.

Monetary Policy Regime 1: Constant money supply.

Suppose the central bank holds the money supply constant at a certain value $\bar{M}$. That is,

$$M_t = \bar{M}$$

for all t. We then have that the growth rate of the money supply is zero:

$$\mu_t = \frac{M_t}{M_{t-1}} - 1 = \frac{\bar{M}}{\bar{M}} - 1 = 0.$$

Recall that in the QTM real output, Y_t, is exogenously given (that is, it is determined outside of the model). Suppose first that real output is constant over time, that is, $g_t = 0$. Then, according to equation (6), we have

$$\pi_t = \mu_t - g_t = 0 - 0 = 0.$$

That is, if the money growth rate is zero and output does not grow, then inflation is zero, or, equivalently, the price level is constant over time.

Suppose now that real output grows at the constant rate g, that is, $Y_t/Y_{t-1} - 1 = g$ for all t. Then looking again at equation (6), we have that the QTM predicts

$$\pi_t = \mu_t - g_t = 0 - g = -g$$

$\Rightarrow$ A policy consisting in a constant money supply ($\mu_t = 0$) in an economy with real output growth ($g > 0$), leads to *deflation* at the rate g.

Monetary Policy Regime 2: Constant Money Growth Rate

Suppose that the central bank expands the money supply at the constant rate $\mu > 0$. That is,

$$\mu_t = \frac{M_t}{M_{t-1}} - 1 = \mu.$$

Also, continue to assume that real output grows at the constant rate $g > 0$. Then, going back to equation (6), we have that according to the QTM, the inflation rate will be equal to

$$\pi_t = \mu_t - g_t = \mu - g$$

That is, a monetary policy consisting in a constant growth rate of the money supply, gives rise to a constant inflation rate equal to the money growth rate less the growth rate of output.

This prediction of the QTM led Milton Friedman to recommend the k-*percent rule,* according to which a sound monetary policy should target a constant growth rate for the money supply at a rate k. And the rate k should roughly equal the average growth rate of the economy, g. Such a policy, according to the QTM, would give rise to an average rate of inflation of zero (i.e., to price stability).

Summing Up

• The Quantity Theory of Money (QTM) is a long-run theory of inflation. It abstracts from nominal rigidities and assumes full employment output.

• Empirically, over long horizons, average inflation moves nearly one-for-one with the average growth rate of money.

• In contrast, the long-run growth rate of real output is unrelated to money growth (money is superneutral).

• The QTM assumes a stable demand for money: $M_t^d = \frac{1}{\bar{v}} P_t Y_t$, where $\bar{v}$ is velocity.

• Money-market equilibrium implies $P_t = \bar{v}\frac{M_t}{Y_t}$, so the price level is proportional to the money supply.

• In growth rates, the QTM predicts $\pi_t = \mu_t - g_t$, and in the long run $\pi = \mu - g$.

• A constant money supply ($\mu_t = 0$) implies zero inflation if $g = 0$, and deflation at rate g if output grows.

• A constant money growth rule (μ constant) implies constant inflation $\pi = \mu - g$, motivating Friedmans k-percent rule.

Lecture 11
The Cagan Model

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

The Cagan Model

An Interest-Elastic Money Demand Function

One criticism of the Quantity Theory of Money (QTM) is its assumption that the demand for money is insensitive to changes in the nominal interest rate. Agents desired real money holdings are assumed to be a constant fraction of output, $\frac{M_t^d}{P_t} = \frac{1}{\bar{v}} Y_t$, regardless of the level of the nominal interest rate. It seems more reasonable to assume that when the interest rate rises, agents reduce their money holdings, which do not earn interest, in favor of interest-bearing assets such as time deposits, bonds, or deposits in mutual funds.

The Cagan model modifies this feature of the QTM by assuming, more realistically, that the demand for real money balances depends not only on real income, but also on the nominal interest rate. Formally,

$$\frac{M_t^d}{P_t} = L(\underset{-}{i_t}, \underset{+}{Y_t}), \tag{1}$$

where M_t^d denotes the demand for nominal money balances in period t; P_t denotes the price level in period t; M_t^d/P_t denotes the demand for real money balances in period t; i_t denotes the nominal interest rate in period t; Y_t denotes real full-employmnent output in period t; and $L(\cdot,\cdot)$ is a function decreasing in its first argument and increasing in its second argument.

The function $L(\cdot,\cdot)$ is known as the *money demand function* or as the *liquidity preference function.*

Why Is the Demand for Money a Decreasing Function of the Nominal Interest Rate?

The demand for money depends negatively on the nominal interest rate because the nominal interest rate represents the opportunity cost of holding money. This is because money does not earn interest. So, by having money in our pockets or in checking accounts, we forgo the interest we could be earning if instead we had invested that money in an interest-bearing asset, such as a bond.

Why Is the Demand for Money an Increasing Function of Real Output?

Because money facilitates transactions, and the higher real output is, the larger the number of transactions in the economy will be (purchases and sales of final goods and services, materials, payment of wages, rents, etc.).

Equilibrium in the Money Market

Let M_t denote the supply of money. As discussed in the last lecture, we can think of M_t as, for example, the sum of currency in circulation and checking deposits (i.e., M1).

In equilibrium the demand for money must equal the supply of money,

$$M_t = M_t^d.$$

Using the money demand function in equation (1) to replace M_t^d, we have that

$$\frac{M_t}{P_t} = L(i_t, Y_t).$$

The Fisher Equation

Relative to the QTM, the Cagan model includes an additional variable, the nominal interest rate, i_t. How is i_t determined?

In a previous lecture, we explained that the nominal interest rate is determined by the real interest rate and expected inflation:

$$1 + i_t = (1 + r_t)(1 + \pi^e_{t+1}),$$

where r_t is the real interest rate between periods t and $t + 1$, and π^e_{t+1} is expected inflation between periods t and $t+1$. You may recall that we referred to this relationship as the Fisher equation.

The Fisher equation implies that the nominal interest rate reflects two components that compensate savers. The term r_t is the real return that rewards the saver for postponing consumption over the investment period. The term π^e_{t+1} compensates for the expected loss of purchasing power that the saved dollars are anticipated to experience as a result of inflation.

How Do People Form Inflationary Expectations?

There are various hypotheses about how people form expectations about future inflation. Here are two prominent ones:

- Adaptive expectations

- Rational expectations

The way expectations are formed will shape the dynamics of inflation in the Cagan model. Let's examine each in turn.

Adaptive Expectations

The adaptive expectations hypothesis says that in forming their expectations about future inflation, people look at current and past values of inflation. For example, one could postulate that people always expect that next period's inflation will be equal to today's inflation, or

$$\pi^e_{t+1} = \pi_t. \tag{2}$$

Another example of adaptive expectations is that people expect next period's inflation to be a weighted average of all current and past rates of inflation, with more distant past inflation rates receiving smaller weights. Formally,

$$\pi^e_{t+1} = (1-\beta)[\pi_t + \beta\pi_{t-1} + \beta^2\pi_{t-2} + \beta^3\pi_{t-3} + \dots] \tag{3}$$

where β is a constant parameter between 0 and 1.* Note that
(a) The weights add up to unity, that is, $(1-\beta)[1+\beta+\beta^2+\beta^3+\dots] = 1$. This means that π^e_{t+1} is a weighted average of current and past inflation rates. And
(b) The weights die out as we consider inflation rates far in the past. To see this, note that the weight on π_{t-j} is $(1-\beta)\beta^j$ for $j = 0, 1, 2, \dots$. Clearly, as $j \to \infty$, we have that $(1-\beta)\beta^j \to 0$.

Note that (2) is a special case of (3) when $\beta = 0$.

*Here β is not related to the subjective discount factor in the NK model, which we denoted with the same greek letter.

Rational Expectations (RE)

This hypothesis assumes that agents understand the structure of the economy and form expectations that are consistent with it. As a result, their forecasts of future inflation are correct up to an error with zero mean.

Forecast errors arise only because the economy may be subject to shocks next period that cannot be anticipated today.

When the economy is not hit by unexpected shocks, rational expectations coincide with *perfect foresight*. Under perfect foresight, the expectation of future inflation equals the future rate of inflation itself:

$$\pi_{t+1}^e = \pi_{t+1}.$$

In words, under rational expectations agents make no systematic forecast errors; under perfect foresight, forecast errors are identically zero.

Taking Stock
The Four Building Blocks of the Cagan Model

The Cagan model consists of four building blocks:

1. Equilibrium in the money market: $\frac{M_t}{P_t} = L(i_t, Y_t)$

2. The Fisher equation: $1 + i_t = (1 + r_t)(1 + \pi^e_{t+1})$

3. An assumption about how inflationary expectations are formed (e.g., adaptive expectations, rational expectations); and

4. Specification of the central bank's monetary policy (to be discussed shortly).

Two Simplifying Assumptions

The purpose of the Cagan model is the study of the determination of inflation, π_t, and real money balances, M_t/P_t, under alternative monetary policy regimes. The behavior of the real interest rate, r_t, or full-employment real output, Y_t, is not explained within the model. Therefore, r_t and Y_t are assumed to be exogenously determined, and, typically, they are assumed to be constant. We will follow this practice and set

$$r_t = r$$

and

$$Y_t = Y,$$

where r and Y are constants.

Monetary Policy

The last building block of the Cagan model is a specification of the monetary policy regime. That is, we need to state how the central bank conducts monetary policy. Here, we will consider a monetary regime in which the central bank expands the money supply at a constant rate.

A Constant Money Growth Rate Policy

Assume that in period 0 the central bank announces that moving forward the money supply will expand at the constant rate $\mu > 0$ each period. That is,

$$M_1 = (1 + \mu)M_0,$$

$$M_2 = (1 + \mu)M_1,$$

and so on. So we have that in any period $t = 0, 1, 2, \ldots$, the money supply is

$$M_{t+1} = (1 + \mu)M_t$$

with the initial money supply, M_0, given.

Suppose also that the demand for money takes the specific functional form

$$L(i_t, Y) = (1 + i_t)^{-\eta}Y,$$

where η is a positive parameter, known as the *interest-rate semielasticity of money demand*. Further, assume that people have perfect foresight, so that

$$\pi^e_{t+1} = \pi_{t+1}.$$

Under these assumptions, we have that the equilibrium is described by the following relationships:

$$\frac{M_t}{P_t} = (1 + i_t)^{-\eta} Y \tag{4}$$

$$1 + i_t = (1 + r)(1 + \pi_{t+1}) \tag{5}$$

$$M_{t+1} = (1 + \mu) M_t \tag{6}$$

for $t = 0, 1, 2, \ldots$, with M_0 given.

Solving for the Equilibrium

Which elements of the model are known and which are unknown? We know Y, r, η, μ, M_0, and the entire path of M_t. We do not know the equilibrium paths of the price level, P_t, inflation, $\pi_t \equiv P_t/P_{t-1} - 1$, the nominal interest rate, i_t, and real money balances, M_t/P_t, for $t = 0, 1, 2, \ldots$

To find the equilibrium paths of these variables, we guess a candidate solution and then verify that it satisfies the model. By verification, we mean checking that the proposed solution satisfies all the equations of the Cagan model, namely (4), (5), and (6).

We conjecture that in equilibrium real money balances, M_t/P_t, are constant over time. This conjecture is reasonable because monetary policy does not change over time (μ is constant). But we must verify that it is consistent with the model.

According to (6), M_t grows at the constant rate μ. Therefore, if real money balances, M_t/P_t, are constant, the price level, P_t, must also grow at rate μ. That is,

$$\frac{P_{t+1}}{P_t} - 1 \equiv \pi_{t+1} = \mu; \quad \text{for } t = 0, 1, 2, \ldots$$

If future inflation is constant and equal to μ, then the Fisher equation under perfect foresight (equation 5) implies that the nominal interest rate is also constant and satisfies

$$1 + i_t = (1 + r)(1 + \mu); \quad \text{for } t = 0, 1, 2, \ldots$$

In turn, if the nominal interest rate, i_t, is constant, then the demand for real money balances, $(1+i_t)^{-\eta}Y$, is also constant. By money market equilibrium (equation (4)), real money balances must therefore satisfy

$$\frac{M_t}{P_t} = [(1+r)(1+\mu)]^{-\eta}Y; \quad \text{for } t = 0, 1, 2, \ldots$$

This confirms that our initial conjecture of constant real money balances is consistent with the model.

We have shown that, according to the Cagan model under rational expectations, if the central bank expands the money supply at the constant rate μ forever, and this policy is correctly anticipated, then inflation will also be constant and equal to μ in every future period; that is, $\pi_t = \mu$ for $t = 1, 2, \ldots$. Inflation in periods $1, 2, \ldots$ is therefore the consequence of the central bank expanding the money supply at rate μ. The higher the rate of money growth, the higher inflation will be. This prediction is identical to that of the Quantity Theory of Money (QTM).

We have also learned that in equilibrium the nominal interest rate, i_t, increases with the money growth rate μ. A higher μ implies higher expected inflation, and higher expected inflation raises the nominal interest rate because savers must be compensated for the loss of purchasing power.

In addition, real money balances, M_t/P_t, decrease with the money growth rate μ. As μ rises, the nominal interest rate increases, so households reduce their holdings of non-interest-bearing money in favor of interest-bearing assets.

Finally, evaluating equilibrium condition (4) in period 0 and solving for P_0, we obtain the initial price level:

$$P_0 = \frac{M_0}{Y}[(1+r)(1+\mu)]^\eta. \tag{7}$$

This expression highlights the key difference between the Cagan model and the QTM. In the QTM, $P_0 = M_0\bar{v}/Y$, so P_0 is unaffected by the future expected growth rate of money, μ. By contrast, in the Cagan model, the expression in equation (7) shows that P_0 increases with the expected future growth rate of money, μ.

Why? A higher future money growth rate implies higher future inflation. This raises inflation expectations ($\pi_1^e \uparrow$), which increases the nominal interest rate today ($i_0 \uparrow$). The higher interest rate induces households to reduce their real money holdings ($L(Y, i_0) \downarrow$).

By money market equilibrium, if the demand for real money balances falls, the real money supply must also fall ($M_0/P_0 \downarrow$). Because M_0 is predetermined, the decline in real money balances must occur through an increase in the initial price level ($P_0 \uparrow$).

None of these effects arise in the QTM, where the initial price level is simply $P_0 = \bar{v}M_0/Y$. In that model, P_0 depends on the current money supply M_0, but not on its future growth rate μ.

The key difference is that in the Cagan model the demand for money is interest elastic, whereas in the QTM it is interest inelastic.

Summing Up

• The Cagan model is an extension of the QTM model in which the demand for money is interest elastic rather than independent of the interest rate.

• The intuition for why the demand for money decreases as the interest rate increases is that money does not earn interest; thus, an increase in the interest rate makes it more expensive to hold money in terms of the interest forgone by not holding interest-bearing assets.

• By the Fisher equation, the interest rate depends on expected inflation. Therefore, in the Cagan model one must specify how expectations are formed. Two examples are rational expectations and adaptive expectations.

• In the absence of uncertainty, rational expectations is equivalent to perfect foresight. Under perfect foresight, people do not make mistakes; that is, expected inflation equals actual future inflation.

• Under adaptive expectations, people use a combination of current and past inflation rates to form their expectations about future inflation.

• If the central bank expands the supply of money at a constant rate μ, then the Cagan model predicts that, in equilibrium, the inflation rate in all future periods equals μ. This result is identical to that of the QTM model.

• However, the Cagan and QTM models differ in their predictions about the initial price level P_0. In the Cagan model, the initial price level P_0 increases with the expected growth rate of the money supply, μ. By contrast, the QTM model predicts that P_p is independent of μ.

Lecture 12

Fiscal Deficits, Money Creation, and Inflation

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Topics Today

- The Government Budget Constraint
- Fiscal Deficits and Money Creation
- The Inflation Tax (or Seignorage Revenue)
- The Laffer Curve of the Inflation Tax
- How Countries Fall into Hyperinflation.

Motivating Question

• In previous lectures, we saw that a high rate of money growth leads to high inflation. This is a central message of both the QTM and the Cagan models.

• But why would a central bank allow the money supply to grow at a high rate?

• In many cases, the reason is that governments run large fiscal deficits and, when the central bank is not independent, finance them by printing money. This lecture examines this explanation.

Augmenting the Cagan Model with a Fiscal Sector

Consider adding to the Cagan model a fiscal authority that purchases goods and services (government spending), levies taxes, and issues public debt.

The building blocks of such a model are:

(1) Equilibrium in the money market: money supply = money demand;
(2) The Fisher equation;
(3) Expectation formation: We will assume that agents are rational;
(4) The government budget constraint;
(5) Fiscal policy;
(6) Monetary policy.

We are familiar with building blocks (1) to (3) and (6). The novel elements of the model are (4) and (5), which have to do with the fiscal side of the government.

(1) Equilibrium in the Money Market

In equilibrium, the real money supply must equal the real money demand,

$$\frac{M_t}{P_t} = L(i_t, Y), \tag{1}$$

where M_t denotes the nominal money supply in period t, P_t the price level in period t, i_t the nominal interest rate in period t, and Y real output (assumed constant).

The money demand function $L(i_t, Y)$ is assumed to be decreasing in i_t and increasing in Y.

(2) The Fisher Equation

$$1 + i_t = (1 + r)(1 + \pi^e_{t+1}), \tag{2}$$

where $\pi_t \equiv P_t/P_{t-1} - 1$ denotes the inflation rate in period t, and π^e_{t+1} denotes people's expectation of π_{t+1} given information available in period t.

(3) Rational Expectations

Assume that people's expectations are correct, unless they are surprised by some unforecastable change in the economic environment. That is, in the absence of a surprise in $t+1$, we have that

$$\pi_{t+1}^{E} = \pi_{t+1}.$$

The Government: Outlays and Revenues

Government Outlays

— The government purchases goods and services in the amount G_t. The cost of these goods and services is P_tG_t.
— It pays interest on the outstanding public debt, $i_{t-1}B_{t-1}$, where B_{t-1} = debt issued in period $t-1$ and due in period t, and i_{t-1} = nominal interest rate in period $t-1$.

Government Revenues

— The government levies taxes, denoted T_t,
— issues new debt, $B_t - B_{t-1}$, and
— prints money, $M_t - M_{t-1}$.

The Government Budget Constraint

The government budget constraint is then given by

$$T_t + (M_t - M_{t-1}) + (B_t - B_{t-1}) = P_t G_t + i_{t-1} B_{t-1}. \tag{3}$$

The right-hand side of this expression represents the government's outlays, and the left hand side represents the government's sources of revenue.

The Fiscal Deficit

Rearranging terms in the government budget constraint (3), we can write

$$P_tG_t - T_t + i_{t-1}B_{t-1} = M_t - M_{t-1} + B_t - B_{t-1} \tag{4}$$

The left-hand side of (4) is called the *fiscal deficit,*

$$\text{fiscal deficit} = P_tG_t - T_t + i_{t-1}B_{t-1}.$$

The *primary fiscal deficit* is the difference between government spending and tax revenue:

$$\text{primary fiscal deficit} = P_tG_t - T_t.$$

So the fiscal deficit is the primary deficit plus interest obligations on the outstanding public debt.

The Government Budget Constraint In Real Terms

We can express the government budget constraint in real terms by dividing the left- and right-hand sides of (4) by the price level P_t. This gives

$$G_t - \frac{T_t}{P_t} + i_{t-1}\frac{B_{t-1}}{P_t} = \frac{M_t - M_{t-1}}{P_t} + \frac{B_t - B_{t-1}}{P_t} \tag{5}$$

The left-hand side of (5) is the fiscal deficit measured in units of goods, or real fiscal deficit, and we will denote it by

$$DEF_t = G_t - \frac{T_t}{P_t} + i_{t-1}\frac{B_{t-1}}{P_t}$$

Moving forward in this lecture, when we say fiscal deficit, we will refer to the real fiscal deficit, DEF_t.

(4) The Fiscal Deficit and the Government Budget Constraint

Using the definition of (real) fiscal deficit, the government budget constraint (5) can be written as

$$DEF_t = \frac{M_t - M_{t-1}}{P_t} + \frac{B_t - B_{t-1}}{P_t} \tag{6}$$

This equation makes it transparent that a fiscal deficit ($DEF_t > 0$) must be financed with money creation ($M_t - M_{t-1} > 0$) or with an increase in government debt ($B_t - B_{t-1} > 0$), or both.

When the government finances part (or all) of its fiscal deficit through money creation rather than debt issuance, we say that part (or all) of the deficit is *monetized.* Thus, monetization refers to the extent to which an increase in M_t is used to finance DEF_t, instead of issuing additional public debt.

Seignorage Revenue

The first term on the right hand side of (6) measures the government's real revenue from money creation and is called seignorage revenue or inflation tax revenue

$$\begin{array}{c}\text{seignorage revenue}\\ \text{(or inflation tax revenue)}\end{array} = \frac{M_t - M_{t-1}}{P_t}. \tag{7}$$

Seignorage revenue is the amount of goods the government can buy with the money it prints. Shortly, it will become clear why it is called inflation tax revenue.

The Fiscal Policy

Assume that the government runs a constant fiscal deficit,

$$DEF_t = DEF,$$

where DEF is a positive constant.

Assume also that the government has exhausted its capacity to finance its deficit by issuing government debt,

$$B_t - B_{t-1} = 0.$$

This means that all of the fiscal deficit must be financed via seignorage revenue (or monetized). Equation (6) then becomes

$$DEF = \frac{M_t - M_{t-1}}{P_t}. \tag{8}$$

The Monetary Policy

Equation (8) describes a central bank with no independence: the monetary authority stands ready to finance, through money creation, the entire fiscal deficit determined by the fiscal authority. In this case, monetary policy is fully subordinated to fiscal policy.

We will show that the central bank can monetize the fiscal deficit, as required by the fiscal authority, by expanding the money supply at a constant rate μ,

$$M_t = (1 + \mu)M_{t-1}. \tag{9}$$

In this environment, the money growth rate μ is not exogenously chosen by the central bank, as in previous lectures. Rather, it is endogenously determined by the government's need to finance the fiscal deficit, DEF.

The Equilibrium Inflation Rate

As in the discussion of the Cagan model, we conjecture (guess) that in equilibrium real money balances, M_t/P_t, are constant. Then, since the nominal money supply, M_t, grows at the rate μ, in order for M_t/P_t to be constant (as conjectured), P_t must also grow at the rate μ, in periods $1, 2, \ldots$, that is, the inflation rate must equal μ,

$$\pi_t = \mu,$$

for $t = 1, 2, \ldots$

The Equilibrium Nominal Interest Rate

Because people have rational expectations and there are no surprises, expected inflation equals actual inflation

$$\pi^e_{t+1} = \pi_{t+1} = \mu,$$

for $t = 0, 1, \ldots$

Now combine this result with the Fisher equation (2), to obtain

$$1 + i_t = (1 + r)(1 + \mu). \tag{10}$$

The Equilibrium Real Money Supply

Substituting the equilibrium value of the nominal interest rate given in (10) into the money market equilibrium condition (1) yields

$$\frac{M_t}{P_t} = L((1+r)(1+\mu) - 1, Y). \tag{11}$$

Because μ, r, and Y are constants, the right-hand side of (11) is also constant. In turn, this implies that the left hand side of (11), M_t/P_t, is constant, validating the initial guess.

The Fiscal Deficit, Money Growth, and Inflation

Suppose that the economy was in this equilibrium also in period $t-1$. Then, our conjecture that in equilibrium the real money supply is constant implies that $M_t/P_t = M_{t-1}/P_{t-1} = L((1+r)(1+\mu)-1, Y)$ and $\pi_t = \mu$, we can write the government budget constraint (8) as

$$\begin{aligned} DEF &= \frac{M_t - M_{t-1}}{P_t} \\ &= \frac{M_t}{P_t} - \frac{P_{t-1}}{P_t}\frac{M_{t-1}}{P_{t-1}} \\ &= L((1+r)(1+\mu)-1, Y) - \frac{1}{1+\pi_t}L((1+r)(1+\mu)-1, Y) \\ &= \frac{\pi_t}{1+\pi_t}L((1+r)(1+\mu)-1, Y) \\ &= \frac{\mu}{1+\mu}L((1+r)(1+\mu)-1, Y). \end{aligned}$$

In sum,

$$DEF = \frac{\mu}{1+\mu}L((1+r)(1+\mu)-1, Y) \qquad (12)$$

Inflation as a Tax on Money Holdings

Since $\pi_t = \mu$, equation (12) can be interpreted as indicating that the fiscal deficit is financed by an *inflation tax.*

Every tax has a *tax rate* and a *tax base.* The same is true with the inflation tax:

The inflation tax rate is $\mu/(1+\mu)$, and is increasing in the inflation rate (or money growth rate), μ.

The inflation tax base is the real money demand $L((1+r)(1+\mu)-1, Y)$, and is decreasing in the inflation rate, μ.

The inflation-tax revenue is the product of the tax rate and the tax base, $\frac{\mu}{1+\mu}L((1+r)(1+\mu)-1, Y)$

The Laffer Curve of the Inflation Tax

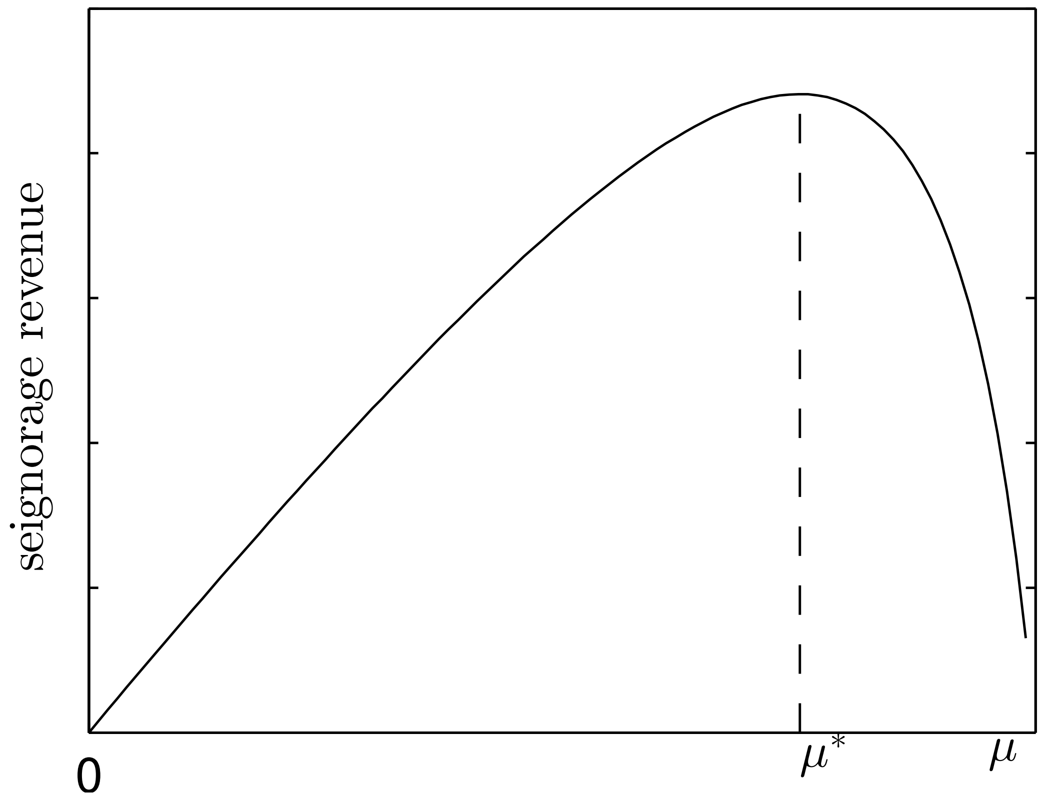
It is not clear whether inflation-tax revenue (equation (7)) increases or decreases with μ, because the equilibrium demand for money, $L((1+r)(1+\mu)-1, Y)$, is decreasing in μ, whereas the inflation-tax rate $\mu/(1+\mu)$ is increasing in μ.

• The next figure displays the typical equilibrium relationship between inflation tax revenue (or seignorage revenue) and the money growth rate. Typically, for low values of μ the inflation tax revenue is increasing in μ. However, as μ gets large the contraction in the tax base (the real money demand) dominates the increase in the tax rate and therefore the inflation tax revenue falls as μ increases.

• There exists a maximum level of inflation tax revenue a government can collect from printing money. In the figure, this occurs when $\mu = \mu^*$.

• The resulting relationship between the growth rate of the money supply and the inflation tax revenue has the shape of an inverted-U and is called the *inflation tax Laffer curve*.

The Laffer Curve of the Inflation Tax



Inflationary Finance

We showed that if the government cannot finance the fiscal deficit by issuing debt, then there exists an equilibrium relationship between the deficit and the money growth rate of the form

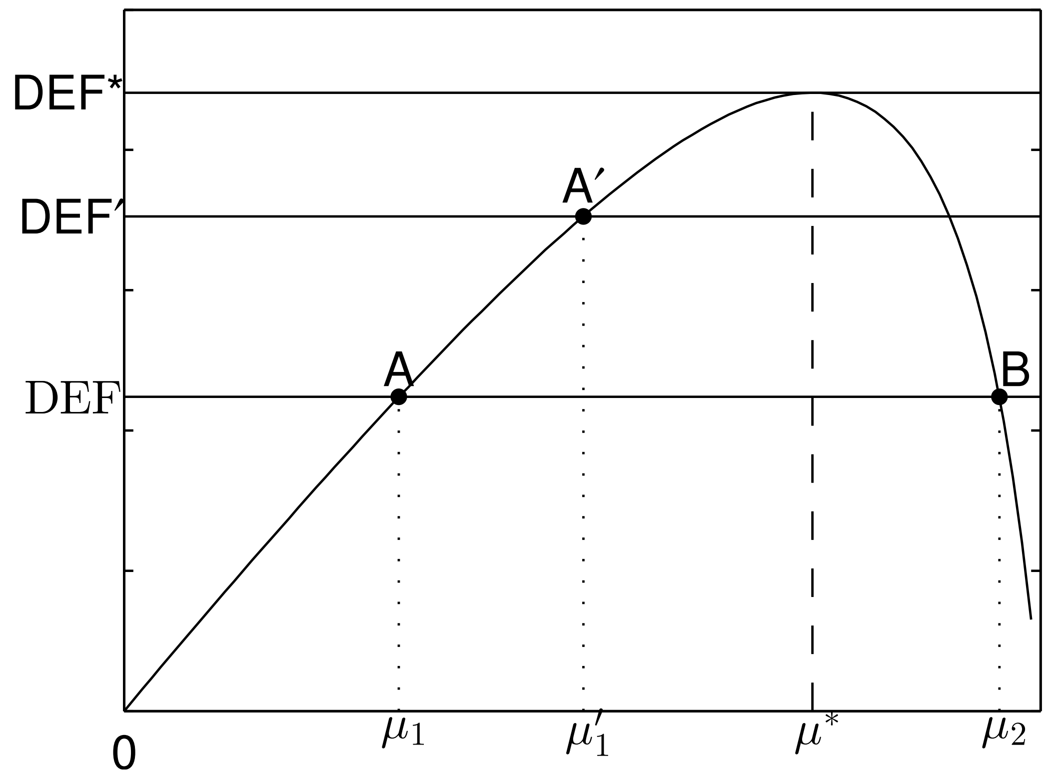
$$DEF = \left(\frac{\mu}{1+\mu}\right) L((1+r)(1+\mu)-1, Y). \tag{13}$$

The next figure illustrates this relationship: The equilibrium occurs when the horizontal line (DEF) intersects the Laffer curve.

There are two equilibria: One occurs on the upward sloping side of the Laffer curd, point A in the figure, and the other on the downward sloping side, point B in the figure.

We assume that the government manages to ensure that the equilibrium happens on the upward-sloping side of the Laffer curve (pint A). This equilibrium is preferred to the one located on the downward-sloping side of the Laffer curve (point B), because it features a lower rate of inflation.

Inflationary finance and the Laffer curve of inflation



Effects of an Increase in the Fiscal Deficit

Suppose the deficit increases from DEF to $DEF' > DEF$.

To finance the larger fiscal deficit, the government is forced to increase the money supply at a faster rate.

At the new equilibrium, point A' in the figure, the rate of monetary expansion, μ_1' is higher than at the old equilibrium.

As a result, the inflation rate and the nominal interest rate are also higher, but real money balances M_t/P_t are lower.

Summarizing:
$DEF \uparrow \Rightarrow \mu \uparrow, \pi_t \uparrow, i_t \uparrow, M_t/P_t \downarrow$

Falling into a Hyperinflation

In some instances, inflationary finance can degenerate into hyperinflation.

A hyperinflationary situation arises when the fiscal deficit reaches a level that can no longer be financed by seignorage revenue alone.

Take another look at the last figure. Fiscal deficits larger than DEF^*, the level of deficit associated with the peak of the Laffer curve, cannot be fully financed by seignorage revenue.

What happens in practice is as follows. Suppose initially the fiscal deficit is DEF. To finance it, the central bank expands the money supply at the rate μ_1. If the deficit increases to DEF', the government increases the money growth rate to μ_1'.

Falling into a Hyperinflation (cont.)

If the deficit increases further to a level higher than DEF^*, the government thinks that to close the fiscal gap, it must accelerate the rate of money creation, just as it did in the past.

If the government increases the money growth rate from μ_1' to a level lower then μ^*, seignorage revenue increases, but not enough to finance the deficit.

The government therefore tries with an even higher money growth rate. But this time this is counterproductive. because seignorage revenue falls—the economy is on the wrong side of the Laffer curve.

This leades the government, still unaware of the impossibility of financing all of the deficit with seignorage, to increase the money supply at an even faster rate, which accelerates inflation.

Seignorage revenue falls again, and the dynamic turns into a vicious cycle that ends in an accelerating inflationary spiral.

Summing Up

• The government budget constraint links fiscal deficits to their financing: money creation or debt issuance.
• The real fiscal deficit is

$$DEF_t = G_t - \frac{T_t}{P_t} + i_{t-1}\frac{B_{t-1}}{P_t}.$$

• When part (or all) of the deficit is financed through money creation, the deficit is said to be partly (or completely) monetized.
• Seignorage revenue equals real money creation,

$$\frac{M_t - M_{t-1}}{P_t},$$

and represents the resources obtained through the inflation tax.
• With no central bank independence and no new debt issuance, money growth μ adjusts to finance DEF.
• In equilibrium, money growth determines inflation:

$$\pi_t = \mu.$$

• Inflation tax revenue equals a tax rate, $\frac{\mu}{1+\mu}$, times a tax base, real money demand, $L((1+r)(1+\mu)-1, Y)$.
• Because the tax base shrinks as inflation rises, inflation tax revenue follows a Laffer curve.
• If the fiscal deficit exceeds the maximum seignorage revenue, attempts to finance it with money creation can lead to hyperinflation.

Lecture 13

Economics UN3213

Intermediate Macroeconomics

Instructor: Professor Martín Uribe

Columbia University

Spring 2026

The Beginning and End of Hyperinflations

Let's recap

In the previous lecture, we studied a government that is financing a constant fiscal deficit DEF with a constant money supply growth rate μ. We established that μ is determined by the expression

$$DEF = \left(\frac{\mu}{1+\mu}\right) L((1+r)(1+\mu)-1, Y). \tag{1}$$

On the right-hand side of equation (1), we referred to the factor $\frac{\mu}{1+\mu}$ as the *inflation tax rate* and to the factor $L((1+r)(1+\mu)-1,Y)$ as the *inflation tax base*. So the base of the inflation tax is the demand for money.

We also established that in equilibrium the inflation rate is equal to the money growth rate,

$$\pi_t = \mu.$$

A Numerical Example

To shed light on the connection between fiscal deficits, money creation, and inflation, suppose that the money demand function is given by$L(i_t, Y) = \gamma \left(\frac{1+i_t}{i_t}\right) Y$, where i_t denotes the nominal interest rate, Y denotes output (GDP) and is assumed to be constant, and γ is a parameter. Let $\gamma = \frac{1}{2}$, $DEF = \frac{1}{3}Y$ (i.e., the fiscal deficit is a third of GDP), $r = 0.05$. (i.e., the real interest rate is 5%).

Appliying equilibrium condition (1), we have that in equilibrium, the relationship between DEF and μ is

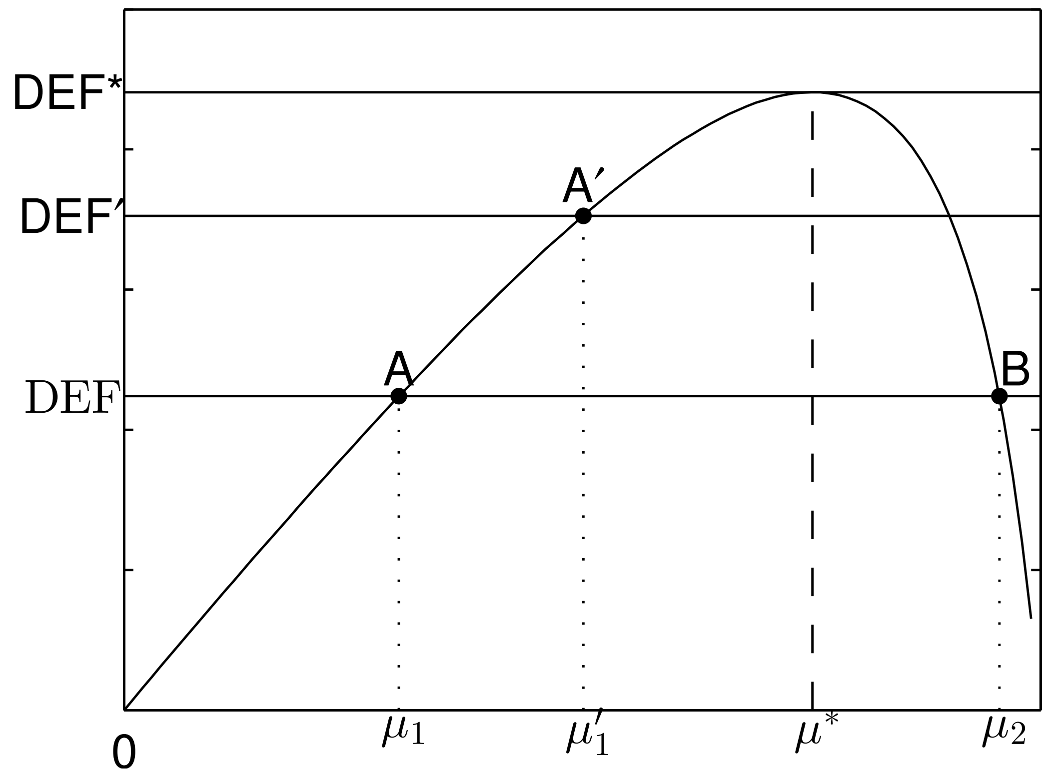
$$DEF = \frac{\mu}{1+\mu}\,\gamma Y \frac{(1+r)(1+\mu)}{(1+r)(1+\mu)-1}.$$

Divide the left and right hand sides of this expression by Y and solve for μ to obtain

$$\mu = \left(\frac{r}{1+r}\right)\frac{DEF/(\gamma Y)}{1-DEF/(\gamma Y)} = \left(\frac{0.05}{1+0.05}\right) \times \frac{(1/3)/(1/2)}{1-(1/3)/(1/2)} = 0.0952$$

The government must increase the money supply at a rate of 9.52% per year. This implies that the rate of inflation will be 9.52% per year. The nominal interest rate is 14.7% per year.

Last class, we also analyzed graphically how changes in the deficit, DEF, affect the equilibrium levels of the money growth rate, μ. We reproduce the graph here:



The figure shows that as the deficit increases, the government must increase the money growth rate (and inflation) to finance it. However, there is a maximum level of fiscal deficit, denoted DEF^* in the figure, that can be financed by money printing. The money growth rate (and inflation) required to finance this level of fiscal deficit, denoted μ^* in the figure, is associated with the peak of the Laffer curve.

Fiscal deficits larger than DEF^* are impossible to finance with money creation. We argued that hyperinflations can be understood as situations in which a government tries, unsuccessfully, to finance a deficit larger than DEF^* by printing money.

Stopping a Hyperinflation

The most fundamental step in ending hyperinflation is to eliminate the underlying unsustainable budgetary imbalances that are at the root of the problem, by reducing DEF to a level below DEF^*.

When this type of structural fiscal reform is undertaken and is understood by the public, hyperinflation typically stops abruptly.

Evidence from Hyperinflations

The quick acceleration of inflation we just described and the sudden stop are typical features of hyperinflations.

Look at the figure on the next slide, displaying the price level in four hyperinflations: Germany, Poland, and Austria in the 1920s, and Zimbabwe at the end of the 2000s. In all cases, the price level is plotted in log scale, so an increase in the slope means an increase in the inflation rate.

Note how in all four cases inflation accelerates in the late part of the hyperinflations.

In all three European hyperinflations, the price level stops growing in a sudden fashion.

In the case of Zimbabwe, the hyperinflation ended because the local currency literally disappeared (people ceased to use it), and was replaced by the U.S. dollar.

The Price Level During the Hyperinflations of Germany, Austria, Poland, and Zimbabwe

47 The Ends of Four Big Inflations

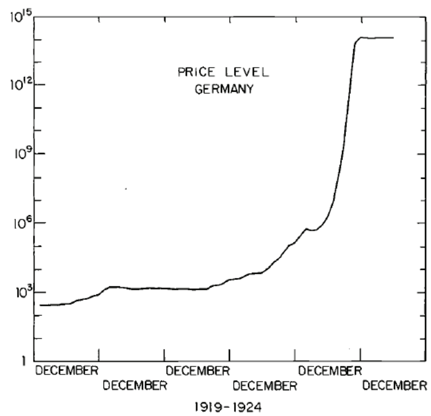


Fig. 2.4 Wholesale prices in Germany.

46 Thomas J. Sargent

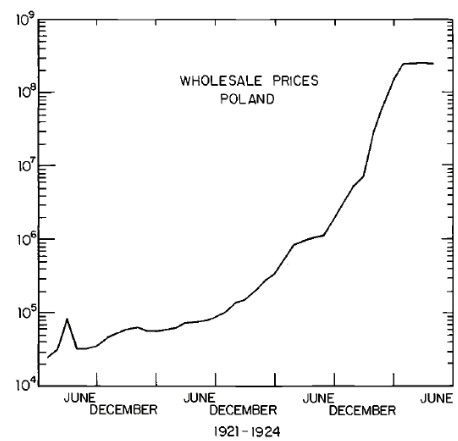


Fig. 2.3 Wholesale prices in Poland.

44 Thomas J. Sargent

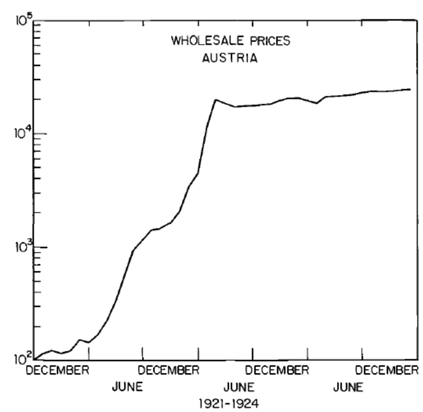
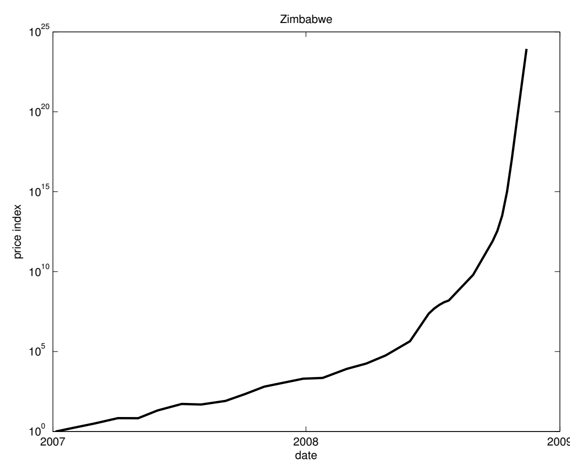


Fig. 2.1 Wholesale prices in Austria.



The German Hyperinflation of 1923 and Its End

Background

- After losing World War I, Germany faced large reparation payments stipulated in the Treaty of Versailles.

- In addition, Germany had accumulated debts to finance war-related government spending.

- After the war, Germany was practically cut-off from international credit markets, which made it difficult to take on debt to finance fiscal imbalances.

- Consequently, the German government resorted to printing large amounts of money to cover the fiscal deficit.

Key Characteristics of the German Hyperinflation

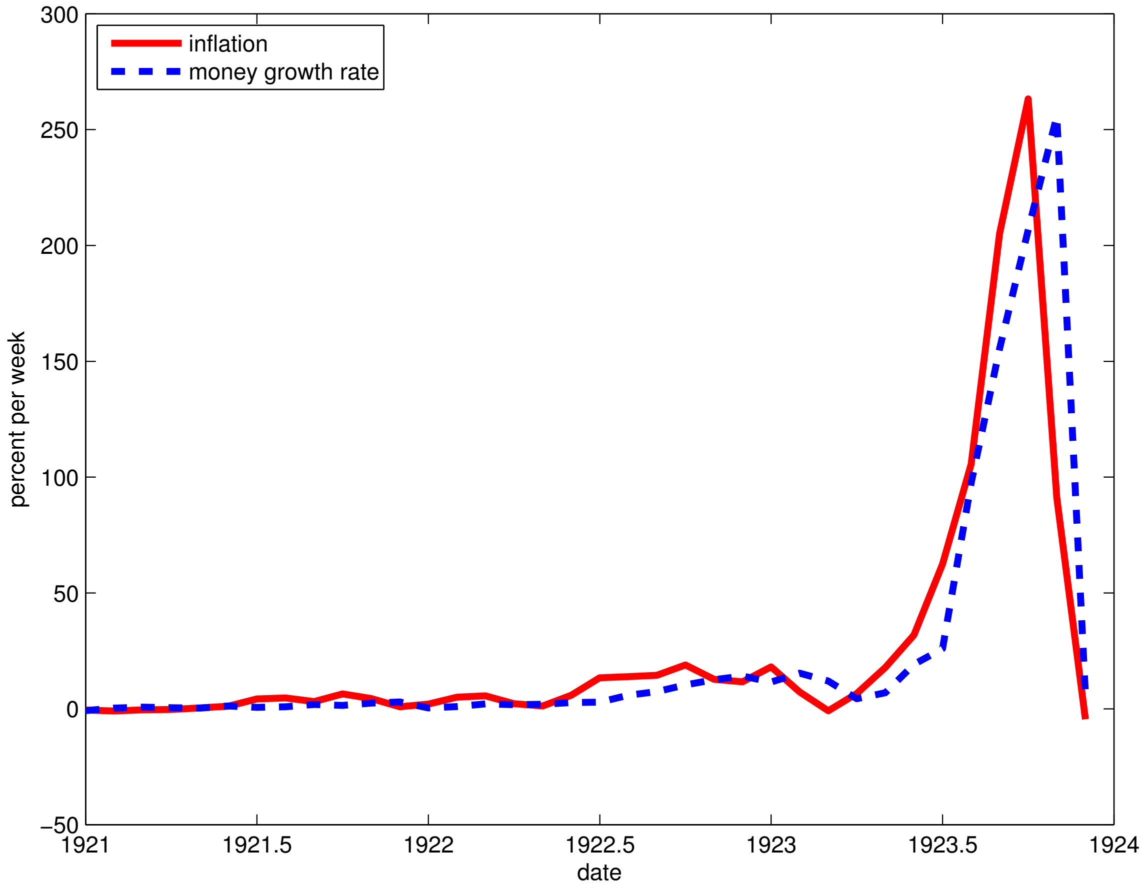
• It was relatively short. During the second half of 1921 and the first half of 1922, inflation was high (about 550 percent per year). But the hyperinflation started in earnest only in the second half of 1922, when the average inflation rate was 90 thousand percent per year. It lasted until November of 1923.

• Both the price level and the money supply grew more or less in tandem during most of the hyperinflation, with two important exceptions (see the graph on the next slide):

— At the beginning of the hyperinflation, inflation seems to lead money growth. This is because the economy demonetizes, that is, M_t/P_t shrinks as people try to reduce real money holdings.

— At the end of the hyperinflation, inflation stops *before* the central bank stops printing money (here inflation also leads money growth, but in going down).

