Akila Weerapana
Wellesley College
Spring '13-'14

ECONOMICS 331: Seminar on Monetary Theory and Policy

Economics 331 is a seminar course that focuses on theoretical and practical aspects of conducting monetary policy. Classes meet on Tuesdays and Fridays from 2.50 p.m. to 4 p.m. in PNE 339. We will also be meeting on Wednesdays in the ALT-2 time slot from 3.35-4.45 pm. A solid understanding of the topics covered in Economics 202 is essential for your success in this course. Economics 203 is also a pre-requisite for this course; if you are concurrently taking Economics 203, and there is space in the class, I may allow you to take the course **but only at my discretion**.

The plethora of unconventional policy responses that the Federal Reserve implemented in response to the 2008 crisis (and the subsequent sluggish recovery) has led to a resurgence of interest in the theory and practice of monetary policy amongst both academics and policy makers. In the era between 1982 and 2007, there was a strong symbiotic relationship between monetary policymakers and academic economists. On the theoretical front, economists made significant breakthroughs in developing macroeconomic models that help establish core principles of good monetary policy making. On the practical front, policymakers in many countries adopted new methods of conducting monetary policy that were successful in maintaining low inflation rates and in reducing economic volatility. At the same time, there was considerable praise for the role played by the Federal Reserve in sustaining the economic expansion known as the Great Moderation, a period of prosperity with low inflation and steady growth that began in the mid 1980s and continued until 2007 with the only interruptions being two relatively mild recessions in 1990/91 and 2001. The global financial crisis and the subsequent deep recession ended this period of relative calm in the economy and substantially reduced the reputation of academic economists but arguably also negatively impacted the reputation of the Fed at least in the eyes of some influential analysts and policymakers.

In the aftermath of the 2008/09 financial crisis and recession Ben Bernanke and the Federal Reserve found that monetary policy was being constrained by reaching the zero lower bound on interest rates and put in place an array of unconventional policies to deal with a sluggish economy in the face of this constrained policy response. The quantitative easing programs of the Fed and the unprecedented scale and scope of the lending programs the Fed put in place after the financial crisis has led to many questions about whether the Fed was overstepping its Congressional mandates and whether they had lost control of the Fed's balance sheet. Similarly academic economists had to face many self-examining questions such as whether the models they use to study the economy did an adequate job of incorporating financial markets and the resultant imperfections that led to asset bubbles, overborrowing, imprudent risk-taking and runs on liquidity that all churned the global economy in the aftermath of 2007.

What this all means, particularly now that Janet Yellen is succeeding Ben Bernanke, is that the time is ripe for a course in monetary theory and policy. This is only enhanced by looking outside the United States where the ever expanding and ever struggling currency union in Europe raises questions for the ECB about the conduct of monetary policy, and when emerging economies like China, India, and Brazil have moved away from fixed exchange rate regimes and need to develop credible monetary policy making institutions. In this class we will explore issues in these two categories - the theory and the practice of monetary policy - in more detail. You will be asked to learn and find yourself tested in a variety of ways. We will develop economic models and analyze their implications in increasingly sophisticated settings. We will read complicated academic journal articles and discuss them in class, You will also be asked to do a couple of small empirical projects that require you to do data analysis, and last but not least, you will be asked to read and analyze details of actual programs and the underlying motivations of the Federal Reserve.

This will be one of the most challenging courses you will take at Wellesley but I also hope that it will be one of the more rewarding courses too. Please do not take this course lightly and make sure that you are willing to commit a lot of time and effort towards it. Your success in this class is extremely important to me; I will be available for consultation more often than not but the key is whether you are willing to devote the time and effort needed to succeed in this class.

OFFICE HOURS

E-Mail : aweerapana@wellesley.edu (Prompt responses to questions sent at a reasonable hour)

Office : PNE 408 (Phone: x2300)

Office Hours : Wednesday and Thursday 1-3 pm (every week). Other times by appointment.

Course Conference : We will be using a Google Site where copies of problem sets, solution sets etc. as well as discussion forums will be maintained. The site is called Econ-331-01 SP-14 and can be found under the Sites tab on your Google page.

TEXTBOOK

Since this is an upper-level seminar course, most of the material discussed will be in the form of papers in academic economic journals.

I would, however, recommend that you acquire two books: *Monetary Policy Strategy* by Rick Mishkin (≈ $25.00 from the Bookstore or Amazon.com) and *The Alchemists: Three Central Bankers and a World on Fire* by Neil Irwin (≈ $15.00 from Amazon.com). The Mishkin text is a good supplement on the more technical side and the Irwin book a good supplement on the more popular press side to what we will cover in class.

Most research papers will be available electronically through electronic journals that Wellesley subscribes to. Photocopies of any articles that are not available through an online service will be made available to you.

COURSE REQUIREMENTS

Homework [25%]:

- This class will be work intensive. I will assign 6 homework assignments over the course of the semester: These homework assignments will constitute 25% of your grade.
- Homework assignments can take the form of traditional problem sets, short essays or empirical projects (or a mix of each) You will have 1 week to do most problem sets (2 weeks if there is a substantial empirical component).
- Late problem sets will suffer a penalty of 25% of eligible points for each day (or portion of a day) that they are late.
- You must bring any grade-related discrepancies to my attention within a week after the graded assignments are returned to you.
- You are encouraged to work on assignments with classmates but you MUST hand in your own uniquely written up assignment.

Midterms [25% each]: Midterm exams will be take-home, week-long, open-book examinations that require 15-20 hours of work. If this seems daunting to you, remind yourselves again that the exam is open book. If you add up all the time you spend studying for a typical 70 minute in-class, closed-book exam, you would (or should!) find that you spend 15 hours or so for a typical exam. So this is not a dramatic change! Exams are challenging, make no mistake about it, but they will be integral to your learning process.

The first midterm exam may be picked up in class either on Tuesday, March 11th, or Wednesday, March 12th and returned 7 days later.

The second midterm exam may be picked up in class either on Tuesday, April 22nd, or Wednesday, April 23rd and returned 7 days later. Each exam will constitute 25% of your grade

Final Project [15%]: The final project for this course asks you to analyze, in detail, one of the numerous policy responses that the Federal Reserve put in place following the 2008/09 recession. This could include any one of the QE programs, the decision to connect future interest rate changes to the state of the economy, any of the extraordinary liquidity provision programs put in place to assist the recovery of financial markets, the bailout of AIG, the regulation of the financial system under the new Dodd-Frank bill, the decision to coordinate with foreign central banks to provide more dollar liquidity to the global financial system etc. I would expect you to work individually to generate a well-written 6-8 page paper that provides a clear assessment of the program and what you think its effectiveness was (or will be). I will also allow you to work on a topic in pairs, provided both parties agree affirmatively to resolve inter-personal conflicts without my intervention. The length and scope of the paper for a two-person project will be greater than for a single person project but nowhere near twice as much.

Class Participation [10%]: It is imperative that assigned readings are completed and assigned questions prepared before you come to class; in a seminar your lack of preparation will not only hurt you but also affect the overall quality of the class. If you miss a class meeting, then answers to assigned questions have to be written up and handed in before the next class to avoid losing 1/10th of your participation grade. My goal is to have interesting and intellectually stimulating class meetings and your participation is essential towards this end. I reserve the right to reward students who do extremely well on the final and/or show a pattern of sustained improvement throughout the semester.

GRADING

Your course grade will depend on two factors: i) the total number of points you have at the end of the semester and ii) how well your total score compares to the class as a whole. There is no rationing of A grades (nor of C grades!). I will give letter grades on midterms and finals purely for informational purposes; I will average your point scores, not your letter grades at the end of the semester (i.e. someone who scores 80/100 on the midterm may get the same letter grade as someone who scored 77/100. However, the 80/100 will be more advantageous at the end of the semester).