Inflation and the Money Growth Rate
Germany 1921:1 to 1923:12
Monthly Frequency at a Weekly Rate



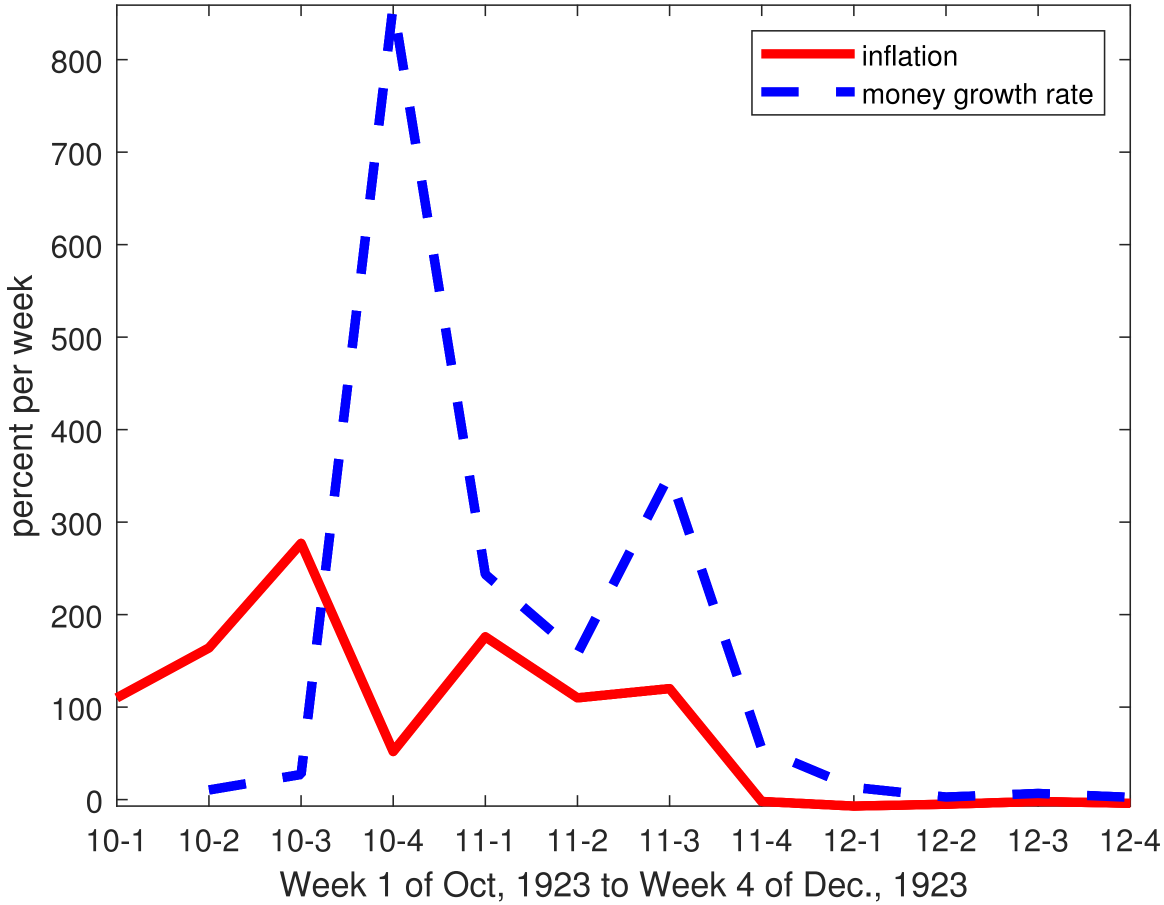
Data Source: Own calculations based on data from P. Michael, A. R. Nobay and D. A. Peel, 1994, for the period 1921:1 to 1923:11, and from Webb 1989, for 1923:12.

The End of the Hyperinflation

The next graph zooms in the last weeks of the hyperinflation, 1923:October:week1 to 1923:December:week4.

The graphs shows the extent to which inflation falls before money growth falls. This is one of the most remarkable features of the German hyperinflation.
Essentially, what happened is that by October 1923 people knew that a stabilization program was in the making and that the hyperinflation would come to an end soon. As a result, they started to rebuild their real money holdings before money stopped growing. The newly created money did not go to buying goods and push prices, but stayed in people's pockets, contributing to the deceleration of inflation.

The Last Weeks of the German Hyperinflation
Inflation and the Money Growth Rate
Germany 1923:October:week1 to 1923:December:week4



Data Source: Own calculations based on data from Webb 1989.

Recapping, two remarkable features of the German hyperinflation are:

(a) At the beginning of the hyperinflation, inflaion increases faster than the money grwth rate.

(b) At the end of the hyperinflation, inflation disappears before the money supply stops growing.

How can we explain these to facts?

Can the Quantity Theory of Money Explain (a) and (b)?

The answer is no. To see this recall that the QTM states that

$$\frac{M_t}{P_t} = \frac{Y}{\bar{v}}, \tag{2}$$

where Y and $\bar{v}$ are constants. Since the right-hand side of (2) is constant, so must be the left-hand side. Thus, the numerator and the denominator of the left-hand side must grow at the same rate every period. In other words, M_t and P_t must grow at the same rate every period.

It follows that the QTM cannot explain neither (a) nor (b) because both (a) and (b) imply M_t and P_t growing at different rates.

Can the Cagan Model Explain (a) and (b)?

Yes, but if one assumes rational expectations. Recall taht when Cagan wrote his paper in the mid 1950s, rational expectations had not yet been discovered. So Cagan was puzzled by (a) and (b), and especially by (b).

To see how the Cagan model can explain (a) and (b) under rational expectations, start with the equilibrium in the money market:

$$\frac{M_t}{P_t} = L(i_t, Y)$$

By the Fisher equation, we have that

$$1 + i_t = (1 + r)(1 + \pi^e_{t+1}).$$

And under perfect foresight, we have that

$$\pi^e_{t+1} = \pi_{t+1}.$$

Combining the above three expressions, we have

$$\frac{M_t}{P_t} = L((1 + r)(1 + \pi_{t+1}) - 1, Y) \tag{3}$$

Suppose now that we are at the beginning of the hyper inflation. People expect that inflation will accelerate, that is, they expect that $\pi_{t+1} > \pi_t$. The interest rate factors in the expected iincrease in inflation, so the interest rate increases today

($i_t \uparrow$). If the interest rate increases today, then the demand for money falls today. So equation (3) implies that

$$\frac{M_t}{P_t} < \frac{M_{t-1}}{P_{t-1}}$$

but this can only happen if the price level grows faster than themoney supply in period t. To see this, rearrange terms in the above expression to get

$$\frac{P_t}{P_{t-1}} > \frac{M_t}{M_{t-1}}$$

that is, if

$$\pi_t > \mu_t,$$

which is precisely what (a) says happened at the beginning of the German hyper-inflation.

Similarly, suppose now that we are near the end of the hyperinflation. The government anounces a fiscal reform and people expect that inflation will fall drastically in the near future. If people expect that inflation will be lower next period, by the Fisher equation the interest rate falls today. if the interest rate falls today, the demand for money increases today. So, by equation (3) we have that

$$\frac{M_t}{P_t} > \frac{M_{t-1}}{P_{t-1}}.$$

This implies that between periods $t-1$ and t, P_t grows more slowly than M_t, which is consistent with fact (b), which says that at the end of the German hyperinflation the price level slowed down before the money supply.

Summing up

• Persistent fiscal deficits financed with money creation generate high inflation and may lead to hyperinflation.
• Seigniorage revenue equals the inflation-tax rate $\frac{\mu}{1+\mu}$ times the real demand for money.
• Because the inflation tax has a Laffer curve, there exists a maximum deficit DEF^* that can be financed by printing money.
• Hyperinflations can be interpreted as situations in which governments attempt to finance deficits larger than DEF^* through money creation.
• The Cagan model predicts that if DEF increases to a level above DEF^*, a hyperinflation can happen very quickly, as the central bank tries to finance with an ever increasing money growth rates a fiscal deficit that is impossible to finance by money creation alone.
• Similarly, the model predicts that if the fiscal deficit is cut from a level above DEF^* to a level below DEF^*, hyperinflation can end very quickly, because if $DEF < DEF^*$ there is a finite money growth rate that can generate enough inflation tax to pay for it.
• Historical episodes (Germany, Austria, Poland, Zimbabwe) show explosive acceleration of the price level followed by abrupt stabilization. Both of these characteristics are predicted by the model we studied in this lecture.
• During hyperinflations, inflation and money growth typically move closely together.
• Two striking facts from the German hyperinflation: inflation initially rises faster than money growth and later collapses before money growth falls.
• The Cagan money-demand model with rational expectations explains these patterns through changes in expected future inflation.

No Lecture 14 (review session)

No Lecture 15 (midterm)

Lecture 16
The Government Budget Constraint

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Motivating Questions

⋄ How does a tax cut, or a government transfer, affect consumption, the real interest rate, and investment?

⋄ Do fiscal deficits due to tax cuts (or to increases in transfers) drive up interest rates and crowd-out investment?

Two Views About Tax Cuts

View I: Tax cuts generate fiscal deficits. The government must borrow to finance the fiscal deficit. More government borrowing drives up interest rates. This hurts investment. Consumption increases because the tax cut puts money in people's pockets.

View II: Because tax cuts lead to higher public debt, sooner or later, the government must increase taxes to repay that debt (including interest). Hence tax cuts today lead to tax increases in the future. Households understand this, so they do not spend the tax cut on consumption. Instead, they save the tax cut to be able to pay for the future expected increases in taxes. So consumption does not increase, the interest rate does not increase, and investment does not fall. This result is known as *Ricardian equivalence.*

Which view is correct?

A Two-Period Model

The economy lasts for two periods, period 1 and period 2.

Basic Units of the Model

1. The Government

2. Firms

3. Households

In this lecture, we will introduce the government.

1. The Government

T_1 = taxes in period 1 (in real terms)

T_2 = taxes in period 2 (in real terms)

The government chooses T_1 and T_2. Initially, we will assume that taxes are lump sum. Lump-sum taxes are taxes that do not depend on the household's income, consumption, labor supply, or any other choice made by the household.

G_1 = government spending in goods in period 1 (in real terms)

G_2 = government spending in goods in period 2 (in real terms)

For most of our analysis we assume that G_1 and G_2 are exogenously given.

The Fiscal Deficit

Let B_t denote real government debt (bonds) issued in period t and maturing in period $t+1$. Let r_t denote the real interest rate on such debt.

The primary fiscal deficit is the difference between government spending and tax revenue,

$$\textbf{Primary Fiscal Deficit} = G_t - T_t.$$

The fiscal deficit is the sum of the primary fiscal deficit and interest payments on the government debt

$$\textbf{Fiscal Deficit} = G_t - T_t + r_{t-1}B_{t-1}.$$

The negative of the fiscal deficit is known as the fiscal surplus or government saving, denoted by S_t^g:

$$S_t^g = T_t - G_t - r_{t-1}B_{t-1}.$$

The Government Budget Constraint in Period 1, $t = 1$

The government finances the fiscal deficit by issuing debt, $B_1 - B_0$, so we have that its budget constraint in period 1 is

$$B_1 - B_0 = G_1 + r_0 B_0 - T_1.$$

For simplicity, we will assume that the government starts period 1 with no debt, $B_0 = 0$. Then the government budget constraint in period 1 becomes

$$B_1 = G_1 - T_1. \qquad (1)$$

Note that because of our assumption that $B_0 = 0$, in period 1 the fiscal deficit equals the primary fiscal deficit.

The Government Budget Constraint in Period 2, $t = 2$

The government budget constraint in period 2 is identical to that in period 1, but with all time subscripts shifted one period forward:

$$B_2 - B_1 = G_2 + r_1 B_1 - T_2.$$

The government cannot issue debt in period 2 ($B_2 = 0$). This is because after period 2 the world ends, so no one would buy it. Rearranging, the government budget constraint in period 2 can then be written as

$$T_2 - G_2 = (1 + r_1)B_1. \tag{2}$$

This expression says that in period 2 the primary fiscal surplus, $T_2 - G_2$, must be large enough to pay the public debt that comes due, B_1, plus interest, $r_1 B_1$.

The Intertemporal Budget Constraint of the Government

Combining the period-1 and period-2 government budget constraints, given in equations (1) and (2), to eliminate B_1, yields the intertemporal budget constraint of the government:

$$G_1 + \frac{G_2}{1+r_1} = T_1 + \frac{T_2}{1+r_1}. \tag{3}$$

This constraint says that the present discounted value of government expenditures (given by the left-hand side) must equal the present discounted value of tax revenues (given by the right-hand side). In other words, for fiscal solvency (or fiscal sustainability) it doesn't matter whether G_1 is larger or smaller than T_1 or whether G_2 is larger or smaller than T_2 as long as the stream of government purchases equals the stream of taxes in present value.

Tax Cuts Today Imply Tax Increases in the Future

Suppose the government cuts taxes in period 1, that is,

$$\Delta T_1 < 0,$$

where Δ denotes change. Suppose that the government does not change government spending in either period, that is,

$$\Delta G_1 = \Delta G_2 = 0.$$

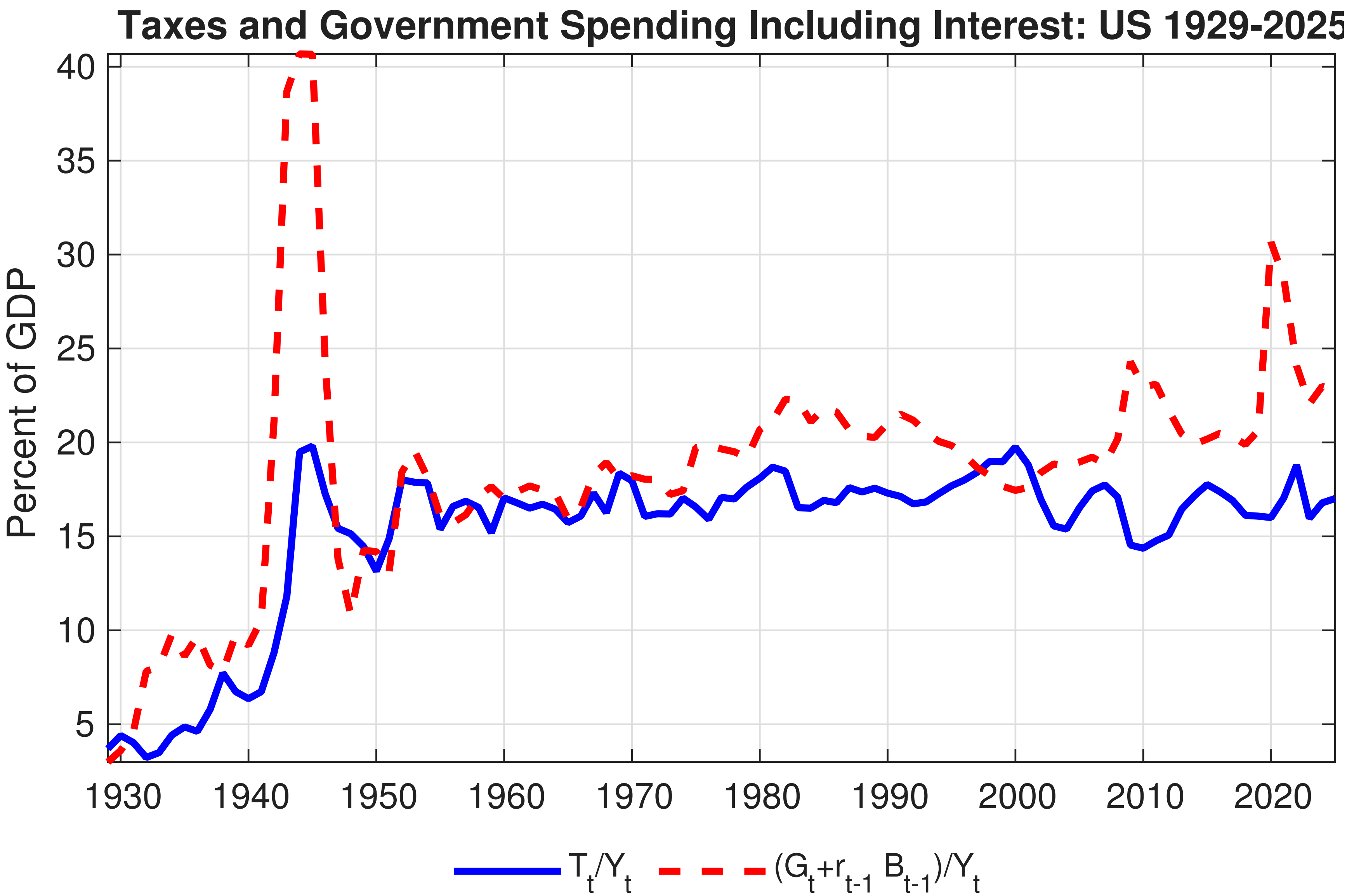
Then, to satisfy the intertemporal budget constraint (3), the government must raise taxes in period 2 by

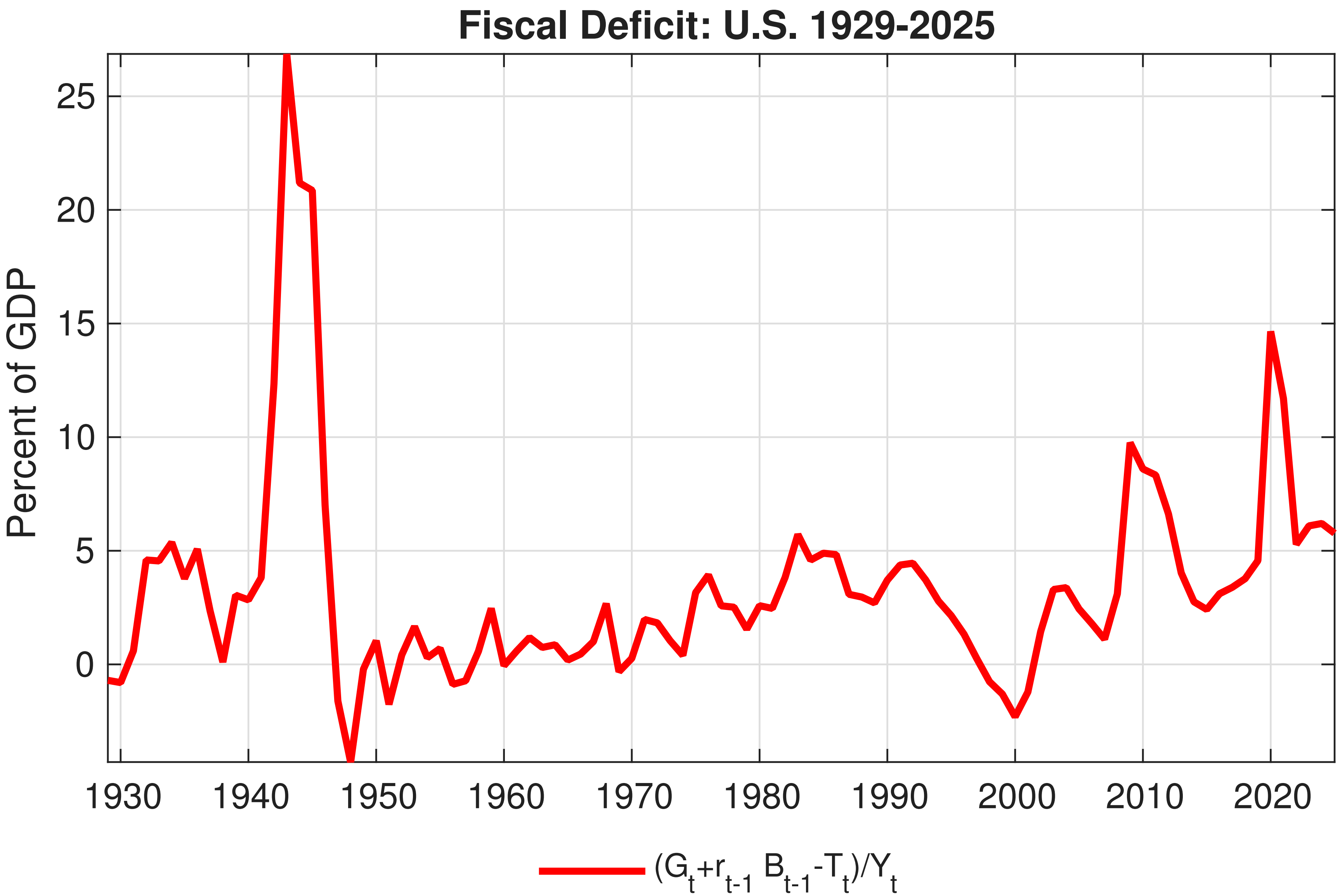
$$\Delta T_2 = -(1 + r)\Delta T_1 > 0.$$

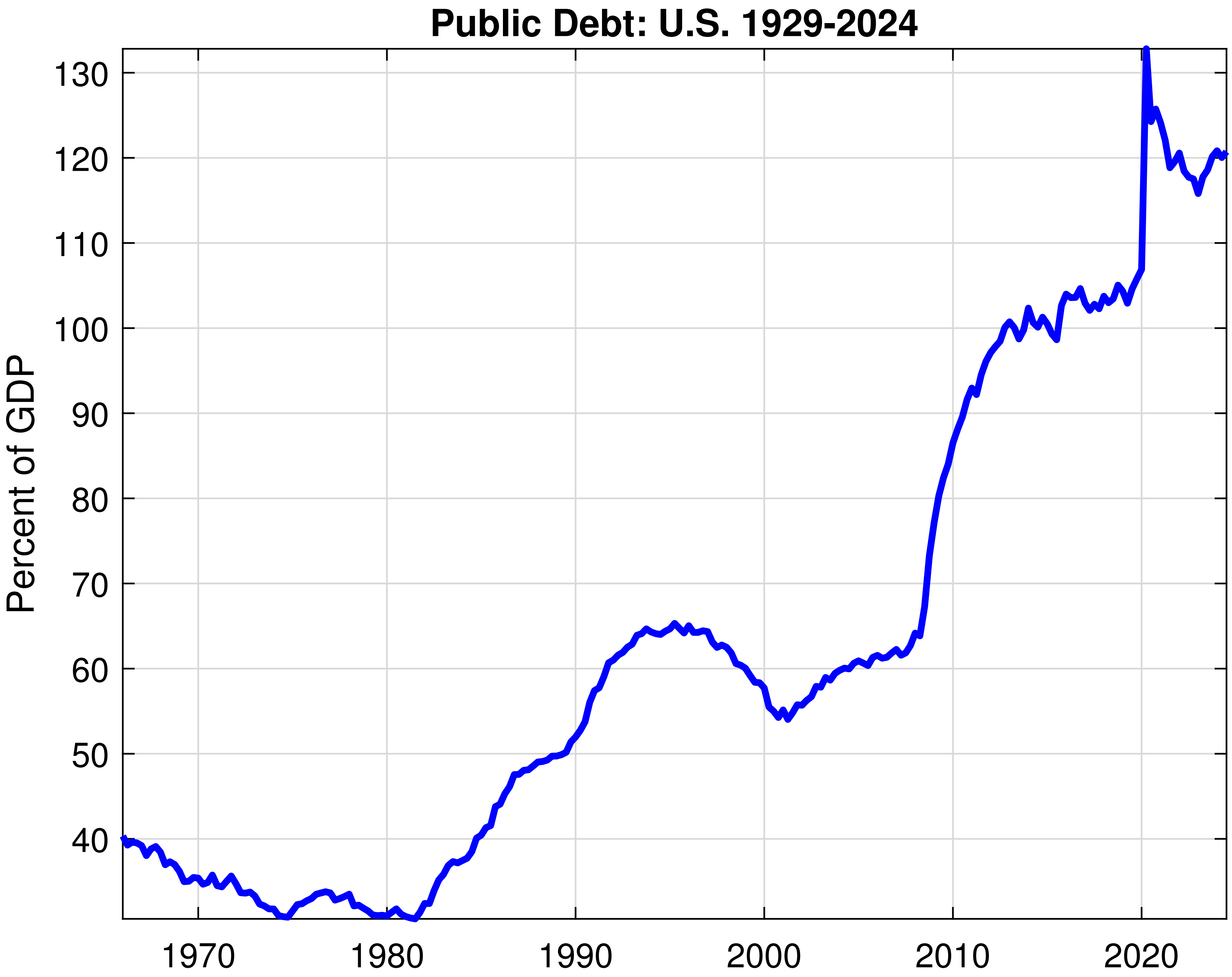
The interpretation of this expression is that if neither current nor future government spending changes, a tax cut now must be financed with debt, which must be paid, ncluding interest, in period 2, and to do that the government must increase taxes in period 2.

Taxes, Government Spending, and Public Debt in the United States

How do government spending, taxes, and the public debt look like in the real world? The figures in the next slides display U.S. data over the period 1929 to 2025.


Taxes and Government Spending Including Interest: US 1929-2025
Percent of GDP
40
35
30
25
20
15
10
5
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
T_t/Y_t
$(G_t+r_{t-1} B_{t-1})/Y_t$


Fiscal Deficit: U.S. 1929-2025
Percent of GDP
25
20
15
10
5
0
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
$(G_t+r_{t-1} B_{t-1}-T_t)/Y_t$


Public Debt: U.S. 1929-2024
Percent of GDP
130
120
110
100
90
80
70
60
50
40
1970
1980
1990
2000
2010
2020

Observations on the Graphs

– Steady increase in the shares of government spending in GDP (from 3% to 23%) and taxes in GDP (from 4% to 17%) since 1929.

– Large increases in government spending in World War II, during the great contraction of 2007-2009, and during the Covid-19 pandemic.

– Large increases in taxes occurred in World War II, which never came back down to their initial level.

– Protracted fiscal deficits during Reagan (1981-1989), the global financial crisis (2008-2009), and the Covid-19 pandemic (2020-2022).

– Only time of fiscal surpluses in recent history: Clinton (1993-2001).

— As a result of chronic fiscal deficits, the public debt has increased more or less continuously since the mid 1960s, from about 40 percent to about 120 percent of GDP.

Summing Up

• The primary fiscal deficit equals government spending minus tax revenue, $G_t - T_t$, and the fiscal deficit equals the primary fiscal deficit plus interest payments on the public debt.

• In period 1, if initial public debt is zero, the government budget constraint is $B_1 = G_1 - T_1$, so the fiscal deficit is financed by issuing debt.

• In period 2, because the economy ends and the government cannot roll over its debt, the primary surplus must be large enough to repay both principal and interest: $T_2 - G_2 = (1 + r_1)B_1$.

• Combining the two one-period budget constraints yields the government's intertemporal budget constraint: the present discounted value of government spending must equal the present discounted value of taxes.

• Therefore, if government spending is unchanged, a tax cut today must be matched by higher taxes in the future; this insight is central to the idea of Ricardian equivalence.

• In U.S. data, chronic fiscal deficits have led public debt to rise from about 40% of GDP in the mid-1960s to about 120% by 2024.

tier A = 52.75

tier B = 34.75

max 70

min 10

median 45.5

Lecture 17
The Investment Schedule

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Recapping

Last lecture, we discussed 2 views about the macroeconomic effects tax cuts: View 1 says that tax cuts do affect the real interest rate, consumption, and investment and View 2 that they don't.

In our quest to understand under what conditions a tax cut affectsconsumption, investment, and the real interest rate, we started to build a model with 2 periods and 3 agents, namely, the government, firms, and households.

In the previous lecture, we introduced the government and derived its intertemporal budget constraint.

In this lecture, we will introduce the firm. We will characterize how the firm chooses the level of investment that maximizes profits.

The firm's behavior will give rise to a useful object called *the investment schedule.*

Firms

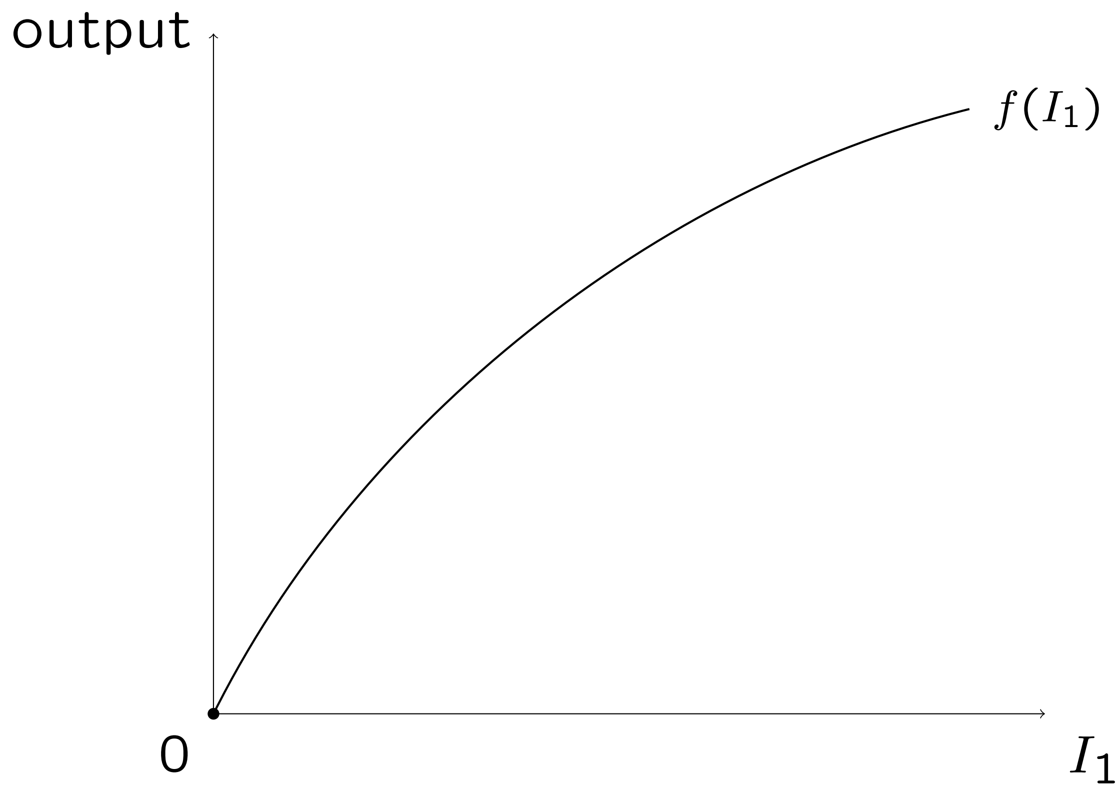
• Suppose that in period 1, firms borrow funds to invest in capital goods (e.g., machines, structures, equipment), which become productive in period 2. So investment in period 1 becomes capital in period 2, which can be used in produciton.

Let I_1 denote investment in period 1. Because investment in period 1 becomes capital in period 2, we refer to I_1 indistinctly as investment or capital.
• In period 2, firms use the capital to produce final goods using the technology

$$\text{Output in period } 2 = f(I_1).$$

The production function $f(\cdot)$ is increasing and concave, as shown on the next page.
• In addition, in period 2 firms must repay their loans in the amount $(1+r_1)I_1$.
• In period 1, firms choose the level of investment, I_1, to maximize profits.

The Production Function



The production function says that output in period 2 is an increasing and concave function in the amount of investment, I_1.

An increasing and concave production function means that more investment raises future output, but each additional unit of investment raises output by less than the previous one

For example, buying a first machine boosts production a lot, but adding a tenth machine increases production only a little. Think of a farm. Bbuying a first tractor greatly increases farm production, but buying a tenth tractor adds much less because the farm has only so much land to work with.

The Firm's Profit Maximization Problem

We denote the firm's profit in period 2 by Π_2. Profit is given by the difference between output, $f(I_1)$, and the cost of investment, including interest, $(1+r_1)I_1$,

$$\Pi_2 = f(I_1) - (1+r_1)I_1. \tag{1}$$

Firms choose investment to maximize profits. That is, the optimization problem of the firm is

$$\max_{\{I_1\}} \left[f(I_1) - (1+r_1)I_1\right],$$

taking as given r_1. The firm takes r_1 as given because it is too small to affect economy-wide financial conditions. It can borrow or lend as much as it wants at the market interest rate r_1, but cannot influence that rate.

The first-order condition associated with the firm's profit maximization problem is obtained by taking the derivative of profit with respect to I_1 and equating the result to zero,

$$\frac{\partial \Pi_2}{\partial I_1} = 0.$$

This yields

$$f'(I_1) - (1 + r_1) = 0,$$

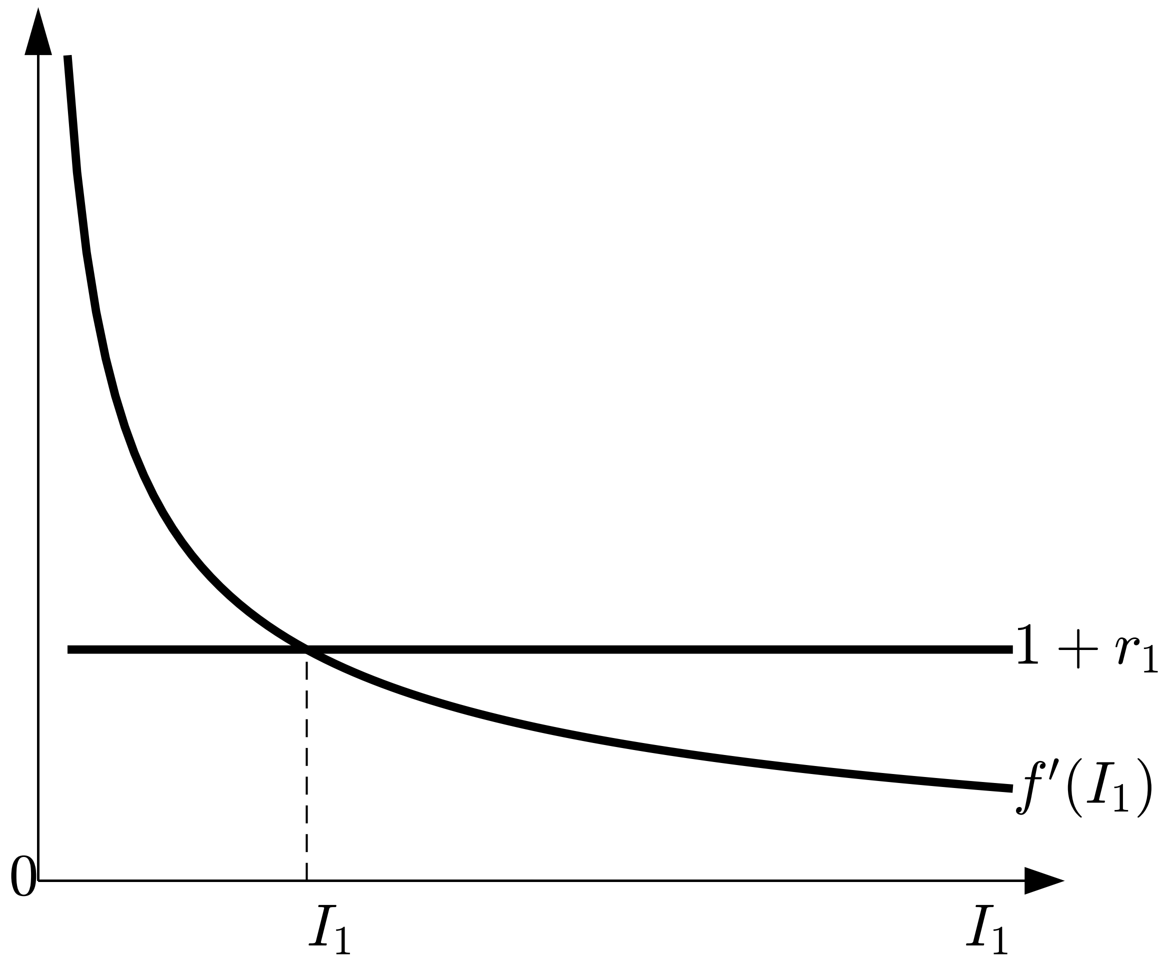
or

$$f'(I_1) = 1 + r_1,$$

where the left-hand side, $f'(I_1)$, is the derivative of $f(I_1)$ with respect to I_1. It is the marginal product of capital and measures the increase in output due to a unit increase in capital. The right-hand side of the firm's optimality condition, $1 + r_1$, is the marginal cost of capital. It measures the increase in the firm's cost resulting from a unit increase in capital: To increase its capital by one unit in period 1, the firm must borrow 1 in period 1. In period 2, it must pay back the amount borrowed, 1 unit, plus interest, r_1. Thus, the marginal cost of capital is $1 + r_1$.

The figure on the next slide illustrates the firm's profit-maximizing investment choice.

par



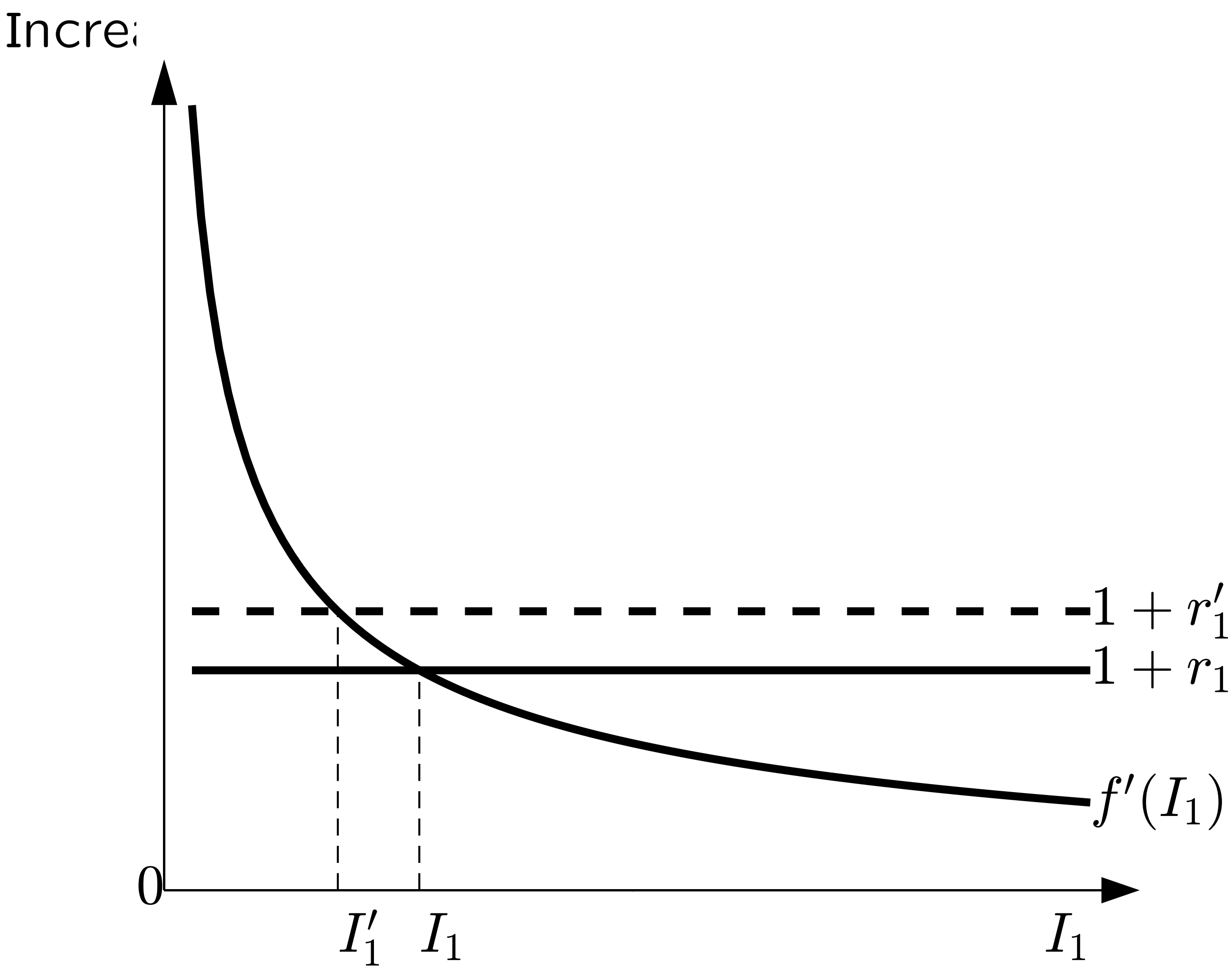
The marginal product of investment, $f'(I_1)$, is decreasing because the firm first undertakes the most productive investment projects, so as investment rises, each additional unit of capital is applied in less and less valuable uses. When the marginal product of capital is decreasing in I_1, we say that the production technology displays diminishing marginal product of capital.

By contrast, the marginal cost of capital, $1 + r_1$, is constant because each extra unit of investment always costs the same: the firm must borrow one more unit in period 1 and repay $1 + r_1$ in period 2. The firm should keep investing when I_1 is below its optimal level because in that region the extra output generated by one more unit of investment exceeds its extra cost, that is, $f'(I_1) > 1 + r_1$, so additional investment raises profits. If $f'(I_1) < 1 + r_1$, the last unit of investment costs more than it adds to output, so reducing investment raises profits. The firm stops adjusting investment when $f'(I_1) = 1 + r_1$ because at that point the benefit and cost of one more unit of investment are exactly equal, so there is no gain from either increasing or decreasing investment.

Effect on Investment of an Increase in the Interest Rate

The next slide illustrates the effect on investment of an increase in the interest rate. In the figure, the interest rate increases from r_1 to $r_1' > r_1$, causing a fall in investment from I_1 to $I_1' < I_1$.

The increase in the interest rate makes some investment projects that were profitable before the interest rate hike (those with the lowest marginal product) to become unprofitable. As a result, the firm abandons those projects.

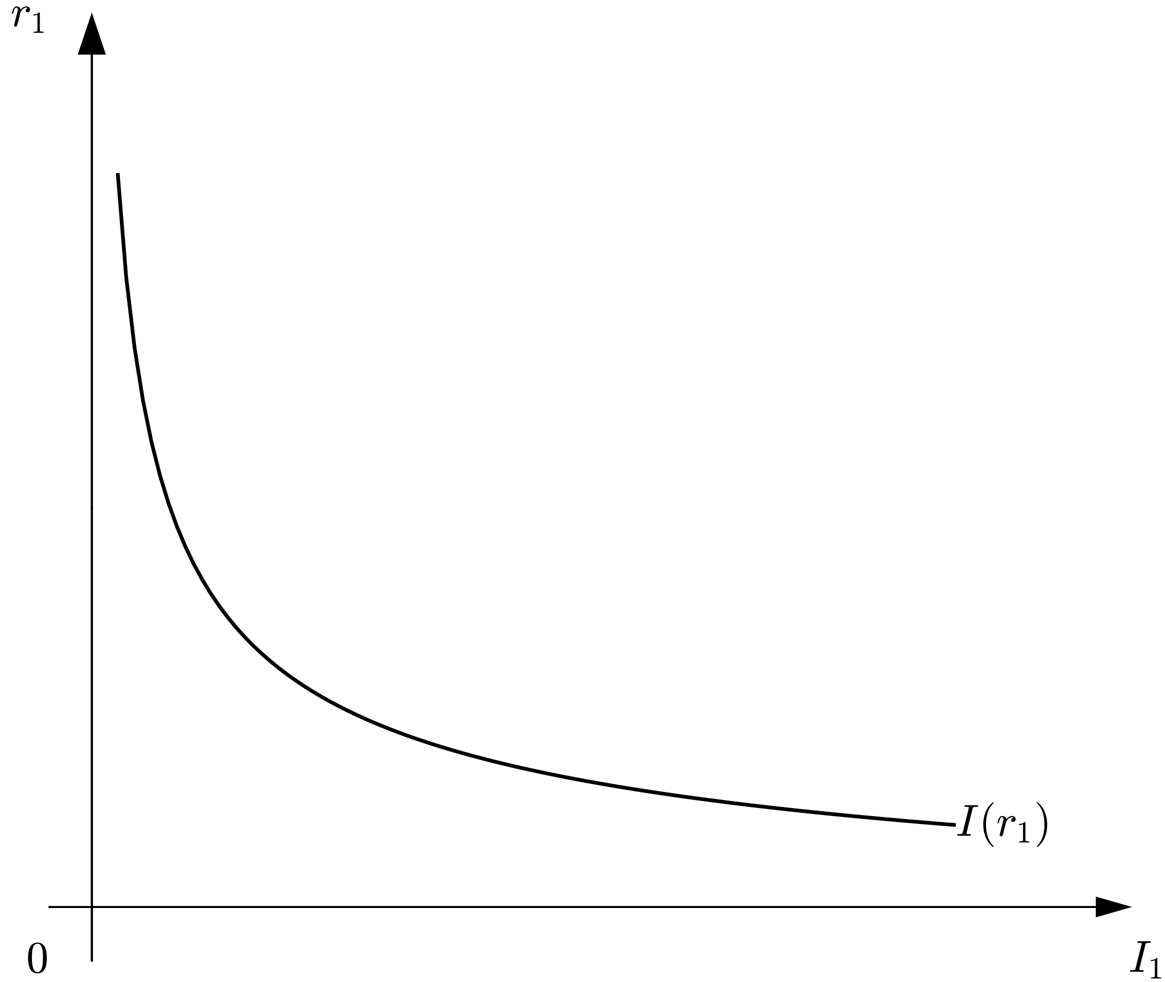

Increa
0
$1 + r_1'$
$1 + r_1$
$f'(I_1)$
I_1'
I_1
I_1

The Investment Schedule

It follows that there exists a negative relationship between r_1 and I_1, which we refer to as the investment schedule:

$$I_1 = I(r_1),$$

with $I'(r_1) < 0$, where $I'(r_1)$ denotes the derivative of $I(r_1)$ with respect to r_1. The figure on the next slide displays the investment schedule in the space (I_1, r_1).


r_1
$I(r_1)$
0
I_1

Effect on Profits of Changes in the Interest Rate

How do profits depend on the interest rate? At the optimum level of investment, profits are given by the following function of the interest rate:

$$\Pi(r_1) \equiv f(I(r_1)) - (1 + r_1)I(r_1).$$

To see how $\Pi(r_1)$ changes in response to a change in r_1, take the derivative of $\Pi(r_1)$ with respect to r_1 to obtain

$$\Pi'(r_1) = f'(I(r_1))I'(r_1) - I(r_1) - (1 + r_1)I'(r_1).$$

Recall that, by the first-order condition of the profit maximization problem, we have that $f'(I_1) = 1 + r_1$. This means that the first and last terms on the right hand side of the above expression cancel each other.

Then we have that

$$\Pi'(r_1) = -I(r_1) < 0$$

This expression says that when the interest rate rises, profits go down. This makes sense because an increase in r_1 raises the financial cost of investment thereby reducing the profitability of the firm.

As we will see in the next lecture, firms are owned by households. Thus profits will be part of the period-2 income of households. So when the interest rate increases, households' income falls.

Summary of Firm Behavior

Investment Demand Schedule:

$$I_1 = I(r_1) \quad \text{with } I'(r_1) < 0$$

Profits:

$$\Pi_2 = \Pi(r_1) \quad \text{with } \Pi'(r_1) < 0$$

An Example

Suppose that the production function is of the form

$$f(I_1) = 2\sqrt{I_1}.$$

The square root is a positive, strictly increasing, and concave function. So this production function looks graphically like the one shown on page 4. The marginal product of capital is given by

$$f'(I_1) = \sqrt{\frac{1}{I_1}}.$$

The marginal product of capital is decreasing in I_1, just like the graph of $f'(I_1)$ shown on page 7.

Equating the marginal product of capital to the marginal cost of capital, we obtain

$$\sqrt{\frac{1}{I_1}} = 1 + r_1.$$

Solving this optimality condition for I_1 yields the investment schedule

$$I(r_1) = \left(\frac{1}{1+r_1}\right)^2$$

This expression says that the optimal level of investment is a strictly decreasing function of the real interest rate.

We can also obtain the optimal level of profits as a function of the real interest rate. To this end, start with the definition of profits and then replace investment for its optimal value:

$$\begin{aligned} \Pi(r_1) &\equiv f(I(r_1)) - (1+r_1)I(r_1) \\ &= 2\sqrt{\left(\frac{1}{1+r_1}\right)^2} - (1+r_1)\left(\frac{1}{1+r_1}\right)^2 \\ &= \frac{1}{1+r_1} \end{aligned}$$

According to this expression, the optimal level of profits is a decreasing function of the real interest rate, which is in line with our previous result.

Summing Up

• Firms borrow in period 1 at the intrest rate r_1 to invest in physical capital, I_1.

• The optimal level of investment occurs when the marginal product of capita., $f'(I_1)$, equals the marginal cost of capital, $1 + r_1$.

• The optimal level of investment is a decreasing function of the real interest rate r_1, called the investment schedule and denoted $I(r_1)$.

• In period 2, firms use the capital built in period 1 to produce goods using the production function $f(I_1)$, which is increasing and concave in I_1.

• In period 2, firms make profits, denoted $\Pi(r_1)$. Profits are a decreasing function of the real interest rate, .

• In period 2, firms distribute profits to households, who own the firms. We will focus on households in the next lecture.

Lecture 18
Households

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Recapping

As stated last class, our goal is to build a model of the equilibrium determination of consumption, investment, and the real interest rate to analyze the macroeconomic effects of fiscal policy, such as changes in taxes and government spedning.

The building blocks of the model we are developing are:
1. The Government (2 classses ago)
2. Firms (last class)
3. Households (today)

Households

Assume that the economy is populated by a large number of identical households that live for two periods, period 1 and period 2. Households derive utility from consumption in each period. Let C_1 denote consumption in period 1 and C_2 consumption in period 2. We summarize the household's preferences by the following utility function:

$$U = \ln C_1 + \ln C_2, \tag{1}$$

where U denotes the lifetime utility of the representative household and ln denotes the natural logarithm.

Utility is increasing in C_1 and C_2 and concave.

Indifference Curves

A convenient way to visualize the household's preferences is by drawing indifference curves, as in the graph on the next page.