UPDATED SYLLABUS FOR ECON 331

DATE	READINGS	TOPICS
	SECTION I: Monetary Policy in a Simple Model of the Macroeconomy	
Tuesday, Jan 28th	Yellen *NABE Speech 2013*	**1. INTRO MODEL I:** Introduction to Economics 331
Friday, Jan. 31st	Weerapana *IS/MP Handout*	**2. INTRO MODEL II:** The IS-MP Model and Monetary Policy
Tuesday, Feb. 4th	Weerapana *IS/MP Handout*	**3. INTRO MODEL III** Short Run Equilibrium in the IS-MP Model
Wednesday, Feb. 5th *[Alt Class 1]*	Weerapana *AD/IA Handout*	**4. INTRO MODEL IV:** The AD-IA Model
Friday, Feb. 7th *[PS 1 handed out]*	Weerapana *AD/IA Handout*	**5. INTRO MODEL V:** Policy Analysis Using the AD-IA Model
	SECTION II: Further Developments of Core Principles and Concepts	
Tuesday, Feb. 11th	Gordon *Economica 2011*	**6. INTRO MODEL VI:** Weaknesses of the AD-IA Model
Friday, Feb. 14th *[PS 2 handed out]*	Gordon *Economica 2011*	**7. CORE I:** The Phillips Curve
Tuesday, Feb. 18th	Gordon *Economica 2011*	**8. CORE II:** Empirical Assessment of The Phillips Curve
Wednesday, Feb. 19th *[Alt Class 2]*	Mishkin *NBER 1996*	**9. CORE III:** The Channels of Monetary Policy Transmission
Friday, Feb. 21st	Romer & Romer *AER 2004*	**10. CORE IV:** The Impact of Monetary Policy
Tuesday, Feb. 25th		**11. CORE V:** Term Structure and Expectations Hypothesis
Friday, Feb. 28th	Landstrom *Working Paper 2009*	**12. CORE VI** Central Bank Independence
Tuesday, Mar. 4th *[PS 3 handed out]*		**13. CORE VII:** Rules vs. Discretion in Monetary Policy
Wednesday, Mar. 5th *[Alt Class 3]*	NO CLASS MEETING	
Friday, Mar. 7th	Barro & Gordon *JME 1983*	**14. CORE VIII** The Importance of Reputation
	SECTION III: The Conduct of Monetary Policy	
Tuesday, Mar. 11th *[MT 1 Handed Out]*	Bernanke & Mishkin *JEP 1997*	**15. CONDUCT I:** Inflation Targeting in Theory
Friday, Mar. 14	Ball & Sheridan *NBER 2003*	**16. CONDUCT II:** Inflation Targeting in Practice
Tuesday, Mar. 18th *[PS 4 Handed Out]*	Kozicki *EPR-KC 1999*	**17. CONDUCT II:** Simple Monetary Policy Rules
Wednesday, Mar. 19th *[Alt Class 4]*	**NO CLASS MEETING**	
March 21st-28th	**No Class Meetings: SPRING BREAK**	

DATE	READINGS	TOPICS
Tuesday, Apr. 1st	Taylor *MPR Book* 1999	**18. CONDUCT III:** Historical Analysis Using Policy Rules
Friday, Apr. 4th		**CONDUCT IV:** Guest Lecture from Prof. Dan Sichel
	SECTION IV: The Zero Lower Bound in a Simple Macro Model	
Tuesday, Apr. 8th *[PS 5 handed out]*	Weerapana *ZLB Handout*	**19. ZLB MODEL I:** The Zero Lower Bound
Wednesday, Apr. 9th *[Alt Class 5]*	Weerapana *ZLB Handout*	**20. ZLB MODEL II:** The AD-IA Model in the ZLB
Friday, Apr. 11th	Bernanke, Reinhart & Sack *AER 2004*	**21. ZLB MODEL III:** Macroeconomic Policy and the ZLB
	SECTION V: Theoretical and Practical Challenges for the Future	
Tuesday, Apr. 15th	Clarida, Gali & Gertler*JEL 1999*	**22. CHALLENGES I:** The New Keynesian Model
Friday, Apr. 18th	Clarida, Gali & Gertler*JEL 1999*	**23. CHALLENGES II:** Comparing the New Keynesian and AD-IA frameworks
Tuesday, Apr. 22nd *[Midterm 2 handed out]*	**No Class Meeting: MONDAY SCHEDULE**	
Wednesday, Apr. 23rd *[ALT Class 6]*	Clarida, Gali & Gertler*JEL 1999*	**24. CHALLENGES III:** Policy Analysis in the New Keynesian Framework
Friday, Apr. 25th	Romer & Romer *NBER 2010*	**25. CHALLENGES IV:** The Accuracy of Forecasts
Tuesday, Apr. 29th *[PS 6 handed out]*	Bernanke & Gertler *NBER 2000*	**26. CHALLENGES V:** Asset Bubbles and Monetary Policy
Friday, May 2nd	Gagnon et al. *NY Fed 2010*	**27. CHALLENGES VI:** Assessing the Impact of Quantitative Easing
Tuesday, May 6th	Blinder *St. Louis Fed 2009*	**28. CHALLENGES VII** Unwinding the Fed's Balance Sheet
Friday, May 9th		**29. CHALLENGES VIII:** Wrap Up

Lecture 1: Seminar on Monetary Theory and Policy

I. INTRODUCTION

- Economics 331 is a seminar course that will cover some of the latest developments in two areas: the theory of monetary economics and the conduct of monetary policy.

- In this class we will explore issues in these two categories - the theory and the practice of monetary policy - in more detail. You will be asked to learn and find yourself tested in a variety of ways. We will develop economic models and analyze their implications in increasingly sophisticated settings. We will read complicated academic journal articles and discuss them in class, You will also be asked to do a couple of small empirical projects that require you to do data analysis, and last but not least, you will be asked to read and analyze details of actual programs and the underlying motivations of the Federal Reserve.

- The plethora of unconventional policy responses that the Federal Reserve implemented in response to the 2008 crisis (and the subsequent sluggish recovery) has led to a resurgence of interest in the theory and practice of monetary policy amongst both academics and policy makers.

- In the era between 1982 and 2007, there was a strong symbiotic relationship between monetary policymakers and academic economists. On the theoretical front, economists made significant breakthroughs in developing macroeconomic models that help establish core principles of good monetary policy making. On the practical front, there was considerable praise for the role played by the Federal Reserve in sustaining the economic expansion known as the Great Moderation, a period of prosperity with low inflation and steady growth that began in the mid 1980s and continued until 2007 with the only interruptions being two relatively mild recessions in 1990/91 and 2001.

- At the same time, policymakers in many countries adopted new methods of conducting monetary policy that were successful in maintaining low inflation rates and in reducing economic volatility.

- The global financial crisis and the subsequent deep recession ended this period of relative calm in the economy and substantially reduced the reputation of academic economists but arguably also negatively impacted the reputation of the Fed at least in the eyes of some influential analysts and policymakers.

- In the aftermath of the 2008/09 financial crisis and recession Ben Bernanke and the Federal Reserve found that monetary policy was being constrained by reaching the zero lower bound on interest rates and put in place an array of unconventional policies to deal with a sluggish economy in the face of this constrained policy response.

- The quantitative easing programs of the Fed and the unprecedented scale and scope of the lending programs the Fed put in place after the financial crisis has led to many questions about whether the Fed was overstepping its Congressional mandates and whether they had lost control of the Fed's balance sheet. Similarly academic economists had to face many self-examining questions such as whether the models they use to study the economy did an adequate job of incorporating financial markets and the resultant imperfections that led to asset bubbles, overborrowing, imprudent risk-taking and runs on liquidity that all churned the global economy in the aftermath of 2007.

- What this all means, particularly now that Janet Yellen is succeeding Ben Bernanke, is that the time is ripe for a course in monetary theory and policy. This is only enhanced by looking outside the United States where the ever expanding and ever struggling currency union in Europe raises questions for the ECB about the conduct of monetary policy, and when emerging economies like China, India, and Brazil have moved away from fixed exchange rate regimes and need to develop credible monetary policy making institutions.

II. REPLACING BEN BERNANKE

- Next to the stock market, monetary policy is the area of economics that has most captured the public interest. Monetary policy changes initiated by the Federal Reserve are covered in great detail in newspapers, and transition of the Chairmanship of the Fed is always one of the most closely watched economic stories of the year.
- The Chair of the Fed is acknowledged as being the most powerful figure as far as the U.S. economy is concerned. This is particularly true for each of the last two chairs: Ben Bernanke and Alan Greenspan.
- We are particularly fortunate to witness an historic transition this year, the ascendancy, on January 31st 2014, of Janet Yellen to become the first woman to Chair the Federal Reserve. Janet Yellen will clearly become the most powerful person in the American economy, every word she speaks will be closely scrutinized by the press, financial markets await her actions and decisions with regard to tapering and quantitative easing with bated breath and no politician in power could ever dream of trying to impose his/her will to make Janet Yellen do their own bidding.
- In the late 1990s when the economy was booming, it would not be an exaggeration to say that Alan Greenspan was idolized as the man responsible for the nation's unprecedented economic prosperity. However once the economy started slumping in 2005/06, then suffered a financial crisis in 2007/08 and entered into the deepest recession since the Great Depression, Greenspan's aura took a beating. Some people criticized Greenspan for keeping interest rates too low for too long, encouraging the formation of a real estate bubble. Others criticized Greenspan for lax policies regarding regulation of banks and the excesses of financial institutions.
- Much of the subsequent dramatic policy response of the Fed to the financial crisis and the great recession occurred under the watch of Ben Bernanke. As the country's leading scholar of the monetary response to the great recession Bernanke was the least controversial and most suitable person for the role that he ended up playing.
- However, that did not mean that Bernanke's tenure has been one long honeymoon period. There have been several different lines of criticism of the Federal Reserve under Bernanke's tenure. There are those who think the Fed has done too much in terms of printing too much money, expanding its balance sheet excessively and overstepping its congressional mandate

in interventions to bail out Bear Stearns, AIG and various other troubled financial institutions/sectors. Yet others criticize the Fed for doing too little to help the economy grow. They argue that the Fed should have engaged in more unconventional monetary policies in the face of the challenges posed by the zero lower bound (ZLB) on interest rates.

- Along with this increased scrutiny of the Fed has come greater skepticism about academics working on monetary policy. There is an increased emphasis placed on understanding how the predictions of economic models would change when we factor in complications like the zero lower bound on interest rates, excessive risk-taking behavior in the banking sector and strong international linkages across countries.

- This course will introduce you to the features of good monetary policy making drawing on academic research and on practical policy making experience. We will cover many important topics that are relevant to current economic conditions in the U.S., Japan, Europe as well as other developed and developing countries. The primary tool of learning will be academic research papers, which are often technically quite challenging as well as being very densely written. Therefore, this class is only recommended for majors who were very comfortable with their intermediate level theory courses: 200, 201 and 202.

III. OVERVIEW OF TOPICS

- What are some of the issues that we will cover in this class? First, we want to establish some basic principles of good monetary policymaking.

- This will basically involve reviewing some of the topics covered in Economics 202, albeit with a different macroeconomic model than what you are used to from your intermediate classes. In the first two weeks of class we will use a model called the Aggregate Demand/Inflation Adjustment model that is basically a spin off of the IS-LM and AD/AS framework that you studied in Economics 202.

- This model will highlight some of the basic features of monetary policy such as the impact of expansionary and contractionary monetary policy on output and inflation in the short and long run, the interplay between monetary and fiscal policy, the role that potential output plays in influencing monetary policy decisions etc.In short, it will give you a good intuitive base for understanding what good monetary policy should be, in theory.

- We will then use a second economic model: the Phillips Curve, to review some key concepts about the potential trade-off between inflation and unemployment and also examine the role of expectations in influencing the effectiveness of monetary policy decisions.

- These two basic models will give us a foundation for thinking about monetary policy. We will build on this foundation by discussing some other core principles about monetary economics.

- The second broad section of the class explores some key subtleties about the basic model of economic fluctuations and monetary policy. In that section, we will discuss the impact of monetary policy on the 'real' economy and the channels through which monetary policy impacts the real economy. We will read a paper that provides a historical analysis of how pivotal a role monetary policy has played in driving economic fluctuations in the United States. We will also read a paper identifying the different channels through which policy changes of the Federal Reserve are transmitted to the economy. Then, we will explore one of these channels in great depth by covering the very important topic of the term structure of interest rates, which shows how monetary policy decisions of the Fed (that move short-term interest rates in the economy) affect longer term interest rates (like mortgages and business loans) that govern most economic activity. This will be particularly useful in thinking about some of the bond purchase programs that the Federal Reserve has put into place in the last few years.

- Last but not least, we study the institutional structure of central banks. In particular, we will focus on why credibility, reputation and independence are vitally important for central banks. In other words, we will study why it is important for central banks to be credible (i.e. for people to believe that they will do what they promise) when they announce policy plans, why it is important for central banks to have a reputation for fighting inflation and why it is important for central banks to be independent from political influence.
- The third broad area we cover in this class focuses on the conduct of monetary policy. We begin by studying the importance of central bank independence before studying monetary policy rules, a tool that is widely used in economic models to capture the systematic behavior of monetary policy making. We will use this tool for analyzing monetary policy decisions, both for gaining historical perspective but also for developing a framework for understanding how to conduct monetary policy in a more integrated global economy.
- The fourth set of topics focuses on particular complicated challenges that Janet Yellen in particular faces as she ascends to her new position. The most critical challenge is the existence of the zero lower bound on the nominal interest rate. We modify the basic model of economic fluctuations we developed at the outset of the course to incorporate the ZLB and show how this restrictions warps our understanding of policy. We then move on to study various challenges in the form of challenges of constructing accurate forecasts, the need to build more realistic models of the macroeconomy and dealing with asset bubbles.
- To flesh this out a little more, a vexing problem facing monetary policy makers - the fact that they do not have a complete data picture of the economy at the time that they make their decisions. However, the armchair quarterbacks, i.e. those economists who many years later go back and look at the decisions that central bankers made have a much more complete picture of the economy. How do policy makers forecast economic variables, and how should they incorporate those forecasts into the decision making process.
- Another question os how monetary policy makers should react (or whether they should react at all) to asset bubbles, whether it be in the stock market or in the real estate market. This has become a very important issue in recent times in the United States, with regard to the dot-com boom and bust of 1998-2002 as well as with regard to the real estate collapse of 2007/08. Similar issues face policymakers all over the world: real estate markets in the U.K. and in Australia, stock markets in China and India.
- Finally, I ask you to do a final project for this course in which I ask you to analyze in close detail one of the numerous policy responses that the Federal Reserve put in place following the 2008/09 recession. This could include any one of the QE programs, the decision to connect future interest rate changes to the state of the economy, any of the extraordinary liquidity provision programs put in place to assist the recovery of financial markets, the bailout of AIG, the regulation of the financial system under the new Dodd-Frank bill, the decision to

coordinate with foreign central banks to provide more dollar liquidity to the global financial system etc. I would expect you to work individually to generate a well-written 6-8 page paper that provides a clear assessment of the program and what you think its effectiveness was (or will be). I will also allow you to work on a topic in pairs, provided both parties agree affirmatively to resolve inter-personal conflicts without my intervention. The length and scope of the paper for a two-person project will be greater than for a single person project but nowhere near twice as much.

IV. LIABILITY WAIVER

- These are the central issues covered in this course. You should only take the class if you are interested in learning more about these issues. If the basic questions don't interest you much then you should not take the course or else you are guaranteed to have an unhappy semester.
- In essence, if you find the goals uninteresting, then you are definitely likely to find the means to achieve those goals terribly uninteresting. I urge you to be 100% sure before committing to taking the class and being 100% committed once you do commit.

Spring Semester '13-'14
Akila Weerapana

Lecture 2: The IS-MP Model

I. INTRODUCTION

- In this class, we begin with a basic workhorse model of undergraduate macroeconomics called the IS-MP/AD-IA model. Some version of this type of model is taught in every undergraduate intermediate macroeconomics course. The most commonly taught variant is the IS-LM/AD-AS model.
- Think of the IS-MP/AD-IA model as a more practical and intuitive version of the IS-LM/AD-AS model that some of you may have learned in Econ 202. Even though this model is a simple one that undergraduates can understand, the core structure of this model is at the heart of macro models used in many central banks today.
- The first piece of this model relies on two important relationships: the IS curve, which shows how interest rates affect GDP in the economy, and the MP curve, which shows how the interest rate is set by the Fed.

II. THE IS CURVE

- The basic specification of the IS Curve is as follows:

$$
\begin{aligned}
Y &= C + I + G + NX \\
C &= a_c(1-t)Y^* + b_c(1-t)(Y - Y^*) \\
\frac{I}{Y^*} &= a_I - b_I r \\
\frac{G}{Y^*} &= a_G \\
\frac{X}{Y^*} &= a_X \\
\frac{M}{Y^*} &= a_M \\
\frac{NX}{Y^*} &= \frac{X - M}{Y^*} = (a_X - a_M)
\end{aligned}
$$

  where r is the real interest rate, $a_c, a_I, a_G, a_X, a_M, b_I$ are all positive parameters, $0 < b_c < a_c$, and Y^* denotes potential output.

- Let's think about what this model is saying. First of all, since it is a model of economic fluctuations, the focus is on fluctuations around the long run growth path of GDP, which is what we label as potential GDP above. Potential GDP, if you recall from 202, is what the economy is capable of sustainably producing in the long run. This is why all the variables are expressed as a fraction of potential GDP.
- The equations for government purchases and for net exports are the most straightforward. Essentially, those two variables are assumed to be exogenously determined. In every model,

we have to make choices about what is endogenous (i.e. what the model determines) and what is exogenous (i.e. what is determined outside the model). This is more art than science. One of the hallmarks of the truly great economists is that they have the ability to derive deep insights with simple models.

- The investment equation is slightly more complex, and basically states that investment has an exogenous component (a_I) and an endogenous component that states that investment is inversely related to the real interest rate. The exogenous investment term could capture investor confidence, whereas the negative relationship reflects the fact that higher real interest rate raises the cost of borrowing to finance (or the opportunity cost of self-financing) investment projects. The parameter b_I is a measure of how responsive investment is to fluctuations in real interest rates.

- The consumption equation is the most complicated. It describes consumer behavior as follows: people consume a constant fraction a_c of their long-term after-tax income, the a_c term could denote consumer confidence. In other words, people look at their long-term income prospects and settle on different spending paths based on their circumstances. For instance, an MBA student would choose a higher level of spending than a philosophy graduate student would because of a higher Y^* and maybe because of a higher a_C.

- The equation also states that consumers then adjust their spending up or down fro this baseline path depending on whether they are currently doing better or worse than their long-term income is. So if a consumer were to win the lottery or get a one-time bonus (i.e. Y increases but Y^* does not), they would increase their typical spending level by adding a fraction b_c of their windfall after taxes $(1-t)(Y-Y^*)$. Conversely, if a consumer lost her job and took a few months off before finding a new job and thus suffered a fall in current income, they would decrease their typical spending level by subtracting a fraction b_c of their shortfall after taxes $(1-t)(Y-Y^*)$. b_c is what we termed the marginal propensity to consume in Econ 202: how much consumption changes in response to income fluctuations. It would be bigger if the consumer had credit constraints - they would have to be more responsive to current income if they can't borrow against their future income.