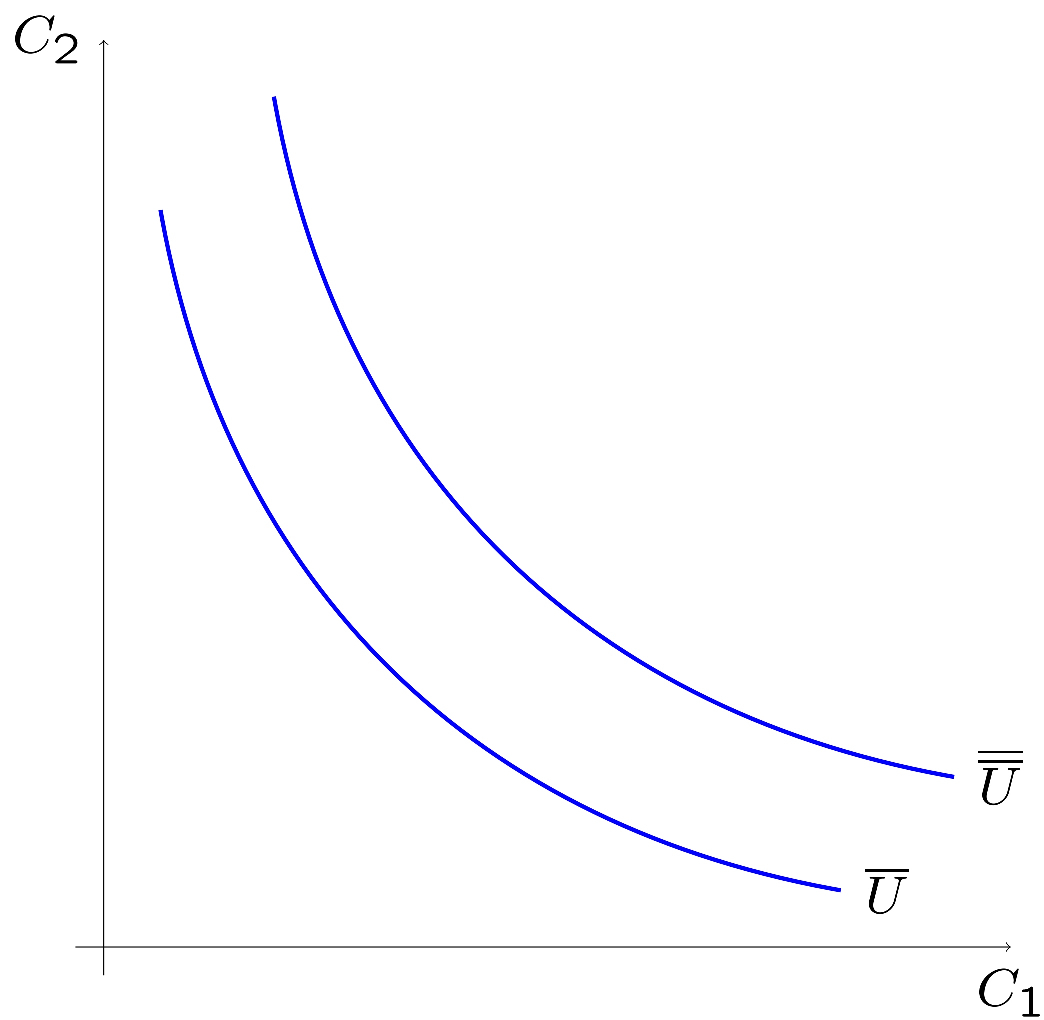
An indifference curve shows the set of pairs of consumption in periods 1 and 2, (C_1, C_2), that provide the same level of utility or happiness.

The graph displays 2 indifference curves: one for the utility level $\overline{U}$ and one for the utility level $\overline{\overline{U}} > \overline{U}$.

The household is equally happy consuming any combination of C_1 and C_2 on $\overline{U}$. Similarly, the household is equally happy consuming any basket on the indifference curve $\overline{\overline{U}}$.

At the same time, the household prefers to be on the indifference curve $\overline{\overline{U}}$ rather than on the indifference curve $\overline{U}$

Indifference Curves



$$\overline{\overline{U}} > \overline{U}$$

Properties of Indifference Curves

- Because both C_1 and C_2 are goods (that is, objects for which more is preferred to less), it follows that indifference curves are downward sloping: if C_1 rises, C_2 must fall for the consumer to remain indifferent, and vice versa.
- As we move northeast in the (C_1, C_2) plane, utility increases.
- Indifference curves densely cover the positive quadrant of the (C_1, C_2) plane: every point in the positive quadrant lies on exactly one indifference curve.
- Indifference curves never cross one another: every point on the positive quadrant belongs to only one indifference curve.
- Indifference curves are convex. If the consumer is consuming relatively much in period 1 and relatively little in period 2, then he is willing to give up a relatively large amount of C_1 for one additional unit of C_2, so the indifference curve is flat. If the consumer is consuming relatively much in period 2 and relatively little in period 1, then he is willing to give up only a relatively small amount of C_1 for one additional unit of C_2, so the indifference curve is steep.

The Household's Budget Constraint in Period 1

In period 1, the household has income, denoted Y_1, and must pay taxes in the amount T_1 to the government. We assume for simplicity that the household starts period 1 with no debts or assets carried over from the past and therefore has no interest income or obligations stemming from such assets.

The household's after-tax income, also known as *disposable income,* is then given by $Y_1 - T_1$. The household allocates its after-tax income to either consumption, C_1, or saving, denoted S_1^p (here, the superscript p stands for "private"). The household's budget constraint in period 1 is then given by

$$S_1^p = Y_1 - T_1 - C_1. \tag{2}$$

Equation (2) is the household's budget constraint in period 1.

The Household's Budget Constraint in Period 2

In period 2, the household receives income equal to Y_2 and pays taxes equal to T_2. Its disposable income is therefore $Y_2 - T_2$. In addition, the household receives its period-1 saving, S_1^p, plus interest income of $r_1 S_1^p$. Thus, the household's total wealth in period 2 is $Y_2 - T_2 + (1 + r_1)S_1^p$.

Because period 2 is the last period of the household's life, it allocates all of its period-2 wealth to consumption, C_2. Therefore,

$$C_2 = Y_2 - T_2 + (1 + r_1)S_1^p. \tag{3}$$

Equation (3) is the household's budget constraint in period 2.

The Household's Intertemporal Budget Constraint

Combine the period-1 and period-2 budget constraints, equations (2) and (3). The result is the household's *intertemporal budget constraint*:

$$C_2 = (1 + r_1)(Y_1 - T_1 - C_1) + Y_2 - T_2. \tag{4}$$

Rearrange this equation by collecting all consumption terms on the left-hand side:

$$C_1 + \frac{C_2}{1 + r_1} = Y_1 - T_1 + \frac{Y_2 - T_2}{1 + r_1}.$$

This way of writing the intertemporal budget constraint makes clear that the present discounted value of lifetime consumption, shown on the left-hand side, must equal the present discounted value of lifetime disposable income, shown on the right-hand side. In a given period, consumption may be greater or less than disposable income. Over its lifetime, however, the household must satisfy the requirement that consumption and disposable income be equal in present discounted value. In other words, the household can shift consumption across periods by borrowing or saving, but it cannot escape its lifetime resource constraint.

The Graph of the Intertemporal Budget Constraint

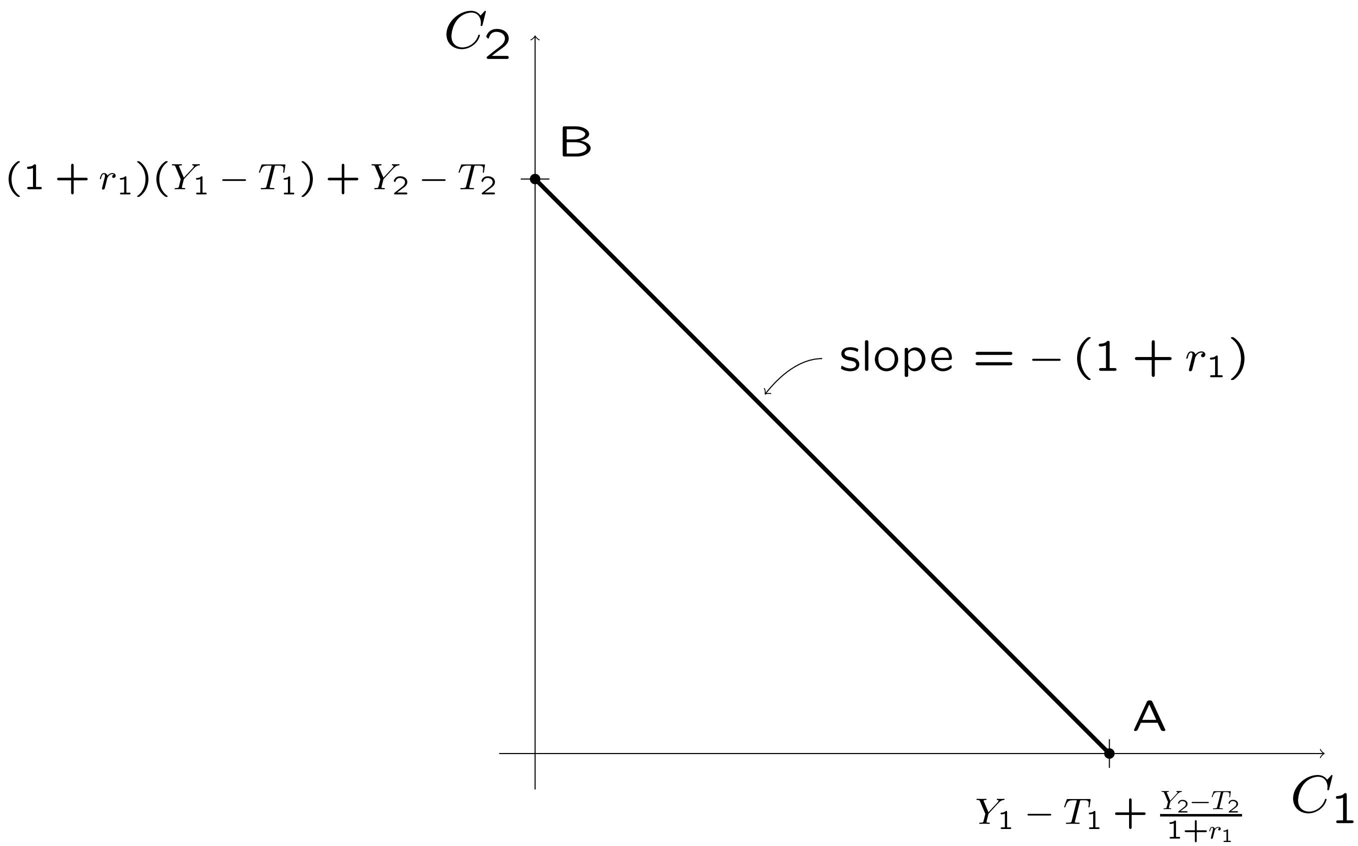
Look again at the household's intertemporal budget constraint (4), reproduced here for convenience:

$$C_2 = (1 + r_1)(Y_1 - T_1 - C_1) + Y_2 - T_2 \tag{4}$$

The household takes as given every object in this expression except for C_1 and C_2. The next graph plots the intertemporal budget constraint in the space (C_1, C_2). The intertemporal budget constraint is a downward sloping straight line, with slope equal to $-(1 + r_1)$. If the household sacrifices one unit of C_1, it can increase C_2 by $1 + r_1$ units. Point A on the horizontal axis marks the level of consumption in period 1 that the household can afford if it chooses to consume nothing in period 2, namely, $C_1 = Y_1 - T_1 + (Y_2 - T_2)/(1 + r_1)$. Similarly, point B on the vertical axis marks the level of period-2 consumption associated with zero consumption in period 1, namely $C_2 = (1 + r_1)(Y_1 - T_1) + (Y_2 - T_2)$. All points connecting A and B are on the household's intertemporal budget constraint, and are therefore affordable or feasible.

Graph of the Intertemporal Budget Constraint

$$C_2 = (1 + r_1)(Y_1 - T_1 - C_1) + Y_2 - T_2$$

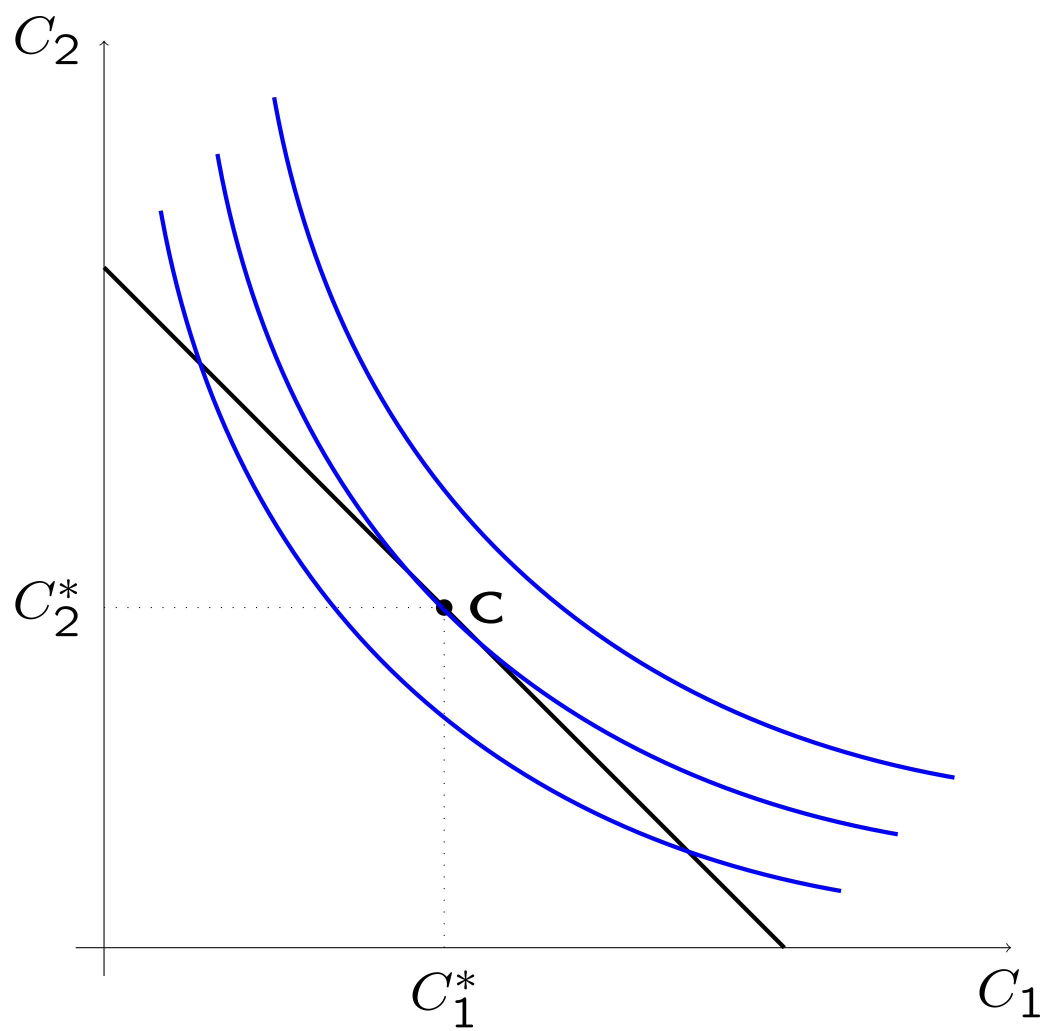


The Household's Optimization Problem

Households pick C_1 and C_2 to maximize their lifetime utility (equation (1)) subject to their intertemporal budget constraint (equation (4)).

The figure on the next slide displays the determination of the optimal consumption basket. The optimum occurs at point C. Of all points on the intertemporal budget constraint, point C attains the highest level of utility. At point C the intertemporal budget constraint is tangent to an indifference curve.

The Optimal Consumption Allocation



Solving the Household's Utility-Maximization Problem Algebraically

With the help of the previous figure, we characterized the optimal consumption choice graphically. Let's redo the same exercise, but algebraically. The optimization problem of the household is to choose C_1 and C_2 to maximize the utility function

$$\ln C_1 + \ln C_2 \tag{1}$$

subject to the intertemporal budget constraint

$$C_2 = (1 + r_1)(Y_1 - T_1 - C_1) + Y_2 - T_2 \tag{4}$$

This is a constrained maximization problem involving two variables, C_1 and C_2, and one constraint, the intertemporal budget constraint. To simplify the problem, let's transform it into an unconstrained problem in only one choice variable, C_1.

To this end, use the intertemporal budget constraint (4) to eliminate C_2 from the utility function (1). This yields

$$\max_{\{C_1\}} \{\ln C_1 + \ln [(1 + r_1)(Y_1 - T_1 - C_1) + Y_2 - T_2]\}$$

Now this is an unconstrained maximization problem in only one choice variable, C_1. To find the value of C_1 that maximizes lifetime utility, take the derivative with respect to C_1 and equate it to zero to obtain the first-order condition

$$\frac{1}{C_1} - \frac{1 + r_1}{(1 + r_1)(Y_1 - T_1 - C_1) + Y_2 - T_2} = 0 \qquad (5)$$

The optimal level of consumption in period 1 is obtained by solving optimality condition (5) for C_1, which yields

$$C_1 = \frac{1}{2}\left[Y_1 - T_1 + \frac{Y_2 - T_2}{1 + r_1}\right] \tag{6}$$

This expression is intuitive: the household consumes half of its lifetime wealth in period 1 and deposits the other half in the bank. In period 2, the household consumes the second half of its lifetime wealth plus the interest earned on its period-1 saving. That is,

$$C_2 = (1 + r_1)\frac{1}{2}\left[Y_1 - T_1 + \frac{Y_2 - T_2}{1 + r_1}\right] \tag{7}$$

This expression can be derived by combining (4) and (6).

Inspecting equations (6) and (7), we see that C_1 is decreasing in r_1 and C_2 is increasing in r_1. This makes sense, because an increase in the interest rate creates an incentive to save more today, that is, to reduce current consumption in favor of future consumption.

Private Saving

Private saving is defined in equation (2), reproduced here for convenience

$$S_1^p = Y_1 - T_1 - C_1 \tag{2}$$

Use (6) to eliminate C_1, which yields

$$S_1^p = \frac{1}{2}\left(Y_1 - T_1 - \frac{Y_2 - T_2}{1 + r_1}\right) \tag{8}$$

According to this expression, private saving is increasing in current disposable income, $Y_1 - T_1$, and decreasing in future disposable income, $Y_2 - T_2$. This is intuitive. If current disposable income goes up, it makes sense to consume part of the increase and save the rest to consume it tomorrow. Also, if future disposable income goes up, it pays to consume part of the increase today by dissaving.

Income in Period 2

Assume that in period 1 the household receives an exogenous endowment of goods equal to Y_1. In period 2 there is no endowment. Instead, household income consists of profits received from the ownership of firms. Recall from the previous lecture that firms earn profits equal to $\Pi(r_1)$. Thus,

$$Y_2 = \Pi(\underset{-}{r_1}) \tag{9}$$

Recall that firms' profits in period 2 are decreasing in the interest rate. Thus, when the interest rate rises, households in period 1 expect their future income to fall. This prospect discourages current consumption, because households feel poorer, and encourages current saving, because they wish to cushion the decline in income in period 2.

We can then rewrite equation (8) as

$$S_1^p = \frac{1}{2}\left(Y_1 - T_1 - \frac{\Pi(r_1) - T_2}{1 + r_1}\right) \tag{10}$$

According to this expression, private saving is increasing in the real interest rate r_1. This occurs for two reasons. First, a higher interest rate makes future consumption cheaper relative to present consumption, inducing the household to substitute away from current consumption and toward future consumption. Second, a higher interest rate lowers period-2 income by reducing firms' profits. In response, the household saves more in period 1 in order to smooth consumption over time.

Summing Up

• Households live for two periods and derive utility from consumption in both periods. Their preferences can be represented by indifference curves in the (C_1, C_2) plane.

• Because households prefer more to less, indifference curves are downward sloping. Because households value a balanced consumption path, indifference curves are convex.

• In period 1, disposable income is $Y_1 - T_1$. The household allocates it between current consumption, C_1, and private saving, S_1^p.

• In period 2, consumption equals disposable income plus the gross return on period-1 saving. Since period 2 is the last period of life, all wealth is consumed.

• Combining the two period budget constraints yields the intertemporal budget constraint: the present discounted value of lifetime consumption must equal the present discounted value of lifetime disposable income.

• The household chooses C_1 and C_2 to maximize lifetime utility subject to its intertemporal budget constraint. Graphically, the optimum is at the tangency between the budget line and an indifference curve.

• With logarithmic utility, the household consumes one half of lifetime wealth in period 1 and the other half in period 2, adjusted by the interest rate.

• Private saving rises with current disposable income and falls with future disposable income. It also rises with the interest rate, both because a higher r_1 makes future consumption more attractive and because it lowers future profit income, prompting households to save more today.

Lecture 19
Ricardian Equivalence

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Motivation

We have completed the construction of a two-period model with three agents: the government, firms, and households.

We are now ready to address the question of how fiscal policy affects the economy, in particular, consumption, investment, and the real interest rate.

We begin by focusing on the effects of tax cuts. As we mentioned, there are two main views on this question.

View I holds that tax cuts boost consumption by putting money in people's pockets. It also holds that they increase fiscal deficits, leading to higher government borrowing, which raises interest rates and crowds out investment.

View II emphasizes that forward-looking households anticipate future tax increases needed to repay the resulting public debt. As a result, they save rather than spend the tax cut, leaving consumption, interest rates, and investment unchanged, a proposition known as *Ricardian equivalence*.

Today, we will analyze the conditions under which View II is correct. In the next lecture, we will study the conditions under which View I is more plausible and examine which set of conditions is more realistic.

National Saving

National saving (often referred to as just saving), which we denote by S_1, is defined as the sum of private saving, S_1^p, and government saving, S_1^g. That is,

$$S_1 \equiv S_1^p + S_1^g \tag{1}$$

Let's refresh the definitions of private and government saving. In previous lectures, we assumed that households and the government live for two periods and start period 1 with no debts or assets carried over from the past. Then in period 1 private saving is what is left of the household's disposable income after consuming, that is,

$$S_1^p = Y_1 - T_1 - C_1.$$

And government saving is given by the fiscal surplus

$$S_1^g = T_1 - G_1.$$

Using these two expressions to eliminate S_1^g and S_1^p from the definition of (national) saving given in (1), gives

$$S_1 = Y_1 - G_1 - C_1 \tag{2}$$

This expression says that saving is given by output minus the sum of private and government spending.

The Saving Schedule

Recall from last lecture that the household's optimal level of consumption in period 1 is given by

$$C_1 = \frac{1}{2}\left[Y_1 - T_1 + \frac{Y_2 - T_1}{1 + r_1}\right] \tag{3}$$

Use (3) to eliminate C_1 from (2) to get

$$S_1 = Y_1 - G_1 - \frac{1}{2}\left[Y_1 - T_1 + \frac{Y_2 - T_2}{1 + r_1}\right]. \tag{4}$$

Finally, let's get rid of T_1, T_2, and Y_2 in (4) as follows:
(a) Using the government's intertemporal budget constraint derived 3 lectures ago, namely, $G_1 + \frac{G_2}{1+r_1} = T_1 + \frac{T_2}{1+r_1}$, get rid of T_1 and T_2 in (4).

(b) Use the assumption that income in period 2 is given by the profits received by households from the firms they own (see last lecture), that is, $Y_2 = \Pi_2(r_1)$, to get rid of Y_2 in (4).

Then, (4) becomes

$$S_1 = \frac{1}{2}\left[Y_1 - G_1 - \frac{\Pi(r_1) - G_2}{1 + r_1}\right]. \tag{5}$$

This expression is the saving schedule.

It shows that saving is increasing in the interest rate. The intuition is twofold. First, a higher interest rate makes current consumption more expensive relative to future consumption: giving up one unit of consumption today yields more consumption tomorrow. As a result, households substitute away from current consumption and toward future consumption, which raises saving. Second, an increase in r_1 reduces households' income in period 2 by lowering profit income in that period ($\Pi(r_1) \downarrow$), which increases the desire to save in period 1 in order to smooth consumption over time.

An increase in the endowment in period 1, Y_1, causes households to save part of the additional income in order to smooth consumption over time. An increase in G_1 reduces the amount of goods available for private consumption in period 1, $Y_1 - G_1$, so households reduce saving in order to smooth consumption over time. Finally, an increase in G_2 reduces the amount of goods available for private consumption in period 2, $\Pi(r_1) - G_2$, so households increase saving in period 1 in order to smooth consumption across time.

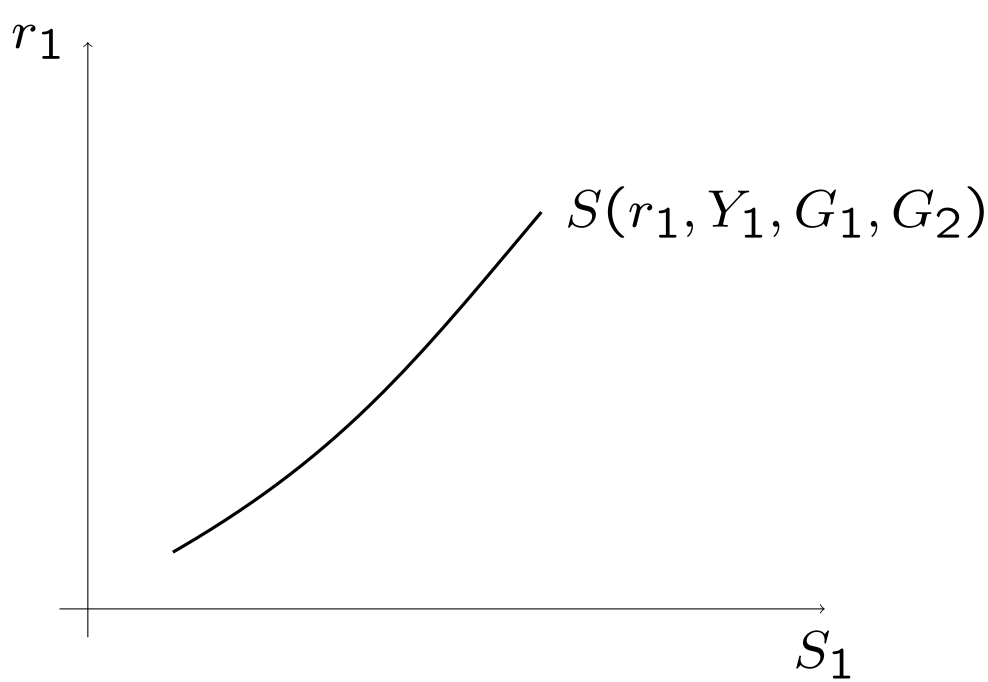
Note that, given Y_1, G_1, G_2, and r_1, national saving is independent of taxes, T_1 and T_2.

We can summarize the saving schedule as

$$S_1 = S(\underset{+}{r_1}, \underset{+}{Y_1}, \underset{-}{G_1}, \underset{+}{G_2}). \tag{6}$$

The following figure plots the saving schedule.

The Saving Schedule



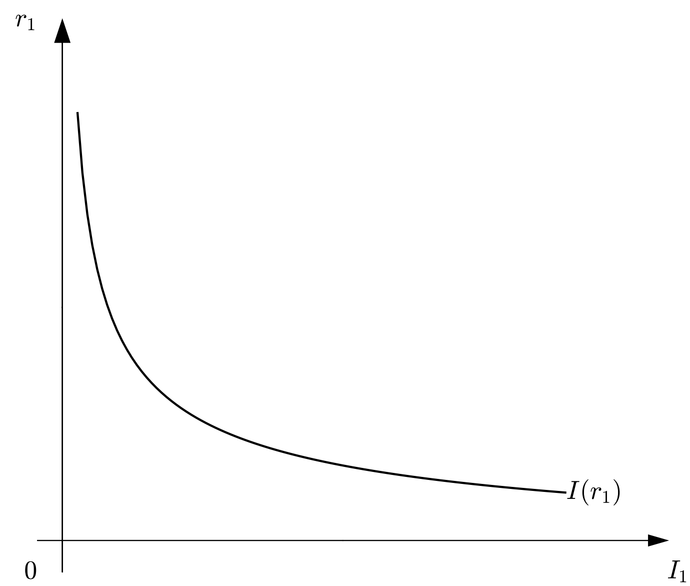
Notes. The saving schedule is increasing in the interest rate, r_1. Changes in lump-sum taxes, holding government spending unchanged in both periods, do not affect the position of the saving schedule.

Recall the Investment Schedule

Two classes ago, we sudied the firm's investment decision and derived the economy's investment schedule,

$$I_1 = I(\underset{-}{r_1}), \tag{7}$$

which says that investment is a decreasing function of the interest rate, as shown in this figure:



Equilibrium

In equilibrium, saving must equal investment,

$$S_1 = I_1.$$

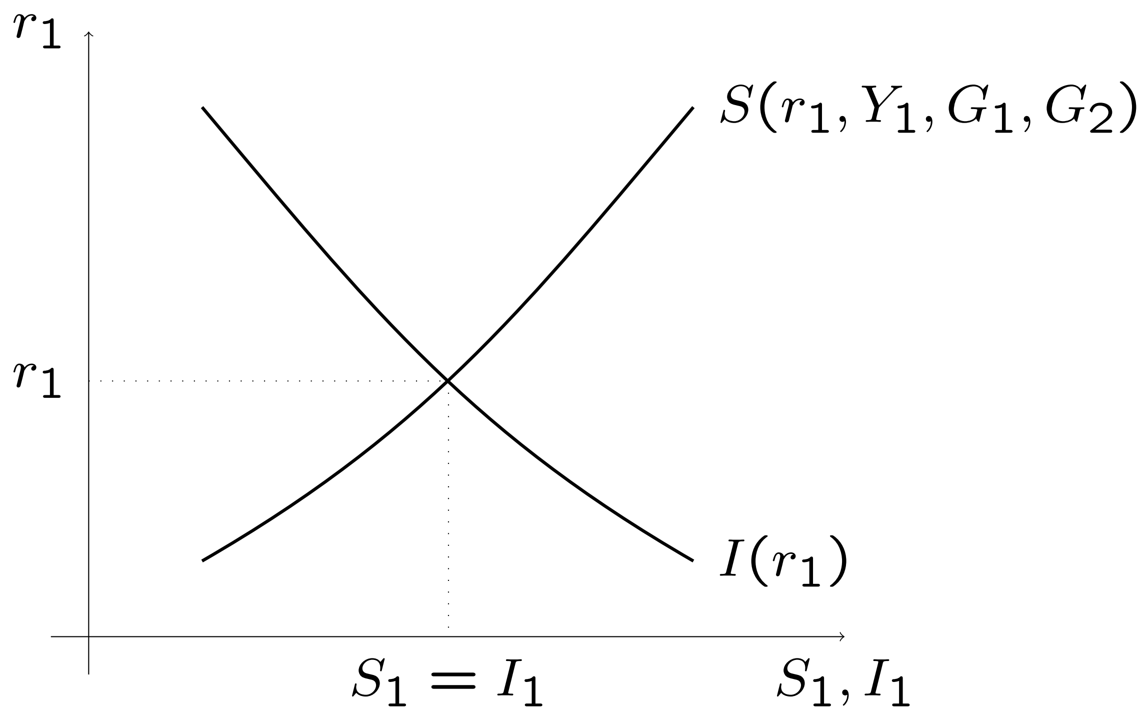
Using (6) and (7), we can write this equilibrium condition as

$$S(r_1, Y_1, G_1, G_2) = I(r_1). \tag{8}$$

This equation determines the equilibrium real interest rate, r_1. We see that, given Y_1, G_1, and G_2, the equilibrium interest rate is independent of the level of taxes in periods 1 and 2, T_1 and T_2.

The next figure illustrates the determination of the equilibrium values of the interest rate, investment, and saving.

Equilibrium



Ricardian Equivalence

We are now in a position to answer the question posed at the beginning of the lecture: What are the effects on consumption, investment, and the real interest rate of a tax cut in period 1, $\Delta T_1 < 0$, financed by a future tax increase, $\Delta T_2 > 0$, with government spending unchanged?

It is clear from equilibrium condition (8) that, since neither T_1 nor T_2 appear in it and since G_1 and G_2 are unchanged, the interest rate, r_1, must also be unchanged. This means that in response to the tax cut the real interest rate r_1 is unchanged. But if the interest rate is unchanged, then so are the levels of saving, S_1 (see equation (6)), and investment, I_1 (see equation (7)).

Private consumption, C_1, is also unaffected by the tax cut. This can be seen as follows: Recall that $S_1 = Y_1 - G_1 - C_1$ (equation (2)). We have established that S_1 is unchanged by the tax cut. Then, since Y_1 and G_1 are assumed to be constant, we have that C_1 is unchanged by the tax cut, $\Delta C_1 = 0$.

Since $S_1^g = T_1 - G_1$, government saving falls by exactly the size of the tax cut, or equivalently, the fiscal deficit rises by exactly that amount. That is, $\Delta S_1^g = \Delta T_1 < 0$. Finally, because national saving is unchanged and satisfies $S_1 = S_1^g + S_1^p$, it follows that $0 = \Delta S_1^g + \Delta S_1^p$. Hence, $\Delta S_1^p = -\Delta S_1^g = -\Delta T_1 > 0$. That is, private saving rises by exactly the size of the tax cut.

The result that a tax cut financed by future tax increases has no effect on the real interest rate, saving, consumption, or investment is known as *Ricardian equivalence*.

Intuition Behind Ricardian Equivalence

If the government cuts taxes today, $\Delta T_1 < 0$, but does not cut government spending either now or in the future, $\Delta G_1 = \Delta G_2 = 0$, then the government debt must increase today by exactly the size of the tax cut, $|\Delta T_1|$. Next period, the government will have to pay this debt, including interest. That is, the government will have to pay $(1 + r_1)|\Delta T_1|$. To do this, the government will have to increase taxes, $\Delta T_2 = (1 + r_1)|\Delta T_1|$. So households don't feel richer when the government cuts taxes in period 1, because they know that they will have to pay higher taxes in the future by an amount that, in present discounted value, is exactly equal to the current tax cut. As a result, they decide to save the tax cut and use it to pay the higher taxes next period. They don't spend any part of the tax cut in consumption today. The increase in private saving exactly offsets the fiscal deficit in period 1, so total saving, S_1 doesn't change. If total saving does not change, then the interest rate in equilibrium does not change. And if the interest rate doesn't change, investment doesn't change either.

Collecting Results:

Consider the policy $\Delta T_1 < 0$ and $\Delta G_1 = \Delta G_2 = 0$. Then, the effect of this tax cut is:

$$\begin{aligned}
\Delta T_2 &= -(1 + r_1)\Delta T_1 > 0 \\
\Delta r_1 &= 0 \\
\Delta S_1 &= 0 \\
\Delta I_1 &= 0 \\
\Delta C_1 &= 0 \\
\Delta S_1^g &= \Delta T_1 < 0 \\
\Delta S_1^p &= -\Delta T_1 > 0
\end{aligned}$$

Ricardian Equivalence in Words

Ricardian equivalence obtains when a change in current taxes, offset by a future tax change of the opposite sign and with government spending unchanged, has no effect on the real interest rate, consumption, or investment.

Caveats

The conditions under which Ricardian equivalence obtains are restrictive:

(I) No one in the economy is credit constrained. That is, people can borrow as much as they want, provided they satisfy their intertemporal budget constraint. This is unrealistic. Many people, especially young people, face difficulties accessing credit markets and therefore cannot consume as much as they would like today. For such individuals, a tax cut is likely to stimulate consumption.

(II) Everyone who benefits from the tax cut is assumed to remain alive when taxes are raised in the future. This is also unrealistic. If the tax cut occurs today and the tax increase is expected to take place ten years from now, for example, then some of those who benefit from the tax cut today will no longer be alive when the tax hike occurs. Such individuals are likely to increase consumption in response to the tax cut, because they do not expect to face higher taxes in the future.

(III) Taxes are lump-sum. This is unrealistic. Governments typically tax some manifestation of income or wealth, such as consumption, labor income, capital income, or net assets. As a result, a tax cut is likely to alter incentives to consume, save, or work.

In the next lecture, we will analyze how Ricardian equivalence breaks down when any of these features does not hold.

We therefore interpret Ricardian equivalence as a benchmark, namely, the macroeconomic effects of tax cuts in an economy without distortions or market failures.

Summing Up

• National saving is the sum of private and government saving:

$$S_1 \equiv S_1^p + S_1^g = Y_1 - G_1 - C_1.$$

• In this two-period economy, national saving depends positively on current income, negatively on current government spending, and positively on future government spending.

• National saving is increasing in the real interest rate for two reasons: households substitute away from current consumption, and lower future profits induce more saving today.

• Investment is decreasing in the real interest rate, so the equilibrium interest rate is determined by the intersection of the saving and investment schedules.

• Given Y_1, G_1, and G_2, the equilibrium values of the real interest rate, saving, and investment are independent of taxes, T_1 and T_2.

• Therefore, a tax cut in period 1 financed by higher taxes in period 2 has no effect on consumption, investment, or the real interest rate.

• The reason is that forward-looking households understand that lower taxes today imply higher taxes tomorrow, so they save the tax cut rather than spend it.

• Under Ricardian equivalence, the fall in government saving caused by the tax cut is exactly offset by an equal rise in private saving.

Lecture 20
Failure of Ricardian Equivalence

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Topics today

Three reasons why Ricardian equivalence may fail:

— Borrowing constraints

— Finite lives

— Distortionary taxes

Today, we will analyze the first two reasons. Next class, we will study the third.

Summary of Ricardian Equivalence

Ricardian Equivalence: A tax cut holding unchanged the path of government spending ($\Delta T_1 < 0$ with $\Delta G_1 = \Delta G_2 = 0$) has no effect on consumption, investment, or the interest rate. (The same for a tax hike.)

We derived this result in the context of a two-period model with three economic units: households, the government, and firms.

In the model, the government levies lump-sum taxes T_1 and T_2 in periods 1 and 2 and consumes goods and services (government spending) in the amounts G_1 and G_2.

Intuition: The government finances the tax cut by issuing public debt ($B_1 \uparrow$), since G_1 is unchanged. So government saving falls ($\Delta S_1^g < 0$). In period 2, since G_2 is unchanged, the government must increase taxes ($T_2 \uparrow$) to pay back the public debt including interest. Agents foresee this in period 1, so they don't spend the tax cut. Instead, they save it ($\Delta S_1^p > 0$), so consumption is unchanged ($\Delta C_1 = 0$). The increase in private saving exactly offsets the fall in government saving ($\Delta S_1^g + \Delta S_1^p = 0$), so (national) saving is unchanged ($\Delta S_1 = 0$). Because saving is unchanged, so is the interest rate and investment ($\Delta r_1 = \Delta I_1 = 0$).

Why Ricardian Equivalence May Fail We will consider three unrealistic assumptions of the model that, if relaxed, lead to the breakdown of Ricardian equivalence:

I. Absence of borrowing constraints.
II. All consumers receiving the tax cut expect to be hit by higher taxes in the future.
III. Lump-sum taxes.

What does failure of Ricardian equivalence mean?
We say that Ricardian equivalence fails when a debt-financed tax cut ($\Delta T_1 < 0$), with government spending unchanged ($\Delta G_1 = \Delta G_2 = 0$), affects consumption ($\Delta C_1 \neq 0$), the interest rate ($\Delta r_1 \neq 0$), saving ($\Delta S_1 \neq 0$), or investment ($\Delta I_1 \neq 0$).

We now analyze what happens to Ricardian equivalence when we relax each of the three assumptions listed above. Today, we focus on the first two.

I. Borrowing Constraints

The model assumes that everybody can borrow or lend as much as he/she wants subject only to satisfying the intertemporal budget constraint.

In reality, however, some people do not have access to credit. This is particularly true for young people, who have difficulty demonstrating that their future income is going to be high enough to repay their debts, and for poor people, who often lack the collateral to back their debts.

Empirical studies place the fraction of consumers subject to some form of borrowing constraint at over 25 percent of households.

Introducing Borrowing Constraints

Consider an economy in which households are borrowing constrained. To keep things simple assume that the borrowing constraint is such that households cannot borrow any funds at all. That is, the borrowing constraint takes the form

$$S_1^p \geq 0.$$

If at the market interest rate the household would like to borrow (i.e., choose $S_1^p < 0$), but instead saves 0 due to the constraint, we say that the borrowing constraint is binding:

$$S_1^p = 0.$$

Recalling the consumer's budget constraint in period 1,

$$C_1 + S_1^p = Y_1 - T_1,$$

we have that when the borrowing constraint is binding, then

$$C_1 = Y_1 - T_1.$$

Effect of a Tax Cut on Consumption when Households are Borrowing Constrained

Suppose now that the government cuts taxes in period 1,

$$\Delta T_1 < 0.$$

Suppose that the household continues to be borrowing constrained after the tax cut. Then, because

$$C_1 = Y_1 - T_1$$

before and after the tax cut, we have that the tax cut changes consumption by the same amount as the tax cut,

$$\Delta C_1 = -\Delta T_1 > 0.$$

This result makes sense: suppose you would like to borrow but cannot because of the constraint. Then, if the government gives you some money through a tax cut, you will spend it. Simple as it looks, this result represents a significant departure from Ricardian equivalence, which holds that a debt-financed tax cut leaves consumption is unchanged.

Effect of a Tax Cut on National Saving when Households are Borrowing Constrained

National saving is the sum of private and government saving,

$$S_1 = S_1^p + S_1^g.$$

Because households are borrowing constrained, private saving is nil, $S_1^p = 0$. So national saving equals government saving, $s_t = S_1^g$. In turn, government saving is the difference between tax revenue and government spending, $S_1^g = T_1 - G_1$. So, when households are borrowing constrained, national saving is given by

$$S_1 = T_1 - G_1.$$

Recalling that we are holding G_1 constant, we have that in response to a tax cut national saving falls by the same amount as the tax cut,

$$\Delta S_1 = \Delta T_1 < 0.$$

This is also a departure from Ricardian equivalence, because under Ricardian equivalence saving does not change in response to a tax cut.

Effect of a Tax Cut on the Interest Rate when Households are Borrowing Constrained

In equilibrium, national saving must equal investment, $S_1 = I_1$. So, recalling that when households are borrowing constrained $S_1 = T_1 - G_1$, we have that in equilibrium

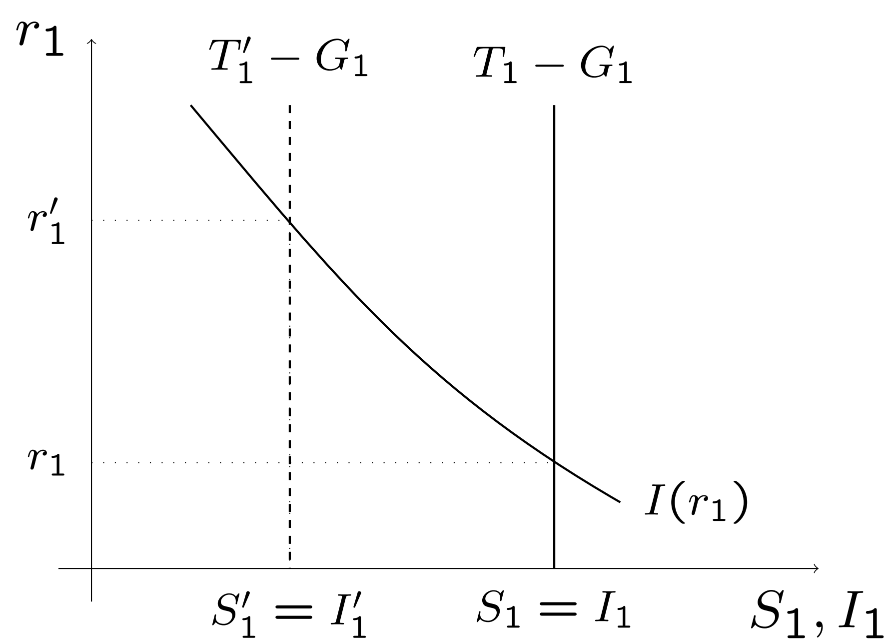
$$T_1 - G_1 = I(r_1).$$

It follows from here that a tax cut, holding G_1 constant, leads to an increase in the interest rate. To see this more formally, differentiate the above expression to get

$$\Delta T_1 = I'(r_1)\Delta r_1 \Rightarrow \Delta r_1 = \frac{\Delta T_1}{I'(r_1)} > 0,$$

since $\Delta T_1 < 0$ and $I'(r_1) < 0$. The intuition behind this result is that the tax cut stimulates consumption and discourages saving, so the interest rate must rise to equilibrate the capital market (i.e., to ensure that saving equals investment). The graph on the next slide illustrates this effect.

Effect of a Tax Cut with Borrowing Constrained Households



When households face borrowing constraints, the saving schedule, $S_1 = T_1 - G_1$, is interest inelastic. Therefore, it is represented by a vertical line in the space (S_1, r_1), as shown in the figure. Before the tax cut, the saving schedule is the solid vertical line and the investment schedule is the solid downward-sloping line. The equilibrium is given by the intersection of these two schedules. At this point, the interest rate is r_1, saving is S_1, and investment is I_1.

A tax cut from T_1 to $T_1' < T_1$ shifts the saving schedule leftward in a parallel fashion, as shown by the broken line. At the initial interest rate r_1, there is now excess demand for funds, because desired investment exceeds saving. As a result, the interest rate rises. The new equilibrium is located at the intersection of the broken vertical line and the solid downward-sloping line. The new interest rate is $r_1' > r_1$, saving is $S_1' < S_1$, and investment is $I_1' < I_1$.

In sum, when households face borrowing constraints, a tax cut stimulates consumption and reduces saving, raises the interest rate, and discourages investment.

Effect of a Tax Cut on Investment when Households are Borrowing Constrained

We just saw graphically that investment falls in response to a tax cut. We can say the same in symbols: because in equilibrium saving must equal investment, $S_1 = I_1$, and because saving falls one-for-one with a tax cut, $\Delta S_1 = \Delta T_1$, we have that investment also falls one-for-one with a tax cut,

$$\Delta I_1 = \Delta T_1.$$

The intuition behind this result can be seen from two perspectives:

(1) As we just discussed, the tax cut raises the interest rate, $\Delta r_1 > 0$. In turn, because investment is a decreasing function of the interest rate, the interest rate hike discourages investment.

(2) In period 1 the economy's resource constraint says that output must equal consumption plus investment plus government spending, $Y_1 = C_1 + I_1 + G_1$.* A tax cut stimulates consumption one-for-one. The endowment, Y_1, and government spending, G_1, are constant. So we have that private consumption crowds out investment one-for-one.

*Can you show that this is true?

Summary of Effects of a Debt-Financed Tax Cut when Consumers are Borrowing Constrained

$$T_1 \downarrow \Rightarrow C_1 \uparrow, S_1 \downarrow, I_1 \downarrow, r_1 \uparrow .$$

Compare this result to the one obtained under no borrowing constrains, namely, no change in C_1, S_1, I_1, or r_1 in response to a decline in T_1.

What if Not Everybody is Borrowing Constrained?

What fraction of the population should be borrowing constrained if we want that aggregate consumption be stimulated one-for-one with the tax cut? Clearly, we need all of the population to be borrowing constrained. Otherwise, those who are not borrowing constrained would save the tax cut and will not experience an increase in consumption. But the assumption that everybody is borrowing constrained is as unrealistic as the assumption that no one is borrowing constrained. Reality is somewhere in between. Therefore, we conclude that if some individuals are borrowing constrained, a tax cut will produce an expansion in consumption but most likely of a smaller magnitude than the tax cut itself.

Borrowing Constraint and Welfare Graphical Representation

The next slide displays the consumer's intertemporal budget constraint (IBC). Point A indicates disposable income, $(Y_1 - T_1, \Pi_2 - T_2)$.

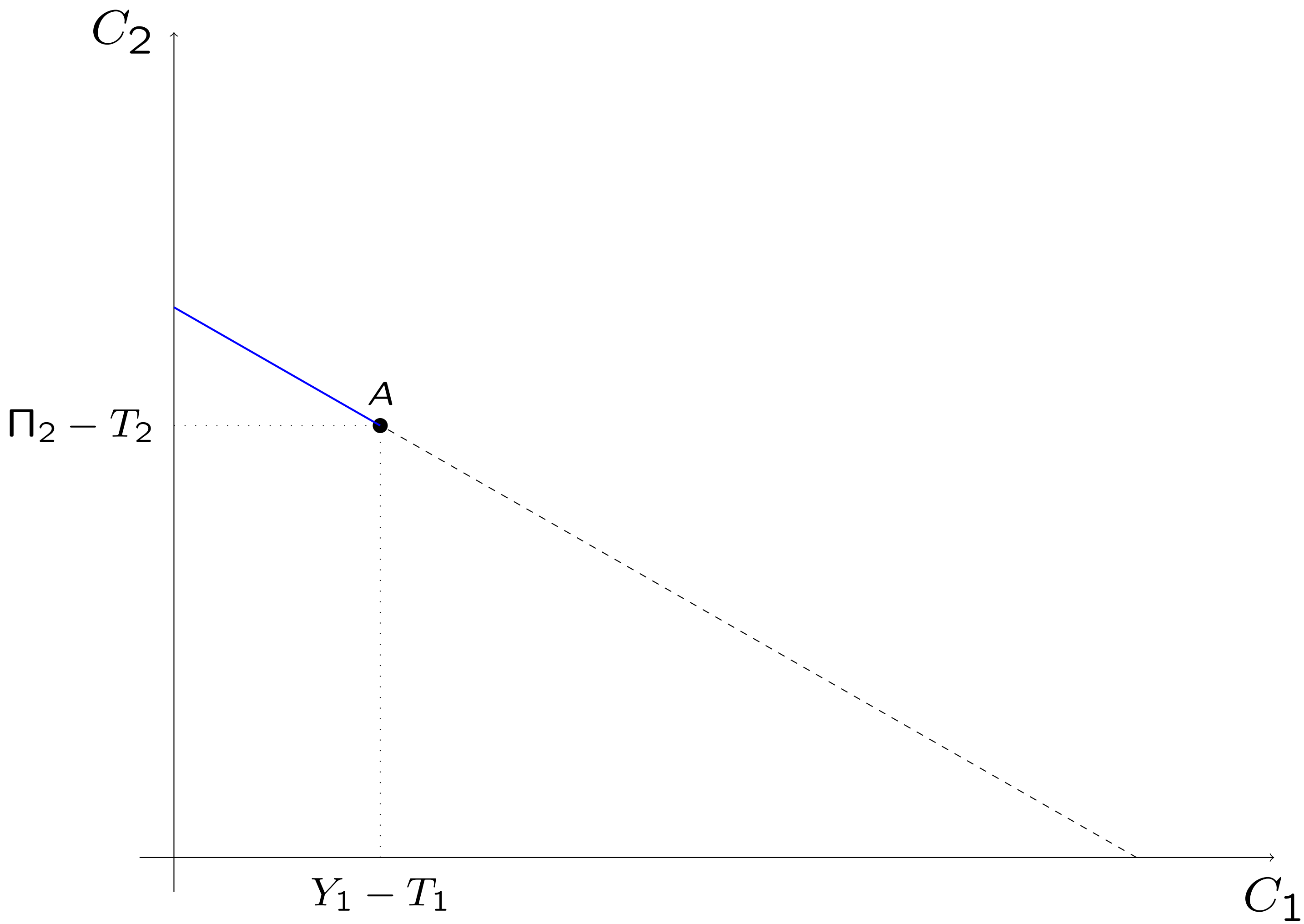
At point A, $C_1 = Y_1 - T_1$, so that saving is zero, $S_1^p = 0$.