- The system above has 7 equations, which makes it very unwieldy. We can greatly reduce the dimensionality of the problem we are solving by combining these equations and doing the following simplifications to derive a more practical version of the IS curve

$$\begin{aligned}
\frac{Y}{Y^*} &= \frac{C}{Y^*}+\frac{I}{Y^*}+\frac{G}{Y^*}+\frac{NX}{Y^*}\\
\frac{Y}{Y^*} &= \left(a_c(1-t)+b_c(1-t)\frac{(Y-Y^*)}{Y^*}\right)+(a_I-b_Ir)+a_G+(a_X-a_M)\\
\frac{Y}{Y^*} &= [a_c+a_I+a_G+(a_X-a_M)-ta_c]-b_Ir+b_c(1-t)\frac{(Y-Y^*)}{Y^*}\\
&\quad \text{subtract 1 from both sides}\\
\frac{Y}{Y^*}-1 &= [a_c+a_I+a_G+(a_X-a_M)-ta_c-1]-b_Ir+b_c(1-t)\frac{(Y-Y^*)}{Y^*}\\
\frac{Y-Y^*}{Y^*} &= [a_c+a_I+a_G+(a_X-a_M)-ta_c-1]-b_Ir+b_c(1-t)\frac{(Y-Y^*)}{Y^*}\\
&\quad \text{Define } \hat{Y}=\frac{Y-Y^*}{Y^*}\\
\hat{Y} &= [a_c+a_I+a_G+(a_X-a_M)-1-ta_c]-b_Ir+b_c(1-t)\hat{Y}\\
\hat{Y}-b_c(1-t)\hat{Y} &= [a_c+a_I+a_G+(a_X-a_M)-1-ta_c]-b_Ir\\
\hat{Y}[1-b_c(1-t)] &= [a_c+a_I+a_G+(a_X-a_M)-1-ta_c]-b_Ir\\
\hat{Y} &= \left(\frac{1}{1-b_c(1-t)}\right)[a_c+a_I+a_G+(a_X-a_M)-1-ta_c]-\left(\frac{1}{1-b_c(1-t)}\right)b_Ir
\end{aligned}$$

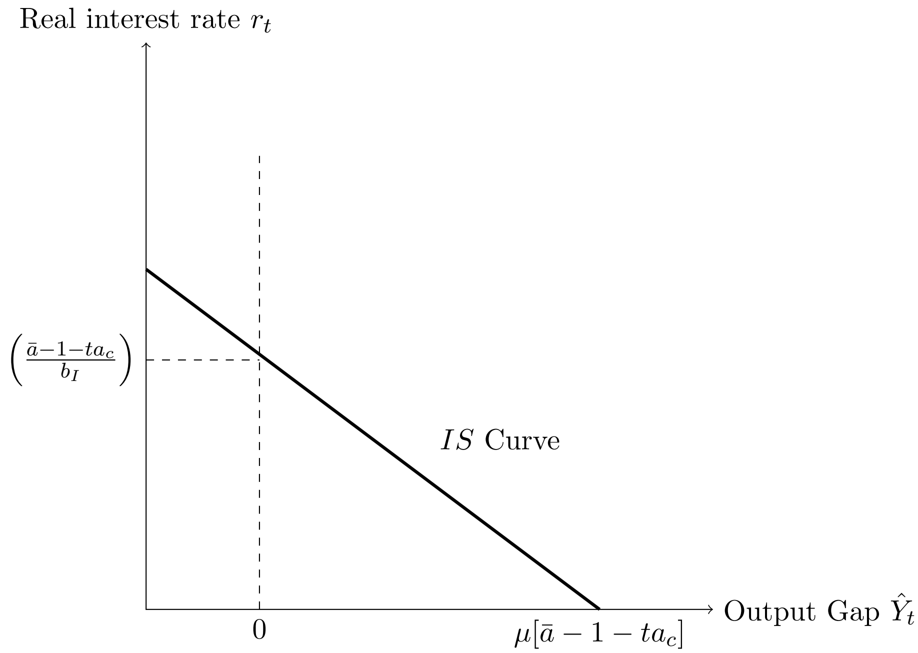
- The term $\hat{Y}$ denoted the percentage deviation of Y from potential output $\hat{Y}=\frac{Y-Y^*}{Y^*}$. We will henceforth call this term **the output gap**.

- If we define $\mu=\frac{1}{1-b_c(1-t)}$ as the Keynesian multiplier and use the short-hand term $\bar{a}=[a_c+a_I+a_G+(a_X-a_M)]$ to capture the sum of the exogenous consumption, investment, government purchases and net exports, we can re-write the IS equation (using t subscripts to denote the output gap and the interest rate as variables that can change over time) as

$$\hat{Y}_t=\mu[\bar{a}-1-ta_c]-\mu b_I r_t$$

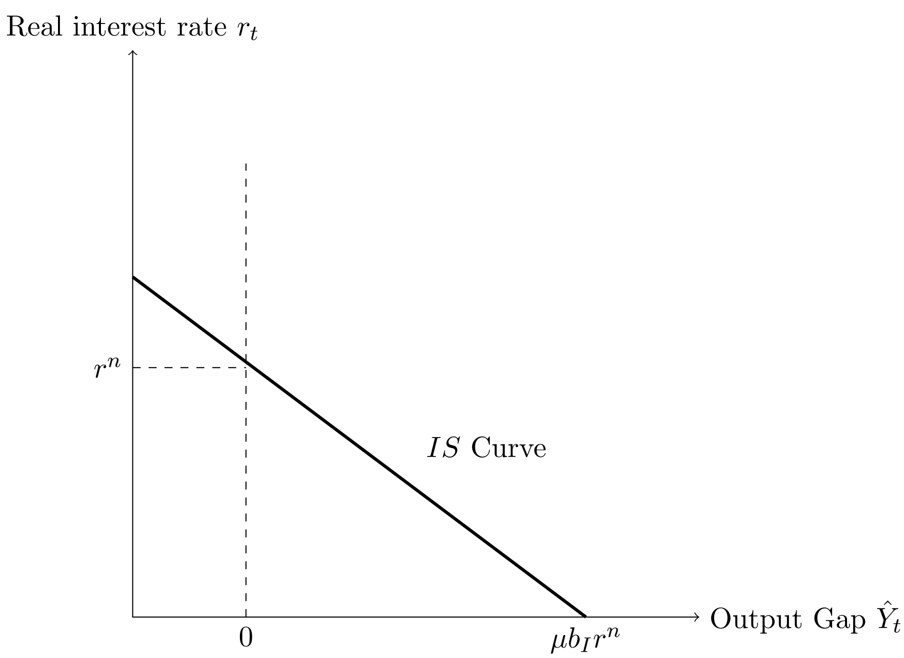
- This is a much simpler equation for the IS curve, the relationship between the output gap $\hat{Y}_t$ and the real interest rate r_t.

- Using this information the IS curve can be shown graphically as follows, with the potential output level denoted by an output gap of zero. Since we study both recessions and booms, we depict the $\hat{Y}=0$ in the middle of the diagram rather than as the Y-axis.



- We can make it even simpler by defining the concept of a natural rate of interest r^n, which is the rate of interest that corresponds to an output gap of zero. By looking at the above equation for the IS curve, we have (by setting $\hat{Y}=0$), $r^n = \frac{\bar{a}-1-ta_c}{b_I}$. Then the IS curve itself can be written as

$$\hat{Y}_t = \mu b_I \left(r^n - r_t\right)$$



- Note that r^n here is determined by the exogenous variables and parameters: $t, a_c, a_I, a_G, a_X, a_M, b_I$. Thus, we do not have to keep track of these individually any more, since r^n will capture the combined effect of those parameters and variables. Note also that increases in spending $a_C, a_I, a_G, (a_X - a_M)$ or decreases in taxes or decreases in b_I will all increase the natural rate of interest ($r^n \uparrow$) while decreases in the $a_C, a_I, a_G, (a_X - a_M)$ or an increase in taxes or increases in b_I will lower the natural rate of interest ($r^n \downarrow$)

II. THE MP CURVE

- The MP curve describes the behavior of a responsible central banker. A simple way of describing the behavior of a responsible central banker is to use a equation of the form

$$r_t = \bar{r}^* + \gamma_\pi(\pi_t - \bar{\pi}^*) + \gamma_y \hat{Y}_t$$

where $\bar{r}^*$ is the desired (targeted) real interest rate, (exogenously given, hence the bar over it), $\bar{\pi}^*$ is the target inflation rate of the Fed (also exogenously given), $\gamma_\pi > 0$ is a constant that denotes how averse the Fed is to deviations of inflation from its target, $\hat{Y}$ is the output gap and $\gamma_y > 0$ is a constant that denotes how averse the Fed is to deviations of output from potential output (i.e. how responsive it is to the output gap).

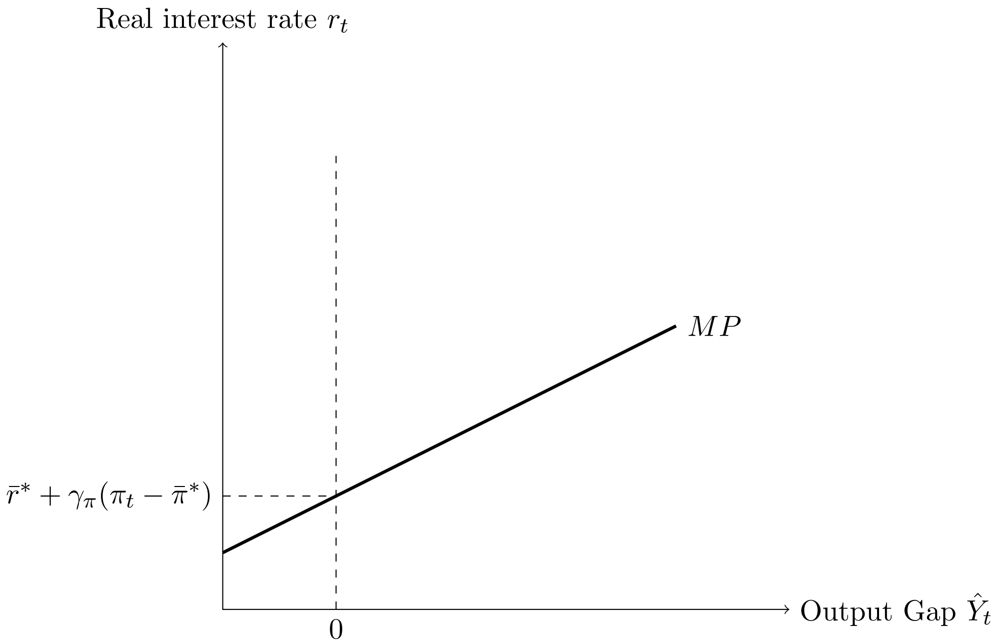
- What exactly is this equation saying? It says that first and foremost that the Fed is concerned about two key macroeconomic variables - the deviation of inflation from its target inflation rate and the output gap. If inflation is at the target and the output gap is zero, then the Fed wants to keep interest rates right around the desired real interest rate, which is a choice of the Fed.

- The rule then describes behavior when the economy deviates from the inflation target. If inflation were to creep up above the targeted level, the Fed would typically respond to this increase in inflation by raising the real interest rate. Conversely if inflation were to fall below the targeted level, the Fed would typically respond to this decrease in inflation by lowering the real interest rate. γ_π controls the intensity of this shift.

- A policymaker who worries more about deviations of inflation from its target (sometimes known as an "inflation hawk") has a high γ_π while a policymaker who worries less about deviations of inflation from its target (sometimes known as an "inflation dove") has a low γ_π.

- In addition to worrying about inflation, the Fed also cares about keeping output at potential output. So when the output gap rises, the Fed tries to decrease spending and GDP by raising r. And when the output gap falls, the Fed tries to increase spending and GDP by lowering r.

- A graphical description of this relationship is given below.



- In the United States, the behavior of the Fed in recent decades is said to be best described by something called the "Taylor Rule", which can be written as

$$r_t = 2\% + 0.5(\pi_t - 2\%) + 0.5(\hat{Y})$$

- We don't use the specific values of 0.5 and 0.5 for the γ coefficients nor the specific values of a target real interest rate of 2% and an inflation target of 2% here in our model, the MP curve is often called a "Taylor-type rule" for monetary policy rather than a Taylor Rule.

- A Taylor-type rule is consistent with the Fed's joint mandate to aim for "stable prices and maximum employment". Some countries have central banks which have an explicit mandate solely to keep inflation at a targeted level. But even those countries central banks exhibit behavior which is consistent with our specification above since, as we will soon see, the output gap has implications for what inflation will turn out to be in the future so responding to it is a good idea for a policy maker.

Lecture 3: Short Run Equilibrium in the IS-MP Model

I. OVERVIEW

- In the last lecture, we laid out the the equations of the IS-MP model. The IS curve summarized how the real interest rate affected the output gap in the economy and the MP curve summarized how the output gap and inflation impacts the real interest rate in the economy.
- In today's class we show how the short-run equilibrium in the economy is determined by the intersection of the IS and MP curves and then discuss how various changes in the economy, as well as various policy responses affect the short run equilibrium.

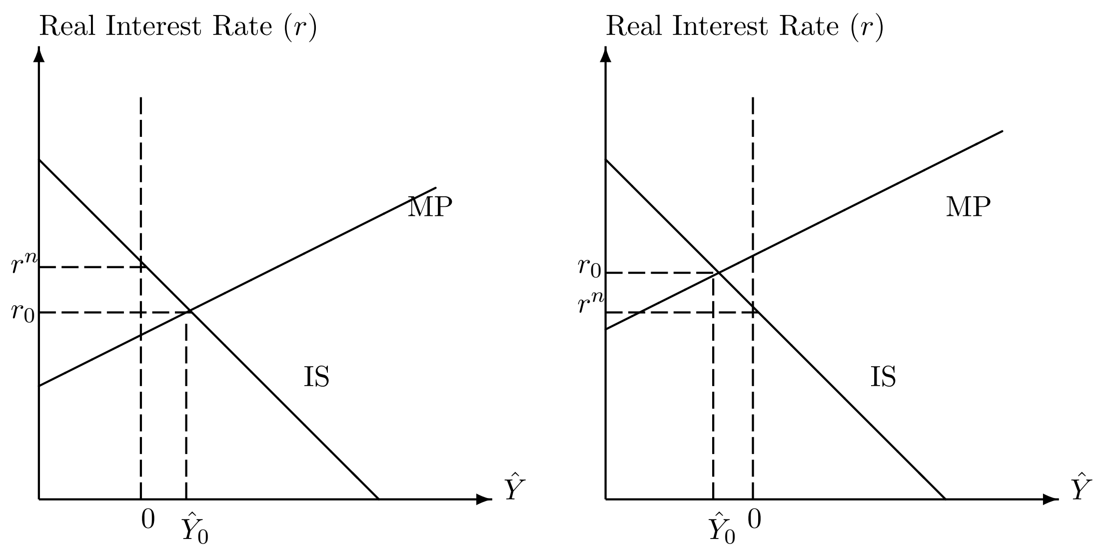
II. SHORT-RUN EQUILIBRIUM

- We now have the two relationships: the negative relationship between the output gap and the real interest rate (the IS curve) and the positive relationship between the output gap and the real interest rate (the MP curve), given by the equations:

$$\begin{aligned} \hat{Y} &= -\mu b_I (r - r^n) \Rightarrow \text{ IS Curve} \\ r &= \bar{r}^* + \gamma_\pi(\pi - \bar{\pi}^*) + \gamma_y(\hat{Y}) \Rightarrow \text{ MP Curve} \end{aligned}$$

- We can show these two curves on the same diagram, which we call an IS-MP diagram. The intersection of the IS curve and the MP curve illustrate the current output gap $\hat{Y}_0$ and the current real interest rate r_0 in the economy.
- The intersection of IS and MP does not have to come at a particular value of the output gap. Since the MP curve is drawn for a exogenously given value of π_t, the intersection could be at, above or below $\hat{Y} = 0$ as shown below, depending on the value of π_t.

The IS-MP Diagram



- The next task is to figure out how that equilibrium is affected by changes in the IS curve and the MP curve.

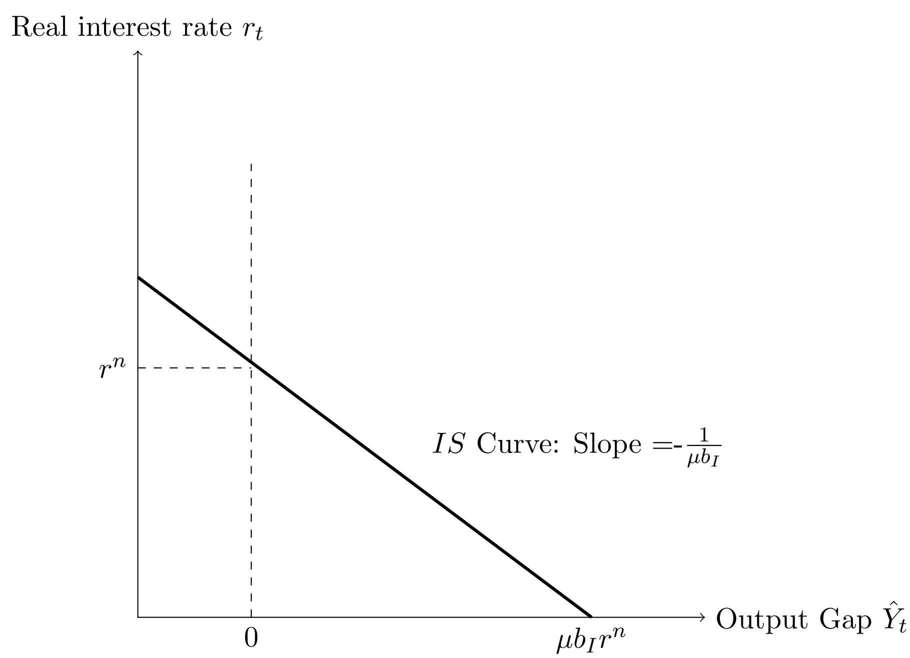
III. SHIFTS IN, AND MOVEMENTS ALONG, THE IS CURVE

Movements Along the Curve

- Since we are graphing the relationship between r and $\hat{Y}$, the key thing to note is that changes in $\hat{Y}$ caused by changes in r are reflected as movements along the IS curve.
- When interest rates decrease, investment rises and as a result the output gap increases as well. This is reflected in a movement to a lower point on the IS curve where interest rates are lower and the output gap is higher.
- Conversely, when interest rates increase, investment spending falls and as a result the output gap decreases as well. This is reflected in a movement to a higher point on the IS curve where interest rates are higher and the output gap is lower.
- There are three other key variables we need to then think about: a change in r^n, a changes in μ and a change in b_I. The first is easier than the other two because the latter two affect the slope of the curve.