For points on the IBC and to the left of point A, consumption in period 1 is less than disposable income $C_1 < Y_1 - T_1$, and saving is positive, $S_1^p > 0$.

For points to the right of A, consumption is greater than disposable income, $C_1 > Y_1 - T_1$, and saving is negative, $S_1^p < 0$.

Under the borrowing constraint $S_1^p \geq 0$, only the part of the IBC equal to or above point A is feasible. The part of the IBC to the right of point A is not feasible and thus indicated with a broken line.

The Intertemporal Budget Constraint of the Household Without and With a Borrowing Constraint



Optimal Consumption Choice Without and With a Borrowing Constraint

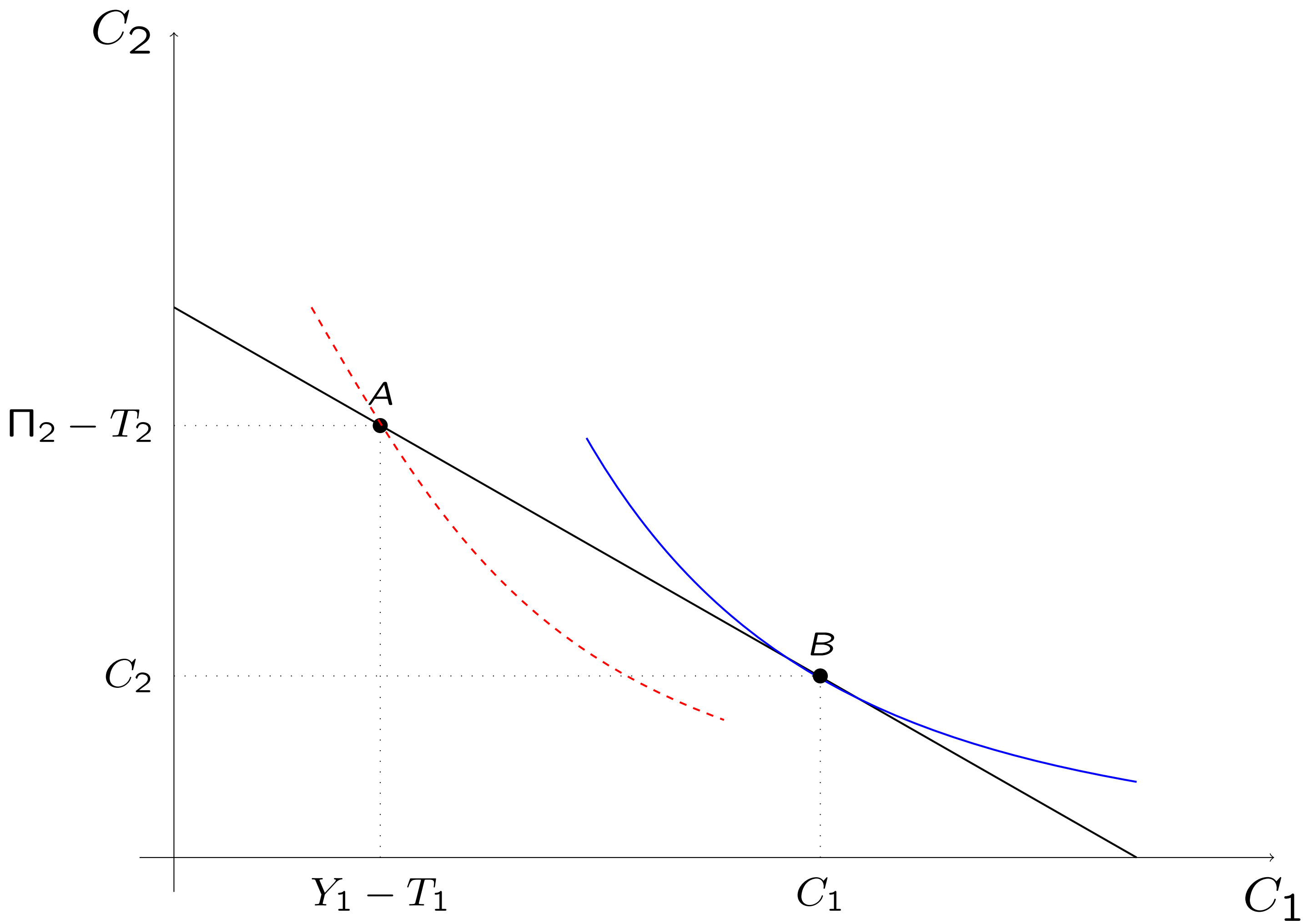
Take a look at the figure on the next slide. The way the figure is drawn, in the absence of the borrowing constraint, the household consumes at point B, where an indifference curve is tangent to the budget constraint.

Point B lies to the right of point A. This means that at point B the household is borrowing, $S_1^p < 0$. Therefore, with the borrowing constraint, point B is no longer a feasible consumption choice for the household.

With the borrowing constraint the optimal consumption choice of the household is point A instead. At point A consumption equals disposable income, $C_1 = Y_1 - T_1$ and saving is nil, $S_1^p = 0$.

The indifference curve that crosses point A is located southwest of the one that crosses point B. This means that the borrowing constraint by limiting the consumer choices is welfare decreasing.

Optimal Consumption Choice
Without and With a Borrowing Constraint



II. Finite Lives

In the model, we assume, realistically, that the government lives until the end of the world. However, unrealistically, we make the same assumption about consumers. They live until the end of the world. In reality, consumers don't live forever.

Assuming that consumers don't live forever raises the possibility that consumers that are around when a tax cut is implemented will not expect to be around when taxes are raised in the future. These households will experience an increase in the present value of their lifetime income stream when the government cuts taxes. Feeling richer, they will increase consumption.

Let's consider this idea more formally.

An Economy with One-Period-Lived Consumers

Suppose, for simplicity, that in the two-period economy the government lives for two periods but households live for only one period. Thus, we have households born in period 1, which are not around in period 2, and households born in period 2, which are not around in period 1. The budget constraint of a household born in period 1 is

$$C_1 + S_1^p = Y_1 - T_1$$

There is no reason for these households to save because they will not be around in period 2. So S_1^p is not positive. By the same token these households cannot borrow because, knowing that they will not be around in period 2, no one would lend them any funds in period 1. So S_1^p cannot be negative. If saving can be neither positive nor negative, then it must be zero,

$$S_1^p = 0.$$

Combining the last two equations, we have that consumption equals disposable income,

$$C_1 = Y_1 - T_1. \tag{1}$$

This is the same result we got under borrowing constraints!

Effects of a Tax Cut with One-Period-Lived Households

All effects of a tax cut under one-period-lived consumers are identical to those under borrowing constrained households. We therefore review them briefly.

Effect on Consumption

Suppose that the government implements a tax cut ($\Delta T_1 < 0$). According to equation (1), the household will use the entire tax cut to purchase consumption goods,

$$\Delta C_1 = -\Delta T_1 > 0.$$

Intuitively, the household will not be around in period 2, so all it can do with the tax cut is consume it: no point in saving any part of it. This means that a stimulus plan consisting in cutting taxes (or equivalently increasing transfers) will stimulate private consumption one-for-one among those who don't expect to be around when the tax increase is brought about. This is a sharp departure from what happens when consumers live forever. In that case, households save the entire tax cut and consumption is unchanged.

Effect on Saving

Because with one-period-lived consumers private saving is nil, we have that national saving must equal government saving

$$S_1 = S_1^g = T_1 - G_1$$

So saving falls one-for-one with the tax cut,

$$\Delta S_1 = \Delta T_1 < 0.$$

Intuitively, the tax cut increases the fiscal deficit but is not offset by an increase in private saving, so total saving falls.

Effect on the Interest Rate and Investment

Equating saving and investment, we have

$$T_1 - G_1 = I(r_1),$$

which is the same equilibrium condition obtained under the assumption that everybody is borrowing constrained. So we have that, with one-period-lived consumers, a tax cut causes national saving to fall ($S_1 \downarrow$), which, because the function $I(\cdot)$ is decreasing in r_1, requires an increase in the interest rate($r_1 \uparrow$), to equilibrate the loans market. In turn, the increase in the interest rate causes investment to fall ($I_1 \downarrow$).

What if Not Everybody is One-Period Lived?

We could again ask, what fraction of the population must expect not to be around when taxes are increased in the future in order for the tax cut to induce a one-for-one expansion in private consumption? Clearly, 100 percent of the population. But this is unrealistic. For example, if the tax increase is expected to take place 10 years into the future, then a relatively small fraction of the currently alive population should expect not to be around for the tax increase. The rest of the population (if not subject to borrowing constraints) will save the tax cut and will not expand its consumption spending. It follows that the stimulative effect of a tax cut stemming from the finite-life channel should not be too large.

Summing Up

• Ricardian equivalence states that a debt-financed tax cut, holding government spending constant, has no effect on consumption, saving, investment, or the interest rate.

• This result relies on three key assumptions: households are not borrowing constrained, all households expect to bear the future tax burden, and taxes are lump sum.

• If households face borrowing constraints, they cannot save the tax cut to pay for future taxes, so they spend it instead.

• In that case, a tax cut raises consumption and lowers national saving one-for-one.

• Because saving falls, the interest rate must rise to restore equilibrium in the loanable-funds market.

• The higher interest rate reduces investment, so a debt-financed tax cut crowds out investment when borrowing constraints are present.

• Ricardian equivalence also fails when households have finite lives, because some of those receiving the tax cut may not be alive when future taxes are raised.

• With finite lives, the effects of a debt-financed tax cut are similar to those under borrowing constraints: consumption rises, saving falls, the interest rate rises, and investment declines.

• The next lecture will focus on distortionary taxes, another source of failure of Ricardian equivalence..

Lecture 21
Distortionary Taxation and Failure of Ricardian Equivalence

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Why Ricardian Equivalence May Fail

Recall the three unrealistic assumptions of the model that, if relaxed, lead to the breakdown of Ricardian equivalence:

I. Absence of borrowing constraints.
II. All consumers receiving the tax cut expect to face higher taxes in the future.
III. Lump-sum taxes.

Last class, we relaxed assumptions I and II and showed that both give rise to economic environments in which a debt-financed tax cut ($\Delta T_1 < 0$ with $\Delta G_1 = \Delta G_2 = 0$) causes an increase in consumption ($\Delta C_1 > 0$) and in the interest rate ($\Delta r_1 > 0$), and a decline in saving ($\Delta S_1 < 0$) and investment ($\Delta I_1 < 0$).

Today, we analyze what happens to Ricardian equivalence when we relax assumption III. Accordingly, we will study an economy with distortionary taxes.

III. Distortionary Taxation

The model used to derive Ricardian equivalence assumes that taxes are lump sum. Lump-sum taxes, however, hardly exist in real life. Have you or people you know ever been taxed independently of income, consumption or wealth? Or have you ever gotten a government transfer that was independent of your income or your employment or health status? Taxes are typically attached to some economic manifestation. For instance, sales taxes are levied on our purchases of consumption goods; the more we purchase the more taxes we pay. Every year, we must pay income taxes. The higher our income, the more taxes we pay. And so on. This means that taxes in general tend to alter our incentives to consume, work, or accumulate wealth. This type of taxes are called distortionary taxes.

No Ricardian Equivalence with Distortionary Taxes: Intuition

To gain intuition on how distortionary taxation can cause the breakdown of Ricardian equivalence, consider an economy with proportional consumption taxes. Specifically, let τ_1 and τ_2 denote the tax rates on consumption in periods 1 and 2, respectively. The tax rate τ_1, for instance, says that for each unit of consumption purchased in period 1, the household must pay τ_1 in taxes.

Suppose now that the government decides to cut taxes by lowering the tax rate τ_1. Suppose also that current and future government spending, G_1 and G_2, are unchanged. If tax revenue in period 1, $\tau_1 C_1$, falls because of the tax cut, then the government will have to increase the consumption tax rate in period 2, τ_2, to guarantee intertemporal solvency. The cut in the current consumption tax rate coupled with the increase in the future consumption tax rate makes current consumption cheaper relative to future consumption. As a consequence, households have an incentive to expand current consumption and reduce future consumption. Thus, saving falls, the interest rate goes up, and investment contracts: Ricardian equivalence fails.

A Two-Period Economy with Consumption Taxes

The budget constraint of the household in period 1 is given by

$$C_1(1+\tau_1)+S_1^p=Y_1$$

And the budget constraint in period 2 is given by

$$C_2(1+\tau_2)=\Pi_2+(1+r_1)S_1^p$$

Combining these two expressions to eliminate S_1^p, we obtain the following intertemporal budget constraint

$$C_1(1+\tau_1)+\frac{C_2(1+\tau_2)}{1+r_1}=Y_1+\frac{\Pi_2}{1+r_1} \tag{1}$$

This expression states that the present discounted value of consumption expenditures, including taxes, must equal the present discounted value of income.

The utility function is as before

$$\ln C_1 + \ln C_2. \tag{2}$$

The consumer's maximization problem consists in choosing C_1 and C_2 to maximize the utility function (2) subject to the intertemporal budget constraint (1), taking as given Y_1, Π_2, τ_1, and τ_2. This is a constrained optimization problem in two variables.

To solve the household's optimization problem, we proceed as we did in the case of lump-sum taxes: Solve the intertemporal budget constraint (1) for C_2 and use the result to eliminate C_2 from the utility function (2). The optimization problem then becomes unconstrained and in only one choice variable, C_1.

Solving the household's intertemporal budget constraint (1) for C_2 gives

$$C_2 = \frac{1+r_1}{1+\tau_2}\left[Y_1 + \frac{\Pi_2}{1+r_1} - C_1(1+\tau_1)\right]$$

Using this expression to eliminate C_2 from the utility function (2), the household optimization problem is to choose C_1 to maximize

$$\ln C_1 + \ln\left\{\frac{1+r_1}{1+\tau_2}\left[Y_1 + \frac{\Pi_2}{1+r_1} - C_1(1+\tau_1)\right]\right\}.$$

Taking the derivative with respect to C_1 and equating it to zero gives

$$\frac{1}{C_1} - \frac{1}{C_2} \times \frac{(1+r_1)(1+\tau_1)}{1+\tau_2} = 0 \Rightarrow \frac{C_2}{C_1} = (1+r_1) \times \frac{1+\tau_1}{1+\tau_2}. \qquad (3)$$

It is clear from this expression that, given r_1, a reduction in τ_1 coupled with an increase in τ_2 causes C_2/C_1 to fall, that is, causes households to consume relatively more in period 1. This makes sense because C_1 became relatively cheaper: the consumption tax distorts the intertemporal consumption choice.

Now solve the optimality condition (3) for C_2 and use it to eliminate C_2 from the household's intertemporal budget constraint (1) to get

$$C_1 = \frac{1}{2(1+\tau_1)}\left[Y_1 + \frac{\Pi_2}{1+r_1}\right] \tag{4}$$

This expression says that, holding r_1 constant, a cut in the current consumption tax rate, causes an increase in current consumption ($\tau_1 \downarrow \Rightarrow C_1 \uparrow$).

Why does C_1 depend on τ_1 but not on τ_2?
Equation (4) implies that C_1 depends on the current consumption tax rate, τ_1, but not on the future consumption tax rate, τ_2. The intuition is as follows.

An increase in τ_1 lowers C_1 for two reasons. First, it makes current consumption more expensive relative to future consumption. This substitution effect induces households to substitute away from C_1

and toward C_2. Second, it reduces the household's effective purchasing power, because each unit of consumption in period 1 now requires more resources. This negative income effect also lowers C_1. Thus, when τ_1 rises, the substitution and income effects go in the same direction, so current consumption falls.

By contrast, an increase in τ_2 has two opposite effects on C_1. On the one hand, it makes future consumption more expensive relative to current consumption. This substitution effect induces households to substitute away from C_2 and toward C_1, pushing current consumption up. On the other hand, it makes the household effectively poorer, because consuming in period 2 now requires more resources. This negative income effect tends to reduce consumption in both periods, including C_1, pushing current consumption down. Under the logarithmic utility function assumed here, these two effects exactly cancel. As a result, C_1 does not depend on τ_2.

Private Saving and Consumption Taxes

Private saving is the portion of income, Y_1, that remains after consumption, C_1, and tax payments. That is,

$$S_1^p = Y_1 - (1 + \tau_1)C_1.$$

Replacing C_1 with its optimal value given in (4), we obtain

$$S_1^p = Y_1 - \frac{1}{2}\left[Y_1 + \frac{\Pi_2}{1 + r_1}\right]. \tag{5}$$

This expression shows that, given the interest rate r_1, private saving does not depend on the tax rate. The intuition is as follows. A cut in τ_1 raises disposable income in period 1 and, all else equal, tends to increase saving. At the same time, however, it makes current consumption cheaper relative to future consumption, which encourages households to consume more today and save less. Under the logarithmic utility function assumed here, these two effects exactly offset each other. As a result, private saving is unchanged by the tax cut. That is, holding r_1 constant,

$$\tau_1 \downarrow \Rightarrow \ \Delta S_1^p = 0.$$

Government Saving and Consumption Taxes

Government saving is given by the difference between tax revenue, $\tau_1 C_1$, and government spending, G_1,

$$S_1^g = \tau_1 C_1 - G_1.$$

Replacing C_1 for its optimal value given in (4) we obtain

$$S_1^g = \frac{\tau_1}{1+\tau_1}\frac{1}{2}\left[Y_1 + \frac{\Pi_2}{1+r_1}\right] - G_1 \tag{6}$$

This expression shows that, given r_1, government saving is increasing in the tax rate τ_1. It follows that, all other things equal, a tax cut causes government saving to fall, or, equivalently, the fiscal deficit to increase. This makes sense: one would expect that a tax cut increases the fiscal deficit.

The Saving Schedule with a Consumption Tax

National saving is given by the sum of private and government saving,

$$S_1 = S_1^p + S_1^g.$$

Using (5) and (6) to replace S_1^p and S_1^g we can write S_1 as

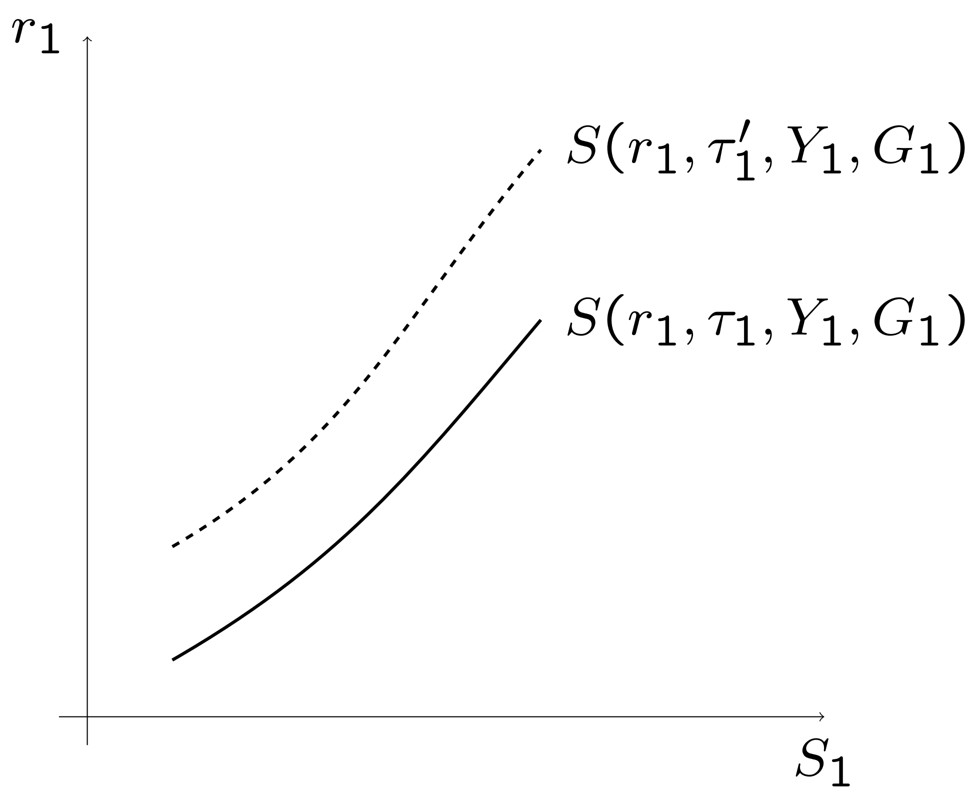
$$S_1 = Y_1 - G_1 - \frac{1}{2 \times (1+\tau_1)} \left[Y_1 + \frac{\Pi(r_1)}{1+r_1} \right]$$

National saving is increasing in the interest rate for the same reasons given in the economy with lump-sum taxes. But saving is also increasing in the current tax rate τ_1, because, given r_1, an increase in the consumption tax rate reduces the fiscal deficit and has no—and for more general preferences a small—effect on private saving. We can summarize this results as follows:

$$S_1 = S(\underset{+}{r_1}, \underset{+}{\tau_1}, \underset{+}{Y_1}, \underset{-}{G_1})$$

This saving schedule is plotted on the next slide.

The Saving Schedule in the Economy with Consumption Taxes



Notes. The saving schedule is increasing in the interest rate, r_1. A reduction in the consumption tax rate in period 1 from τ_1 to $\tau_1' < \tau_1$ shifts the saving schedule up and to the left.

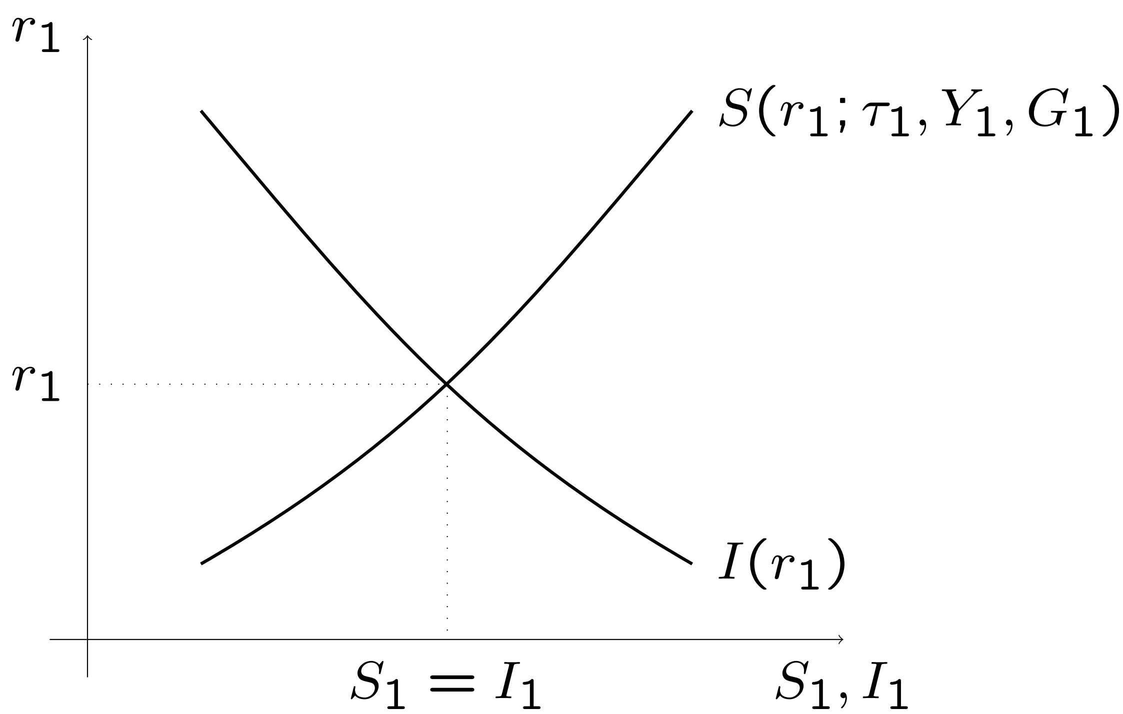
The Equilibrium Interest Rate

In equilibrium we have that national saving must equal investment, or

$$S(r_1; \tau_1, Y_1, G_1) = I(r_1)$$

The next slide illustrates the determination of the equilibrium interest rate as the intersection of the saving and investment schedules.

Equilibrium in the Economy with Consumption Taxes



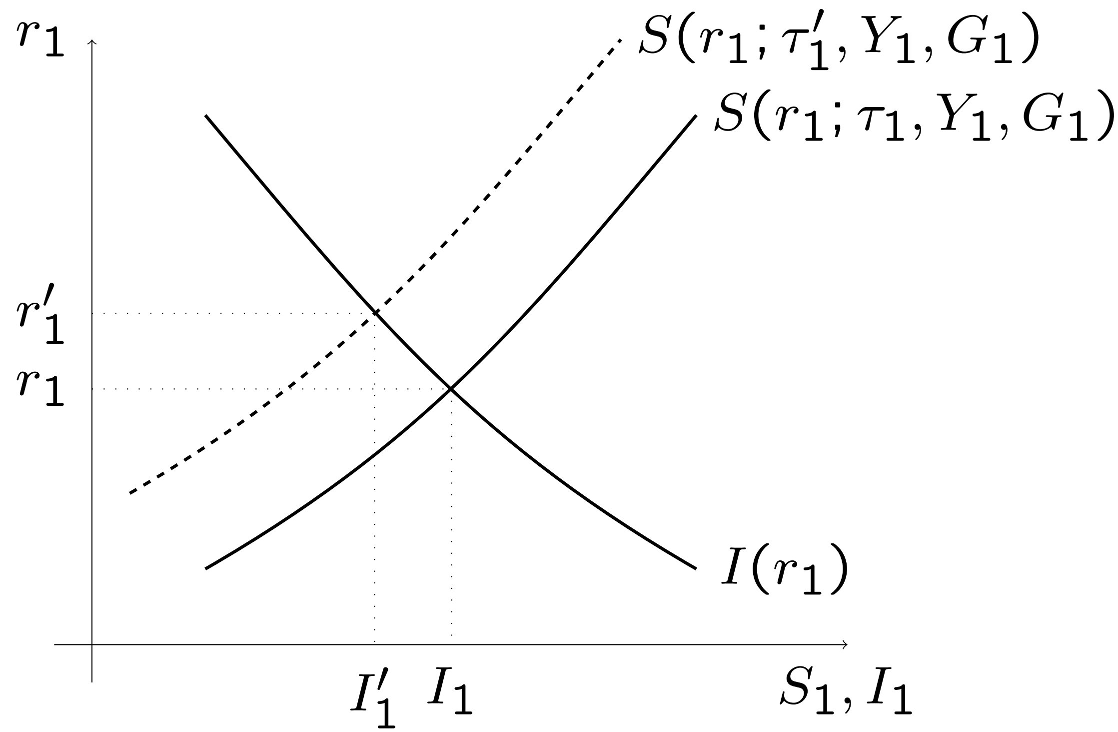
Effect of a Cut in the Consumption Tax Rate, τ_1

Suppose the government implements a reduction in the consumption tax rate from τ_1 to $\tau_1' < \tau_1$. The situation is illustrated in the figure that appears in the next slide. Before the tax cut, the saving schedule is the upward sloping solid line. The equilibrium occurs at its intersection with the investment schedule, given by the downward sloping line. The interest rate is r_1 and investment is I_1.

The fall in the tax rate shifts the saving schedule up and to the left, as shown by the upward sloping dashed line. At the new equilibrium, the interest rate is higher $r_1' > r_1$, and investment is lower, $I_1' < I_1$. Saving also falls in equilibrium.

The tax cut causes an increase in private consumption, $C_1 \uparrow$. To see this, recall the resource constraint $Y_1 = C_1 + I_1 + G_1$ and note that I_1 falls while Y_1 and G_1 are unchanged.

Effect of a Cut in the Consumption Tax Rate



Intuition and Summary

Intuitively, the tax cut raises the fiscal deficit (i.e., lowers government saving). Given the interest rate, the tax cut does not significantly affect private saving (with log-linear preferences, the case we consider here, the private saving schedule does not change at all in response to the tax cut). Thus, the national saving schedule shifts left: for every interest rate the country wants to save less. At the prevailing interest rate the capital market is out of equilibrium, investment demand exceeds the supply of savings. Equilibrium in the capital market then requires an increase in the interest rate, which encourages private saving and discourages investment.

Summarizing,

$$\tau_1 \downarrow \Rightarrow r \uparrow, I_1 \downarrow, S_1 \downarrow, C_1 \uparrow, S_1^g \downarrow .$$

Again, these effects are qualitatively in sharp contrast with the ones obtained under the assumption of lump-sum taxation, in which a tax cut leaves the interest rate, investment, saving, and consumption unchanged.

Summing Up

• Ricardian equivalence can fail when taxes are distortionary rather than lump sum.

• To illustrate this point, we studied a two-period economy with proportional consumption taxes, τ_1 and τ_2.

• A cut in the current consumption tax rate, τ_1, makes current consumption cheaper relative to future consumption and therefore induces households to consume more today.

• Given the interest rate, a cut in τ_1 does not change private saving under log utility, because the increase in disposable income and the incentive to consume more today exactly offset each other.

• By contrast, a cut in τ_1 lowers government saving, because it reduces tax revenue and therefore increases the fiscal deficit.

• As a result, national saving falls, the saving schedule shifts inward, the equilibrium interest rate rises, and investment declines.

• Therefore, with distortionary taxation, a debt-financed tax cut raises current consumption and the interest rate and lowers saving and investment, in contrast to the case of lump-sum taxation.

Lecture 22

Government Spending Shocks

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Government Spending Shocks Financed With Lump-Sum Taxes

We saw in a previous class that with lump-sum taxes the saving schedule is given by

$$S_t = \frac{1}{2}\left[Y_1 - G_1 - \frac{\Pi(r_1) - G_2}{1 + r_1}\right] \tag{1}$$

where S_1 =national saving; Y_1 =endowment in period 1; G_1=government spending in period 1; G_2 =government spending in period 2; r_1 =real interest rate; and $\Pi(r_1)$=profit income from the ownership of firms received in period 2.

Equation (1) says that national saving in period 1 depends on the difference between resources available today and resources expected to be available in the future, both net of government spending. If current disposable resources, $Y_1 - G_1$, are high relative to future disposable resources, $\frac{\Pi(r_1)-G_2}{1+r_1}$, households save more today in order to smooth consumption over time. Conversely, if future expected resources rise relative to current resources, households feel richer in the future and save less today.

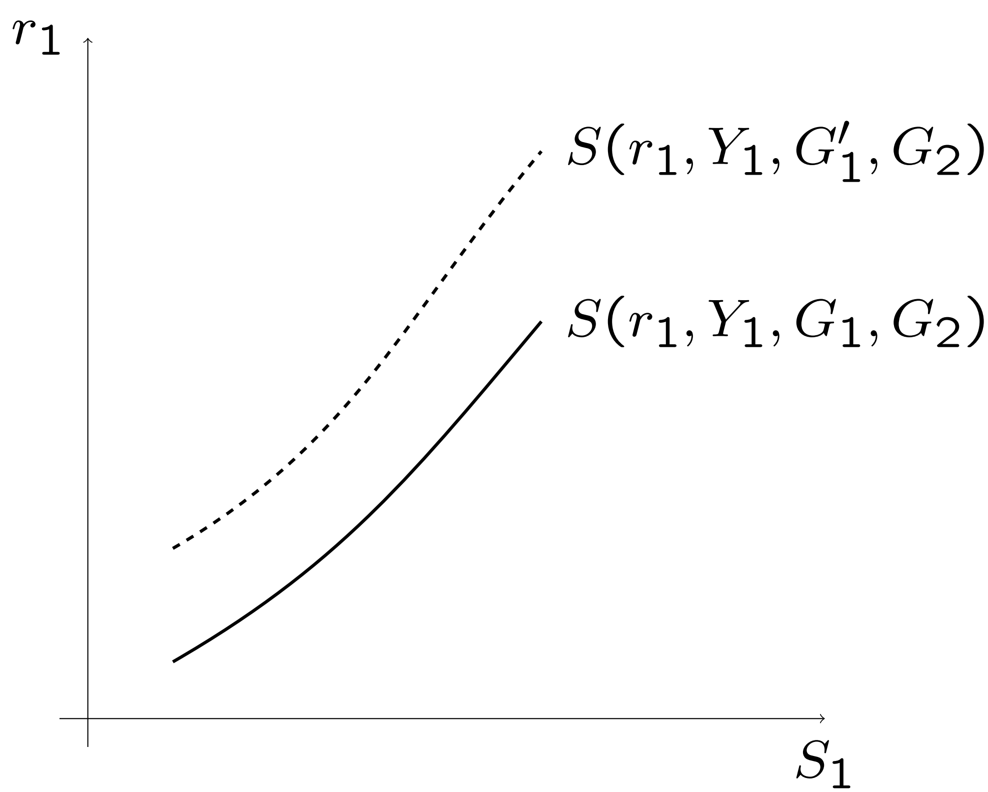
An increase in government spending in period 1 ($G_1 \uparrow$) lowers current disposable resources and therefore reduces national saving at any given interest rate, r_1.

We summarize the saving schedule as

$$S_1 = S(\underset{+}{r_1}, Y_1, \underset{-}{G_1}, G_2)$$

The graph on the next slide shows how an increase in G_1 shifts the saving schedule.

The Saving Schedule and a Change in Government Spending



Notes. The saving schedule is increasing in the interest rate, r_1. An increase in government spending in period 1 from G_1 to $G_1' > G_1$ shifts the saving schedule up and to the left.

Intuition

The previous graph shows that an increase in government spending in period 1 shifts the saving schedule up and to the left. That is, for any given value of the interest rate, r_1, national saving falls. The intuition is that an increase in government spending in period 1 lowers current disposable resources, $Y_1 - G_1$, while leaving future disposable resources unchanged. As a result, resources become relatively scarcer today than in the future, and national saving falls,.

Effects of an Increase in Government Spending

In equilibrium, saving must equal investment,

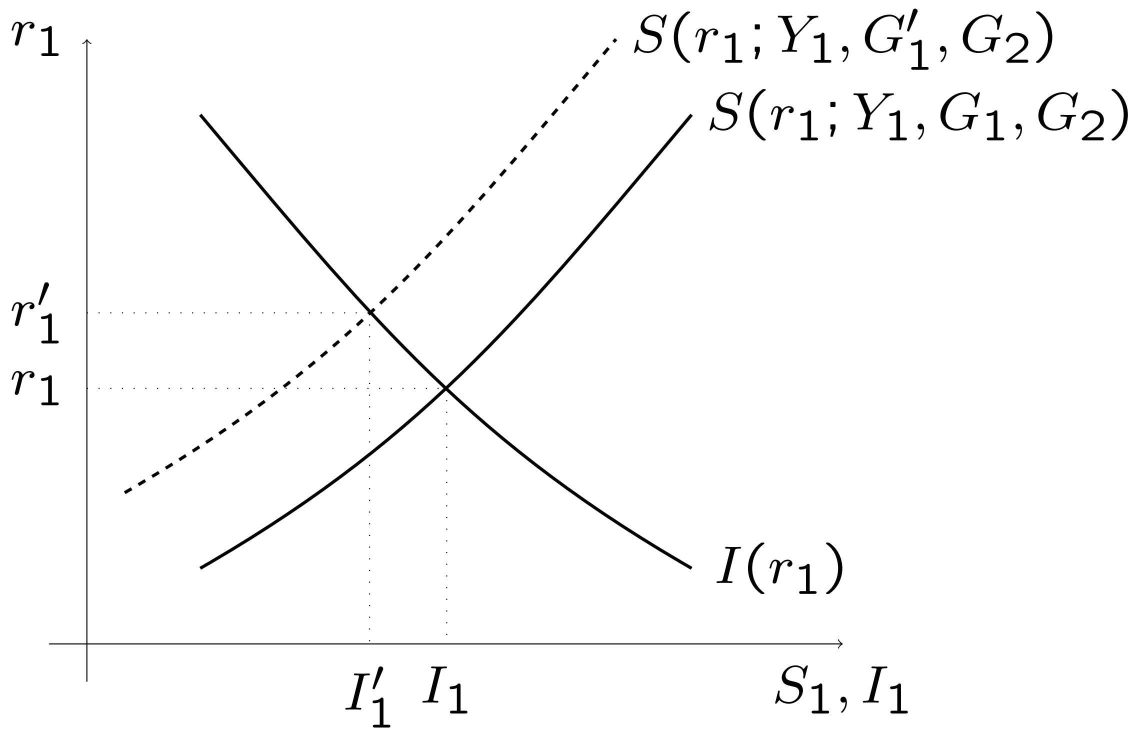
$$S(r_1, Y_1, G_1, G_2) = I(r_1).$$

Suppose now that government spending in period 1 increases from G_1 to $G_1' > G_1$. All else equal, saving falls, causing an excess demand for funds. Market clearing then requires an increase in the real interest rate ($r_1 \uparrow$). The increase in r_1 causes investment to fall.

Intuitively, the increase in government spending reduces the availability of goods for consumption or investment. So either consumption or investment or both must fall. The increase in the real interest rate discourages consumption and investment, restoring equilibrium.

The figure on the next page illustrates this effects.

Effect of an Increase in Government Spending



Notes. Initially, the equilibrium is where the solid saving schedule and the investment schedule cross. When government spending increases from G_1 to $G_1' > G_1$, the saving schedule shifts up and to the left, as shown with the broken curve. The investment schedule is unchanged. At the new equilibrium, the interest rate is increases from r_1 to $r_1' > r_1$, and investment falls to $I_1' < I_1$. Saving also falls, because it must equal investment in equilibrium.

Effect of an Increase in Government Spending on Consumption

We just deduced that an increase in government spending ($G_1 \uparrow$) causes an increase in the real interest rate ($r_1 \uparrow$).

In a previous class, we established that in equillibrium consumption in period 1 is given by

$$C_1 = \frac{1}{2}\left[Y_1 - G_1 + \frac{\Pi(r_1) - G_2}{1 + r_1}\right]$$

This expression says that in equilibrium households consume half of the present discounted value of all goods produced in the economy net of government consumption. It is clear from this expression that both the increase in G_1 and the increase in r_1 reduce consumption ($C_1 \downarrow$). Intuitively, higher government spending makes households poorer (fewer resources are available for the private sector) prompting them to tighten their belts and consume less. Meanwhile, the rise in the real interest rate encourages households to save, shifting consumption from the present to the future.

Summary: Effects of an Increase in Government Spending

Collecting results, we have that

$$G_1 \uparrow \Rightarrow r_1 \uparrow; I_1 \downarrow; S_1 \downarrow; C_1 \downarrow$$

Crowding Out: When an increase in government spending causes a reduction in private investment, we say that *government spending crowds out investment.* Similarly, when an increase in government spending causes a reduction in private consumption, we say that *government spending crowds out consumption.*

Role of the Market. Note how the market helps improve the intertemporal allocation of resources. When G_1 rises, disposable resources available for private use become scarcer today. Investment is a vehicle for transferring goods from the present to the future: resources not consumed today are used to build capital, which raises production tomorrow. But when government spending increases in period 1, the economy needs more goods for current use. The increase in the interest rate, $r_1 \uparrow$, facilitates this adjustment by discouraging investment, that is, by reducing the transfer of goods from the present to the future. It also discourages current consumption, which is efficient because resources are now relatively scarce in the present.

An Increase in Future Expected Government Spending

Suppose that in period 1, it is revealed that G_2 will increase

$$G_2 \uparrow$$

Examples of future expected increases in government spending:

– A conflict of the country with a foreign country increases the probability of a war in the coming years. People expect that in the coming years the government will be spending more resources in defense (arms, a bigger army, etc.).

– The country is chosen by FIFA to host the soccer world cup taking place in eight years. Over the next years it will have to construct a number of new stadiums and renovate subways, airports, highways, etc.

Future Government Spending and Saving

Let's take a new look at equation (1) giving the saving schedule, which we reproduce here for convenience

$$S_t = \frac{1}{2}\left[Y_1 - G_1 - \frac{\Pi(r_1) - G_2}{1 + r_1}\right] \tag{R1}$$

This expression says that given r_1, an increase in future government spending causes an increase in national saving, $G_2 \uparrow \Rightarrow S_1 \uparrow$.

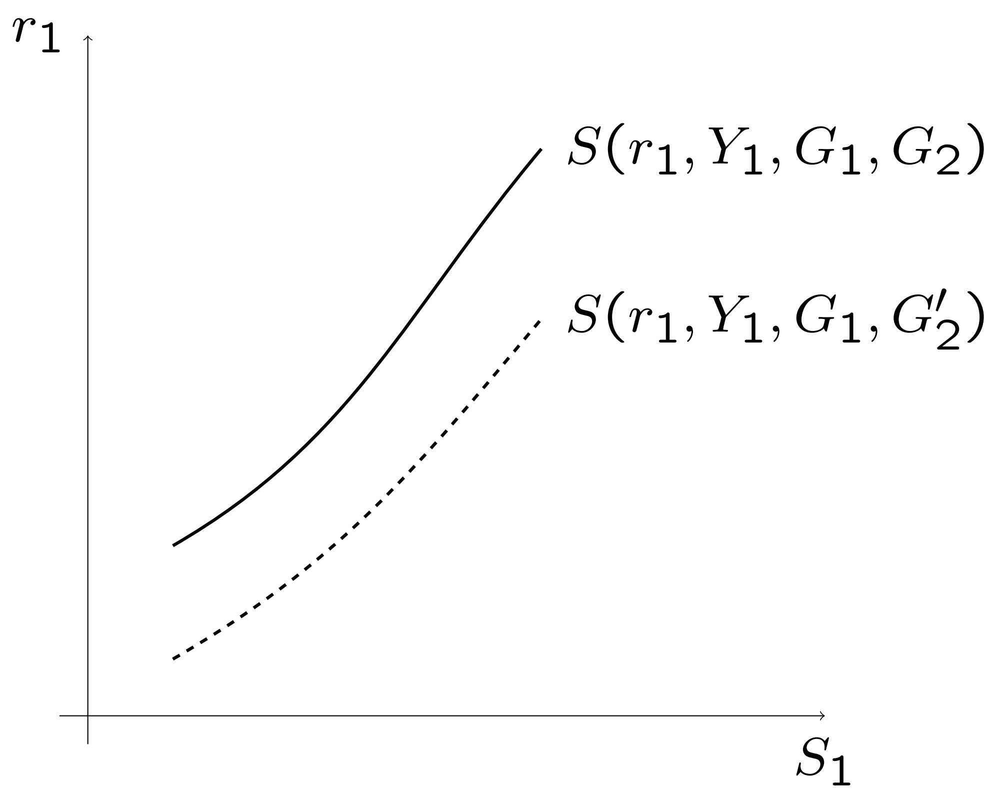
Intuitively, people expect that because the government will purchase more goods in the future, there will be fewer resources for private consumption in the future. So, to smooth consumption over time, people decide to consume less and save more today.

So we can summarize the saving schedule as follows:

$$S_1 = S(\underset{+}{r_1}, Y_1, \underset{-}{G_1}, \underset{+}{G_2})$$

The figure on the next slide illustrates this relationship.

The Saving Schedule and a Change in Future Government Spending



Notes. The saving schedule is increasing in the interest rate, r_1. An increase in future government spending in period 2 from G_2 to $G_2' > G_2$ shifts the saving schedule down and to the right. So for each interest rate, national saving is higher.

Effects of an Increase in Future Government Spending

In equilibrium, saving must equal investment,

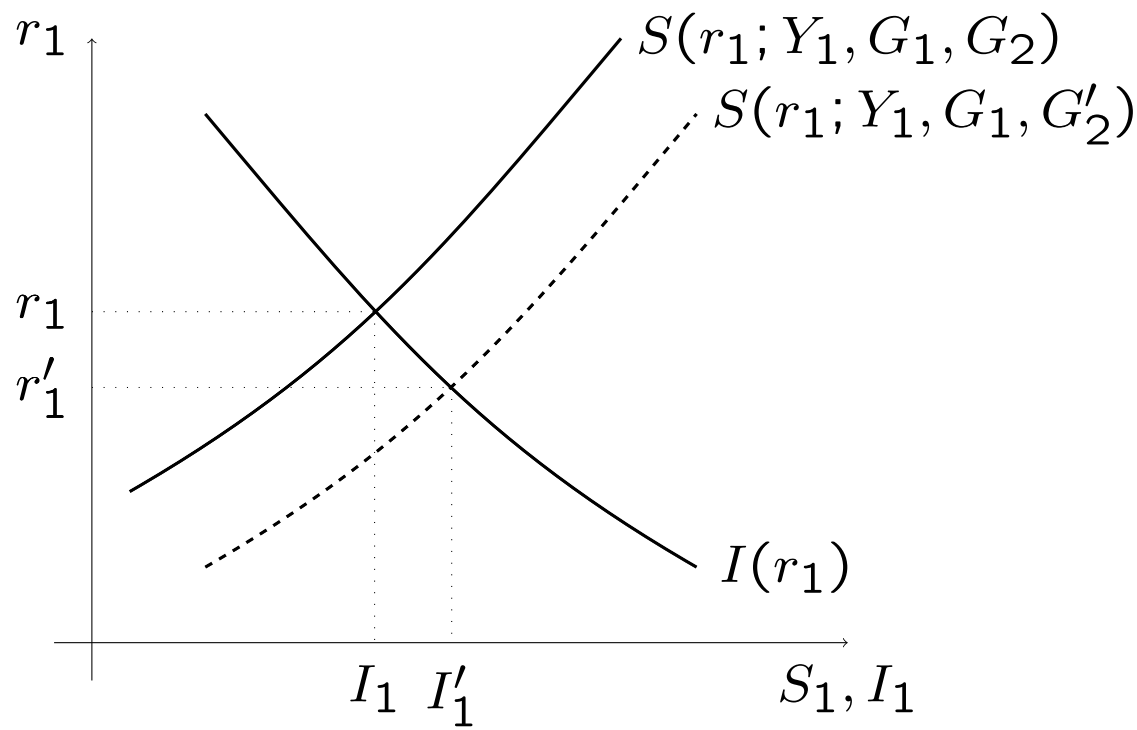
$$S(r_1, Y_1, G_1, G_2) = I(r_1).$$

If future government spending rises from G_2 to $G_2' > G_2$, all else equal, saving increases, creating an excess supply of funds. Market clearing then requires a decline in the real interest rate ($r_1 \downarrow$), which in turn raises investment.

Intuitively, higher future government spending reduces the availability of goods for consumption in period 2. Households respond by saving more to shift resources from period 1 to period 2. This increase in saving lowers the interest rate and stimulates investment. As we said earlier, investment is, in fact, the only mechanism through which goods can be transferred across periods: in period 1, resources are used to build physical capital (e.g., structures and machines), which then produces goods in period 2 via the production function. These goods are then consumed in that period.

The figure on the next page illustrates these effects.

Effect of an Increase in Future Government Spending



Notes. Initially, the equilibrium is where the solid saving schedule and the investment schedule cross. When future government spending increases from G_2 to $G_2' > G_2$, the saving schedule shifts down and to the right, as shown with the dashed curve. The position of the investment schedule is unchanged. At the new equilibrium, the interest rate is lower at $r_1' < r_1$, and investment increases from I_1 to $I_1' > I_1$. Saving also increases, because it is equal to investment in equilibrium.

Effect of an Increase in Future Government Spending on Consumption

We know that in equilibrium saving is given by

$$S_1 = Y_1 - C_1 - G_1.$$

Y_1 and G_1 remain unchanged. Moreover, we just established that an increase in G_2 leads to an increase in S_1. It follows that C_1 must fall.

This effect is intuitive: the expectation that goods available to households in period 2 will be more scarce (due to higher government consumption) induces people to reduce current consumption and increase saving in order to smooth consumption over time.

Summary: Effects of an Increase in Future Government Spending

Collecting results, we have that

$$G_2 \uparrow \Rightarrow r_1 \downarrow; I_1 \uparrow; S_1 \uparrow; C_1 \downarrow$$

Government Spending Financed with Distortionary Consumption Taxes

The analysis thus far assumes implicitly that government spending is financed with lump-sum taxes.

What happens when a government spending shock is financed with distortionary taxes?

With lump-sum taxes, it doesn't matter whether the increase in government spending is financed with current or future taxes (Ri-cardianEquivalence). By contrast, as we saw last lecture, when taxes are distortionary, the timing of taxes matters.

We now consider an increase in G_1 financed with consumption taxes in period 1, ($\tau_1 \uparrow$).

A Balanced-Budget Rule

Suppose that the government follows a rule whereby government spending each period are fully financed with taxes levied that same period. Under this rule, the government cannot issue debt to financed spending. This type of fiscal policy is called a *balanced-budget rule.*

Formally, under a balanced budget rule we have that

$$G_1 = \tau_1 C_1 \tag{2}$$

The left hand side of (2) is government spending in period 1, and the right hand side is tax revenue in period 1. So government spending in period 1 is financed with tax revenue in period 1.

The Saving Schedule

Last class, we saw that with consumption taxes, consumption in period 1 is given by

$$C_1 = \frac{1}{2 \times (1+\tau_1)}\left[Y_1 + \frac{\Pi(r_1)}{1+r_1}\right] \tag{3}$$

Combine (2) and(3) to eliminate $\tau_1 C_1$. This gives

$$C_1 + G_1 = \frac{1}{2}\left[Y_1 + \frac{\Pi(r_1)}{1+r_1}\right] \tag{4}$$

We also know that in equilibrium national saving is given by the difference between output and the sum of private public consumption, that is,

$$S_1 = Y_1 - G_1 - C_1. \tag{5}$$

Combining (4) and (5) to eliminate C_1+G_1 gives the saving schedule

$$S_1 = \frac{1}{2}\left[Y_1 - \frac{\Pi(r_1)}{1+r_1}\right]. \tag{6}$$

Note that neither G_1 nor τ_1 enter in the saving schedule. So an increase in G_1 finance with an increase in taxes in period 1 under a balanced budget rule, given the interst rate, does not cause a change in saving.