Shifts and Slope Changes of the IS Curve

- Let's graph the IS curve ($\hat{Y} = -\mu b_I(r - r^n)$) again in isolation to think about it's shape and slope.



1. *The impact of a change in r^n*
   - Consider the IS curve you drew above with a vertical intercept of r^n and a slope of $\frac{-1}{\mu b_I}$. You can clearly see that changes in r^n affect the intercept, not the slope. An increase in r^n will shift the IS curve out and a decrease in r^n will shift the IS curve in.

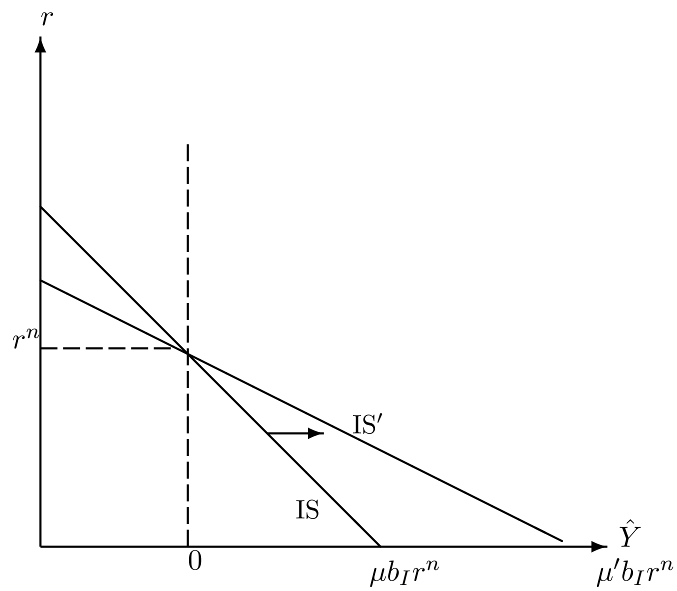
- If you think about what is contained in $r^n = \frac{\bar{a}-1-ta_c}{b_I}$, we can state more specifically that the IS curve shifts out when
  (a) **Increases** in consumer confidence (a_c)
  (b) **Increases** in investor confidence (a_I)
  (c) **Increases** in preferences for the size of government (a_G)
  (d) **Increases** in export oriented nature of the economy (a_X)
  (e) **Decreases** in the import-oriented nature of the economy (a_M)
  (f) **Decreases** in taxes (t)
  (g) **Decreases** in the responsiveness of investment to the real interest rate (b_I)
- Conversely, **decreases** in consumer confidence (a_c), investor confidence (a_I), preferences for the size of government (a_G) or export oriented nature of the economy (a_X), **increases** in taxes, the import-oriented nature of the economy (a_M) or the responsiveness of investment to interest rates (b_I) will shift the IS curve **in**.
- The intuition here is fairly straightforward, when spending on domestic goods and services goes up the IS curve will shift out, when spending goes down, the IS curve will shift in.

2. *The impact of a change in μ*

- An **increase** in μ is a little more complicated because in the IS curve you drew above you can clearly see that changes in μ affect the slope. Let's see how we show the impact on the diagram.
- Consider what happens when there is an increase in μ. This will make the IS curve flatter around the natural rate of interest. Conversely, a decrease in μ will make the IS curve steeper around the natural rate of interest.
- The intuition here is pretty straightforward. A larger multiplier means that any change in spending has a magnified impact on the economy. It therefore makes fluctuations larger: good times become even better and bad times become even worse since a given change in spending gets multiplied by a bigger value. That is what the graph shows, $\hat{Y}$ rises when $\hat{Y} > 0$ and $\hat{Y}$ falls when $\hat{Y} < 0$
- What causes the multiplier μ to change? Since $\mu = \frac{1}{1-b_c(1-t)}$ we can see that an increase in the marginal propensity to consume (b_c) or a decrease in the income tax rate (t) will raise the multiplier μ. Conversely, a decrease in the marginal propensity to consume (b_c) or an increase in the income tax rate (t) will lower the multiplier μ.

EXAMPLE 2

- A rise in μ will cause the IS curve to flatten

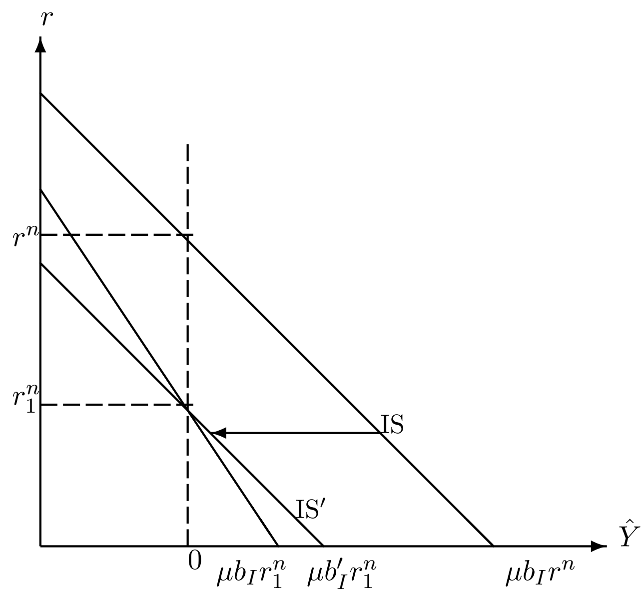


3. *The impact of a change in b_I*

- We need to pay special attention to changes in b_I. Why? Because b_I affects the slope directly and also affects the intercept r^n.
- A larger value of b_I will also make the IS curve flatter (remember that the slope is $-\frac{1}{\mu b_I}$). A higher b_I means that investment becomes more sensitive to the interest rate. This is a good thing if interest rates are below the natural rate and a bad thing if interest rates are above the natural rate. That is exactly what the graph showed above when the slope changes: $\hat{Y}$ rises when $\hat{Y} > 0$ and $\hat{Y}$ falls when $\hat{Y} < 0$
- In addition to the slope change, the intercept, which is $r^n = \frac{\bar{a}-1-ta_c}{b_I}$ is impacted. A **higher** b_I leads to the IS curve shifting in.
- So the bottom line is that if investment becomes more sensitive to the interest rate, the IS curve shifts IN AND the IS curve flattens out. This illustrates the complexity of this channel and makes intuition harder to come by.
- Think about it this way: if investment becomes more sensitive to the interest rate that will lower spending (because investment depends negatively on the interest rate) leading to the inward shift of the IS curve. However, that negative effect is not uniform, it is more pronounced when interest rates are higher than the natural rate and less pronounced when interest rates are lower than the natural rate.

EXAMPLE 3

- An increase in b_I will cause the IS curve to shift in AND become flatter. I have shown both steps here but typically we would only draw the lines labeled IS and IS$'$.

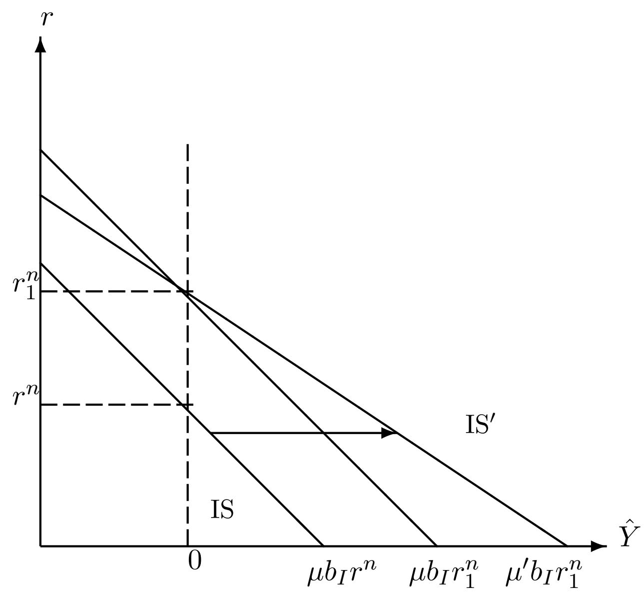


4. *The impact of a change in t*

- Alas, we are not out of the woods yet. We also need to pay special attention to changes in t. Why? Because t affects the multiplier μ and hence the slope but it also affects r^n and hence the intercept. So similar to b_I we have to think about slope and intercept changes.
- So let's figure it out mathematically and then intuitively. Lower taxes lead to a larger multiplier $t \downarrow \rightarrow \mu \uparrow$. A higher multiplier makes the IS curve flatter. We already showed that a higher multiplier means that good times are even better and bad times are even worse.
- In addition to the slope change, consider the intercept, which is $r^n = \frac{\bar{a}-1-ta_c}{b_I}$. Lower taxes lead to a larger numerator and lead to a higher natural rate of interest.
- This means a shift out of the IS curve. What we have therefore showed is that **lower taxes** leads to the IS curve shifting out (more spending) AND the IS curve flattening out (good times becoming better, bad times becoming worse).
- Conversely, **higher taxes** lead to the IS curve shifting in (less spending) AND the IS curve becoming steeper (good times becoming worse, bad times becoming better).
- Intuitively, lower taxes leads to more spending and shifts the IS curve out. Again the impact is not uniform: this time the higher multiplier makes good times better and bad times worse.

EXAMPLE 4

- A decrease in the income tax rate t will cause the IS curve to shift out AND become flatter. I have shown both steps here but typically we would only draw the lines labeled IS and IS$'$.



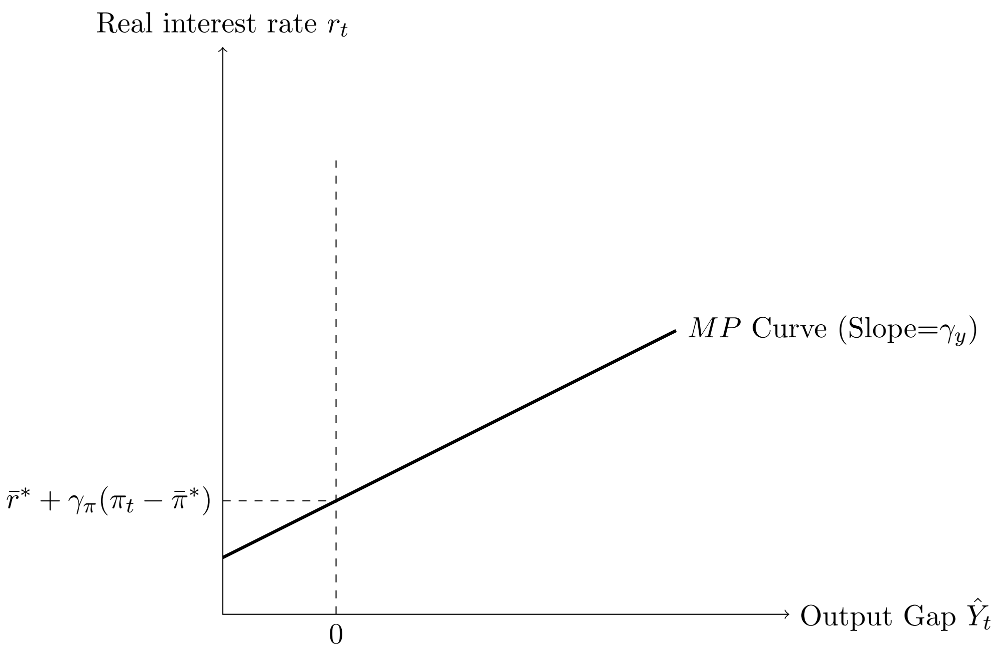
III. SHIFTS IN, AND MOVEMENTS ALONG, THE MP CURVE

Movements Along the MP Curve

- The relationship is upward sloping because increases (decreases) in the output gap lead the Fed to raise (lower) real interest rates. As with the IS curve, we need to distinguish between movements along a curve and shifts of a curve. The first thing to keep in mind about the MP curve is that changes in r that are driven by changes in the output gap are reflected as movements along the MP curve.

Shifts and Slope Changes of the MP Curve

- Let's graph the MP curve ($r = \bar{r}^* + \gamma_\pi(\pi - \bar{\pi}^*) + \gamma_y \hat{Y}$) again in isolation to think about it's shape and slope.



1. *The impact of a change in $\bar{r}^*, \bar{\pi}^*$ or π_t*

   - Consider the MP curve you drew above with a intercept of $\bar{r}^* + \gamma_\pi(\pi_t - \bar{\pi}^*)$ and a slope of γ_y. The MP curve will shift up (higher intercept) if $\bar{r}^* \uparrow$ or $\pi_t \uparrow$ or $\bar{\pi}^* \downarrow$. Conversely, The MP curve will shift down (lower intercept) if $\bar{r}^* \downarrow$ or $\pi_t \downarrow$ or $\bar{\pi}^* \uparrow$.
   - All three of these changes can be intuitively understood the same way. If the Fed raises real interest rates for reasons other than in response to a change in the current output gap, then the MP curve will shift up; if the Fed lowers real interest rates for reasons other than a change in $\hat{Y}$, then the MP curve will shift down.
   - The three reasons for the Fed raising interest rates are the Fed aiming for a higher desired real interest rate ($\bar{r}^* \uparrow$), the Fed aiming for a lower target inflation rate (becoming more hawkish) ($\bar{\pi}^* \downarrow$) or the Fed facing a higher inflation rate ($\pi_t \uparrow$).

2. *The impact of a change in γ_π*

   - A change in γ_π is slightly more complicated. We know that this term only affects the intercept so it should look like the above three at first glance. But when you look at the intercept of the MP curve you drew above, which was $\bar{r}^* + \gamma_\pi(\pi - \bar{\pi}^*)$, you can see that the impact on the intercept when $\gamma_p i$ changes depends on the value of $(\pi - \bar{\pi}^*)$.
   - When γ_π rises, if $(\pi - \bar{\pi}^*) > 0$ then the intercept will increase (MP shifts out). However, if $(\pi - \bar{\pi}^*) = 0$ then there is no change. Finally, if if $(\pi - \bar{\pi}^*) < 0$ then the intercept will decrease (MP shifts in).
   - How can we make intuitive sense of this? An increase in γ_π is an increase in hawkishness of the Fed. In other words, the Fed is becoming less tolerant of deviations of inflation from the target. How would this be reflected in the actions of the Fed? Well if inflation is on target, i.e. $(\pi - \bar{\pi}^*) = 0$, then the Fed's behavior is unaffected. If inflation is above target, $(\pi - \bar{\pi}^*) > 0$, then the Fed raises interest rates and if inflation is below target, $(\pi - \bar{\pi}^*) = 0$, the Fed lowers interest rates.
   - Again the essential intuition is that the MP curve will shift up when the Fed raises rates and down when the Fed lowers rates. An increase in hawkishness does not automatically imply that the Fed will raise rates: depending on the circumstances the Fed will raise (when $\pi_t > \bar{\pi}^*$), lower (when $\pi_t < \bar{\pi}^*$)or leave rates unchanged (when $\pi_t = \bar{\pi}^*$).

3. *The impact of a change in γ_y*

   - In contrast to the three previous examples, a change in γ_y affects the slope. A higher γ_y will result in the MP curve becoming steeper while a lower γ_y will cause the MP curve to become flatter.
   - The intuition for this is also pretty straightforward. A higher γ_y means that the Fed is becoming more concerned about the output gap. If the output gap is zero, this has no effect on the Fed's behavior. If the output gap is positive the Fed will raise rates but if the output gap is negative the Fed will lower rates.
   - Again the essential intuition is that the MP curve will shift up when the Fed raises rates and down when the Fed lowers rates. An increase in how much the Fed cares about output fluctuations does not automatically imply that the Fed will raise rates: depending on the circumstances the Fed will raise (when $\hat{Y} > 0$), lower (when $\hat{Y} < 0$)or leave rates unchanged (when $\hat{Y} = 0$).

Lecture 4: The AD-IA Model

I. OVERVIEW

- In the last lecture, we derived the IS-MP model, the short run equilibrium of the economy and established how changes in behavior by consumers and firms in the economy, changes in fiscal policy with regard to taxes and government purchases and changes in monetary policy would affect the short-run equilibrium of the model.
- It is important to keep in mind, however, that the MP curve is drawn for a given inflation rate in the economy. Inflation itself is exogenous to the IS-MP portion of the model. We therefore need to extend the IS-MP framework to incorporate endogenous changes in inflation.
- In today's class, we extend the model to make inflation endogenous. We begin by deriving the relationship between a given inflation rate and real GDP in the economy, which we call the AD curve. We then derive another relationship called the IA curve that describes how inflation changes over time. The combination of these two curves, represents the complete model of the macroeconomy.