The intuition behind this result is as follows. An increase in G_1 reduces the resources available for private consumption today, making resources relatively scarcer in the present than in the future. This effect tends to reduce saving at any given interest rate. At the same time, financing the increase in government spending with a higher consumption tax leaves private saving unchanged under log preferences, because, as we saw last class, the income and substitution effects exactly offset each other, but it raises government saving by increasing tax revenue. Therefore, the increase in G_1 tends to lower saving, while the increase in τ_1 tends to raise it. With log preferences, these two effects exactly cancel out.

Equilibrium

In equilibrium, saving must equal to investment, $S_1 = I_1(r_1)$. Using (6), we can write this expression as

$$\frac{1}{2}\left[Y_1 - \frac{\Pi(r_1)}{1+r_1}\right] = I(r_1) \tag{7}$$

Because neither G_1 nor τ_1 appears in equilibrium condition (7), we have that *an increase in government spending in period 1 ($G_1 \uparrow$) financed with consumption taxes in period 1 by a government that follows a balanced-budget rule has no effect on the interest rate, investment, or saving.*

Effect on Consumption

The resource constraint of the economy in period 1 says that

$$Y_1 = C_1 + G_1 + I_t$$

Since Y_1 is fixed and I_1 does not change when G_1 changes, we have that *an increase in government spending in period 1 ($G_1 \uparrow$) financed with consumption taxes in the same period by a government that follows a balanced-budget rule causes a one-for-one fall in consumption $\Delta C_1 = -\Delta G_1$). That is, government spending crowds out consumption one for one*

Summarizing: with consumption taxes and a balanced-budget rule

$$G_1 \uparrow \Rightarrow r_1 \text{ unchanged}; I_1 \text{ unchanged}; S_1 \text{ unchanged}; C_1 \downarrow$$

Taking Perspective

In this lecture, we found that increases in government spending, whether current or expected, financed with lump-sum taxes or with distortionary taxes, always crowd out consumption.

What situation is this result meant to capture?

It's meant to capture a situation in which the economy is in or near full employment in period 1. Under these circumstances, an increase in one component of aggregate demand (G_1, say), can happen only if another component of aggregate demand (C_1 or I_1) falls. In other words, in this situation an increase in one component of aggregate demand must necessarily crowd out other components of aggregate demand.

By contrast, in a situation in which the economy suffers involuntary unemployment—like in the new-Keynesian model studied earlier in the course—this does not need to be the case. In this case, an increase in G_1, say, can take place without C_1 or I_1 falling, because the resources to meet the increased aggregate demand for goods can come from a reduction in unemployment that increases the aggregate supply of goods.

Summing Up

• In the lump-sum-tax economy, an increase in current government spending, G_1, lowers current disposable resources and shifts the saving schedule up and to the left: for any given interest rate, national saving falls.

• In equilibrium, an increase in G_1 raises the real interest rate and lowers investment and consumption. Thus, current government spending crowds out both investment and consumption.

• An increase in expected future government spending, G_2, makes future resources relatively scarcer and therefore raises current saving.

• In equilibrium, an increase in G_2 lowers the real interest rate, raises investment, and lowers current consumption.

• When government spending is financed with distortionary consumption taxes, the timing of taxation matters, unlike in the lump-sum-tax case.

• Under a balanced-budget rule with consumption taxes, an increase in G_1 financed by a contemporaneous increase in τ_1 has no effect on the interest rate, investment, or national saving, but it crowds out private consumption one for one.

Lecture 23

Global Imbalances

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Motivation

Countries trade a lot with one another, and the United States is no exception. This fact elicits a number of questions:

- How big are international transactions in goods, services, and financial assets for the United States and other countries?

- Does the United States have a trade deficit or a trade surplus with the rest of the world? What about China, Europe, and Latin America?

- Is the United States an external debtor or an external creditor?

- How have the trade balance and the international asset position of the United States and other countries evolved over time?

This lecture addresses these and other related questions.

Overview

The main focus of the present lecture is descriptive. In later lectures, we will ask more positive questions such as

- Why do countries run trade deficits in some years and trade surpluses in others?
- Why do countries borrow from abroad?
- Can countries borrow forever from abroad?
- What determines the size of a country's external debt?

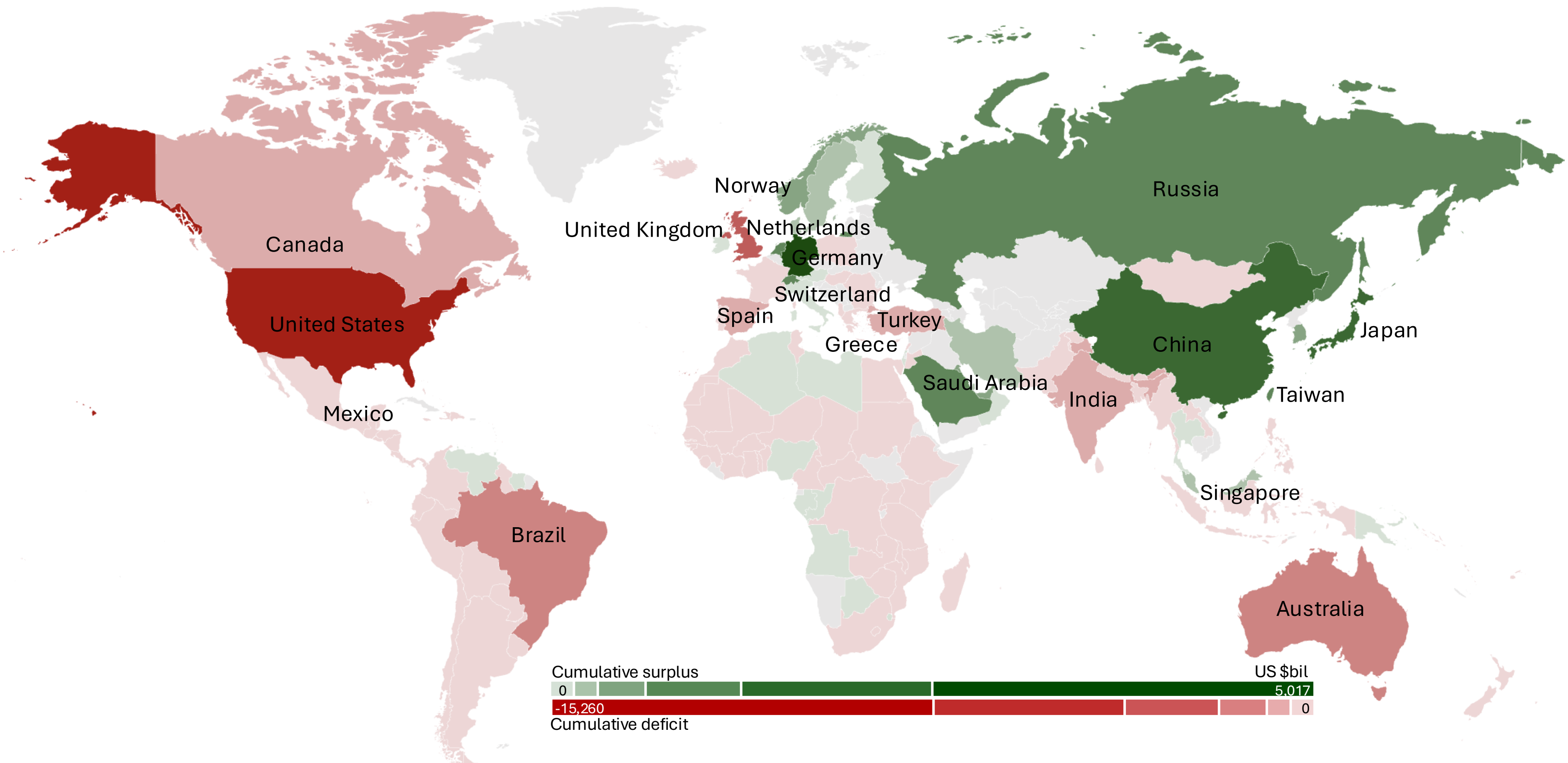
The Geography of External Debt

Take a look at the heat map on slide 5. It displays with colors the accumulated current account balances between 1980 and 2023. We will define current account balance more precisely below, but roughly speaking, it is the difference between exports and imports of goods, services, and factor payments. Up to changes in asset prices, a country's current account deficit in a given year equals the change in that country's net external debt. So if we add up a country's current account deficits for the years 1980 to 2023, we get the change in its external debt between 1980 and 2023. The map shows that the country with the biggest accumulated current account deficit (brightest red) is the United States. Its cumulative deficit was $15.3 trillion. The countries that have been financing these deficits (deepest green) are Germany ($5.0 trillion), Japan ($4.9 trillion), China ($4.7 trillion), and oil and gas exporting countries (members of OPEC, Russia, and Norway).

Overall, the picture is one of unbalanced international trade, with some countries running protracted current account deficits and others running protracted surpluses. If all countries were in balance, the map would look pastel white. Instead, it looks mostly either flaming red or dark green, reflecting large *global imbalances.*

Cumulative Current Account Balances Around the World

1980-2023, in billions of U.S. dollars



Notes: The map shows for each country the sum of annual current account balances (in billions of U.S. dollars) in 143 countries covering the period 1980 to 2023, or 44 years. For a country to be included in the sample at least 40 consecutive years of current account data are required. An exception is Russia which starts in 1994 and has only 30 years of data. The resulting panel is unbalanced. For 133 countries there are 44 observations, and for the average country there are 38 observations. Countries with less than 40 years of data (other than Russia) appear in gray. Cumulative current account surpluses appear in green and cumulative current account deficits in red. There are six shades of red and green corresponding to, respectively, at least one half, one fourth, one eighth, one sixteenth, and one thirty-second of the maximum cumulative current account deficit (U.S.: $15,260bn) and the maximum cumulative current account surplus (Germany: $5,017bn). Country names are displayed for the countries with the top 10 largest cumulated current account surpluses and deficits. The data source is Milesi-Ferretti, Gian Maria, "The External Wealth of Nations Database," 2024, The Brookings Institution (based on Lane, Philip R. and Gian Maria Milesi-Ferretti, "The External Wealth of Nations Revisited: International Financial Integration in the Aftermath of the Global Financial Crisis," IMF Economic Review 66, 2018, 189–222.).

The International Transactions Accounts

In the United States, international transactions are recorded by the Bureau of Economic Analysis (www.bea.gov) in the *International Transactions Accounts* (ITA), also known as the *Balance of Payments*.

The balance of payments has three components:

1. current account

2. financial account

3. capital account (quantitatively unimportant)

In the following slides we will introduce each component.

The current account is the sum of three accounts:

$$\begin{aligned}\text{current account} &= \text{trade balance} + \\ &\quad \text{primary income balance} + \\ &\quad \text{secondary income balance}^{*}\end{aligned}$$

*previously net unilateral transfers

The Trade Balance and the Current Account

The Trade Balance

An important statistic in the ITA is the *Trade Balance*, which measures the difference between exports of goods and services and imports of goods and services:

Goods Balance*= Exports of Goods − Imports of Goods

Service Balance = Exports of Services − Import of Services

Trade Balance = Goods Balance + Service Balance

Examples of internationally traded goods: textiles, oil, cars, computers, soybeans, wheat.
Examples of internationally traded services: education, medical care, tourism, consulting.

In the United States, the goods balance has historically been negative, whereas the services balance has typically been positive. Moreover, the goods deficit has generally been much larger in absolute value than the services surplus. As a result, the overall trade balance has usually been negative. This pattern has been a persistent feature of U.S. international trade for many years.

*or Merchandise Trade Balance.

The U.S. Trade Balance in 2024

Exports of goods and services: \$3.2 trillion
Imports of goods and services: \$4.1 trillion

Trade balance = \$3.2 - \$4.1 = -\$0.9 trillion.
When the trade balance is negative, we say the country runs a *trade deficit.*

Is \$0.9 trillion a big or small number?

Let's relate it to the size of the U.S. economy. In 2024, GDP was \$29.2 trillion. Letting TB denote the trade balance, we have

$$\frac{TB}{GDP} = -\frac{0.9}{29.2} = -0.031$$

or the trade deficit was 3.1 percent of GDP. Now is this a small or a big number? Shortly, we will see how the accumulation of trade deficits of this magnitude or even smaller turned the United States from a creditor in the 1980s to the world's largest debtor in a span of less than 20 years. So it's a big number if it persists for years.

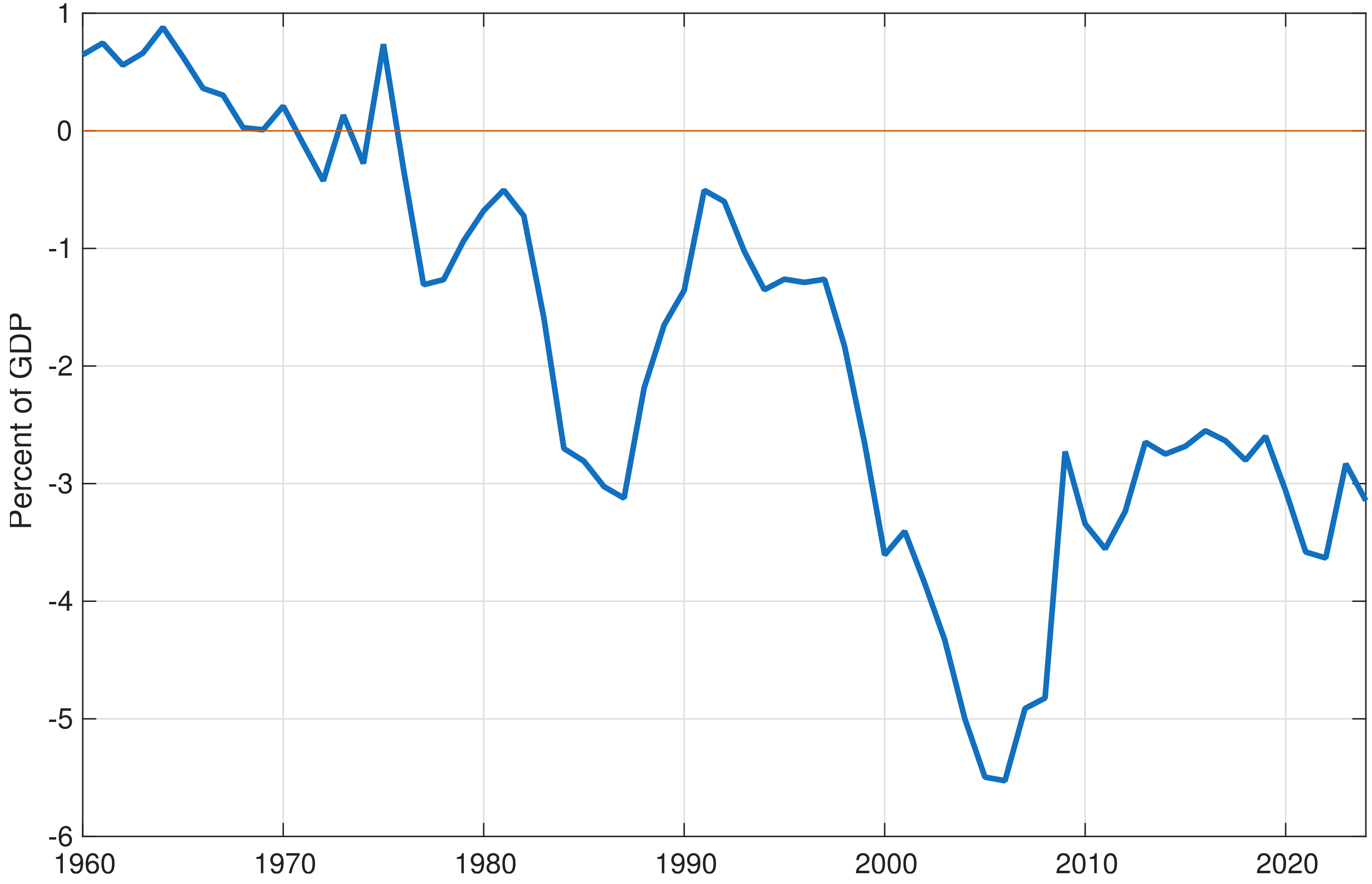
The U.S. Trade Balance Over Time

Is the size of the trade deficit in 2024 typical for the United States? Look at the graph on the next slide (slide 12), which plots the trade balance as a fraction of GDP since 1960.

The graph shows that the trade balance declined steadily from a trade surplus of 0.65 percent of GDP in 1960 to a trade deficit of near 6 percent by the beginning of the global financial crisis of 2007–2009. The global financial crisis seems to have put a stop (at least for now) to the downward trend in the trade balance. In fact, the global financial crisis was associated with an improvement in the trade balance to a deficit of around 3 percent of GDP. This size of trade deficit has persisted to the end of the sample (2024). Hence, the answer to the question of how typical the 2024 trade deficit of 3 percent is, would be that it is typical for the past 15 years.

The U.S. Trade Balance: 1960–2024

(Percent of GDP)



Data Sources: BEA, bea.gov. TB data: ITA Table 1.1. GDP data: NIPA Table 1.1.5.

The Primary Income Balance

The second component of the current account is the *Primary Income Balance*, which measures the difference between factor incomes received from the rest of the world and factor incomes paid to the rest of the world. These net income payments are recorded separately for capital and labor.

- Net income from capital is called *Net Investment Income* and consists of payments such as dividends, interest, or profits.
- Net income from labor is called *Net Compensation of Employees* and records earnings of U.S. residents temporarily employed abroad and compensation payments to foreigners temporarily working in the United States.

$$\begin{aligned}\text{Primary Income Balance} &= \text{Net Investment Income} + \\ &\quad \text{Net Compensation of Employees}\end{aligned}$$

In the United States, net investment income has typically been small and often positive, indicating that income earned by U.S. residents on foreign assets has tended to slightly exceed income paid to foreigners on U.S. assets. By contrast, net compensation of employees has typically been negative and quantitatively very small, reflecting the fact that payments to foreign workers in the United States tend to exceed payments received by U.S. residents working temporarily abroad. As a result, the overall primary income balance in the United States is usually small relative to the trade balance.

The Secondary Income Balance

The third component of the current account is *Secondary Income*, which keeps record of the difference between gifts received from the rest of the world and gifts given to the rest of the world. These gifts can involve private agents or governments.

$$\begin{aligned}\text{Secondary Income Balance} &= \text{Net Private Transfers} + \\ &\quad \text{Net Government Transfers}\end{aligned}$$

In the United States net secondary income is typically negative, indicating that the U.S. makes more gifts than it receives. The most relevant examples of secondary income include U.S. residents sending monetary gifts (personal remittances) to relatives living abroad or the U.S. government sending aid to foreign countries or to areas of the world suffering from natural disasters, endemic diseases, or armed conflicts.

The Current Account

To recap, the current account is the sum of the trade balance, the primary income balance, and the secondary income balance

$$\begin{aligned}\text{Current Account} &= \text{Trade Balance} + \\ &\quad \text{Primary Income Balance} + \\ &\quad \text{Secondary Income Balance}\end{aligned}$$

The current account is an important concept because if the current account is negative, all other things equal, the net external debt of the country goes up, and if the current account is positive, it falls.

The table on the next slide (slide 16) displays the U.S. current account and its three components in 2024.

The U.S. Current Account in 2024

		Billions of dollars	Percentage of GDP
1	Current Account	-1,133.6	-3.9
2	Trade Balance	-917.8	-3.1
3	Balance on Goods	-1,213.0	-4.2
4	Balance on Services	295.2	1.0
5	Primary Income Balance	-8.9	-0.0
6	Net Investment Income	11.7	0.0
7	Net Compensation of Employees	-20.6	-0.1
8	Secondary Income	-206.9	-0.7
9	Private Transfers	-164.0	-0.6
10	Government Transfers	-42.9	-0.1

Data Source: Authors' calculations based on data from ITA Tables 1.1 and 5.1. and NIPA Table 1.1.5. of the BEA. Lines 2, 5, and 8 may not add up to line 1 because of rounding errors.

Observations on the U.S. Current Account in 2024

• In 2024, the U.S. ran a large current account deficit, 3.9% of GDP.

• The bulk of the current account deficit stems from a large trade deficit, 3.1% of GDP.

• The country had a deficit in the trade balance on goods and a surplus in the trade balance on services. The United States imports manufactured goods (e.g., cellphones, computers, vehicle parts) and exports human-capital-intensive services (higher education, R&D, health care, professional consulting). Thus, the United States typically runs a trade deficit in goods and a trade surplus in services. And 2024 was no exception in this regard.

• Net investment income was small but positive, which means that investments of U.S. residents in foreign assets paid more in interest, dividends, and profits, than the investments of foreign residents in U.S. assets.

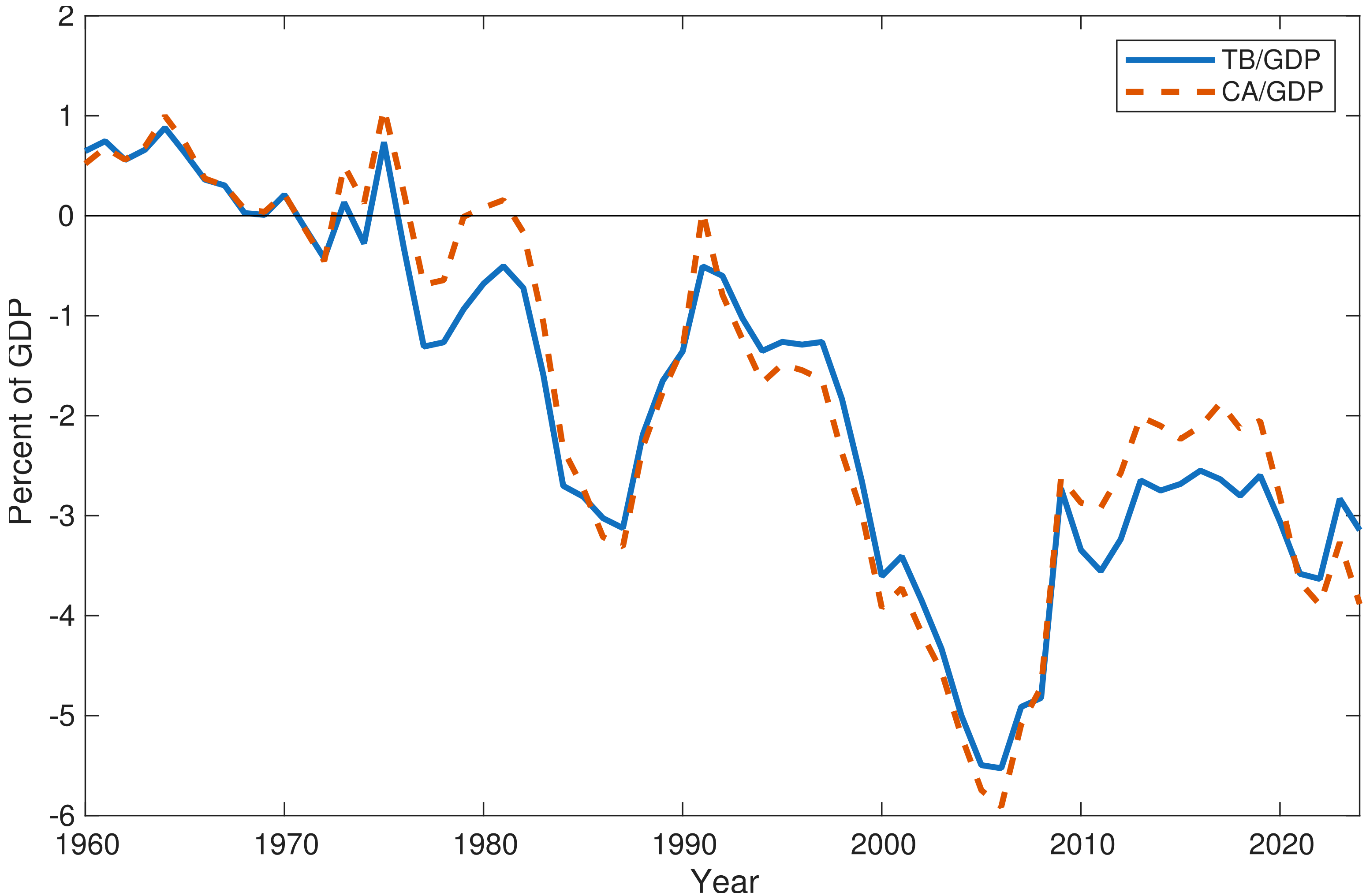
• Net Compensation of Employees was negative, which means foreign residents received more payments from U.S. employers than U.S. residents received from foreign employers.

• The Secondary Income Balance was negative, which means that the United States gave more gifts to the rest of the world than it received. These gifts are largely personal remittances. Personal remittances typically are payments that U.S. residents (immigrants) are sending to relatives and friends residing in the country they emigrated from.

In the United States, the Trade Balance and the Current Account are Similar in Size and Move in Tandem Over Time

We saw in the previous table that for the year 2024, the bulk of the U.S. current account was the trade balance. The figure on the next slide (slide 19) shows that this is indeed true pretty much all the time.

The U.S. Trade Balance and Current Account as Percentages of GDP, 1960–2024



Notes. TB and CA stand for trade balance and current account, respectively. Authors' calculations based on data from ITA Table 1.1 and NIPA Table 1.1.5 of the BEA.

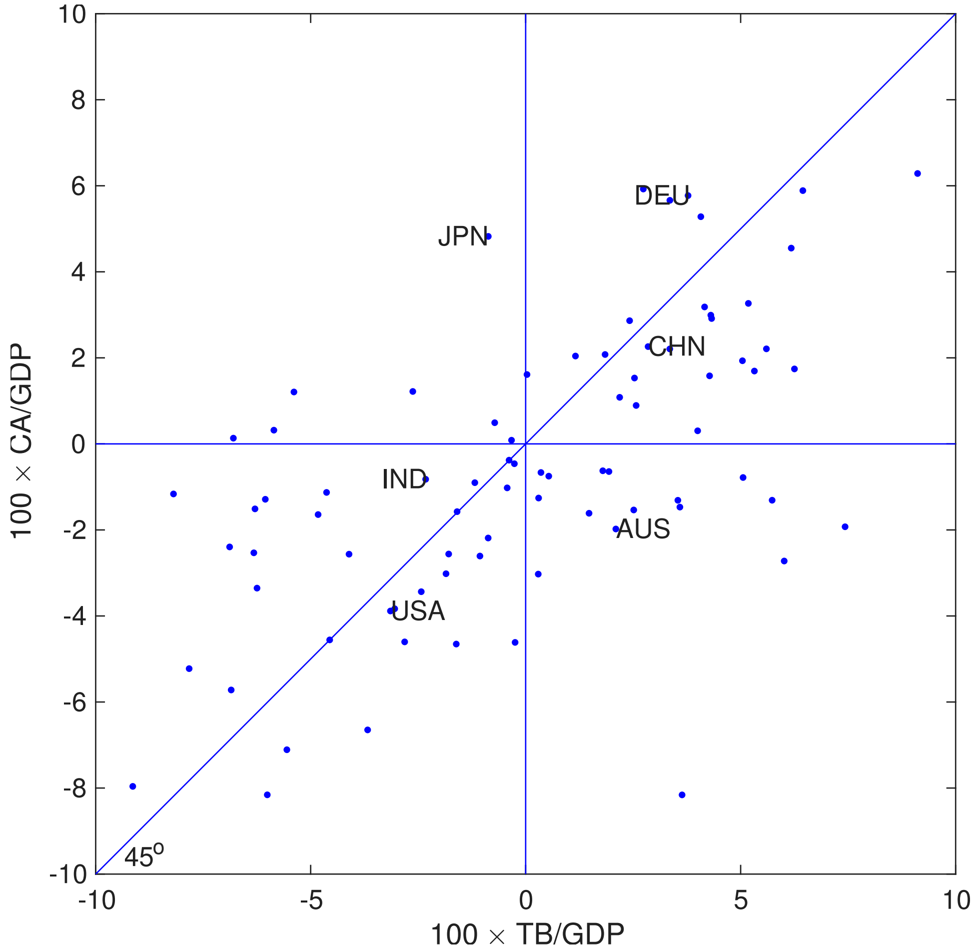
Trade Balances and Current Account Balances Across Countries

The Trade Balance and the Current Account Also Often Move in Tandem in Other Countries

The figure on the following slide (slide 22) plots the current account against the trade balance, both expressed as percentages of GDP, for 81 countries in 2024. Each dot represents a country.

The figure shows that many dots fall within a relatively narrow corridor around the 45-degree line. The clustering around the 45-degree line suggests that, as in the United States, in many other countries the trade balance is the dominant component of the current account.

Trade Balance and Current Account as Percentage of GDP across Countries in 2024



Notes. TB denotes the trade balance and CA denotes the current account balance. For countries other than the United States, the data source is World Development Indicators (WDI). Country names are shown using ISO abbreviations. Countries in the WDI database with trade balances or current account balances exceeding ± 10 percent of GDP were excluded, resulting in a total sample of 81 countries.

The previous figure also shows that the current account and the trade balance need not have the same sign (as is the case in the United States) and that the current account can be either larger or smaller than the trade balance. Any sign pattern is possible, as shown in the following table.

The Current Account of Selected Countries as Percentage of GDP in 2024

		AUS	CHN	DEU	IND	JPN	USA
1	Current Account	-1.9	2.3	5.8	-0.8	4.8	-3.9
2	Trade Balance	1.1	2.9	3.8	-2.6	-1.1	-3.1
3	Primary Income	-3.0	-0.7	3.5	-1.3	6.7	-0.0
4	Net Investment Income	-2.5	-0.7	3.4	-1.4	6.7	0.0
5	Compensation of Employees	-0.5	0.1	0.1	0.1	-0.0	-0.1
6	Secondary Income	-0.0	0.1	-1.6	3.1	-0.8	-0.7
7	Private Transfers	-0.1	0.1	-0.8	3.1	-0.7	-0.6
8	Government Transfers	0.1	0.0	-0.8	-0.0	-0.0	-0.1

Notes. The table presents the current account of Australia, China, Germany, India, Japan, and the United States in 2024 expressed as a percentage of GDP. For countries other than the United States the data sources are the IMF's Balance of Payments (BOP) and World Economic Outlook (WEO) Datasets. Lines 2, 3, and 6 may not add up to line 1 because of rounding errors.

Observations on the table

Recall: CA = TB + Primary Income Balance + Secondary Income Balance

China:
$\frac{\text{TB}}{\text{GDP}} > \frac{\text{CA}}{\text{GDP}} > 0$ because Primary Income < 0. China receives negative net investment income on a positive(!) net foreign asset position.

Germany:
$\frac{\text{CA}}{\text{GDP}} > \frac{\text{TB}}{\text{GDP}} > 0$ because Primary Income Balance > 0. Germany receives positive net investment income on a positive net foreign asset position.

Japan:
$\frac{\text{CA}}{\text{GDP}} > 0 > \frac{\text{TB}}{\text{GDP}}$ because Primary Income Balance > 0. Japan receives positive net investment income on a positive net foreign asset position that exceeds its trade deficit.

India:
$\frac{\text{TB}}{\text{GDP}} < \frac{\text{CA}}{\text{GDP}} < 0$ because Secondary Income Balance > 0: India receives private transfers (remittances) equal to 3.1 percent of GDP.

Australia:
$\frac{\text{CA}}{\text{GDP}} < 0 < \frac{\text{TB}}{\text{GDP}}$ because Primary Income Balance < 0. Australia is a top-10 net world debtor, so it makes large interest payments (2.5% of GDP) to the rest of the world.

United States:
$\frac{\text{CA}}{\text{GDP}} < \frac{\text{TB}}{\text{GDP}} < 0$ because Secondary Income Balance < 0. U.S. residents make private transfers (send remittances) to residents abroad, -0.6 percent of GDP.

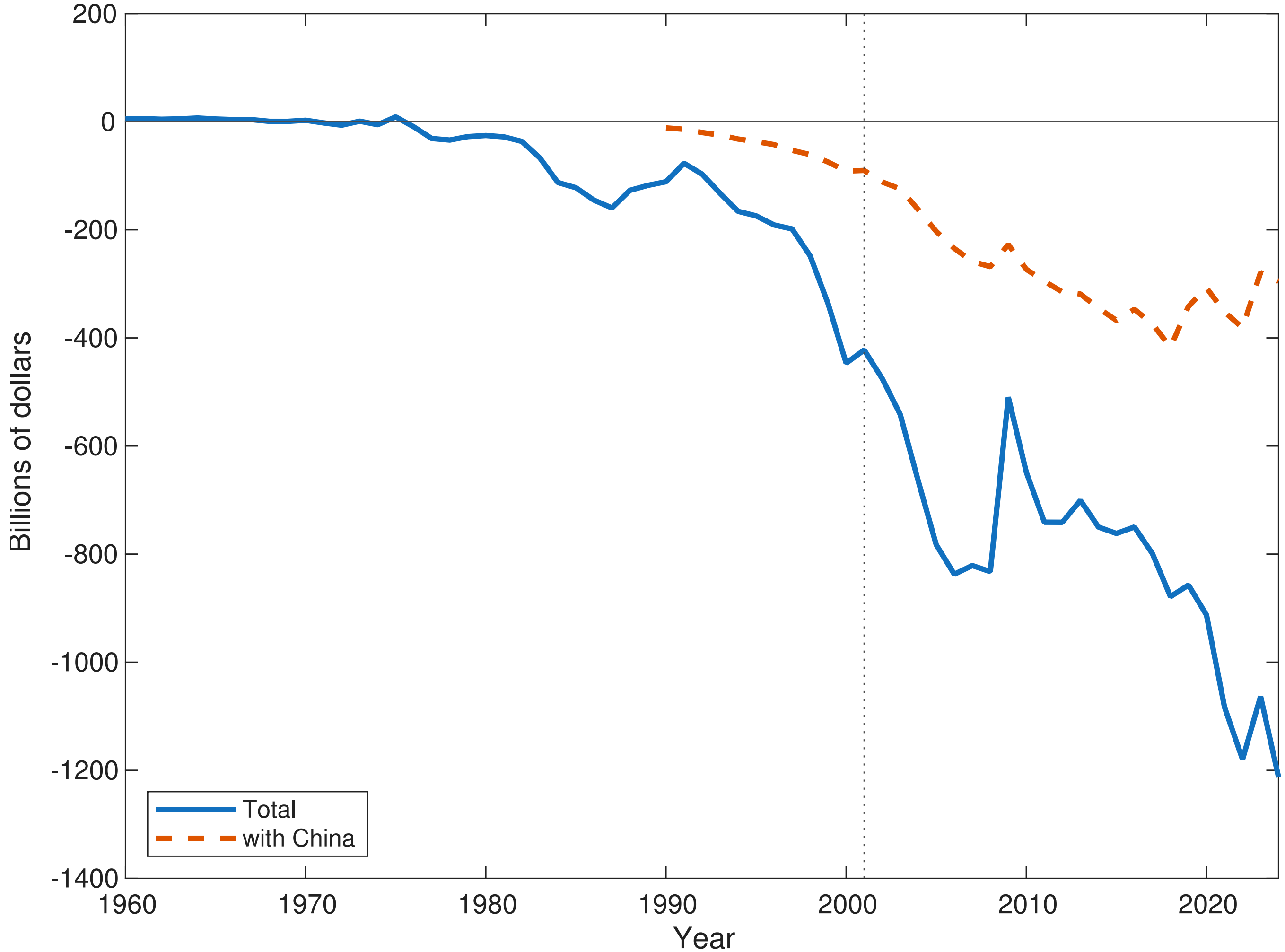
Imbalances in U.S.-China Trade

The figure on the next slide (slide 26) shows that a sizable fraction of the U.S. merchandise (i.e., goods) trade deficit is accounted for by its trade with China.

The fraction of the U.S. merchandise trade deficit accounted for by deficits with China widened steadily following China's accession to the WTO in 2001 rising from about 20 percent in 2000 to near 50 percent by 2015.

By the end of the sample in 2024, however, this share had fallen to 25 percent, which is not that different from its pre-WTO-accession level. Two candidate explanations for this narrowing of the bilateral trade imbalances are an increase in trade triangulation after the imposition of import tariffs by the Trump administration starting in 2018 and a generalized decline in Chinese exports during the COVID-19 pandemic.

The U.S. Merchandise Trade Balance with China, 1990-2024



Notes. The data source for the U.S. merchandise trade balance is ITA Table 1.1. The data source for the bilateral merchandise trade balance between the United States and China is OECD, http://stats.oecd.org for the period 1990 to 2002 and ITA Table 1.3 for the period 2002 to 2024. The vertical line marks the year 2001, when China became a member of the WTO.

The World Map of Current Account Balances

If the United States is running a large current account deficit, some other countries must be running current account surpluses. Why? Because it must be the case that:

$$CA^{\mathsf{US}} + CA^{\mathsf{ROW}} = 0,$$

where ROW stands for rest of the world.

So who is running big cumulative current account surpluses? Look again at the heat map in slide 5.

The 10 largest cumulative current account surpluses over the period 1980 to 2023 were observed in Germany, Japan, China, Russia, Netherlands, Taiwan, Saudi Arabia, Switzerland, Singapore and Norway in that order.

Here are the top 10 largest cumulative current acount surplus and deficit countries.

Rank	Country	Surplus $tn
1	Germany	5.0
2	Japan	4.9
3	China	4.7
4	Russia	1.7
5	Netherlands	1.5
6	Taiwan	1.4
7	Saudi Arabia	1.4
8	Switzerland	1.3
9	Singapore	1.3
10	Norway	1.2

Rank	Country	Deficit $tn
1	United States	-15.3
2	United Kingdom	-2.1
3	Brazil	-1.1
4	Australia	-1.0
5	India	-0.7
6	Canada	-0.7
7	Spain	-0.7
8	Turkey	-0.6
9	Mexico	-0.5
10	Greece	-0.4

Summing Up

- The balance of payments has three main components: the current account, the financial account, and the capital account. The current account is the economically most important part of this lecture.
- The current account equals the trade balance plus the primary income balance plus the secondary income balance. A current account deficit tends to increase a countrys net external debt.
- In 2024, the United States ran a sizable current account deficit of 3.9 percent of GDP. Most of this deficit reflected a trade deficit of 3.1 percent of GDP.
- The U.S. typically runs a deficit in goods trade and a surplus in services trade. In 2024, this pattern continued, with a large goods deficit partly offset by a services surplus.
- For the United States, the trade balance and the current account are similar in size and tend to move together over time. This is true because the nontrade components of the current account are relatively small.
- Across countries, the trade balance and the current account often move together, but they need not have the same sign. Primary and secondary income flows can create important differences between the two.
- Global imbalances are large and persistent. Since 1980, the United States has accumulated the worlds largest current account deficit, while countries such as Germany, Japan, and China have accumulated large surpluses.
- A significant share of the U.S. goods trade deficit has been associated with trade with China. This bilateral imbalance widened after China joined the WTO and narrowed again in the later part of the sample.

Lecture 24

The Net International Investment Position

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

The Net International Investment Position*

A country's net international investment position (NIIP) is the difference between its foreign asset position (A) and its foreign liability position (L)

$$NIIP = A - L.$$

–If the NIIP is negative ($A < L$), then the country is a net debtor to the rest of the world.
–And if the NIIP is positive ($A > L$), the country is a net creditor to the rest of the world.

The net international investment position and the current account are related. The current account balance reflects a country's net borrowing needs. For example, in 2024 the United States ran a current account deficit of $1.1 trillion. To pay for this deficit, the United States must either reduce its international asset position (A) or increase its international liability position (L), or both. That is, a current account deficit reduces the NIIP and a current account surplus increases it.

---

*This lecture is based on chapter 1 of *International Macroeconomics*, by Stephanie Schmitt-Grohé, Martín Uribe, and Michael Woodford, 2022, Princeton University Press.

• Look at the figure on slide 4. It shows the U.S. current account (CA) for the period 1960 to 2024 and the U.S. net international investment position (NIIP) for the period 1976 to 2024, both in percent of GDP.*

• The NIIP was positive at the beginning of the sample (1976).

• The large CA deficits of the 1980s brought the NIIP to negative territory.

• Even larger CA deficits occurred during the 1990s, and the United States ended that decade as the world's largest external debtor.

• The CA deficit continued to increase until the onset of the global financial crisis (GFC) in late 2007, reaching 6% of GDP that year.

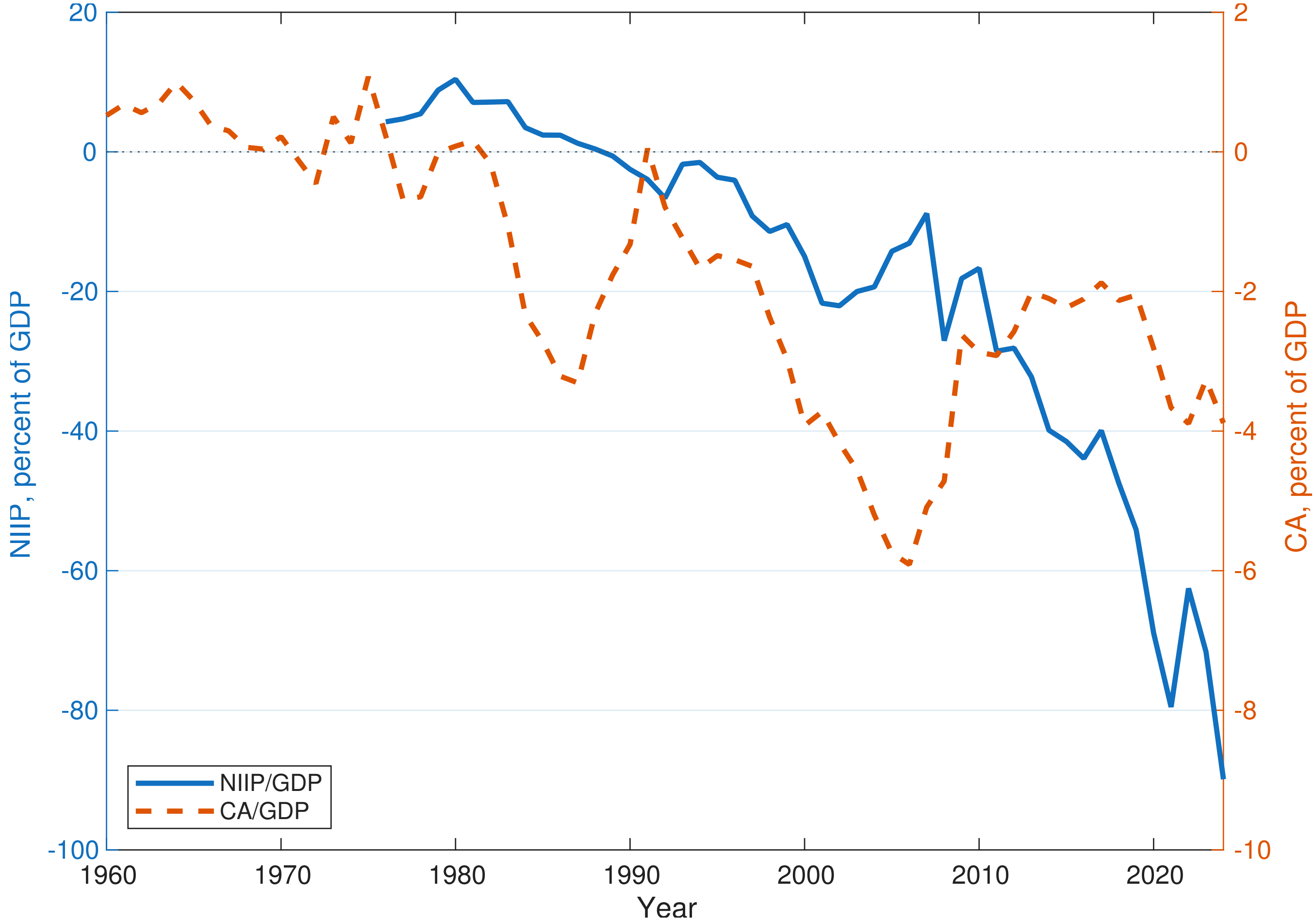
• During the GFC, the CA deficits became smaller, but still sizable at around 3% of GDP.

• By the end of 2024, the NIIP stood at -$-26.2 trillion or 90 percent of GDP.

• A natural question is whether the U.S. CA deficits are sustainable over time.

*The BEA does not provide the NIIP prior to 1976.

The U.S. Current Account and Net International Investment Position



Notes. CA, NIIP, and GDP stand for current account, net international investment position, and gross domestic product, respectively. The sample period for CA starts in 1960, and for NIIP in 1976, due to data availability. Authors' calculations based on data from ITA Table 1.1, IIP Table 1.1, and NIPA Table 1.1.5 of the BEA.

The CA is a Flow and the NIIP a Stock

All else equal, the net international investment position (NIIP) increases when the current account (CA) is positive and decreases when it is negative. Thus, the CA is a flow variable, while the NIIP is a stock variable.

To understand the distinction, think of a water tank. The water level in the tank—a stock—represents the NIIP. The current account is like the flow of water entering or exiting the tank through pipes.

If more water flows into the tank than flows out, the CA is positive and the NIIP rises over time. Conversely, if more water leaves the tank than enters, the CA is negative and the NIIP declines.

Valuation Changes

Look again at the figure on slide 4. Notice that not all years in which the current account is negative correspond to years in which the NIIP falls. This is particularly evident just before the beginning of the global financial crisis in 2007. In general, changes in the NIIP are not always exactly equal to the changes in the CA.

This is because the current account is not the only source of changes in the net international investment position. The NIIP can also change when the market value of a country's international assets or liabilities changes due to movements in stock prices, bond prices, or exchange rates. This source of changes in the NIIP is known as valuation changes.

Valuations Changes (cont.)

The Net International Investment Position changes for two reasons, surpluses or deficits in the current account and valuation changes:

$$\Delta NIIP = CA + \text{valuation changes}$$

with

valuation changes = changes in the market value of the country's foreign asset and liability positions (due to currency appreciations or depreciations changes in stock prices, etc.)

Let's analyze by means of an example how valuation changes can affect the NIIP.

Example

• International assets (A): 25 shares in Italian carmaker Fiat. The price of each share is 2 euros. The exchange rate is 2 dollars per euro. Then
$A = 25 \times 2 \times 2 = 100$ dollars.

• International liabilities (L): 80 U.S. bonds held by foreigners. Price 1 dollar per unit. Then
$L = 80 \times 1 = 80$ dollars.

• $NIIP = A - L = 100 - 80 = 20$ dollars.

Example (cont.)

- **A depreciation of the euro**

Now suppose that the euro depreciates to 1 dollar per euro. Then,

- $A = 25 \times 2 \times 1 = 50$ dollars.

- $L = 80$ dollars (unchanged because U.S. bonds are denominated in dollars)

- $NIIP = A - L = 50 - 80 = -30$ dollars.

- Conclusion: Just because of a change in the exchange rate, the country went from being a creditor to being a debtor of the rest of the world.

Example (concluded)

- **An Increase in Foreign Equity Prices**

Suppose now that the price of the Fiat share jumps to 7 euros. Then,

- $A = 25 \times 7 \times 1 = 175$ dollars.

- $L = 80$ dollars is unchanged.

- $NIIP = A - L = 175 - 80 = 95$ dollars

- $\Rightarrow$ the country went from net debtor (-$30) to net creditor (+$95) just because the Italian stock market went up.

- **Conclusion:** The above hypothetical examples illustrate how a country's net international investment position can display large swings because of movements in asset prices or exchange rates. This is indeed the case in actual data as well, as we will see next.

Valuation Changes in the United States

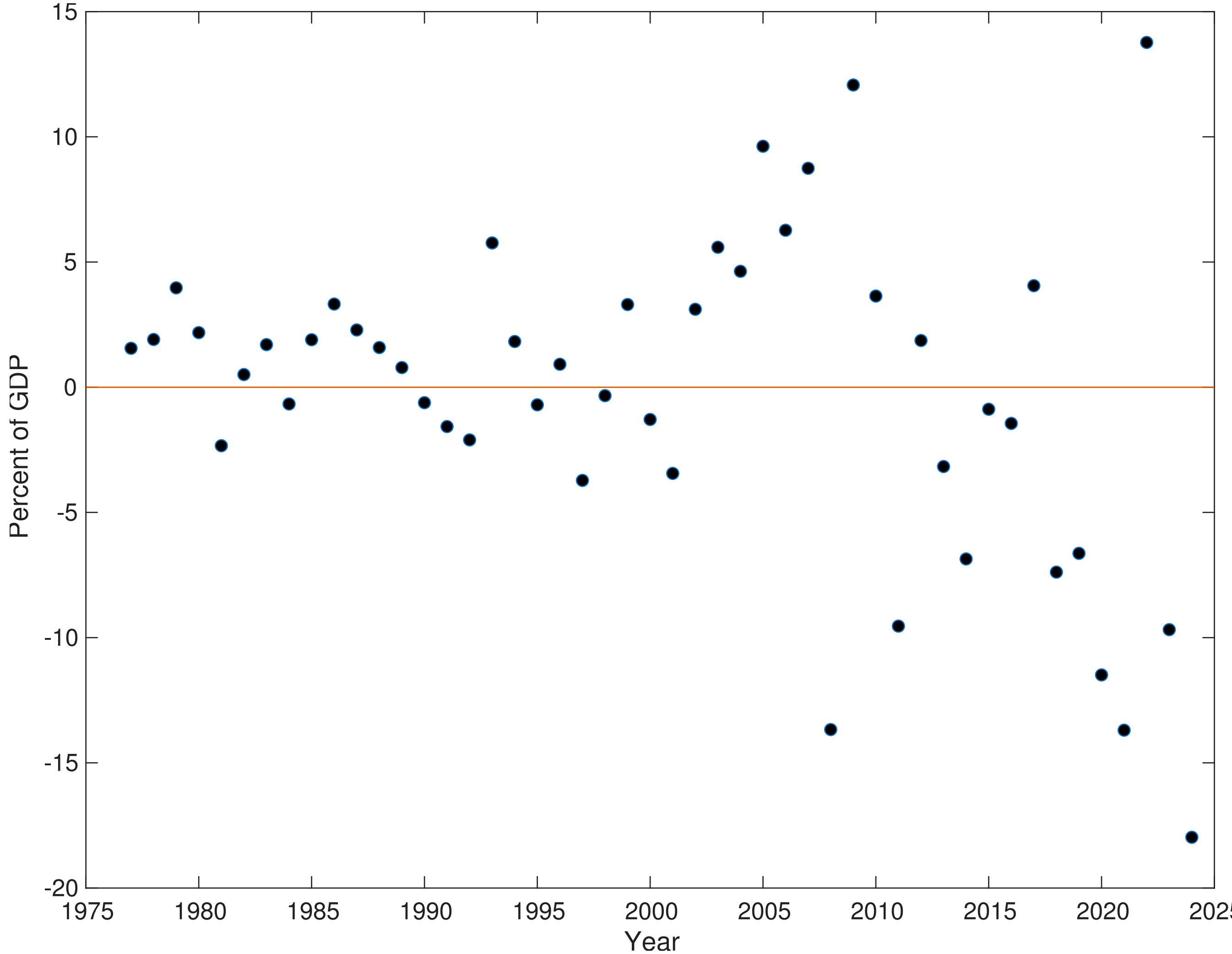
Look at the figure in slide 12, which plots valuation changes in the United States since 1976. It shows that

- Valuation changes can be large. We have observed valuations changes as large as ± 15 percent of GDP.

- Over the period 2000 to 2010 mostly valuation gains for the US, since then mostly valuation losses.

- Large valuation changes are a recent phenomenon. Until the year 2003, the typical valuation change was ± 3 percent of GDP.

Valuation Changes in the U.S. Net International Investment Position



Notes. The figure shows year-over-year changes in the U.S. net international investment position arising from valuation changes expressed in percent of GDP. Authors' calculations based on data from ITA Table 1.1, IIP Table 1.1, and NIPA Table 1.1.5 of the BEA.

Valuation Changes Before the Global Financial Crisis (2002 to 2007)

• From 2002 to 2007, the U.S. cumulative CA deficit was $3.9 trillion (32% of GDP).

• Yet, the NIIP improved by $80 billion, $0.08 trillion.

• This means that valuation changes during this period amounted to almost $4 trillion, $3.98 trillion to be exact. The main drivers were:

(1) The dollar depreciated by 20%. This causes large positive valuation changes because U.S.-owned foreign assets are mostly in foreign currency, whereas U.S. liabilities are mostly in dollars.

(2) The stock markets in foreign countries significantly outperformed the U.S. stock market: cumulative return from 2002 to 2007, 190% abroad versus 90% in the United States. As a result, the U.S. net equity position went from $0.04 trillion in 2002 to $3 trillion in 2007.

Valuation Changes After the Global Financial Crisis (2008–2024)

• Large positive valuation changes came to a sudden stop in 2008 (look at the figure in slide 12): that year, valuation changes were -15% of GDP, mostly from an enormous drop in foreign stock markets.

• Since 2010, and especially during the COVID-19 pandemic, the U.S. NIIP has suffered mostly valuation losses, with a total of $-15.0 trillion. One reason is that for most years since 2010 U.S. stocks have outperformed foreign stocks. Every time the U.S. stock market goes up, the value of U.S. portfolio equity liabilities (U.S. stocks held by foreign investors) goes up. And when the foreign stock market goes up, the dollar value of the U.S. portfolio equity asset position (foreign stocks held by U.S. investors) goes up. If U.S. stocks outperform foreign stocks, as they did in most years since 2010, the value of the U.S. net foreign portfolio equity position goes down, that is, the U.S. suffers valuation losses.

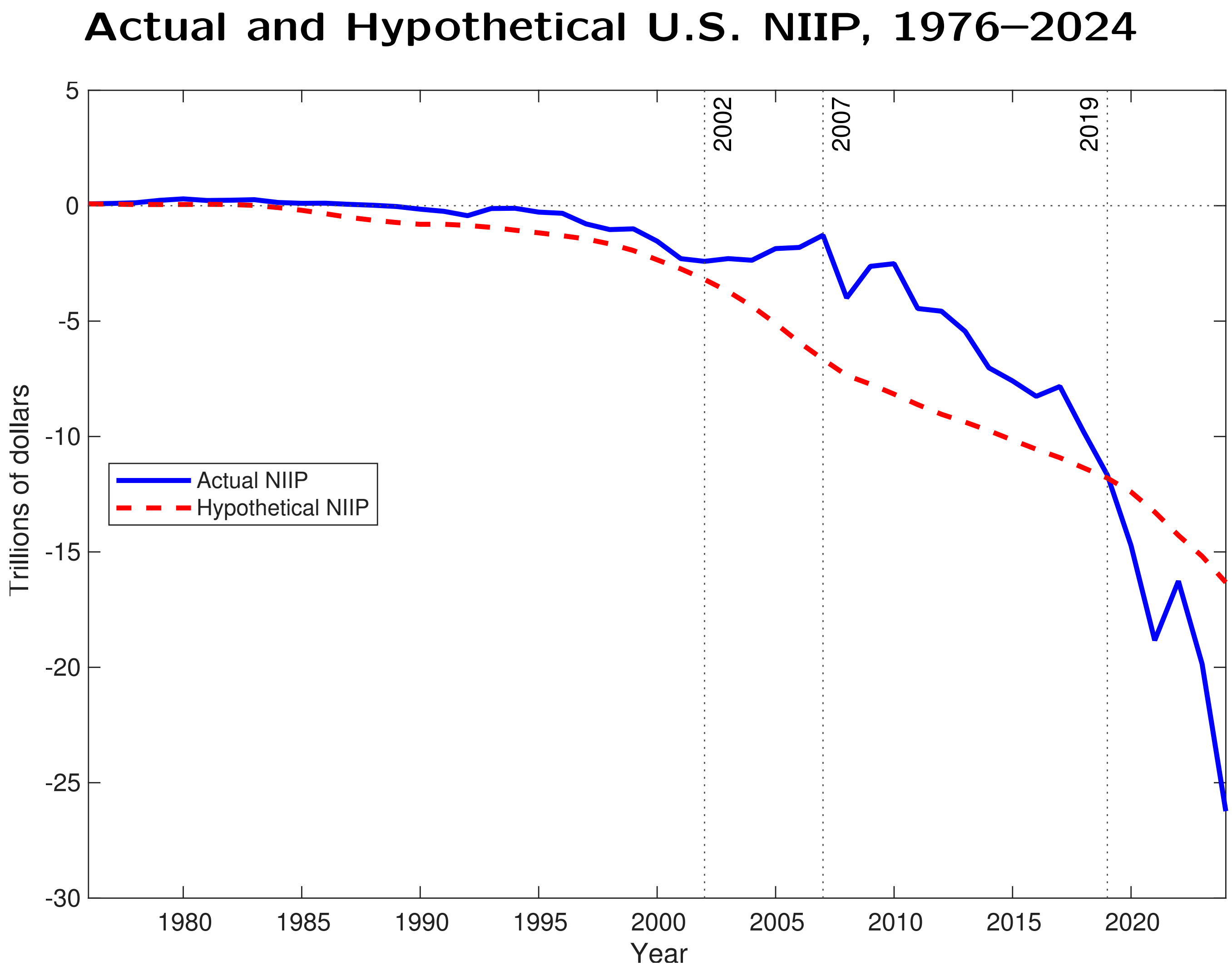
A Hypothetical NIIP That Excludes Valuation Changes

The figure on slide 16 shows the cumulative impact of valuation changes on the NIIP. It plots the actual U.S. NIIP since 1976 and a hypothetical NIIP constructed by removing valuation changes from the actual NIIP.

To construct the hypothetical NIIP for a given year $t > 1976$, start with the NIIP of the initial year, $NIIP_{1976}$, and add all of the CA balances from 1977 until the year of interest.

$$\text{Hypothetical } NIIP_t = NIIP_{1976} + CA_{1977} + CA_{1978} + \cdots + CA_t.$$

The figure on slide 16 plots the actual and hypothetical net international investment positions over the period 1976–2024.



Notes. The hypothetical NIIP for a given year is computed as the sum of the NIIP in 1976 and the cumulative sum of current account balances from 1977 to the year in question. Authors' calculations based on data from IIP Table 1.1 and ITA Table 1.1 of the BEA.

Observations on the Hypothetical NIIP

• Until 2002, the actual and hypothetical NIIP were not significantly different from each other ⇒ valuation changes were small.

• In 2002 the hypothetical NIIP starts to fall at a faster pace. At the same time the actual NIIP rises. ⇒ large positive valuation changes.

• Without this lucky strike, the NIIP in 2007 would have been -$6.6 trillion (or -46% of GDP) instead of the actual -$1.3 trillion (or -9% of GDP) .

• In the years following the global financial crisis, US equity markets outperformed foreign stock markets, leading to valuation losses and closing the gap between the hypothetical and actual NIIP. By 2019 the gap had closed meaning that all valuation gains since 1976 had evaporated.

• After 2019 the actual NIIP fell below the hypothetical NIIP, indicating that since 1976 the U.S. has experienced a cumulative valuation loss. This calls into question the view that the United States *on average* benefits from positive valuation changes.

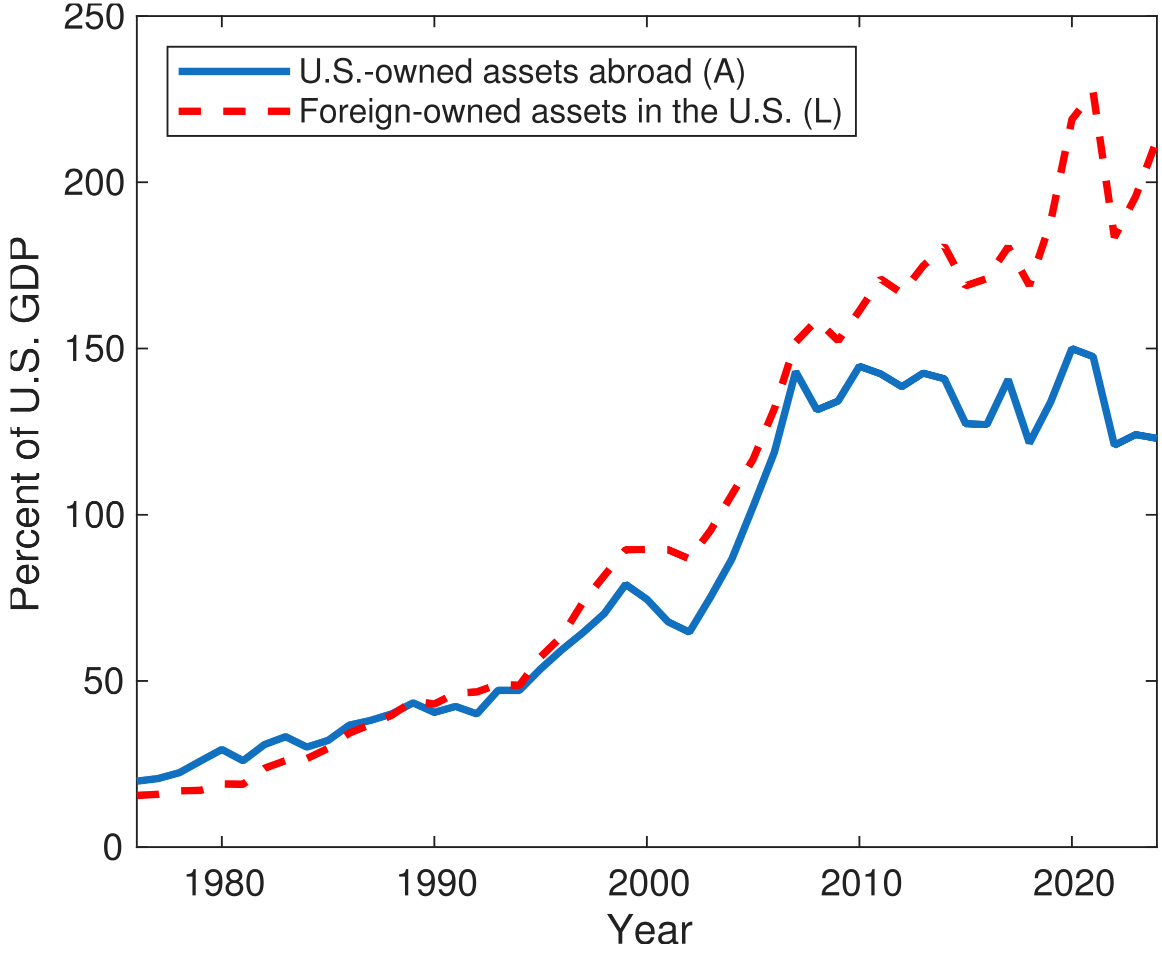
Gross Positions and Valuation Changes

Take a look at the figure in the next slide (slide 19). It shows that U.S. gross positions (international assets and international liability positions) have expanded enormously since the 2000s.

This explosion in gross positions is a key feature of financial globalization. It is also one reason why valuation changes have become so large in absolute value over the past two decades. To see this, consider the following example:

• Suppose in country x $A = L = 1$ and in country y $A = L = 1000$.
• Suppose GDP is 100 in both countries.
• Then, in both countries NIIP=0% of GDP.
• Suppose the value of foreign assets (A) increases by 10% in both countries.
• This causes the NIIP to go from 0 to 0.1 in country x, and from 0 to 100 in country y. Thus, the NIIP increases to 0.1% of GDP in country x and to 100% of GDP in country y.

U.S.-Owned Assets Abroad and Foreign-Owned Assets in the United States, 1976–2024



Notes. The figure shows that the gross U.S. foreign asset position and the gross U.S. foreign liability position have risen sharply since the mid 1990s. Authors' calculations based on data from IIP Table 1.1 and NIPA Table 1.1.5 of the BEA.

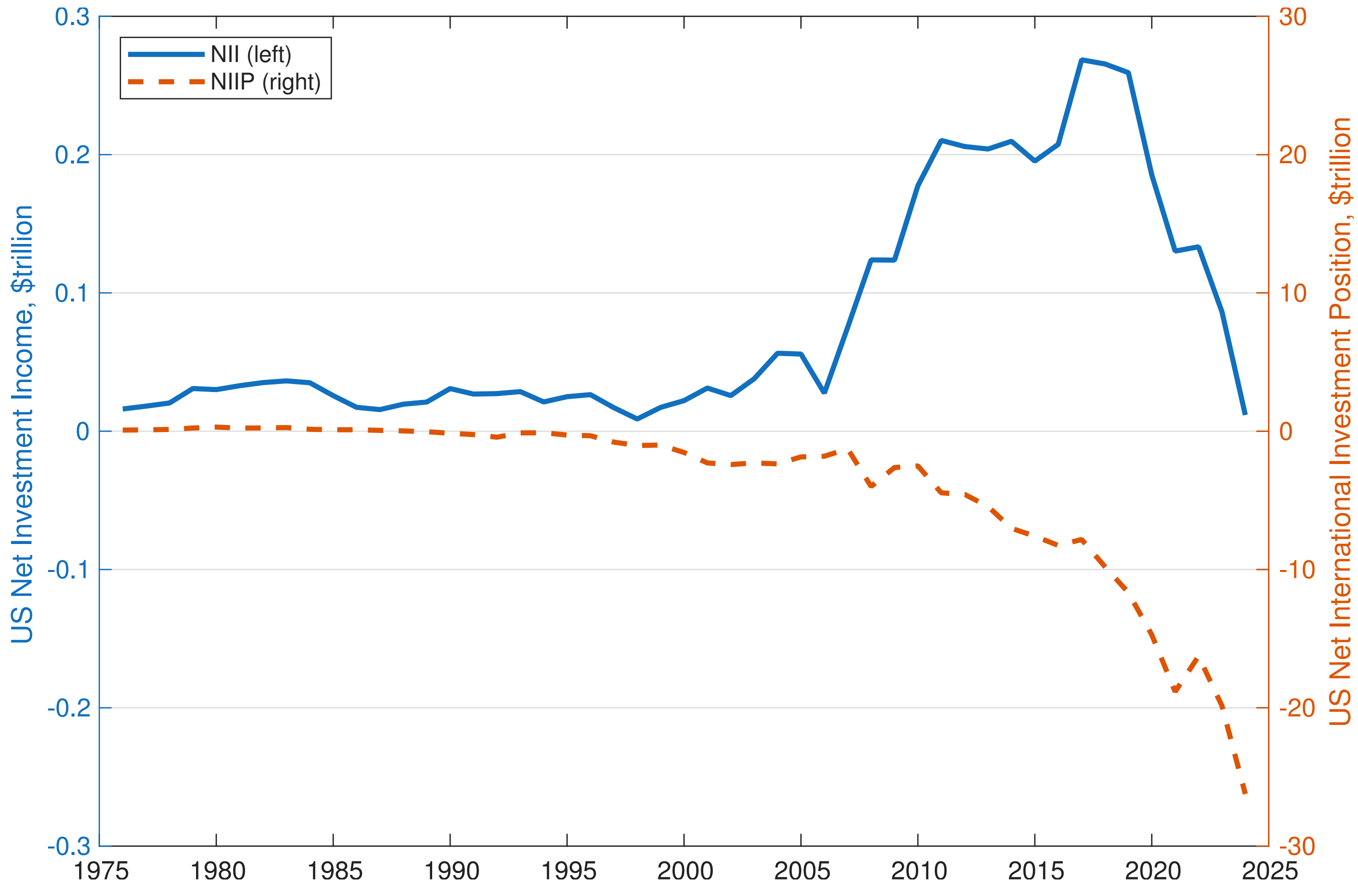
The Negative-NIIP-Positive-NII Paradox

Suppose you had a balance on your credit card. Would you expect to receive interest payments from your credit card company or to have to make payments to your credit card company? Most likely the latter.

Well, that is not what happens with the United States. Look at the figure on the next slide. Even though the U.S. is the largest external debtor in the world, on net it *receives* investment income from the rest of the world. Letting NII denote net investment income, this means we observe NII > 0.

How can this paradoxical situation happen? Here are two suggested explanations: *Dark Matter* and *Return Differentials*. After the next figure, we will spell them out.

Net Investment Income (NII) and the Net International Investment Position (NIIP), United States, 1976 to 2024



Notes. Authors' calculations based on data from IIP Table 1.1 and ITA Table 1.1 of the BEA.

What is plotted?

Solid (blue) line: Net Investment Income (NII), which are income receipts on U.S.-owned assets abroad (dividends, interest, or profits) minus income payments on foreign-owned assets in the United States. [left scale, $tn]

Broken (red) line: Net International Investment Position (NIIP), given by international assets (A) minus international liabilities (L). [right scale, $tn]

Sample: 1976 to 2024.

Explaining the NII-NIIP Paradox: (I) Dark Matter

The Dark Matter hypothesis maintains that in reality the U.S. net international investment position is positive but that the Bureau of Economic Analysis fails to account for all of it. The source of the underestimation according to this explanation is that U.S. foreign direct investment contains intangible capital, such as entrepreneurial capital and brand capital, whose value is not correctly reflected in the official balance of payments. At the same time, the argument goes, this intangible capital invested abroad may generate income for the United States, which is appropriately recorded.

Assuming this theory is valid, how much dark matter is there in the NIIP? Let's make a simple calculation. First some notation:

TNIIP = the 'true' net international investment position.

NIIP = the observed net international investment position (-$19.9 trillion at the start of 2024).

NII = net investment income ($0.0117 trillion in 2024).

Dark Matter (cont.)

Net investment income is the return on the True Net International Investment Position. So, letting r denote the interest rate, we have

$$NII = r \times TNIIP$$

Let's take a value of r of 5% per year. Then solving for TNIIP we have

$$TNIIP = \frac{NII}{r} = \frac{0.0117}{0.05} = \$0.2344 \text{ trillion}$$

Dark matter is the difference between the true and the recorded NIIPs, or

$$\begin{aligned} \text{Dark Matter} &= \text{TNIIP - NIIP} \\ &= 0.2344 - (-19.9) \\ &= \$20.1 \text{ trillion} \end{aligned}$$

Dark Matter (concluded)

So, according to the dark matter hypothesis, at the start of 2024 the United States didn't owe $19.9 trillion to the rest of the world. On the contrary, the rest of the world owed $0.2344 trillion to the United States.

$20.1 trillion of dark matter seems like a big figure to go unnoticed by the BEA.

Explaining the NII-NIIP Paradox: (II) Return Differentials

This second explanation is motivated by the observation that the gross international asset position of the U.S. historically was predominantly composed of risky but high-return assets, such as foreign equity and foreign direct investment, whereas its gross international liability position is mainly composed of safer low-return assets, such as U.S. government bonds (e.g., T-bills).

This observation is referred to as the *exorbitant privilege*.

Let A continue to denote the U.S. international asset position and L its international liability position. Then $NIIP = A - L$. Let r^A be the return on A, and r^L the return on L.

The question is how large does the interest rate differential on assets and liabilities, $r^A - r^L$, have to be to explain the paradox.

Start by noting that the NII must equal the difference between investment income and investment payments, that is,

$$NII = r^A A - r^L L. \tag{1}$$

Return differentials (continued)

Now let's put some numbers. At the start of 2024, the U.S. gross international asset position was $A = \$34.4$ trillion, and its gross international liability position was $L = \$54.3$ trillion.

In addition, the average real rate of return on U.S. T-bills, which we will use as a proxy for r^L, was 5.0 % per year. (Data from the FRED.) Finally, as we mentioned earlier, NII was \$0.0117 trillion in 2024.

Thus, we set $A = 34.4$, $L = 54.3$, $NII = 0.0117$, and $r^L = 0.05$.

We wish to find the value of r^A that solves the paradox. To this end, solve equation (1) for r^A and evaluate

$$r^A = \frac{NII + r^L L}{A} = \frac{0.0117 + 0.05 \times 54.3}{34.4} = 0.0793$$

That is, $r^A = 7.93\%$, or an interest rate differential between the U.S. foreign assets and liabilities of $r^A - r^L = 7.93 - 5.0 = 2.93\%$ per year. This doesn't look like such an exaggerated interest rate premium.

Return differentials (continued)

The analysis thus far assumes that foreign investors hold only U.S. bonds in their international asset portfolio. This is a good simplification of reality until 2010. But since then, the ratio of equity to bonds in the U.S. international liability position is closer to 1; that is, roughly half is in equity and half in bonds. (See, for example, Atkeson et al. AER 2025.) Suppose that the return on equity (r^A) is the same domestically and abroad. Accordingly, the rate of return on U.S. foreign liabilities, r^L, is $r^L = \frac{1}{2}(r^A + r^L)$, where $r^L = 0.05$ as before.

$$NII = r^A A - r^L L = r^A A - \frac{1}{2}(r^A + r^L)L.$$

Evaluating this expression using actual numbers gives

$$0.0117 = r^A \times 34.4 - \frac{1}{2} \times (r^A + 0.05) \times 54.3,$$

which gives

$$r^A = 18.9\%.$$

The corresponding premium of equity over government bonds is 13.9 percent ($r^A - r^L = 18.9\% - 5\%$)

The Flip Side of the NIIP-NII Paradox

If we divide the world into two groups, the United States (US) and the rest of the world (RW), then the rest of the world must display the flipped paradox—that is, a positive net foreign asset position and negative net investment income. Note that

$$NIIP^{US} = A^{US} - L^{US} = L^{RW} - A^{RW} = -NIIP^{RW}$$

and

$$NII^{US} = r^A A^{US} - r^L L^{US} = r^A L^{RW} - r^L A^{RW} = -NII^{RW}.$$

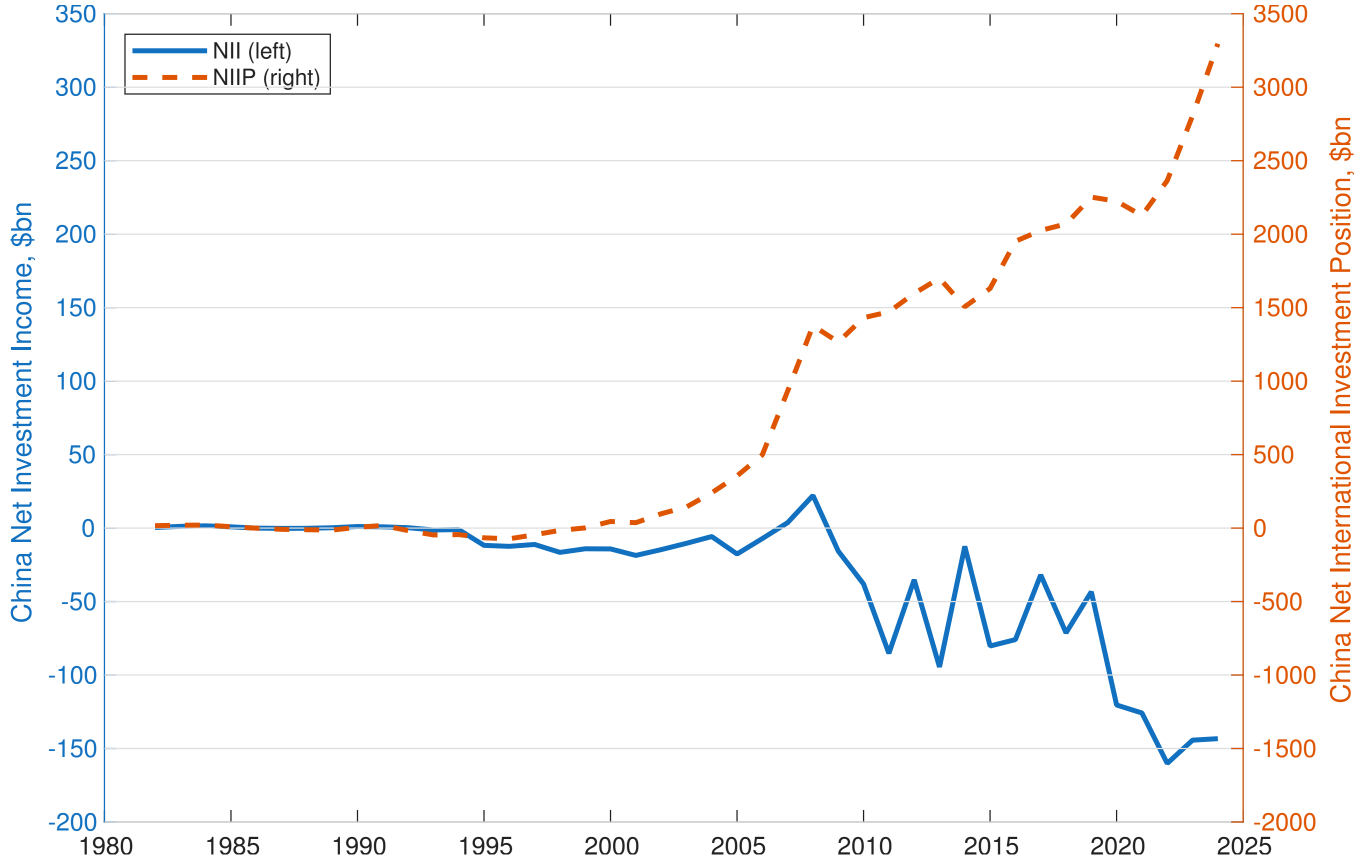
Let's look at a particular country, namely, China. Why China? First, as we observed when discussing global imbalances (see the heat map in on slide **??**), China has been accumulating large current account surpluses for the past quarter century, so it is a likely candidate to have a positive NIIP. Second, last lecture a table showed that in 2024 its NII was negative, so that could be the smoking gun.

The Flip Side of the NIIP-NII Paradox (continued)

The figure on the next slide plots the NIIP and NII of China for the period 1982 to 2024. Prior to accession to the WTO in 2001, the NIIP was near zero, thereafter it grew rapidly, reaching $3.3 trillion by 2024. Net investment income, NII, was close to zero prior to 2001 but then began falling, reaching -$0.14 trillion in 2024. Thus, China displays the flipped NIIP-NII paradox, a positive NIIP and a negative NII.

A possible explanation of the Chinese flipped paradox is that China's foreign asset holdings have relatively more safe, low-return instruments, such as U.S. Treasury securities, while China's foreign liabilities contain more high-return financial instruments, such as foreign direct investment.

Net Investment Income and the Net International Investment Position, China 1982–2024



Notes. The figure shows that China displays the flipped NIIP-NII paradox. Since accession to the WTO in 2001, with the exception of the global financial crisis years (2007 and 2008), China recorded a positive NIIP and a negative NII. Data Sources: NIIP for 1982 to 2023 is from Lane and Milesi-Ferretti, op. cit., and for 2004 to 2024 from the BOP/IIP database of the IMF. NII data is from the BOP database of the IMF.

Summing Up

• A country's net international investment position (NIIP) is the difference between its foreign asset position and its foreign liability position, $NIIP = A - L$. A positive NIIP means the country is a net creditor; a negative NIIP means it is a net debtor.

• The current account (CA) and the NIIP are closely related: current account surpluses tend to improve the NIIP, whereas current account deficits tend to deteriorate it. Thus, the CA is a flow variable and the NIIP is a stock variable.

• The United States has run persistent current account deficits since the early 1980s and, as a result, has become the world's largest net external debtor. By the end of 2024, the U.S. NIIP stood at about -$26.2 trillion, or about -90% of GDP.

• Changes in the NIIP are not determined by the current account alone. They also reflect valuation changes: $\Delta NIIP = CA +$ valuation changes.

• In the United States, valuation changes have become much larger since the early 2000s, in part because gross foreign asset and liability positions have expanded enormously.

• From 2002 to 2007, large positive valuation changes offset the effect of sizable U.S. current account deficits, but since 2010 the United States has experienced mostly valuation losses. This suggests that valuation gains have not permanently shielded the United States from the consequences of persistent current account deficits.

• The United States displays a NIIP-NII paradox: despite having a negative NIIP, it continues to record positive net investment income (NII). Two leading explanations are the dark matter hypothesis and the return-differential hypothesis.

• The flip side of the U.S. paradox must appear elsewhere in the world as a positive NIIP together with negative NII. China is an important example of this flipped NIIP-NII paradox.

Lecture 25

Current Account Sustainability

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Motivation*

A natural question that arises from our description of the recent history of the U.S. external accounts is whether the observed trade and current account deficits are sustainable in the long run. In this lecture, we develop a framework to address this question.

*This lecture is based on chapter 2 of *International Macroeconomics*, by Stephanie Schmitt-Grohé, Martín Uribe, and Michael Woodford, 2022, Princeton University Press.

Can a Country Run a Perpetual Trade Balance Deficit?

It depends on whether the country is a net debtor or a net creditor. If it is a net debtor, that is, if its net international investment position is negative, then the answer is no. For in this case, the country will have to run a trade balance surplus at some point to service its debt.

If the country is a net creditor of the rest of the world, that is, if its net international investment position is positive, then it can run a perpetual trade deficit and finance it with the interest generated by its net investments abroad.

Let's analyze this issue more formally.

Consider an economy that lasts for two periods, period 1 and period 2. It begins period 1 with a net foreign asset position of B_0. If $B_0 < 0$, the country is a net debtor to the rest of the world; if $B_0 > 0$, it is a net creditor to the rest of the world. Let $r > 0$ denote the interest rate. Then the country's net investment income in period 1 is rB_0. Let the trade balance in period 1 be denoted by TB_1.

The change in the country's net international investment position in period 1, $B_1 - B_0$, has two sources: the trade balance and net investment income,

$$B_1 - B_0 = TB_1 + rB_0.$$

This expression says that the larger the trade balance, the more the country's net asset position tends to rise. If the country exports more than it imports, so that $TB_1 > 0$, then its net asset position tends to increase. If instead the country imports more than it exports, so that $TB_1 < 0$, then its net asset position tends to decline.

The above expression also says that net investment income, rB_0, affects the country's net asset position. If the country is a net creditor vis-à-vis the rest of the world, so that $B_0 > 0$, then it receives interest income from abroad, $rB_0 > 0$, and its net asset position tends to rise. If instead the country is a net debtor, so that $B_0 < 0$, then it must pay interest to the rest of the world, $rB_0 < 0$, and its net asset position tends to decline.*

*We are assuming that there are no valuation changes, no international payments to employees, and no international transfers.

Rearranging this expression, we obtain

$$B_1 = (1 + r)B_0 + TB_1. \tag{1}$$

A similar expression holds in period 2

$$B_2 = (1 + r)B_1 + TB_2 \tag{2}$$

At the end of period 2, the country cannot hold assets or debts because no one will be alive in period 3 to collect (the world ends in period 2). This means that

$$B_2 = 0. \tag{3}$$

Combining (1), (2), and (3) yields

$$(1+r)B_0 = -TB_1 - \frac{TB_2}{1+r}, \tag{4}$$

which states that the net foreign asset position (including interest) equals the present discounted value of its future trade deficits. It is clear from this expression that if the country is a net debtor, $B_0 < 0$, then it must run a trade balance surplus at some point. However, if the country is a net creditor of the rest of the world, $B_0 > 0$, then it can afford running trade deficits in both periods. This result holds not just for two-period economies, but for economies lasting any number of periods, including an infinite number of periods.

Since the United States is a net debtor, the present analysis implies that it will have to revert its trade balance deficits at some point in the future.

Can a Country Run a Perpetual Current Account Deficit?

The answer to this question is, again, yes, provided the country's initial net foreign asset position is positive. To see this, recall that the change in the net international investment position is the current account

$$CA_1 = B_1 - B_0$$

Similarly, in period 2 we have

$$CA_2 = B_2 - B_1$$

Combining these two expressions to eliminate B_1 and recalling that $B_2 = 0$, we obtain

$$B_0 = -CA_1 - CA_2,$$

which implies that the country can run current account deficits in both periods only if the initial net asset position is positive. This result holds for economies lasting any finite number of periods.

Saving, Investment, and the Current Account

In any period, say period 1, saving, investment, and the current account are linked by the identity

$$CA_1 = S_1 - I_1$$

This expression is intuitive. The country's saving in excess of what is needed to finance domestic investment must be allocated to purchases of foreign assets—where else could those resources go? But the change in the net foreign asset position is precisely the current account.

To derive the above identity more formally, recall that a country's aggregate supply of goods and services in any given period is the sum of gross domestic product, denoted Y_1, and imports, denoted IM_1. The aggregate demand for goods and services is the sum of private consumption, C_1, government consumption, G_1, investment, I_1, and exports, X_1:

$$Y_1 + IM_1 = C_1 + G_1 + I_1 + X_1$$

Now add net investment income, rB_0, to both sides of the previous expression and recall that the trade balance is the difference between imports and exports, or $TB_1 = X_1 - IM_1$, to get

$$Y_1 + rB_0 = C_1 + G_1 + I_1 + TB_1 + rB_0$$

The sum of GDP and net investment income is known as National Income, denoted Y_1^n. Also, recall that the sum of net investment income and the trade balance is the current account,

$$CA_1 = rB_0 + TB_1.$$

Thus, we can write

$$Y_1^n = C_1 + G_1 + I_1 + CA_1 \tag{5}$$

Finally, the difference between national income and private and public consumption is national saving, or

$$S_1 = Y_1^n - C_1 - G_1.$$

Combining this expression with the one above, we get the expression we were looking for

$$CA_1 = S_1 - I_1.$$

Domestic Absorption, National Income, and the Current Account

Domestic absorption is defined as the sum of private consumption, government consumption, and investment. Letting A_1 denote domestic absorption, we have

$$A_1 = C_1 + G_1 + I_1.$$

Combining this expression with (5), we can express the current account as

$$CA_1 = Y_1^n - A_1,$$

which states that the current account is the gap between national income and the domestic absorption of goods and services.

Connecting with the Last Lecture

In the last lecture, we saw that, absent valuation changes, current account surpluses increase a country's net foreign asset position, whereas current account deficits decrease it. In the notation of this lecture, this relationship can be written as

$$CA_1 = B_1 - B_0,$$

which is the same expression derived in slide 7. Thus, this identity links the material from the last lecture to the notation and framework developed in this lecture.

Earlier in this lecture, we also showed that

$$B_1 - B_0 = TB_1 + rB_0.$$

Since $B_1 - B_0 = CA_1$, we can rewrite this expression as

$$CA_1 = TB_1 + rB_0.$$

This expression also connects to the last lecture: in the absence of compensation of employees from abroad and international transfers, the current account equals the sum of the trade balance and net investment income.

Summing Up

• A country that is a net external debtor cannot run a perpetual trade balance deficit.

• A country that is a net external debtor cannot run a perpetual deficit in the current account. This result applies to economies that last for any finite number of periods.

• We derived four alternative expressions for the current account:

$$
\begin{aligned}
CA_t &= B_t - B_{t-1} \\
CA_t &= rB_{t-1} + TB_t \\
CA_t &= S_t - I_t \\
CA_t &= Y_t^n - A_t
\end{aligned}
$$

The Road Ahead

• All four of the above expressions for the current account are accounting identities. They do not provide any explanation, or theory, of the determinants of the current account.

• To understand what determines the current account we need a model, that is, a story of the economic behavior of households, firms, governments, and foreign residents. This is the focus of the following chapters.

Lecture 26
Determination of the Current Account

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Motivation

We deduced that in an open economy, saving need not equal investment in equilibrium. The difference between saving and investment is the current account.

We now wish to understand what determines the current account. That is, what factors determine when a country will have a current account deficit (like in the United States) or a current account surplus (like in China or Japan).

We wish to be able to address questions such as how do changes in government spending affect the current account? How do changes in productivity affect the current account? How do disturbances in the rest of the world affect a country's the current account?

We will consider the determination of the current account in small and large economies.

A Small Open Economy

What does 'small' and 'open' mean in this context?

• An economy is small when world prices and interest rates are independent of domestic economic conditions: the country is not economically large enough to affect world markets.

• An economy is open when it trades in goods and financial assets with the rest of the world.

• Most countries in the world are small open economies:

– Examples of developed small open economies: the Netherlands, Switzerland, Austria, New Zealand, Australia, Canada, Norway.

– Examples of emerging small open economies: Argentina, Chile, Peru, Bolivia, Greece, Portugal, Estonia, Latvia, Thailand, Vietnam.

– Examples of developed large open economies: United States, Japan, Germany, and the United Kingdom.

– Examples of emerging large open economies: China.

– Examples of closed economies: North Korea, Venezuela, Cuba.

• Economic and geographic size are not necessarily related: Australia and Canada are geographically large but economically small. The UK and Japan are geographically small but economically large. • Similarly, economic and demographic size are not necessarily related: India, Indonesia, and Pakistan are demographically large but economically small.

Note. No economy is completely open or completely closed. Reality is more complex, but we can say that some economies are quite open (e.g., United States (pre-Trunp!), Canada, Germany) some are quite closed (e.g., N. Korea, Venezuela, Cuba) and some are in between (e.g., Argentina, China, Turkey, Iran).

The Current Account Schedule

We established that, for any country, the current account equals the difference between saving and investment:

$$CA_1 = S_1 - I_1, \tag{1}$$

where CA_1 denotes the current account in period 1, S_1 denotes saving in period 1, and I_1 denotes investment in period 1. The intuition behind this expression is straightforward: if the economy saves more resources than it requires for investment, it can export the excess, thereby generating a current account surplus. Conversely, if the economy dedicates more resources to investment than it saves, it must cover the difference with net imports, thus running a current account deficit. This expression holds not just for period 1, but for any period.

In previous lectures, we derived, in the context of a two-period economy, the saving and investment schedules:

$$S_1 = S(\underset{+}{r_1}, \underset{+}{Y_1}, \underset{-}{G_1}, \underset{+}{G_2}) \tag{2}$$

and

$$I_1 = I(\underset{-}{r_1}), \tag{3}$$

where r_1 denotes the real interest rate in period 1, Y_1 denotes output in period 1, and G_1 and G_2 denote government spending in periods 1 and 2, respectively.

From (1), (2), and (3), we have that the current account is a function of r_1, Y_1, G_1, and G_2:

$$CA_1 = CA(\underset{+}{r_1}, \underset{+}{Y_1}, \underset{-}{G_1}, \underset{+}{G_2}).$$

This expression is called the *current account schedule*. Let's interpret each of its arguments:

$\diamond$ $r_1 \uparrow \Rightarrow$ higher return on saving incentivizes households to postpone consumption and increase saving. Firms, facing a higher cost of financing, cut investment. Because saving rises and investment falls, the current account improves.

$\diamond$ $Y_1 \uparrow \Rightarrow$ households feel richer today and wish to consume more both today and in the future (consumption smoothing). To consume more next period, they increase saving today. Investment is unaffected. Thus, the current account improves.

$\diamond$ $G_1 \uparrow \Rightarrow$ the economy as a whole is poorer, because the government takes resources away. People do not want this fall in resources to cause a one-for-one decline in present consumption, but wish to smooth consumption over time. So, given the interest rate, desired consumption falls but by less than the increase in government spending. Thus, national saving falls. Investment is unaffected. Thus, the current account deteriorates.

$\diamond$ $G_2 \uparrow \Rightarrow$ Again, society as a whole is poorer, as the government takes resources away from private consumption. Given the interest rate, consumption falls. But, because households like to smooth consumption over time, desired consumption falls in both periods, not just in period 2. The fall in current consumption implies an increase in saving. Investment is unaffected. Thus, the current account improves.

We now present a graphical derivation of the current account schedule.

Graphical Derivation of the Current Account Schedule
Take a look at the figure on the next page. The left panel depicts the saving and investment schedules. The right panel depicts the current account schedule, which is the horizontal difference between the saving and investment schedules.

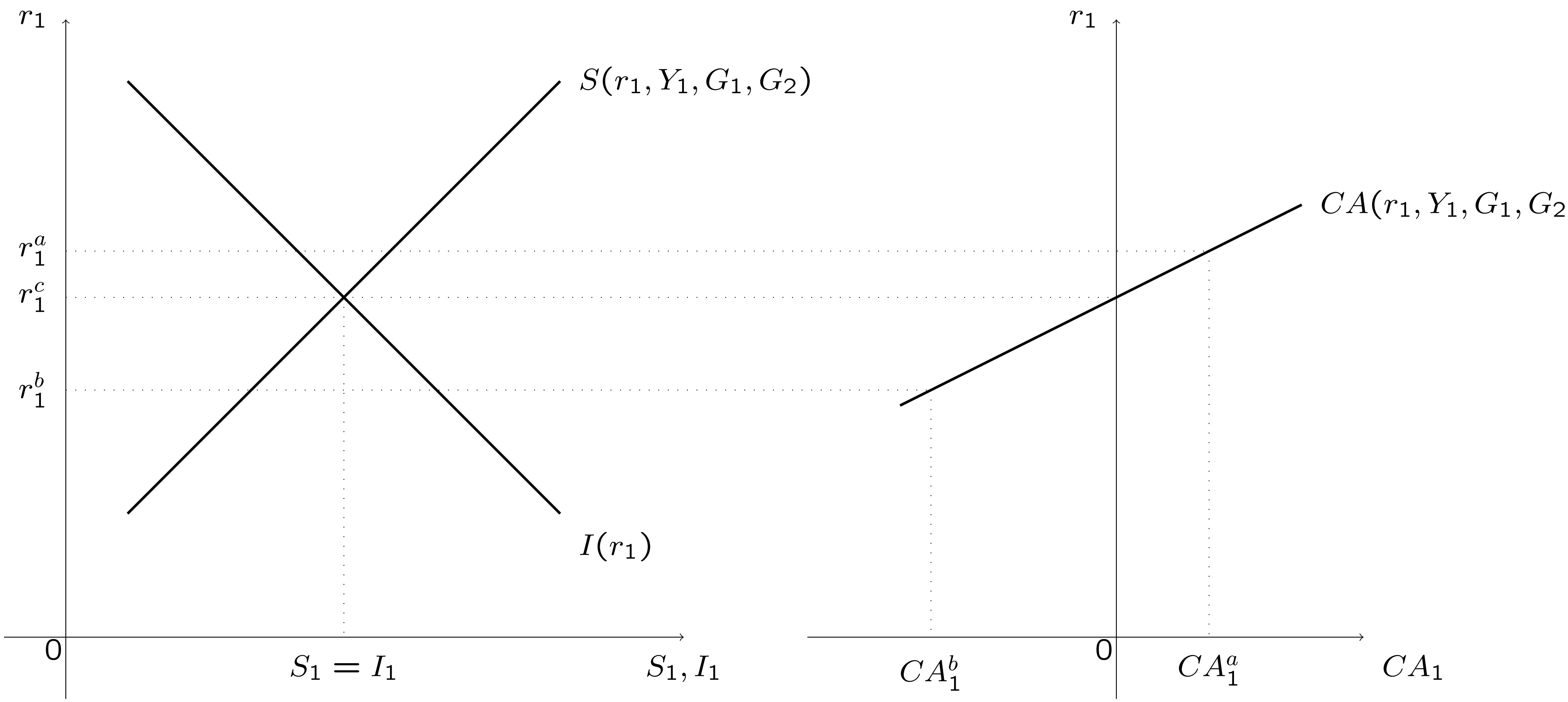
Suppose that the interest rate is r_1^a. From the left panel, we see that at this level of the interest rate saving exceeds investment. Accordingly, the right panel shows that when $r_1 = r^a$ the current account is in surplus.

If the interest rate is equal to r_1^c, then investment equals saving and the current account is zero. The interest rate r_1^c is the one that would prevail in a financially closed economy; that is, in an economy that does not have access to international capital markets. Financially closed economies are said to be in *financial autarky*.

For interest rates below r_1^c, such as r_1^b, investment is larger than saving so that the country runs a current account deficit.

In general, as the interest rate decreases, the current account deteriorates; therefore, as shown in the right panel, the current account is an increasing function of the interest rate.

The Current Account Schedule



Notes. The figure illustrates the derivation of the current account schedule. At r_1^c, saving equals investment ($S_1 = I_1$; left panel), and the current account is balanced ($CA_1 = 0$; right panel). This is the interest rate that would prevail in a closed economy. A higher rate, like r_1^a, raises saving and lowers investment ($S_1^a > I_1^a$), generating a current account surplus ($CA_1^a > 0$). Conversely, a lower rate, such as r_1^b, reduces saving ($S_1^b < S_1^c$) and boosts investment ($I_1^b > I_1^c$), leading to a current account deficit ($CA_1^b < 0$).

Free Capital Mobility

Suppose that households and firms can trade financial assets freely with the rest of the world. This situation is known as *free capital mobility.* In this environment, in equilibrium the domestic interest rate, r_1, must equal the world interest rate, denoted by r_1^*,

$$r_1 = r_1^*.$$

To see why this condition must hold, consider what would happen if it did not: If $r_1 > r_1^*$, domestic assets yield a higher return than foreign assets, so foreign investors lend to the domestic economy and domestic residents borrow abroad. This capital inflow raises the supply of loanable funds and drives r_1 down. Conversely, if $r_1 < r_1^*$, domestic residents lend abroad and foreign investors withdraw funds, generating capital outflows that reduce the supply of funds and push r_1 up. In equilibrium, these arbitrage forces imply $r_1 = r_1^*$.

Equilibrium in a Small Open Economy

In a small open economy, domestic factors do not influence the world interest rate. In particular, the levels of saving and investment in a small economy are too small to affect world financial conditions, and, as a result, the world interest rate is independent of domestic saving or investment.

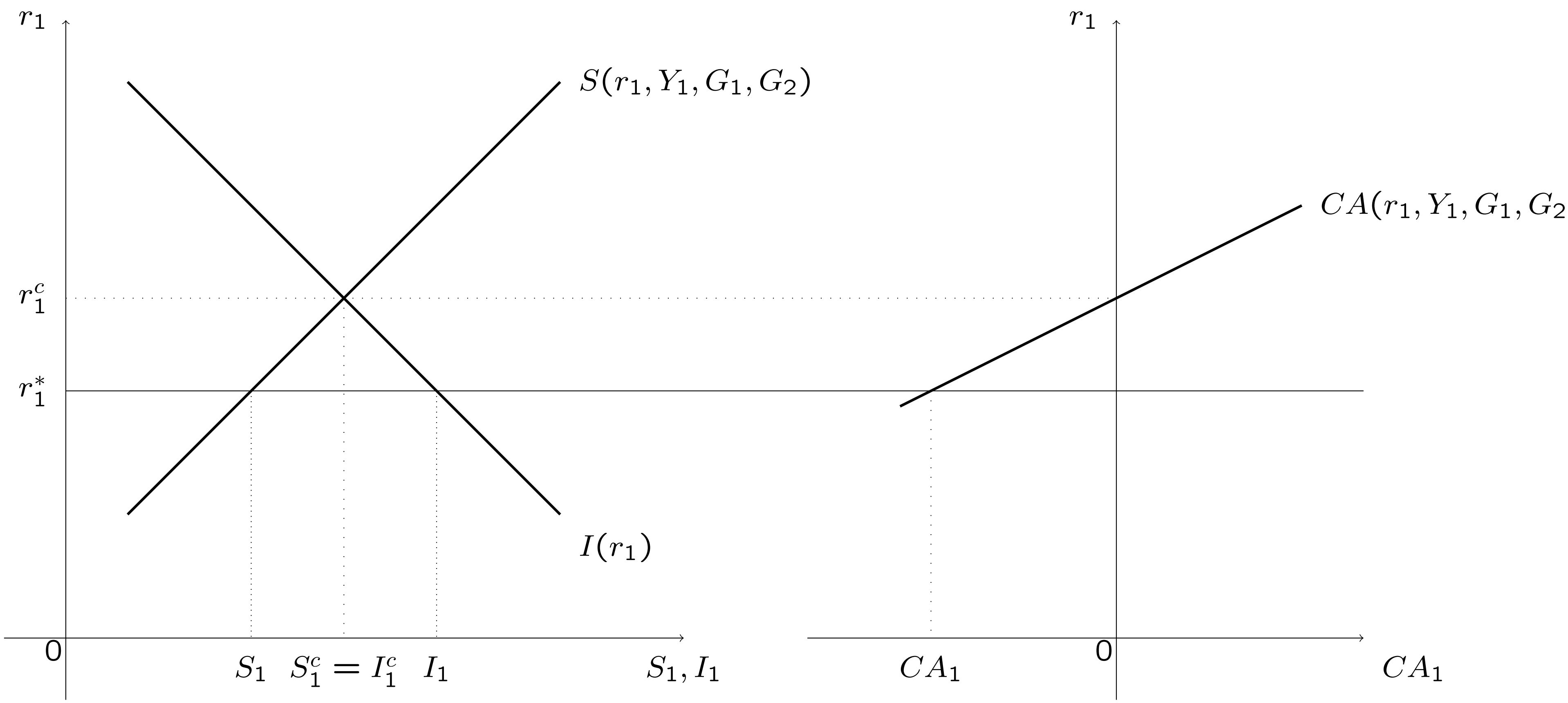
The equilibrium in a small open economy is illustrated in the next figure.

In the graph, the world interest rate, r_1^*, is represented by a horizontal line, as it does not depend on S_1, I_1, or CA_1. In the case shown in the figure, at the world interest rate, investment exceeds saving (left panel), resulting in a current account deficit, $CA_1 < 0$ (right panel).

The interest rate that would prevail in a closed economy (where $CA_1 = 0$) is denoted by r_1^c. In this example, r_1^c is higher than the world interest rate ($r_1^c > r_1^*$).

When the world interest rate is below the closed-economy interest rate, opening the economy lowers the domestic interest rate. As a result, households save less and firms invest more than they would in a closed economy: $S_1 < S_1^c$ and $I_1 > I_1^c$.

Equilibrium in a Small Open Economy



Notes. The figure shows equilibrium in a small open economy under free capital mobility. The world interest rate r_1^* is given by the horizontal line. At r_1^*, investment exceeds saving ($I_1 > S_1$; left panel), leading to a current account deficit ($CA_1 < 0$; right panel). The interest rate r_1^c corresponds to a closed economy, where saving equals investment ($S_1^c = I_1^c$) and the current account is balanced ($CA_1 = 0$). Compared to the closed economy, the open economy has lower saving and higher investment at the prevailing interest rate.

Adjustment to an Increase in the World Interest Rate

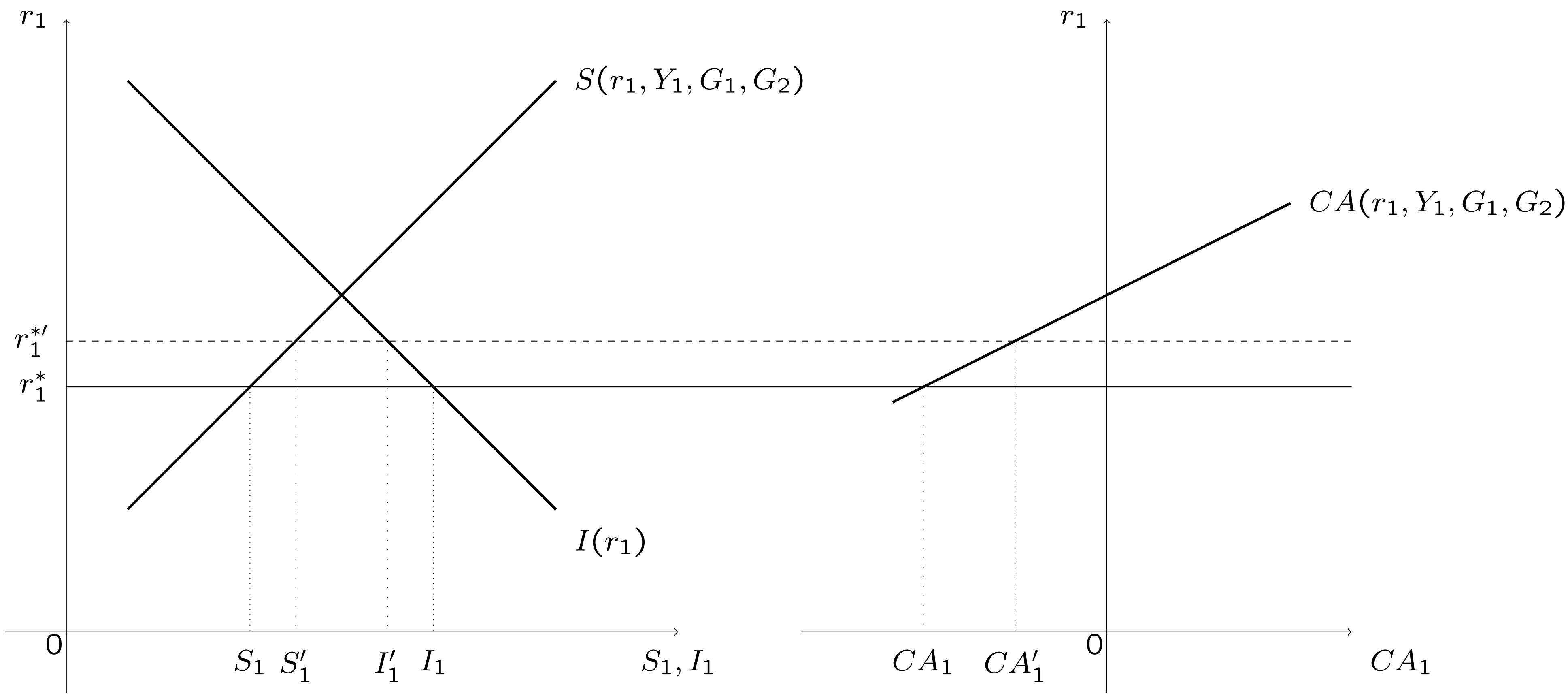
Suppose that the world interest rate increases from r_1^* to $r_1^* > r_1^*$. The siguation is depiced in the next slide. Initially, saving equals S_1, investment equals I_1, and the current account equals CA_1.

The response to the increase in the world interest rate the positions of the saving and investment schedules are unaffected As a result, the position of the current account schedule in to affected either.

The increase in the world interest rate stimulates saving and discourages investment. Consequently, the current account improves.

Summarizing, we have that
$r_1^* \uparrow \Rightarrow S_1 \uparrow, I_1 \downarrow,$ and $CA_1 \uparrow$.

Adjustment to an Increase in the World Interest Rate



Notes. The figure illustrates the adjustment to an increase in the world interest rate from r_1^* to $r_1^{*\prime} > r_1^*$. The initial rate r_1^* is shown by the solid horizontal line, and the new rate $r_1^{*\prime}$ by the dashed line. The higher interest rate stimulates saving, raising it from S_1 to S_1', and discourages investment, lowering it from I_1 to I_1' (left panel). As a result, the current account improves from CA_1 to CA_1' (right panel).

Adjustment to a Increase in Government Spending: The Twin Deficits

Do fiscal deficits cause current account deficits?

This is a recurrent question in policy discussions. It is important because it is part of a larger question related to whether external imbalances are due to domestic or external factors. The fiscal deficit would be an internal factor. The term "twin deficits" refers to the possibility that fiscal deficits may cause current account deficits.

In the context of the United States, recall that current account deficits started in the early 1980s. Around that time, the Reagan administration embarked in expansionary fiscal policy, stemming primarily from significant increases in government spending on defense and in tax cuts. These measures generated large fiscal deficits. A natural question at the time was whether the fiscal deficit was the root cause of the incipient current account deficits.

The question of whether fiscal deficits cause current account deficits is also relevant today. The second Trump administration is asking Congress for more than a trillion dollar increase in spending to wage the war with Iran. What would be the impact of this increase in government spending on the current account?

Let us analyze the effect of an increase in government spending in our two-period model. Suppose that, in period 1, government spending increases from G_1 to G_1'. This increase could arise, for example, from an expansion of national defense programs. Suppose that the increase in government spending is financed with debt; that is, taxes in period 1, T_1, are unchanged. Suppose further that the additional debt is expected to be repaid in period 2 through an increase in lump-sum taxes, T_2.

Because the government does not change taxes in period 1, the increase in government spending causes a one-for-one increase in the fiscal deficit, $G_1 - T_1$, or, equivalently, a one-for-one fall in government saving in period 1,

$$S_1^g = T_1 - G_1 \Rightarrow \Delta S_1^g = -\Delta G_1 < 0.$$

Does the increase in government spending also cause an increase in the current account deficit?

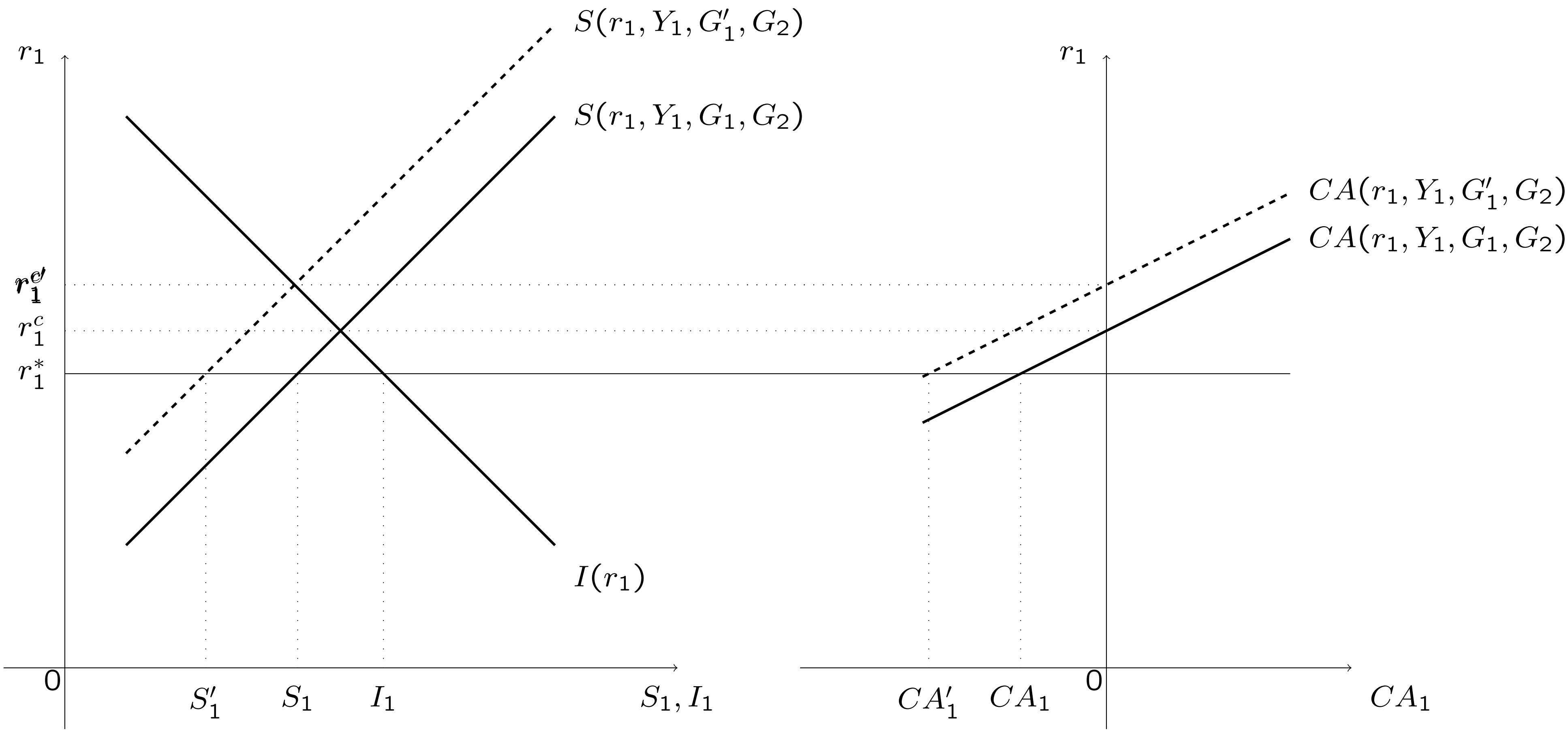
The situation is illustrated in the next figure.

In the figure, the world interest rate is r_1^*. Prior to the change in fiscal policy, saving equals S_1 and investment equals I_1 (left panel). Because, at the world interest rate, investment exceeds saving, the current account is initially in deficit ($CA_1 < 0$, right panel).

The increase in government spending shifts the saving schedule up and to the left, as shown by the dashed line in the left panel: at any given interest rate, the economy saves less than before the increase in G_1. The investment schedule is unaffected. At any given interest rate, the gap between saving and investment becomes less positive or more negative. That is, the current account deteriorates at each interest rate, which means that the current account schedule shifts to the left, as shown by the dashed line in the right panel.

In equilibrium, following the increase n government spending in period 1 saving falls from S_1 to S_1', the current account deteriorates from CA_1 to CA_1', and investment is unchanged:
$G_1 \uparrow \Rightarrow S_1 \downarrow, CA_1 \downarrow,$ and I_1 is unchanged

Effect of an Increase in G_1 on the Current Account



This analysis suggests that a debt-financed increase in government spending causes both an increase in the fiscal deficit and an increase in the current account deficit. Put differently, a debt-financed increase in government spending causes twin deficits.

Note how different the adjustment is in open and closed economies. Take another look at the figure. The upward and leftward shift in the saving schedule is the same regardless of whether the economy is open or closed. In the closed economy, however, saving must equal investment and the current account is zero at all times. Thus, the increase in G_1 raises the interest rate from r_1^c to $r_1^{c\prime}$. The higher interest rate stimulates saving and discourages investment. As a result, saving falls by less than in the open economy, and investment falls, whereas in the open economy investment is unchanged.

Thus, in the open economy, the adjustment occurs through the current account, whereas in the closed economy, it occurs through the interest rate.

The following table summarizes the adjustment to an increase in government spending in the closed and open economies.

Effect of a Debt-Financed Increase in Government Spending, $G_1 \uparrow$

Economy	r_1	Fiscal Deficit	CA_1	S_1	I_1
Open	$--$	$\uparrow$	$\downarrow$	$\downarrow$	$--$
Closed	$\uparrow$	$\uparrow$	$--$	$\downarrow$	$\downarrow$

Can you show that consumption, C_1, falls in both the open and closed economies? Can you show that it falls by more in the closed economy than in the open economy?

Summing Up

• In an open economy, the current account equals saving minus investment: $CA_1 = S_1 - I_1$.

• Saving depends positively on r_1, Y_1, and G_2, and negatively on G_1; investment depends negatively on r_1.

• The current account schedule is increasing in r_1: higher interest rates raise saving and reduce investment.

• In a small open economy with free capital mobility, the domestic interest rate equals the world interest rate: $r_1 = r_1^*$.

• In a closed economy, the interest rate, denoted r_1^c, is the one at which the saving schedule intersects the investment schedule, so that $S_1 = I_1$.

• If $r_1^* < r_1^c$, the economy runs a current account deficit: $S_1 < I_1$.

• An increase in the world interest rate raises saving, lowers investment, and improves the current account.

• A debt-financed increase in government spending, $G_1 \uparrow$, raises the fiscal deficit and shifts the saving schedule up and to the left: the economy saves less at any interest rate. In a small open economy, saving falls and the current account worsens, while investment and the interest rate are unchanged.

• Thus, in a small open economy, adjustment occurs through the current account rather than through the interest rate.

Lecture 27

Adjustment to Productivity Shocks in the Open Economy

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Motivation

Last class, we studied how the current account, saving, and investment adjust to changes in the world interest rate, r_1^*, and government spending, G_1.

In this lecture, we explore how the current account adjusts to changes in productivity.

Productivity changes can occur for a number of reasons:
– Weather conditions can affect the productivity of farming land (e.g., crops depend on factors such as rainfall and temperature) and can also impact the production and distribution of manufactured goods and services: for example extreme weather can cause the shutdown of airports and roads.
– New discoveries can influence productivity: the same amount of capital can produce more goods. Technological progress may arise at varying speeds, leading to large productivity increases at some times and smaller increases at others. Productivity can even decline, for example, if a technological advancement previously in use is later found to be harmful to human health—e.g., the use of asbestos in construction.

Changes in Productivity and the Production Function

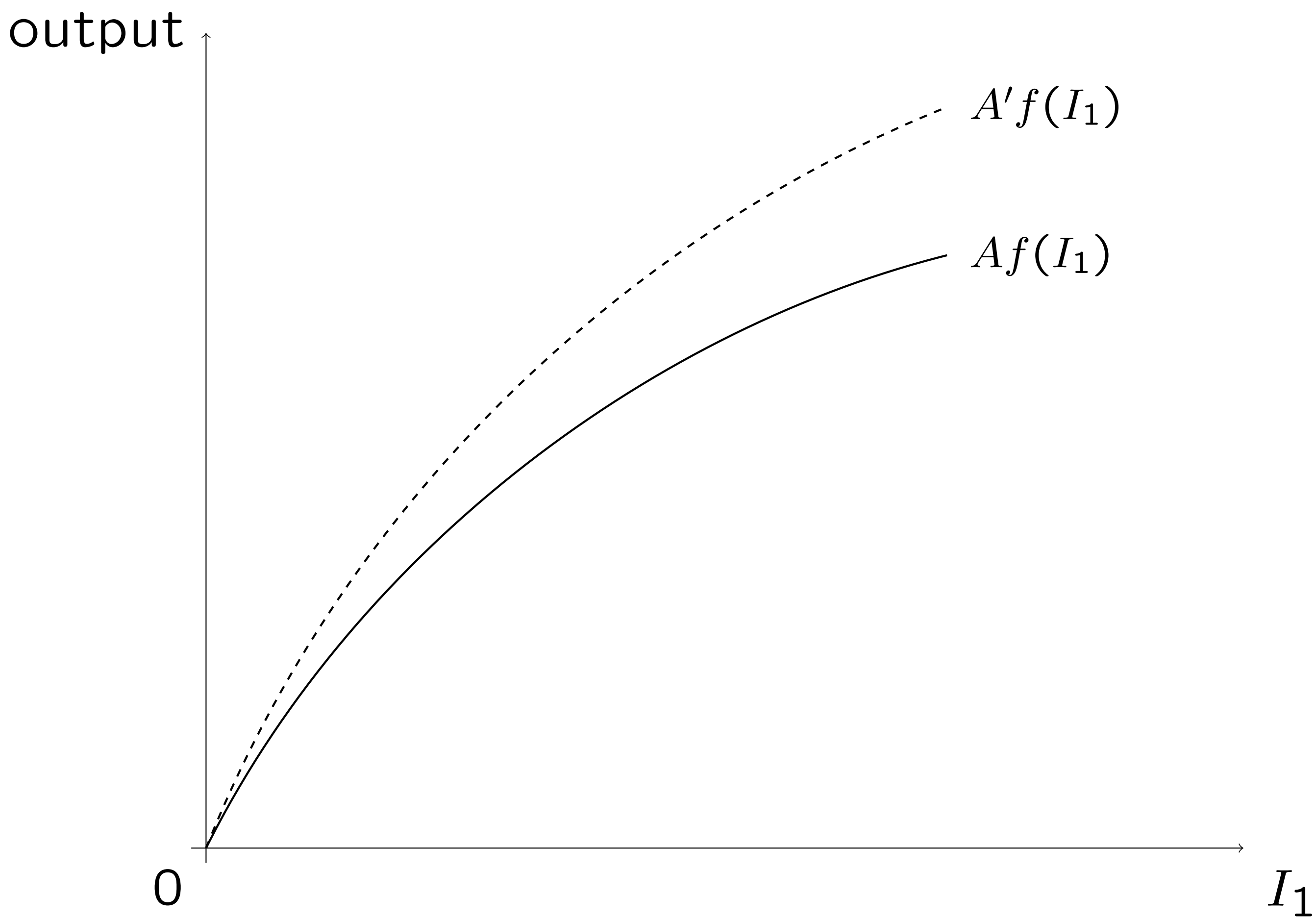
Thus far, we assumed that the production function is of the form $f(I_1)$, where $f(\cdot)$ is a given function, for example, $f(I_1) = \sqrt{I_1}$. Suppose now that the production function is of the form

$$\text{Output in period 2} = Af(I_1),$$

where A is a productivity factor. For exaple, in the square-root example, if $A = 3$, we have that the production function is $3\sqrt{I_1}$.

An increase n A represents an increase in productivity, because at every level of investment the firm can now produce more output. The next figure illustrates this idea.

The Productioin Function and a Positive Productivity Shock



Notes. The figure illustrates the effect of a positive productivity shock, from A to A', on the production function. After the shock, the production function shifts upward (dashed line), allowing for a higher level of output at each level of investment.

The Firm's Profit Maximization Problem

As we did before, we denote the profits of the firm in period 2 by Π_2. Profit is given by the difference between output, $Af(I_1)$, and the cost of investment, including interest, $(1+r_1)I_1$,

$$\Pi_2 = Af(I_1) - (1+r_1)I_1. \tag{1}$$

Firms choose investment to maximize profits. That is, the optimization problem of the firm is

$$\max_{\{I_1\}} \left[Af(I_1) - (1+r_1)I_1\right],$$

taking as given r_1.

The first-order condition associated with the firm's profit maximization problem is obtained by taking the derivative of profits with respect to I_1 and equating the result to zero,

$$\frac{\partial \Pi_2}{\partial I_1} = 0.$$

This yields $Af'(I_1) - (1 + r_1) = 0$, or

$$Af'(I_1) = 1 + r_1,$$

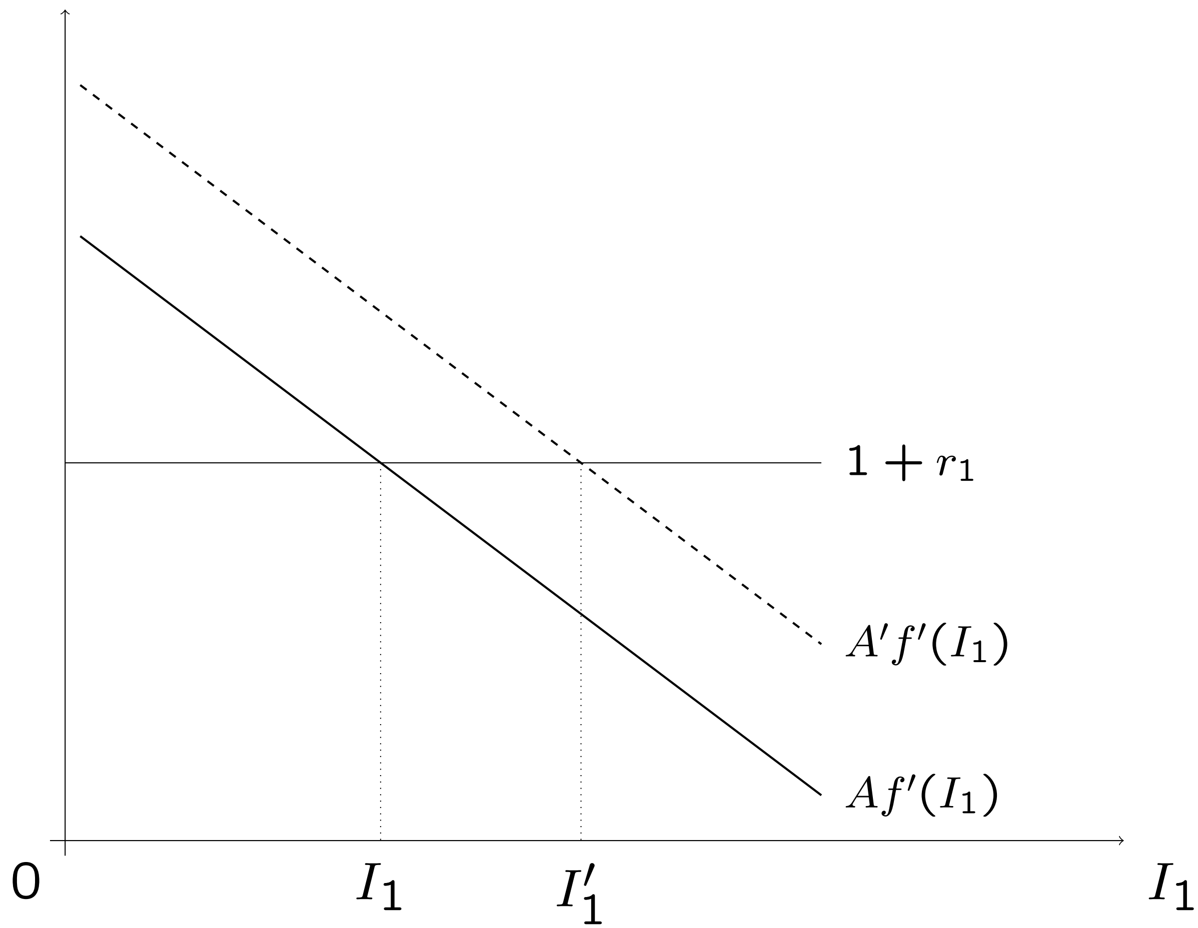
where the left-hand side, $Af'(I_1)$, is the marginal product of capital, given by the derivative of $Af(I_1)$ with respect to I_1.

How does the optimal level of investment change in response to a positive productivity shock? The figure on the next slide illustrates this effect.

Initially, productivity is A and the optimal level of investment, I_1, occurs where the marginal product of capital, $Af'(*_1)$, given by the thick solid downward sloping line, crosses the marginal cost of capital, $1 + r_1$, shown with a thin solid horizontal line.

A positive productivity shock from A to A' increases the marginal product of capital at any level of investment. In the figure, this is shown with a dashed line. At the old optimal level of investment, I_1, now the marginal product of capital is higher than its marginal cost, $A'f'(I_1) > 1 + r_1$, so it pays for the firm to expand it capital stock. The new optimal level of investment is $I_1' > I_1$.

A Positive Productivity Shock and the Optimal Level of Investment



Notes. The figure illustrates the effect of a positive productivity shock from A to A' on the optimal level of investment. The shock shifts the marginal product of capital upward (dashed line). Investment increases from I_1 to I_1'.

Summarizing, we have established that given r_1,

$$A \uparrow \Rightarrow I_1 \uparrow .$$

As before, it is clear that, given the level of productivity, A, an increase in the interest rate causes a reduction in the optimal level of investment,

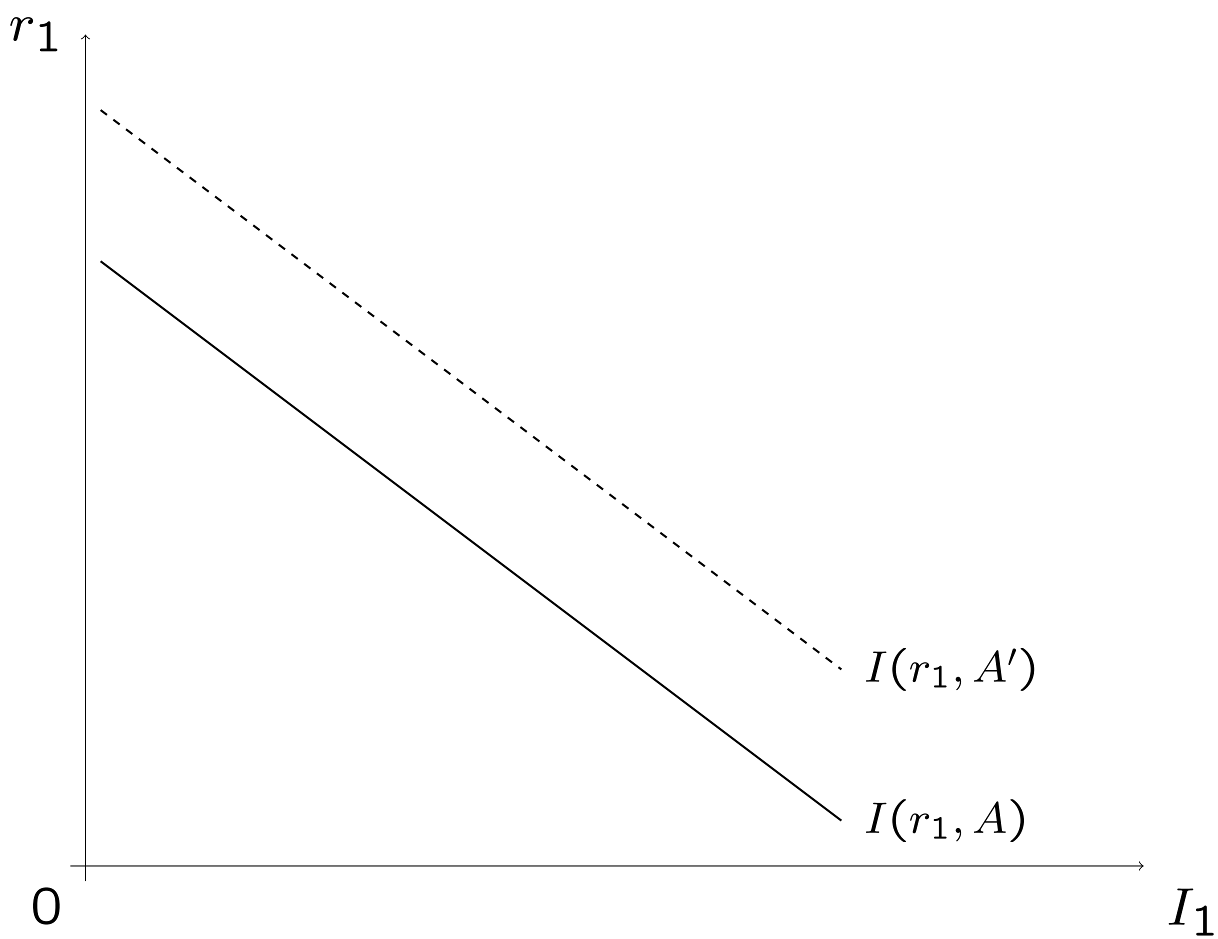
$$r_1 \uparrow \Rightarrow I_1 \downarrow .$$

So we can write the investment schedule as

$$I_1 = I(\underset{-}{r_1}, \underset{+}{A})$$

As before, in the space (I_1, r_1), the investment schedule is a downward sloping line, as shown in the next figure. A positive productivity shock (in the figure from A to A'), shifts the investment schedule up and to the right (dashed line).

The Investment Schedule and a Positive Productivity Shock



Notes. The depicts the investmnent schdule. It is a downward sloping line in the space (I_1, r_1). A positive productivity shock from A to A' shifs the investment schedule to the right, as shown by the dashed line.

Productivity Shocks and Profits

What happens with the firm's profits after a positive productivity shock?

To address this question, take another look at the figure on page 7. Recall that profits are given by the triangular area below the marginal product, $Af'(I_1)$, and above the marginal cost of capital, $1 + r_1^*$. A positive productivity shock from A to $A' > A$ shifts the marginal product of capital function up and to the right (dashed line). As a result, the triangular area below it and above $1 + r_1$ increases. We conclude that , given the interest rate r_1, a positive productivity shock raises profits,

$$A \uparrow \Rightarrow \Pi_1 \uparrow$$

This is intuitive, because the increase in productivity implies that firms can produce more output for any given level of investment. So even if the firm did not change it level of investment, an increase in

A would automatically increase its profits. This is because, with I_1 and r_1 constant, the cost of capital, $(1+r_1)I_1$, does not change, but the level of output increases from $Af(I_1)$ to $A'f(I_1)$. If, in addition, the firm adjusts the level of investment optimally, profits increase even more.

Holding poductivity constant, as before, if the interest rate increases profits go down,

$$r_1 \uparrow \Rightarrow \Pi_2 \downarrow .$$

So we can write the profit function as

$$\Pi_2 = \Pi(\underset{-}{r_1}, \underset{+}{A}).$$

Let's consider an example.

An Example

Suppose that the production function is of the form

$$Af(I_1) = A\sqrt{I_1.}, \tag{2}$$

with $A > 0$. You may recall that in a previous lecture, when we first studied the investment schedule, we considered an example in which the production function was $2\sqrt{I_1}$. This is a special case of the class of technologies analyzed here, with $A = 2$.

For any positive value of A,the production function given in (2) is positive, strictly increasing, and concave. The marginal product of capital is given by

$$Af'(I_1) = \frac{A}{2}\sqrt{\frac{1}{I_1}}.$$

The marginal product of capital is decreasing in I_1, so the production technology displays diminishing marginal product of capital. Equating the marginal product of capital to the marginal cost of capital, we obtain

$$\frac{A}{2}\sqrt{\frac{1}{I_1}} = 1 + r_1. \tag{3}$$

Solving the optimality condition (3) for I_1 delivers the investment schedule

$$I(r_1, A) = \left(\frac{A/2}{1+r_1}\right)^2,$$

which is a strictly decreasing function of the real interest rate, r_1, and a strictly increasing function of the productivity factor A.

To obtain the optimal level of profits, write the definition of profits and then replace investment for its optimal value:

$$\begin{aligned}\Pi(r_1, A) &\equiv f(I(r_1, A)) - (1+r_1)I(r_1, A) \\ &= A\sqrt{\left(\frac{A/2}{1+r_1}\right)^2} - (1+r_1)\left(\frac{A/2}{1+r_1}\right)^2 \\ &= \frac{1}{4} \cdot \frac{A^2}{1+r_1}.\end{aligned}$$

So the optimal level of profits is a decreasing function of the real interest rate, r_1,, and an increasing function of productivity, A, which is in line with our previous analysis.

Productivity Shocks and Saving

We just established that productivity affects investment. Does it also affect saving? The answer is yes. And the reason is that households are the ownersof firms. So they reeive profits when firms distribute them. And, in tuern, as we just saw, profits depend on productivity. So, when productivity goes up, households feel richer and decide to consume more in periods 1 and 2. But profits are distributed in period 2, not in period 1. The the desired increase in consumption in period 1 comes entirely out of cutting saving.

We have just established that productivity affects investment. But does it also affect saving? The answer is yes. The reason is that households are the owners of firms and receive the profits those firms distribute. As we have seen, profits are increasing in productivity. Thus, when productivity rises, households anticipate higher profits and feel wealthier, prompting them to increase consumption in both periods. However, since profits are distributed in period 2, the increase in period-1 consumption must be financed entirely by reducing saving.

Let's look at this more formally. Recall that in the two-period economy with log preferences, households in period 1 optimally choose to consume half of the present discounted value of their disposable income:

$$C_1 = \frac{1}{2}\left[Y_1 - T_1 + \frac{\Pi(r_1, A) - T_2}{1 + r_1}\right] \tag{4}$$

From this expression, we see that, all else equal, a positive productivity shock—an increase in A—raises consumption. The reason is that as A increases, households anticipate higher profits in period 2. Feeling wealthier, they choose to consume more in the current period.

Recall also the intertemporal government budget constraint, which says that the present discounted value of taxes must equal the present discounted value of government spending:

$$T_1 + \frac{T_1}{1+r_1} = G_1 + \frac{G_1}{1+r_1}$$

Use this expression to get rid of T_1 and T_2 in (4). This yields

$$C_1 = \frac{1}{2}\left[Y_1 - G_1 + \frac{\Pi(r_1, A) - G_2}{1+r_1}\right] \tag{5}$$

Recall also that national saving equals

$$S_1 = Y - C_1 - G_1$$

Combining this expression with (5), we finally obtain

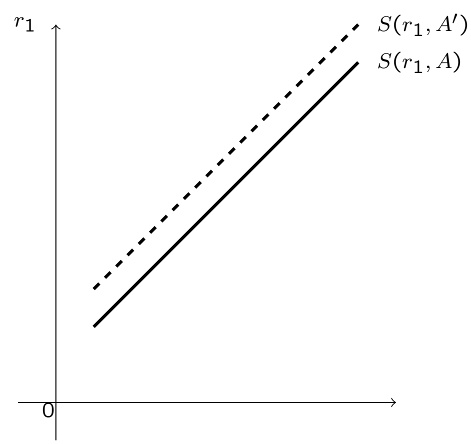
$$S_1 = \frac{1}{2}\left[Y_1 - G_1 - \frac{\Pi(r_1, A) - G_2}{1+r_1}\right]$$

This expression shows that, holding the interest rate constant, an increase in productivity ($A \uparrow$) leads to a decline in saving. The intuition is as discussed earlier: a rise in productivity increases profit income in period 2. Anticipating this, households feel wealthier already in period 1 and wish to consume more. Since output remains unchanged in period 1, the only way to finance higher consumption is by reducing saving.

We sumarize this result by writing the saving schdule as

$$S_1 = S(\underset{+}{r_1}, \underset{-}{G_1}, \underset{+}{G_2}, \underset{-}{A}).$$

The figure below depicts the saving schedule. An increase in productivity from A to A' sifts the schedule up and to the left.



Note that to avoid clutter, the label of the saving schedule omit three arguments, namely, Y_1, G_1, and G_2.

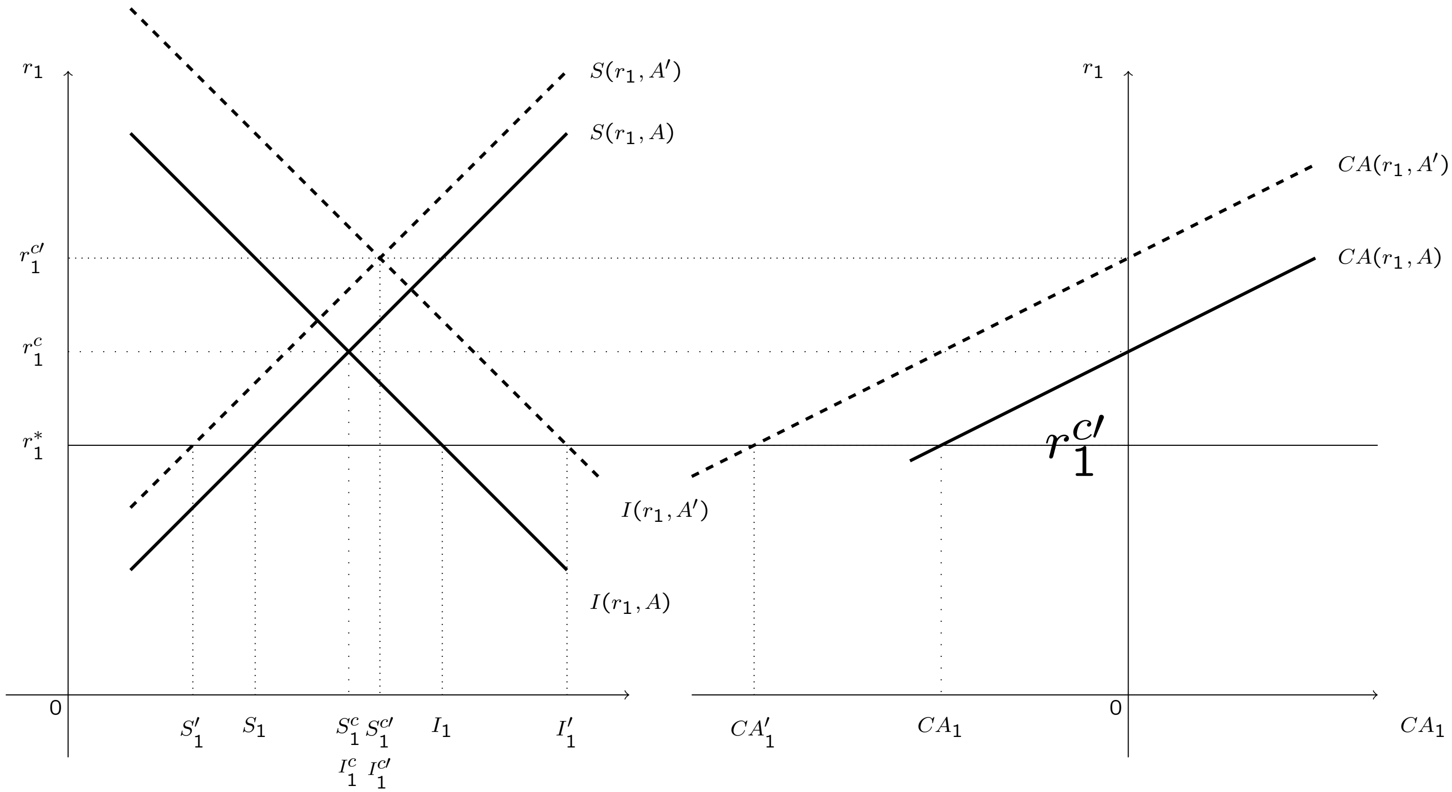
We are now ready to analyze how productivity shocks affect the current account, saving, and investment.

Adjustment of the Current Account to a Productivity Shock

Suppose the productivity A increases to A'. The situation is illustrated in the next figures. In response to this positive productivity shock, the saving schedule shifts up and to the left (dashed upward sloping line in the left panel) and the investment schedule shifts up and to the right (dashed downward sloping line in the left panel). Now at any given interest rate, the difference between saving and investment becomes smaller. Since the current account is precisely the difference between saving and investment, we have that the current account schedule shifts to the left (dashed line in the right panel). At the world interest rate r_1^*, the positive productivity shock causes a fall in saving, an increase in investment, and a deterioration of the current account.

In a closed economy, the increase in the demand for loanable funds (firms wish to increase investment) and the reduction in the supply of funds (households wish to save less) push the interest rate up. The equilibrium level of investment is in principle ambiguous. But it assuming that the demand schedule shifts vertically by more than the saving schedule does, both saving and investment will increase.

Adjustment of the Current Account to Productivity Shocks



The figure illustrates the effect of a positive productivity shock from A to A' on saving, investment, and the current account. The positive productivity shock shifts the saving schedule up and to the left (left panel, dashed upward sloping dashed line) and the investment schedule up and to the right (left panel, downward sloping dasdhed line). As a result, the current account schedule shifts up and to the left (dashed line in the right panel) In the new equilibrium, saving falls, investment increases, and the current account deteriorates.

In the closed economy, assuing that the saving schedule does not shift vertically by as much as the investment schedule, saving and investment and the interest rate all increase.

Summing Up

• A productivity shock raises output at any level of investment: $Af(I_1)$ shifts up when $A\uparrow$.

• Firms choose I_1 to satisfy $Af'(I_1) = 1 + r_1$; higher A raises the marginal product of capital.

• Hence, $A\uparrow \Rightarrow I_1\uparrow$ (investment schedule shifts right); $r_1\uparrow \Rightarrow I_1\downarrow$.

• Higher productivity increases firm profits: $A\uparrow \Rightarrow \Pi_2\uparrow$.

• Households anticipate higher future income and increase current consumption (wealth effect).

• Because output in period 1 is fixed, higher C_1 implies lower saving: $A\uparrow \Rightarrow S_1\downarrow$.

• Thus, productivity shocks shift investment up/right and saving up/left.

• In an open economy, $A\uparrow$ leads to $I_1\uparrow$, $S_1\downarrow$, and a deterioration of the current account.

• In a closed economy, the positive productivity shock raises the interest rate; saving and investment must remain equal, so the equilibrium adjustment occurs through r_1.

Lecture 28

Large Open Economies

Intermediate Macroeconomics

Economics UN3213

Professor Martín Uribe

Columbia University

Spring 2026

Motivation

Thus far, we have focused on how the current account, saving, investment, and consumption are determined in a small open economy.

A key assumption in that framework is that the economy is too small to affect the world interest rate, r_1^*.

But what if the economy is large, like the United States or China? A recession or boom in such countries can cause significant shifts in the global supply and demand for funds, influencing world financial markets and, therefore, the world interest rate itself. For these economies, it is not appropriate to treat the world interest rate as exogenous. Instead, we must model it as an endogenous variable, that is, one determined within the system.

Thus, when we analyze adjustment in a large economy, the current account, saving, investment, consumption, and the world interest rate are jointly determined.

A Large Open Economy

• Let's divide the world into two regions, the United States (US) and the rest of the world (RW).

• Because a U.S. current account deficit represents the current account surplus of the rest of the world and conversely, we have that

$$CA^{US} + CA^{RW} = 0,$$

where CA^{US} and CA^{RW} denote, respectively, the current account balances of the United States and the rest of the world.

The Current Account Schedules of US and RW

As we saw earlier, the current account schedule of a country is an increasing function of the interest rate. So we can write

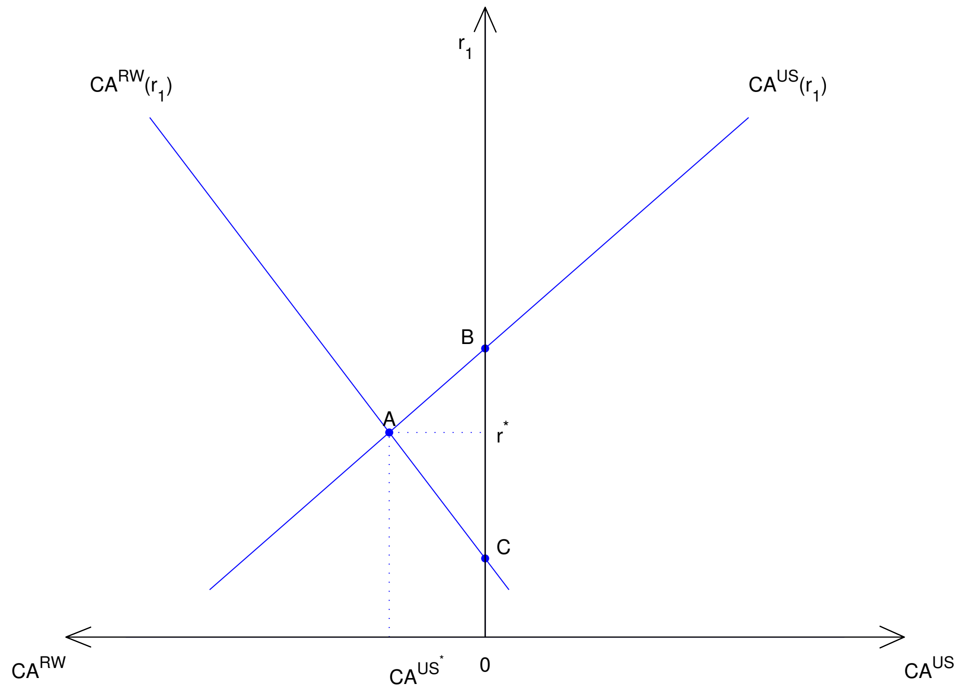
$$CA_1^{US} = CA^{US}(\underset{+}{r_1}),$$

and

$$CA_1^{RW} = CA^{RW}(\underset{+}{r_1}),$$

This is true for any country, large or small. The intuition is familiar by now: The current account is the difference between saving and investment. And an increase in the interest rate induces households in the United States and the rest of the world to increase saving in period 1. Also it induces U.S. and RW firms to cut investment in the same period. (Note that, to avoid clutter, in the current account schedules of the US and RW we include the interest rate, but don't list all of their other arguments such initial endowments, government spending, and productivity shocks.)
The next slide plots the two current account schedules in the space (CA, r).

Current account determination in a large open economy



- The horizontal axis measures from left to right the current account balance of the United States and from right to left the current account balance of the rest of the world.
- Equilibrium occurs at the intersection of the current account schedules of the United States and the rest of the world (point A).
- In this example, in equilibrium, the United States runs a current account deficit and the rest of the world a surplus.
- The equilibrium interest rate is r^*.
- If the two economies were closed, the equilibrium would be at point B in the United States and at point C in the rest of the world.

A Positive Productivity Shock in the United States

• Suppose that in period 1 firms in the United States learn that their capital will be more productive in period 2. Specifically, if the production function in the United States is $Af(I_1)$, then we have that $A \uparrow$.

• Example: a technological improvement, such as fracking, discovered in period 1 that is expected to be in place in period 2.

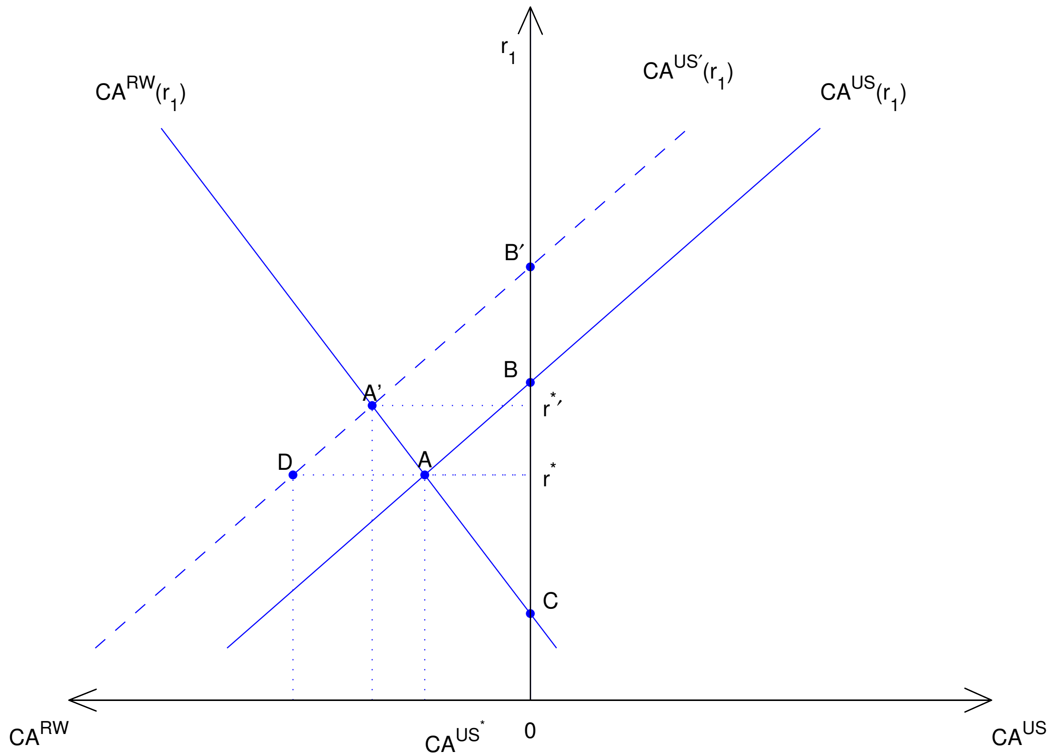
• This causes the U.S. investment schedule to shift up and to the right. (as shown last lecture)

• Also, U.S. households, in anticipation of higher future profit income generated by the investment boom, reduce current saving at any given interest rate, so that the U.S. saving schedule shifts up and to the left (also shown last lecture)

• Thus the current account schedule of the United States (difference between the saving and investment schedules) shifts up and to the left. (shown last lecture)

The figure on the next slide shows how this affects the equilibrium in the world economy.

Adjustment to a Positive Productivity Schock in the United States



• The positive productivity shock shifts the current account schedule of the United States up and to the left as shown with a broken line.
• The equilibrium before the shock is at point A, and after the shock is at point A', where the world interest rate is higher, the current account deficit of the United States is larger, and the current account surplus of the rest of the world is higher.
• In a closed world economy, the interest rate would have increased in the US (from B to B'), and would have remained unchanged in the RW (point C).

U.S. Current Account Deficit: Made in the US or Due to a Global Saving Glut?

• The current account in the United States has been negative virtually all the time since the mid 1980s. The deterioration in the current account was particularly pronounced in the decade prior to the global financial crisis (GFC):

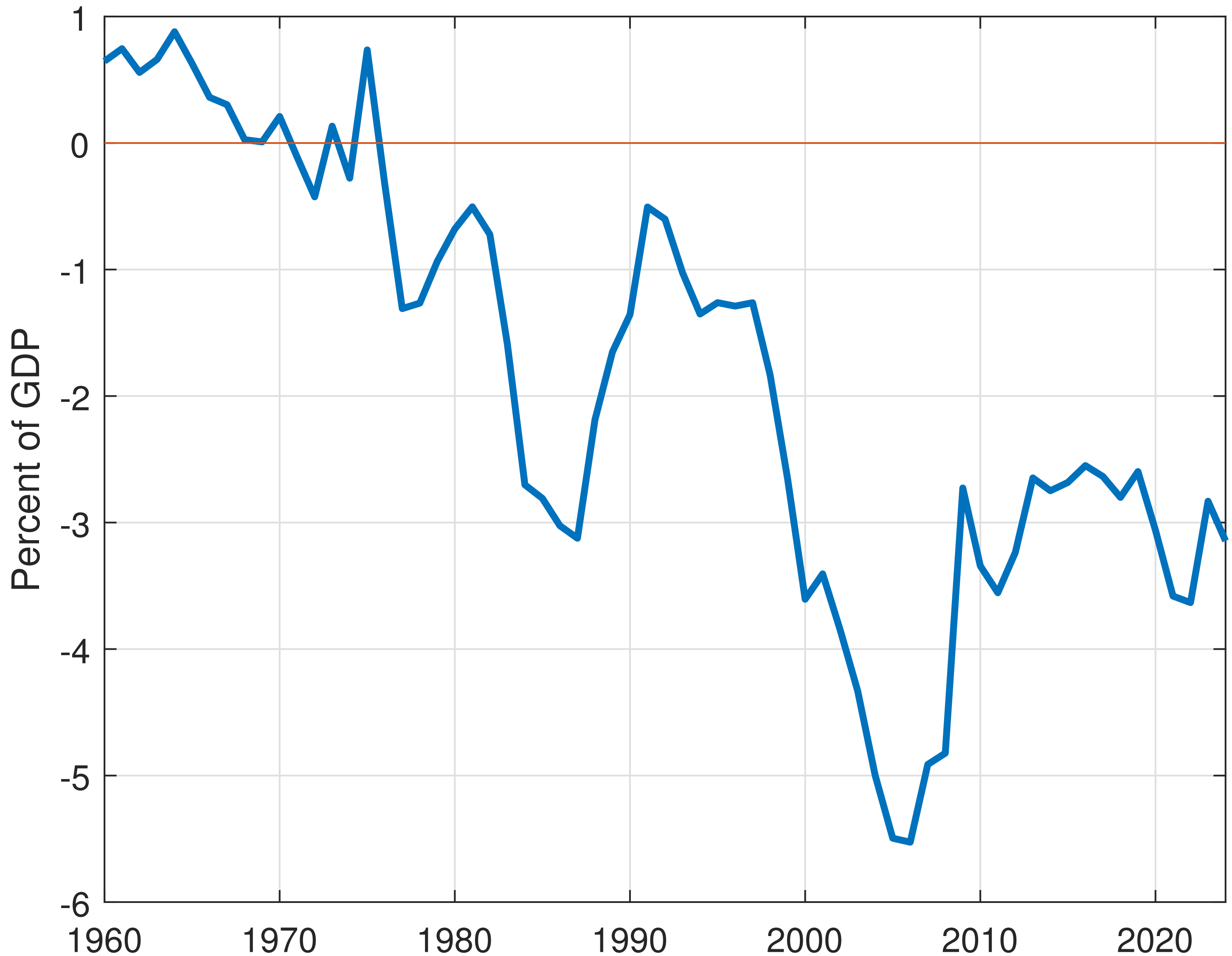
Between 1996 and 2006, the U.S. current account deficit increased from 1.5% of GDP to about 6% (from $200bn to $800bn), see the figure on the next slide.

• Was this large rise in the current account deficit primarily driven by domestic or external factors?

• Two competing explanations have been proposed:

— The global saving glut hypothesis.
— The made in the U.S. hypothesis.

The U.S. Trade Balance as a Share of GDP



Data Source: BEA, bea.gov. TB data: ITA Table 1.1. GDP data: NIPA Table 1.1.5.

The Global Saving Glut Hypothesis

• It maintains that the U.S. current account deficits were due to external factors. Specifically, it says that the U.S. current account deficits occurred because the rest of the world experienced a heightened desire to save:

— Emerging countries increased foreign reserve accumulation to avoid or be better prepared to face future external crises.
— Government induced foreign currency depreciation aimed at promoting export-led growth (e.g., China).
— Some developed countries increased saving rates in preparation for an aging population.

The Made in the U.S. Hypothesis

It maintains that the large U.S. current account deficits were due to economic developments inside the United States.

— Persistent U.S. fiscal deficits reduced national saving at any given interest rate.
— Financial innovation, mortgage securitization, and easier lending standards in the United States relaxed borrowing constraints, inducing more household borrowing and lower saving at any given interest rate.
— Stronger U.S. growth prospects relative to the rest of the world fueled investment at any given interest rate.

Which View Is Right?

• Look at the left panel of the figure on the next slide. The initial equilibrium is at point A.

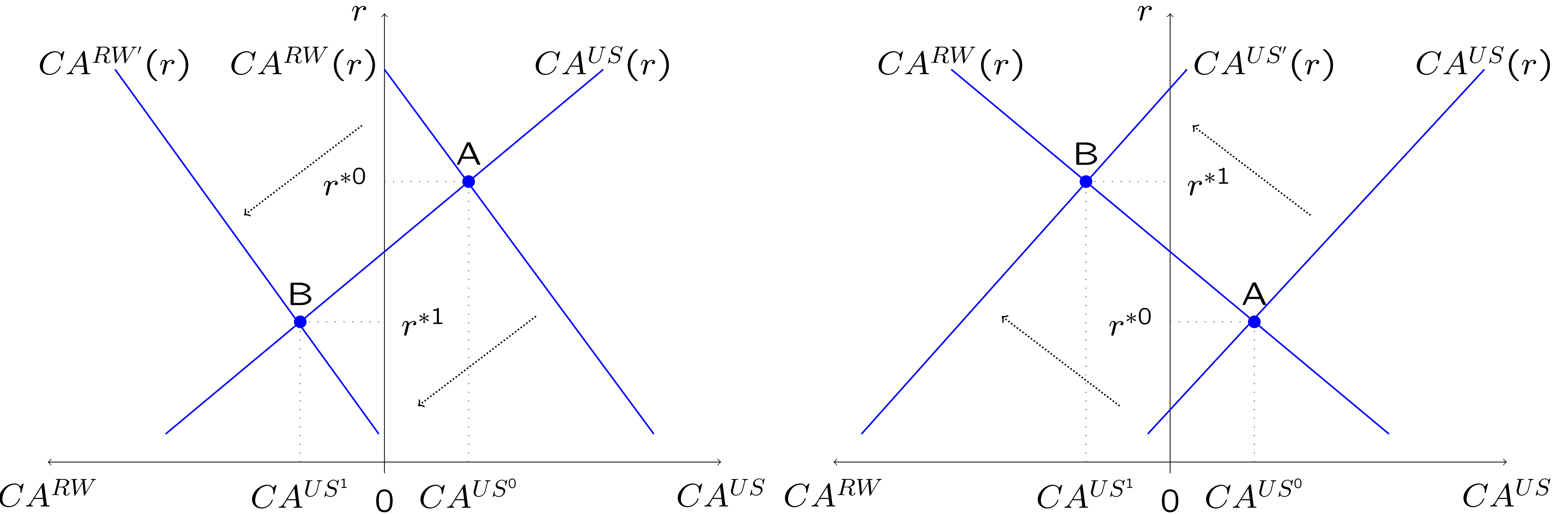
• An increase in desired saving in the RW shifts the CA schedule of the RW down and to the left. The U.S. CA schedule doesn't move.

• The new equilibrium, point B, features a deterioration in the current account of the United States from CA^{US^0} to CA^{US^1} and a fall in the world interest rate from ${r^*}^0$ to ${r^*}^1$.

• Intuition: the United States will borrow more from the rest of the world only if it becomes cheaper to do so (only if the interest rate falls).

U.S. Current Account Deterioration: Global Saving Glut or "Made in the U.S.A?

Global Saving Glut Hypothesis **"Made in the U.S.A." Hypothesis**



Which View Is Right? (cont.)

- The made in the U.S.A. hypothesis is illustrated in the right hand panel of the figure in the previous slide. The initial equilibrum is at point A.

- Under this view, the current account schedule of the United States shifts up and to the left. The current account schedule of the rest of the world is unchanged.

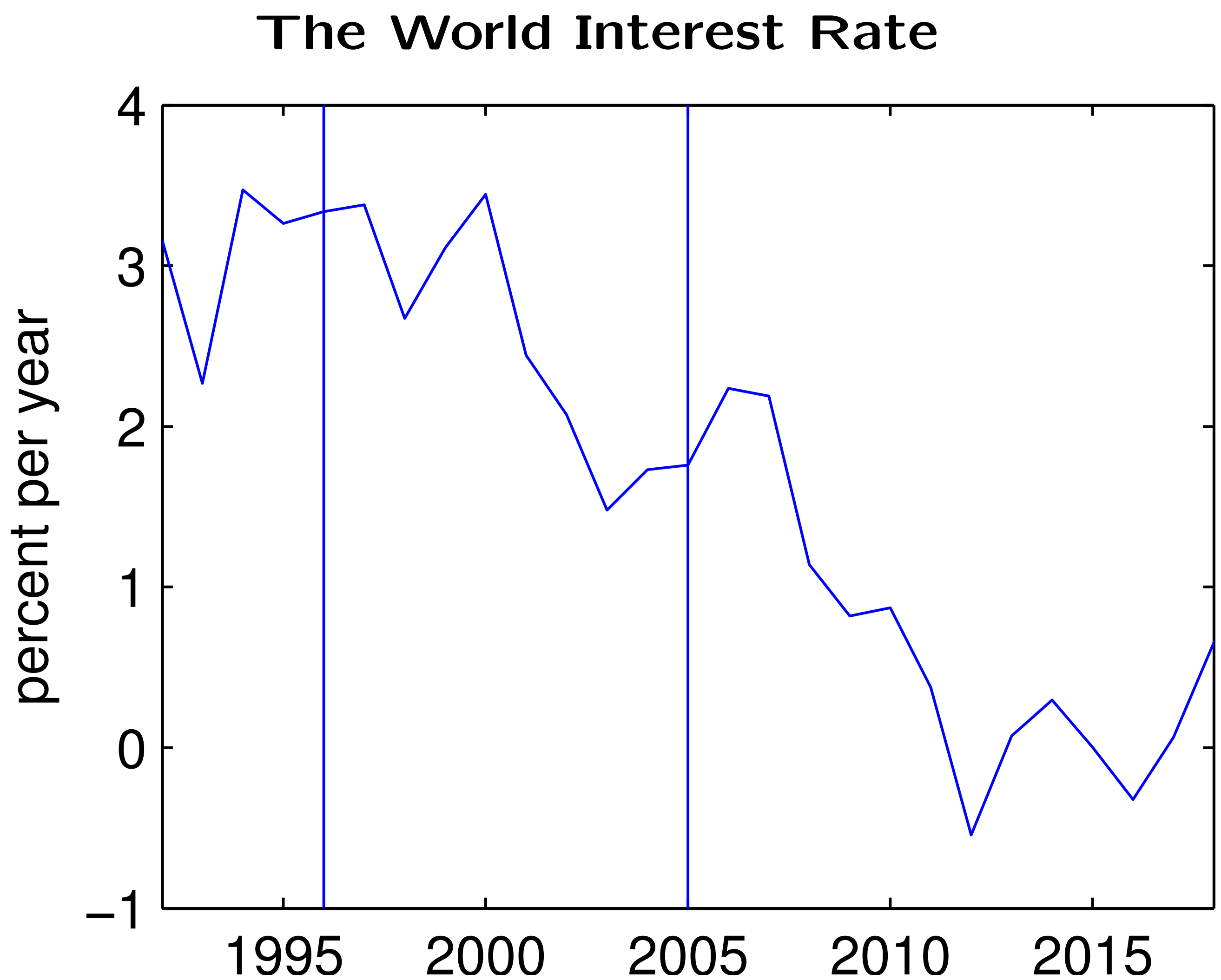
- The new equilibrium, point B, features a deterioration in the current account of the United States and a rise in the world interest rate.

And the Winner Is . . .

• Both hypotheses can explain a deterioration in the U.S. current account.

• However, the global saving glut hypothesis implies a decline in world interest rates, whereas the made in the U.S.A. hypothesis implies that world interest rates should have gone up.

• Hence we can use data on interest rates to find out which hypothesis is right. The next slide shows a time series plot of the world real interest rate.



Notes. The world interest rate is measured as the difference between the rate on 10-year U.S. Treasury securities and expected inflation.

So. . .

• The figure shows that, overall, the deterioration of the U.S. current account was associated with a declining real interest rate, lending support to the global saving glut hypothesis.

Summing Up

- In a large open economy, the world interest rate is endogenous and jointly determined with global saving and investment.

- World equilibrium requires that the current account of the United States plus that of the rest of the world equals zero.

- The equilibrium interest rate is determined by the intersection of the current account schedules of the U.S. and the rest of the world.

- A positive productivity shock in the U.S. raises the world interest rate and increases the U.S. current account deficit.

- The global saving glut hypothesis attributes U.S. deficits to higher saving in the rest of the world.

- The "made in the U.S." hypothesis attributes U.S. deficits to lower saving or higher investment in the U.S.

- A fall in world interest rates supports the global saving glut hypothesis over the domestic explanation.

THANK YOU!

Your UNI and name:

Department of Economics
Columbia University

Professor Martín Uribe
Spring 2026

Homework 1

Intermediate Macroeconomics

(ECON UN3213)

Due Wednesday, February 11, before class on Gradescope

Write your answers in the space provided

Exercise 1 (Two Recession Types). This question is motivated by the discussion in the first class. Consider two countries, A and B. In year 1, GDP per capita in both countries is 100. During normal times, GDP per capita in both countries grows at 2 percent per year. However, in period 2, both countries suffer a recession in which GDP per capita falls by 10 percent. Fortunately, the recession is short-lived. In period 3, country A returns to its normal growth rate, while country B not only returns to its normal growth rate but also recovers its trend level of GDP per capita.

1. Calculate the levels of GDP per capita in countries A and B in years 2, 3, and 4, by filling out the table. Use the remaining space to explain your calculations.

Year	Country A	Country B
1		
2		
3		
4		

(Additional space for Exercise 1, question1, if needed.)

2. Consider the ratio of GDP per capita in country B to that in country A in year 4. Is this ratio equal to 1.10, that is, is GDP per capita in country B 10 percent higher than in country A? Is it equal to 1.10×1.02, that is, slightly more than 12 percent higher? In any case, explain why.

3. Suppose instead that, starting in year 3, country A grows at a constant rate $\gamma > 2\%$ per year, while country B continues to grow at 2 percent per year. Is it possible for country A to eventually overtake country B in terms of GDP per capita? Explain your answer.

Exercise 2 (Unanchoring of Expectations). Consider an economy where the Phillips curve is

$$\hat{\pi} = \beta \hat{\pi}^e + \kappa \hat{y} + \epsilon^{cp}$$

and the IS curve is

$$\hat{y} = -\gamma(\hat{i} - \hat{\pi}^e) + \epsilon^d,$$

where $\hat{\pi}$ denotes the deviation of inflation from the intended target, $\hat{y}$ denotes the deviation of output from full employment, $\hat{\pi}^e$ denotes the deviation of expected inflation from the inflation target, ϵ^{cp} is a cost-push shock, and ϵ^d is a demand shock. Suppose that the central bank's objectives are price stability and full employment. Let $\beta = 0.5$, $\kappa = 0.2$, and $\gamma = 0.3$. Suppose also that there are no shocks buffeting the economy ($\epsilon^{cp} = \epsilon^d = 0$), but that inflationary expectations are unanchored. Specifically, assume that $\hat{\pi}^e = 1$. Calculate the equilibrium values of $\hat{\pi}$, $\hat{y}$, and $\hat{i}$ under the following monetary interventions (Show your work and explain the intuition behind your results.):

1. The central bank does not intervene, $\hat{i} = 0$.

(Additional space for Exercise 2, question1, if needed.)

2. The central bank is ultra hawkish and intervenes to ensure that the inflation rate is at its target level, $\hat{\pi} = 0$.

3. The central bank is ultra dovish and intervenes to ensure full employment, $\hat{y} = 0$.

4. The central bank adopts an intermediate position and intervenes to ensure that the output gap is the mean of the ones that obtain under the ultra dovish and the ultra hawkish stances.

5. If forced to choose between the central bank that does nothing and the ultra dovish central bank, which does the ultra hawkish central bank prefer? Use a graphical analysis and explain.

6. If forced to choose between the central bank that does nothing and the ultra hawkish central bank, which does the ultra dovish central bank prefer? How would your answer change if you knew that the welfare function of the ultra dovish central bank is $-\hat{y}^2$?

7. The welfare function of the president of the country is $\hat{y}$. Which of the four policy alternatives discussed above does she prefer? Explain.

END OF HOMEWORK 1

YOUR UNI AND NAME:

Department of Economics
Columbia University

Professor Martín Uribe
Spring 2026

Homework 2

Intermediate Macroeconomics

(ECON UN3213)

Due Wednesday, February 18, before class on Gradescope

Exercise 1 (Policy-Signal Expectations). Consider an economy where the Phillips curve is

$$\hat{\pi} = \beta\hat{\pi}^e + \kappa\hat{y} + \epsilon^{cp}$$

and the IS curve is

$$\hat{y} = -\gamma(\hat{i} - \hat{\pi}^e) + \epsilon^d,$$

where $\hat{\pi}$ denotes the deviation of inflation from the intended target, $\hat{y}$ denotes the output gap, $\hat{\pi}^e$ denotes the deviation of expected inflation from the inflation target, ϵ^{cp} is a cost-push shock, and ϵ^d is a demand shock. Let $\gamma = 0.25$, $\beta = 0.5$, and $\kappa = 0.75$. Suppose also that there are no cost-push shocks ($\epsilon^{cp} = 0$), but that the economy is hit by a negative demand shock of 1 percent, that is, $\epsilon^d = -1$. Suppose that the normal nominal interest rate is 3 percent ($\bar{i} = 3$) and that the central bank does not respond to the shock ($\hat{i} = 0$).

1. Calculate the equilibrium values of $\hat{\pi}$ and $\hat{y}$ under the following two expectation formation hypotheses:

   (a) Expectations are anchored at the inflation target $\bar{\pi}$, that is, $\hat{\pi}^e = 0$.

(Additional space if needed.)

(b) Agents form expectations in a policy-signal way. Specifically, people expect that future inflation moves inversely with the nominal interest rate, $\hat{\pi}^e = -\alpha\hat{i}$, with $\alpha > 0$. Under this expectations formation hypothesis, a higher-than-normal nominal interest rate leads agents to expect lower-than-target inflation (and vice versa). Suppose that $\alpha = 0.4$.

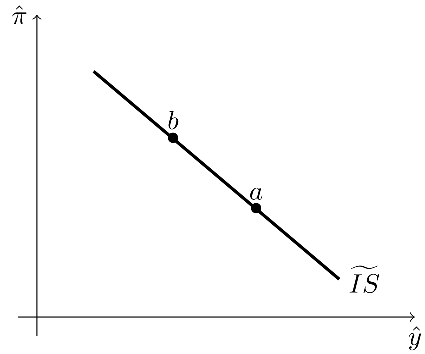
2. Provide intuition for any differences in the solution under expectation formation hypotheses (a) and (b).

3. Now assume that the central bank does intervene to bring the economy as close as possible to full employment ($\hat{y} = 0$). Calculate $\hat{\imath}$, $\hat{y}$, and $\hat{\pi}$ under the expectation formation hypotheses given in (a) and (b) above.

(Additional space if needed.)

4. Provide intuition for any differences in the solution under expectation formation hypotheses (a) and (b) when the government intervenes.

Exercise 2 (Changes in the interest rate along the modified IS curve). The figure on the next page displays the modified IS curve. State whehter the following statement is true, false, or uncertain and explain: The deviation of the nominal interest rate from its normal value ($\hat{i}$) is higher at point b than at point a.



(Additional space if needed.)

END OF HOMEWORK 2

YOUR UNI AND NAME:

Department of Economics
Columbia University

Professor Martín Uribe
Spring 2026

Homework 3

Intermediate Macroeconomics

(ECON UN3213)

Due Wednesday, February 25, before class on Gradescope

Exercise 1 (An Import Tariff Increase). Suppose the parameter of the IS curve is $\gamma = 0.5$, and the parameters of the Phillips curve are $\beta = 0.75$ and $\kappa = 0.25$. Suppose that inflationary expectations are anchored. Suppose further that import tariffs increase firms' costs according to $\epsilon^{cp} = 0.3\tau$, where ϵ^{cp} is the cost-push shock and τ is the import tariff rate. Suppose that if the import tariff is transitory, its direct impact on aggregate demand is $\epsilon^{d} = -0.4\tau$, where ϵ^{d} is a demand shock. If instead the tariff is anticipated, its direct effect on aggregate demand is $\epsilon^{d} = 0.4\tau$. Suppose that the central bank is dovish, in the sense that its objective is to keep output as close as possible to full employment ($\hat{y} = 0$). Assume that the normal nominal interest rate is 3 percent ($\bar{i} = 3$). Calculate the equilibrium values of the output gap ($\hat{y}$), the deviation of inflation from its intended target ($\hat{\pi}$), and the deviation of the nominal interest rate from its normal level ($\hat{i}$) in response to the imposition of an import tariff of 5 percent ($\tau = 5$), under the three scenarios listed below. In each case, show your work and provide intuition.

1. The import tariff is perceived as persistent or permanent.

(Additional space if needed

2. The tariff is perceived as transitory.

3. The tariff is anticipated.

END OF HOMEWORK 3

YOUR UNI AND NAME:

Department of Economics
Columbia University

Professor Martín Uribe
Spring 2026

Homework 4

Intermediate Macroeconomics

(ECON UN3213)

Due Wednesday, March 4, before class on Gradescope

Exercise 1 (The QTM). Indicate whether the following statement is true, false, or uncertain, and explain why. Over the past four decades, the average inflation rate in the United States has been 3 percent, and the average growth rate of real GDP has been 4 percent. According to the Quantity Theory of Money, the Fed must have expanded the money supply at 1 percent.

Exercise 2 (The Cagan Model and Financial Innovation). Suppose that the demand for money is given by

$$\frac{M_t^d}{P_t} = (1+i_t)^{-\eta}\frac{Y}{\Gamma_t},$$

where M_t^d is the nominal demand for money, P_t is the price level, i_t is the nominal interest rate, $\eta = 2$ is the interest semielasticity of money demand, Y is real output, and Γ_t is a trend capturing financial innovation. Think of Γ_t as capturing any innovation that allows agents to economize on their money holdings, such as the introduction of ATM machines in the late 1960s, home banking in the early 1980s, or AI-based digital banking tools in the 2020s. Suppose that people have perfect foresight. Suppose further that $Y = 1$, that Γ_t grows at 1 percent, that is, $\Gamma_{t+1} = 1.01\Gamma_t$ for $t = 0, 1, 2, \ldots$, that $\Gamma_0 = 1$, that the nominal money supply, denoted M_t, grows at 5 percent ($\mu = 0.05$), that $M_0 = 100$, and that the real interest rate is constant and equal to 3 percent ($r = 0.03$).

1. Guess that in equilibrium the real money supply, M_t/P_t, falls according to

$$M_{t+1}/P_{t+1} = \frac{M_t/P_t}{1.01},$$

for $t = 0, 1, 2, \ldots$, that is, the real money supply falls at a constant rate slightly below 1 percent. Given your guess, what is the inflation rate, π_{t+1}, in periods $t = 0, 1, 2, \ldots$.

(Additional space if needed.)

2. Calculate the nominal interest rate, i_t, in periods $t = 0, 1, 2, \ldots$

3. Check whether your guess is correct, that is, check whether, given your guess, the real demand for money, $\frac{M_t^d}{P_t}$ grows at the same rate as the real money supply, M_t/P_t.

4. What is the price level in period 0, P_0?

END OF HOMEWORK 4

YOUR NAME AND UNI:

Department of Economics
Columbia University

Professor Martín Uribe
Spring

Practice Midterm Exam

Intermediate Macroeconomics

(ECON UN3213)

Note. The exam has 75 points and you have 75 minutes to complete it.

Exercise 1 (True, False, or Uncertain (TFU)). State whether the following statements are True, False, or Uncertain, and explain why. No points will be given to answers without explanation.

1. **(TFU. 3.75 points. Shifts in the IS Curve.)** Suppose that initially $\hat{i} = \hat{\pi}^e = \epsilon^d = 0$. Suppose that the economy suffers a negative demand shock of size -1 percentage point (that is, $\epsilon^d = -1$). This causes the IS curve to shift to the left. If the central bank wishes to restore the IS curve to its initial position, it will have to cut the interest rate by 1 percentage point (that is, it will have to set $\hat{i} = -1$).

2. **(TFU. 3.75 points. Price Stickiness and the Phillips Curve.)** Suppose that when $\hat{y} = 1$, the Phillips curve implies that $\hat{\pi} = 1$. Suppose now that prices become stickier. If $\hat{y} = 1$, then the Phillips curve must now imply that $\hat{\pi} > 1$.

3. **(TFU. 3.75 points. Unanchored expectations.)** A fall in expected inflation $\hat{\pi}^e < 0$, if the government does not intervene, causes unemployment and a fall in inflation.

4. **(TFU. 3.75 points. Room for Interest Rate Cuts.)** Suppose that the normal real interest rate is 4 percent ($\bar{r} = 4$), that the inflation target is 2 percent ($\bar{\pi} = 2$), and that the deviation of the interest rate from target is -1 percent ($\hat{i} = -1$). Then, the central bank can cut the interest rate by at most 1 percentage point without violating the zero lower bound (ZLB).

5. **(TFU. 3.75 points. The QTM)** Paraguay's GDP grows at 2 percent per year on average. The government has an inflation target of 2 percent per year. An advisor suggests that the central bank should expand the money supply on average at 2 percent per year. According to the Quantity Theory of Money (QTM), this piece of advise is correct.

6. NOT RELEVANT FOR 2026 **(TFU.3.75 points. The Baumol-Tobin Money Demand Model.)** Chase Bank removed the ATM machine located in the lobby of Susan's building. The Baumol-Tobin model of money demand predicts that Susan's demand for money will go up.

Exercise 2 (15 points. Recoveries: Level Versus Growth Rate). The following table pertains to two hypothetical economies, A and B:

Quarterly Growth Rate of GDP per Capita

Time Period	A	B
1950:Q1 to 2024:Q1 (average)	3	3
2024:Q1 to 2024:Q2	-10	-10
2024:Q2 to 2024:Q3		
2024:Q3 to 2024:Q4		

In economy A, the *level* of GDP per capita recovered its trend path in 2024:Q3. In economy B the *growth rate* of GDP per capita recovered its trend path in 2024:Q3. Fill in the blanks in the table for 2024:Q3 and 2024:Q4 for economies A and B (four numbers). Briefly explain.

Exercise 3 (15 points. Demand Shocks and Monetary Policy). Consider an economy where the Phillips curve is

$$\hat{\pi} = \beta\hat{\pi}^e + \kappa\hat{y} + \epsilon^{cp}$$

and the IS curve is

$$\hat{y} = -\gamma(\hat{i} - \hat{\pi}^e) + \epsilon^d,$$

where $\hat{\pi}$ denotes the deviation of inflation from the intended target, $\hat{y}$ denotes the deviation of output from full employment, $\hat{\pi}^e$ denotes the deviation of expected inflation from the inflation target, ϵ^{cp} is a cost-push shock, and ϵ^d is a demand shock. Let $\beta = 0.75$, $\gamma = 0.25$, $\kappa = 0.3$. Suppose that there are no cost-push shocks ($\epsilon^{cp} = 0$), that inflationary expectations are anchored ($\hat{\pi}^e = 0$), and that the normal level of the nominal interest rate is 5 percent ($\bar{i} = 5$). Suppose that the economy suffers a negative demand shock of 1 percent ($\epsilon^d = -1$). Before the shock, the nominal interest rate was at its normal level ($i = \bar{i}$). In response to the adverse demand disturbance, the central bank lowers the interest rate to 3 percent ($i = 3$).

1. Find the equilibrium values of $\hat{\pi}$ and $\hat{y}$ under the central bank's response. Is it sufficient to fully achieve the dual goal of price stability and full employment?

2. If your answer to the previous question is no, what would be your advise for the level of the nominal interest rate? Show your work.

Exercise 4 (15 points. The Cagan Model and Inflation). Consider a money demand function $L(i_t, Y_t)$, where Y_t denotes output and i_t denotes the nominal interest rate. Suppose that the nominal interest rate is constant at 3 percent ($i_t = 0.03$) for $t = 0, 1, 2, \ldots$, and that output is 100 ($Y_t = 100$) for $t = 0, 1, 2, \ldots$. Suppose further that the money supply, M_t, grows at 1 percent per period ($M_{t+1} = (1 + 0.01)M_t$) for $t = 0, 1, 2, \ldots$.

1. What is the inflation rate in periods $t = 1, 2, 3, \ldots$? To answer this question, do you need to make any assumptions about how inflation expectations are formed? Explain.

2. Assuming that agents have perfect foresight, what is the real interest rate for $t = 1, 2, \ldots$?

Exercise 5 (7.5 points The Fiscal Deficit and the Inflation Tax). Suppose the demand for real money balances is of the form

$$\frac{M_t^d}{P_t} = \frac{Y}{1+i_t}$$

where M_t^d is the demand for nominal money balances in year t, P_t is the price level in year t, i_t is the nominal interest rate in year t, and Y is real output assumed to be constant and equal to 1. Suppose that the money growth rate, denoted μ, is constant and equal to 70 percent per year, so that $M_t = 1.7 \times M_{t-1}$, for $t = 0, 1, 2, \ldots$, where M_t denotes the nominal money supply in year t. Assume further that the real interest rate, denoted r, is 4 percent per year, that the real fiscal deficit, denoted DEF, is constant, and that the government has exhausted its ability to finance it issuing debt. Finally, suppose people have rational expectations. Calculate the real fiscal deficit, DEF, that the government is financing with the inflation tax.

END OF EXAM

YOUR UNI AND NAME:

Department of Economics
Columbia University

Professor Martín Uribe
Spring 2026

Homework 5

Intermediate Macroeconomics

(ECON UN3213)

Not graded, but covered on the midterm

Exercise 1 (Fiscal Deficits and the Inflation Tax I). Suppose that the demand for money is of the form

$$L(i_t, Y) = AYe^{\alpha - \frac{\gamma i_t}{1+i_t}},$$

where Y denotes real income, i_t denotes the nominal interest rate, and $A > 0$, α, and $\gamma > 1$ are parameters. Suppose that the real fiscal deficit is constant and equal to DEF. Suppose that agents have rational expectations and that the central bank expands the money supply at the constant rate μ, that is

$$M_t = (1 + \mu)M_{t-1},$$

where M_t denotes the money supply in period t. Finally, suppose that the real interest rate is nil ($r = 0$).

1. Let μ^* be the money growth rate that maximizes the government's inflation-tax revenue. Find μ^* as a function of DEF, Y, A, α, and γ.

(Additional space if needed.)

2. Suppose that $\mu = \mu^*$. Suppose that time is measured in years. Suppose further that $A = 1.5$, $\alpha = 1$, and $\gamma = 6$. Compute μ^*. What is the rate of inflation? What is the deficit-to-income ratio (DEF/Y) that can be financed with the inflation tax rate μ^*?

3. **(Bonus Question 1, not tested in midterm.)** Continue to assume that $A = 1.5$, $\alpha = 1$, and $\gamma = 6$. Suppose further that the fiscal deficit is 5 percent of GDP ($DEF/Y = 0.05$). Can this level of fiscal imbalance be financed with a finite rate of money creation? If so, let $\bar{\mu}$ be the rate of money growth that finances this level of deficit. Compute $\bar{\mu}$. It might not be possible to find a closed-form solution for $\bar{\mu}$ because the model might be too nonlinear. In this case, use a calculator and proceed as follows: Let μ^{upper} be an upper bound for $\bar{\mu}$, that is, μ^{upper} is a money growth rate that finances a deficit-to-GDP ratio larger than 5 percent. Similarly, let μ^{lower} be a lower bound for $\bar{\mu}$ in the sense that it finances a deficit-to-GDP ratio less than 5 percent. You can start with any pair of bounds. For example, you can use $\mu^{upper} = \mu^*$ and $\mu^{lower} = 0$. These picks for μ^{upper} and μ^{lower} are two known numbers, since you already computed μ^*. Then, continue as follows:

   (a) Set $\mu^{try} = (\mu^{upper} + \mu^{lower})/2$. This is a number.

   (b) Compute the inflation-tax revenue as a ratio of GDP associated with μ^{try}, that is $\frac{\mu^{try}}{1+\mu^{try}} L((1 + r)(1 + \mu^{try}) - 1, Y)/Y$. Call this number $(DEF/Y)^{try}$.

   (c) If $(DEF/Y)^{try}$ differs from 5 percent by less than 1 tenth of one percent (i.e., if $|(DEF/Y)^{try} - 0.05| < 0.001$, then you found $\bar{\mu}$ and the procedure is completed.

   (d) Otherwise, if $(DEF/Y)^{try} - 0.05 > 0.001$, update the upper bound by setting $\mu^{upper} = \mu^{try}$, and if $(DEF/Y)^{try} - 0.05 < -0.001$, update the lower bound by setting $\mu^{lower} = \mu^{try}$. Go to step 3a and perform another round of this procedure.

(Additional space if needed.)

4. **(Bonus Question 2, not tested in midterm.)** Modify the numerical algorithm to find the second money growth rate that finances a deficit of 5 percent of GDP, the one on the 'wrong' side of the Laffer curve.

Exercise 2 (Fiscal Deficits and the Inflation Tax II). Suppose the demand for money is given by

$$L(i_t, Y) = \left(0.24 - 0.36\,\frac{i_t}{1+i_t}\right) Y,$$

where i_t denotes the nominal interest rate, and Y denotes real GDP. GDP is assumed to be constant. Suppose that the real interest rate is zero ($r = 0$) and that agents have perfect foresight.

1. Find the money growth rate μ that maximizes inflation-tax revenue, denoted μ^*. (Hint: Let $x \equiv \frac{\mu}{1+\mu}$. First find the value of x that maximizes inflation-tax revenue. Then determine the corresponding value of μ^*.)

(Additional space if needed.)

2. What is the fiscal-deficit-to-GDP ratio, DEF/Y, that can be monetized at μ^*?

3. Suppose the fiscal-deficit-to-GDP ratio is 2.5 percent. Find the money growth rate μ required to monetize this level of fiscal deficit.

END OF HOMEWORK 5

YOUR NAME AND UNI:

Department of Economics
Columbia University

Professor Martín Uribe
Spring 2026

Homework 6

Intermediate Macroeconomics

(ECON UN3213)

Due Wednesday, April 1, before class on Gradescope

Exercise 1 (The Government's Intertemporal Budget Constraint). Consider a 2-period economy. The government levies lump-sum taxes T_1 and T_2 in periods 1 and 2. Suppose that $T_2 = 2.1$. Government spending is $G_1 = 3$ and $G_2 = 1$. The initial level of debt is nil ($B_0 = 0$), and the interest rate in period 1 is 10 percent ($r_1 = 0.1$).

1. Calculate T_1. What is the primary deficit in period 1?

(Additional spece if needed.)

2. Calculate the level of public debt in period 1, B_1. Explain why its sign makes sense.

3. What is the (overall) fiscal deficit in period 2?

4. Suppose now that the government decides to balance the primary deficit in period 1. What is the new value of the public debt in period 1, B_1? What is the new fiscal deficit in period 2? Explain the intuition behind your result.

Exercise 2 (The Investment Schedule). Suppose that the firm's production function is of the form

$$f(I_1) = AI_1^\alpha$$

where $A > 0$ and $\alpha \in (0, 1)$ are parameters. Let r_1 denote the real interest rate in period 1.

1. Derive the investment schedule. Show your work.

(Additional space, if needed.)

2. The parameter A measures the level of technological progress. Technological innovations cause A to increase. Suppose that A increases to $A' > A$. Using a graph, show how this technological improvement affects the investment schedule.

(Additional spece, if needed.)

The following exercise will not be graded, but will be discussed in recitations and office hours.

Exercise 3 (True, False, or Uncertain (TFU)). State whether the following statements are true, false, or uncertain and explain.

1. Consider a 2-period economy. The initial public debt is zero ($B_0 = 0$). The primary deficit is zero in both periods. This government satisfies its intertemporal budget constraint.

2. Consider a 2-period economy. The initial public debt is zero ($B_0 = 0$). The government runs primary surpluses in both periods. This government does not satisfy its intertemporal budget constraint.

3. If the real interest rate in period 1 is zero ($r_1 = 0$), then the firm's optimal level of investment in period 1 is infinite ($I_1 \to \infty$).

END OF HOMEWORK 6

YOUR NAME AND UNI:

Department of Economics
Columbia University

Professor Martín Uribe
Spring 2026

Homework 7

Intermediate Macroeconomics

(ECON UN3213)

Due Thursday, April 9, at noon on Gradescope

Exercise 1 (Lump-Sum Taxes and Government Spending). Consider a two-period economy. Households preferences are described by the utility function

$$\ln C_1 + \ln C_2,$$

where C_1 denotes consumption in period 1 and C_2 denotes consumption in period 2. In period 1, households receive an endowment $Y_1 = 50$. In period 2, households receive profits from firms that they own, denoted Π_2. Households pay lump-sum taxes T_1 and T_2 in periods 1 and 2, respectively, and can save or borrow at the interest rate r_1. Firms borrow funds in period 1 to invest I_1 units of goods in physical capital. In period 2, firms produce output using the technology

$$\text{output in period 2} = 10\sqrt{I_1}$$

and pay back their loans. Firms maximize profits and distribute them to households. The government levies lump-sum taxes to households in the amounts T_1 and T_2 in periods 1 and 2, respectively. Taxes in period 1 equal 1 ($T_1 = 1$). The government consumes $G_1 = 2$ units of goods in period 1 and $G_2 = 0$ in period 2.

1. Derive the investment schedule, $I_1 = I(r_1)$ and profits, $\Pi(r_1)$.

(Additional space, if needed.)

2. The saving schedule was derived in class. Evaluate it using the numerical values of Y_1, G_1, and G_2, together with the profit function $\Pi(r_1)$ derived in the previous question. This should yield a function of the interest rate r_1 alone.

3. Find the equilibrium interest rate, r_1, investment, I_1 and consumption in period 1, C_1. Your answer should be three numbers. Show your work.

4. Suppose now the government embarks on a massive spending program in period 1. As a result we now have $G_1 = 23$. Find the new equilibrium levels of the interest rate, investment, and consumption in period 1. Provide intuition.

END OF HOMEWORK 7

YOUR NAME AND UNI:

Department of Economics
Columbia University

Professor Martín Uribe
Spring 2026

Homework 8

Intermediate Macroeconomics
(ECON UN3213)
Due Wednesday, April 15, before class on Gradescope

Exercise 1 (Consumption Taxes). Consider a two-period economy. Households preferences are described by the utility function

$$\ln C_1 + \ln C_2,$$

where C_1 denotes consumption in period 1 and C_2 denotes consumption in period 2. In period 1, households receive an endowment $Y_1 = 4$. In period 2, households receive profits from firms that they own, denoted Π_2. Households pay consumption taxes in periods 1 and 2. The consumption tax rates are denoted τ_1 and τ_2. The consumption tax rate in period 1 is 25 percent ($\tau_1 = 0.25$). Government spending is 1 in period 1 and 0.2 in period 2 ($G_1 = 1$ and $G_2 = 0.2$). The government and households can borrow or lend at the interest rate r_1. Firms borrow funds in period 1 at the interest rate r_1 to invest I_1 units of goods in physical capital. In period 2, firms produce output using the technology

$$\text{output in period } 2 = 2\sqrt{I_1}$$

and pay back their loans. Firms maximize profits and distribute them to households.

1. Calculate the equilibrium interest rate, r_1, investment, I_1, consumption in periods 1 and 2, C_1 and C_2, and the consumption tax rate in period 2, τ_2. Show your work.

(Additional space, if needed.)

2. Suppose now that the government cuts the consumption tax rate in period 1, τ_1, from 25 percent to 20 percent. Calculate the equilibrium values of r_1, I_1, C_1, C_2, and τ_2. Provide Intuition.

END OF HOMEWORK 8

YOUR NAME AND UNI:

Department of Economics
Columbia University

Professor Martín Uribe
Spring 2026

Homework 9

Intermediate Macroeconomics
(ECON UN3213)
Due Wednesday, April 22, before class on Gradescope

Exercise 1 (An Economy with Financial Constraints and Distortionary Taxes). Consider a two-period economy in which, due to a malfunctioning financial sector, households are unable to borrow or lend ($S_1^p = 0$). Suppose that in period 1 income is given by $Y_1 = 3$. The government levies consumption taxes in periods 1 and 2. The consumption tax rate in period 1 is 50 percent ($\tau_1 = 0.5$). Government spending in periods 1 and 2 is given by $G_1 = 0.4$ and $G_2 = 0.36$. Suppose that output is produced with the production function

$$\text{Output in period } 2 = 1.16 I_1 - 0.1 I_1^2$$

1. Calculate investment in period 1 (I_1), the interest rate (r_1), consumption in periods 1 and 2 (C_1 and C_2), and the consumption tax rate in period 2, τ_2 (note that if $\tau_2 < 0$, then the government is subsidizing consumption in period 2).

(Additional space, if needed.)

2. Suppose the household's utility function is of the form

$$\ln C1 + \ln C2.$$

At the given value of τ_1 and the values of τ_2 and r_1 you obtained in the previous question, how much would the household consume in periods 1 and 2 if it were not financially constrained? Provide intuition. Hint: This question does not ask you to compute the equilibrium without financial constraints, but only the optimal level of consumption without such constraints, given the values of r_1, τ_1, and τ_2 obtained in the previous question. If needed to compute C_1 and C_2, use the value for profits corresponding to the previous question.

(Additional space, if needed.)

Exercise 2 (Distortionary Taxes and a Balanced-Budget Rule). Consider a two-period economy in which the government levies a consumption tax and follows a balanced-budget rule. Let τ_1 and τ_2 be the consumption tax rates in periods 1 and 2. Suppose that the consumption tax rate in period 1 is 10 percent ($\tau_1 = 0.1$) and that government spending is $G_1 = 1$ in period 1 and $G_2 = 0.8$ in period 2. Suppose that in period 1 households receive an endowment $Y_1 = 15$.

1. Calculate the equilibrium values of period-1 consumption, C_1, period-1 saving, S_1, and period-1 investment, I_1.

(Additional space, if needed.)

2. Firms produce output in period 2 using the technology

$$\text{Output in period 2 } = 4.4\sqrt{I_1}.$$

Find the real interest rate, r_1.

3. Find consumption in period 2, C_2, and the consumption tax rate in period 2, τ_2.

END OF HOMEWORK 9

YOUR NAME AND UNI:

Department of Economics
Columbia University

Professor Martín Uribe
Spring 2026

Homework 10

New Questions and Practice Questions for the Final Exam

Intermediate Macroeconomics

(ECON UN3213)

Due Wednesday, April 29, before class, via Gradescope

Answer all questions. A subset of them will be graded.

Note. Write your answers in the space provided for each question.

Exercise 1 (True, False, or Uncertain (TFU)). State whether the following statements are true, false, or uncertain and explain.

1. (TFU, xxx points.) Suppose that government spending and lump-sum taxes increase by 100 (that is, $\Delta G_1 = \Delta T_1 = 100$). This fiscal policy leaves the primary fiscal deficit unchanged, but is likely to cause an increase in the interest rate ($\Delta r > 0$) and a contraction in investment ($\Delta I_1 < 0$).

2. (TFU, xxx points.) A firm has the production function $2\sqrt{I_1}$ and invests 4 units in period 1 ($I_1 = 4$). The real interest rate is 0 ($r_1 = 0$). This firm makes zero profits.

3. (TFU, xxx points.) Continuing with the firm with the production function $2\sqrt{I_1}$ that invests 4 units in period 1 ($I_1 = 4$), with the real interest rate equal to 0 ($r_1 = 0$). This firm is investing the optimal amount.

4. (TFU, xxx points.) Suppose that half of the population lives for only one period and the other half is borrowing constrained. If the government cuts lump-sum taxes by 1 in period 1, then all households increases consumption by 1 in period 1.

5. (TFU, xxx points.) All else equal, an appreciation of the U.S. dollar is likely to reduce its net international investment position (NIIP) through valuation effects.

6. (TFU, xxx points.) According to the Dark Matter hypothesis, the Chinese statistics overestimate the level of China's net international investment position (NIIP).

7. (TFU, xxx points.) Saving and investment are stock variables, but the difference between saving and investment (the current account) is a flow variable.

Exercise 2 (Investment Schedule). Consider a 2-period closed economy model with production. Suppose firms borrow in period 1 at the interest rate r_1 to finance investment in physical capital, I_1, which becomes productive in period 2. The production function in period 2 is given by $\frac{1}{\alpha} I_1^{\alpha}$.

1. (xxx points.) For what range of values of α is the production function nonnegative and increasing in I_1?

2. (xxx points.) For what range of values of α is the marginal product of capital diminishing in I_1?

3. (xxx points.) For the remainder of this exercise assume that α is such that the production function is strictly increasing and the marginal product is diminishing. State the firm's profit-maximization problem.

4. (xxx points.) Find the investment schedule, $I(r_1)$.

5. (xxx points.) Show that the investment schedule is decreasing.

Exercise 3 (Borrowing Constraints and Consumption Taxes). Consider a two-period economy in which households face the borrowing constraint $S_1^p \geq 0$. Suppose that the constraint is binding. In period 1, the household receives an exogenous endowment of goods $Y_1 = 50$, and the government levies a proportional tax on consumption at the rate $\tau_1 = 0.25$ and has expenditures in goods and services in the amount $G_1 = 2$. Firms borrow in period 1 at the interest rate r and use the funds to invest in physical capital, denoted I_1. Investment becomes productive in period 2. The investment schedule is

$$I_1 = \frac{12.5}{(1+r)^2}.$$

1. (xxx points.) Calculate private consumption in period 1 (C_1), government saving in period 1 (S_1^g), and national saving in period 1 (S_1).

2. (xxx points.) Calculate the equilibrium real interest rate (r).

Exercise 4 (Dark Matter Versus Return Differentials). Suppose net investment income is $NII = 300$, the net international investment position is $NIIP = -2000$, the international liability position is $L = 5000$, and the interest rate on international liabilities is 4 percent ($r^L = 0.04$).

1. (xxx points.) Economic consultant Jim Taylor, a strong advocate of the return differential hypothesis, maintains that the rate of return on the country's international assets, denoted r^A, is different from the return on its net international liabilities, r^L. Find the value of r^A consistent with Taylor's view.

2. (xxx points.) Economist Carol Powell does not support the idea of return differentials. Instead, she defends the dark matter hypothesis. Specifically, she believes that A is not accurately recorded and that the rate of return is 4 percent on both A and L. Calculate the amount of dark matter and the 'true' international asset position, which we will denote TA, consistent with Powell's view.

Exercise 5 (xxx points. CA Sustainability). Consider a two-period open economy. Suppose that the initial net asset position of the country is -1 ($B_0 = -1$) and that the net asset position in period 1 is 2 ($B_1 = 2$). Suppose further that the interest rate is 10 percent ($r = 0.1$). Find the trade balance and the current account in periods 1 and 2 (TB_1, CA_1, TB_2, and CA_2).

END OF HOMEWORK 10