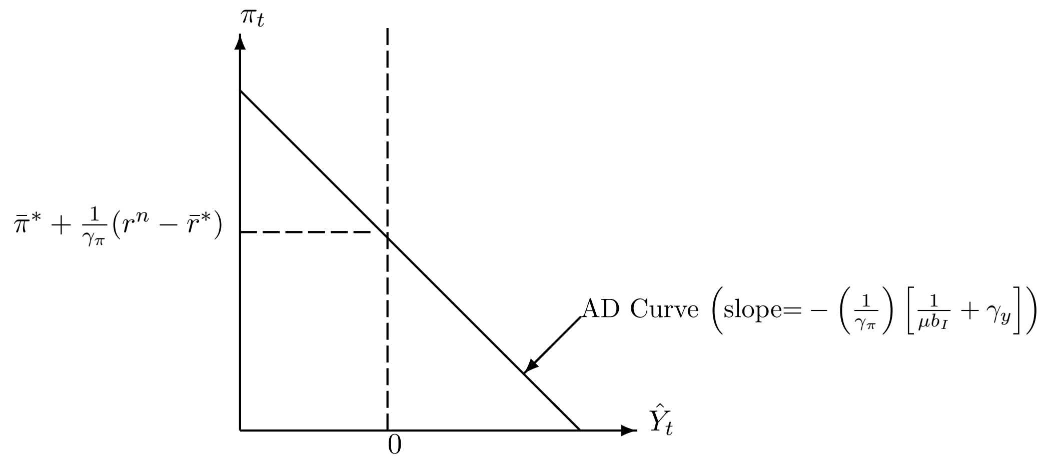
II. COMBINING THE IS CURVE AND THE MP CURVE TO OBTAIN THE AD CURVE

- Inflation is exogenous to the IS-MP model and our next task is to endogenize inflation by deriving a relationship between inflation and the output gap from the IS-MP model.
- Mathematically, we can derive the AD curve by finding a relationship between π and $\hat{Y}$. We do this by using the MP curve to relate π to r and then using the IS curve to relate r to $\hat{Y}$. In plain English, we substitute in for r in the IS curve using the MP curve.

$$
\begin{aligned}
\hat{Y}_t &= -\mu b_I(r_t - r^n) \Rightarrow \text{ From IS Curve} \\
r_t &= \bar{r}^* + \gamma_\pi(\pi_t - \bar{\pi}^*) + \gamma_y \hat{Y}_t \Rightarrow \text{ From MP curve} \\
\hat{Y} &= \mu b_I r^n - \mu b_I \left(\bar{r}^* + \gamma_\pi(\pi_t - \bar{\pi}^*) + \gamma_y \hat{Y}_t\right) \\
\hat{Y} &= \mu b_I(r^n) - \mu b_I\left(\bar{r}^*\right) - \mu b_I \gamma_\pi(\pi_t) + \mu b_I \gamma_\pi(\bar{\pi}^*) - \mu b_I \gamma_y(\hat{Y}_t) \\
(1 + \mu b_I \gamma_y)\,\hat{Y} &= \mu b_I\left(r^n - \bar{r}^* + \gamma_\pi \bar{\pi}^*\right) - \mu b_I \gamma_\pi(\pi_t) \\
\hat{Y} &= \left(\frac{\mu b_I}{1 + \mu b_I \gamma_y}\right)(r^n - \bar{r}^* + \gamma_\pi \bar{\pi}^*) - \left(\frac{\mu b_I \gamma_\pi}{1 + \mu b_I \gamma_y}\right)\pi_t
\end{aligned}
$$

- This is an ugly expression but again we do not have to worry about memorizing anything in this class. The end goal here (or more accurately, the end hope here) is that we can figure out the behavior of the AD curve via the exhaustive list of IS shifts and MP shifts we studied in the previous class.

- Graphically we can depict the AD curve more precisely by showing that the intercept (where $\hat{Y}=0$) is $\pi_t = \bar{\pi}^* + \frac{1}{\gamma_\pi}(r^n - \bar{r}^*)$ and the slope $\left(\frac{d\pi}{d\hat{Y}}\right) = -\left(\frac{1}{\frac{\mu b_I \gamma_\pi}{1+\mu b_I \gamma_y}}\right) \equiv -\left(\frac{1}{\gamma_\pi}\right)\left[\frac{1}{\mu b_I} + \gamma_y\right]$ as now as follows:



- The intuition for the AD curve is straightforward: when inflation rises, the Federal Reserve raises the real interest rate which in turn lowers investment spending and lowers the output gap.

- Conversely, when inflation falls, the Fed will lower the real interest rate, which in turn increases investment spending and raises the output gap.

III. MOVEMENTS ALONG AND SHIFTS IN THE AD CURVE

- The next task is to understand what caused the AD curve to shift and what causes a movement along the AD curve. The first thing to keep in mind is that changes in the output gap that are driven by changes in the current inflation rate are reflected as movements along the AD curve.

- An easy way to organize ones thoughts about what the factors that shift the AD curve may be is to consider the two relationships that lay at the heart of the AD curve - the IS relationship and the MP relationship. The factors that shift (or change the slope of) the IS or MP curve out are the ones that we need to think about in terms of how they affect the AD curve. We will take each of the relationships in turn.

How Changes in the IS curve affect AD

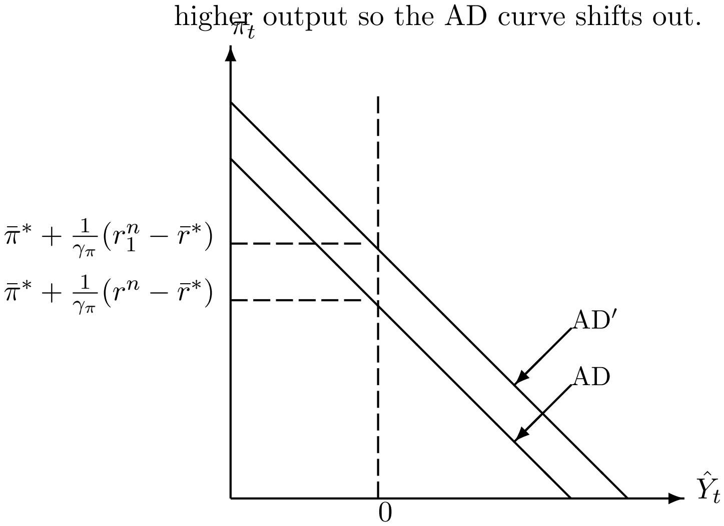
- In our discussion of the IS curve, we said the following:

  1. The IS curve would shift out when (r^n) rose.
  2. The IS curve would become flatter if the multiplier (μ) rose.
  3. The IS curve would shift in and become steeper if taxes (t) rose.
  4. The IS curve would shift in and become flatter became more responsive to investment (b_I rose).

- We can consider each of these by looking at the AD relationship.

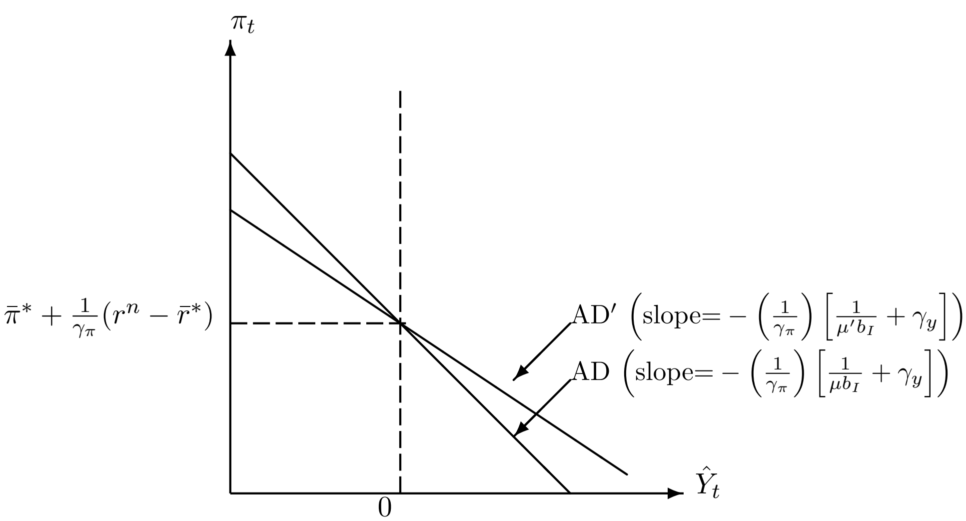
Case 1: An increase in r^n

- If r^n rises, then the slope of AD is unaffected but the intercept increases. Therefore, the AD curve will shift out. Conversely, a fall in r^n will shift the AD curve in. Intuitively, this makes sense. More spending, which is what typically raises the natural rate of interest will result in higher output so the AD curve shifts out.



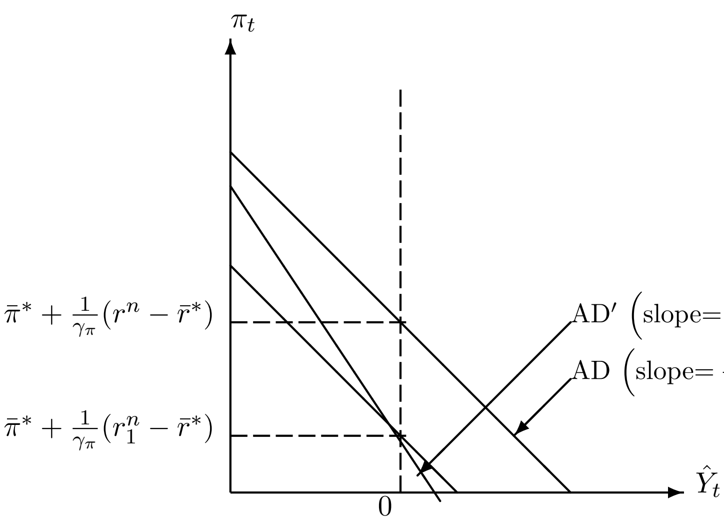
Case 2: An increase in μ

- If μ rises, then the slope of the AD curve is what is affected. When $\mu \uparrow$ the slope will move closer to zero. So the AD curve will become flatter. Intuitively, a higher multiplier makes good times better and bad times worse, which is consistent with what happens when the slope becomes flatter.



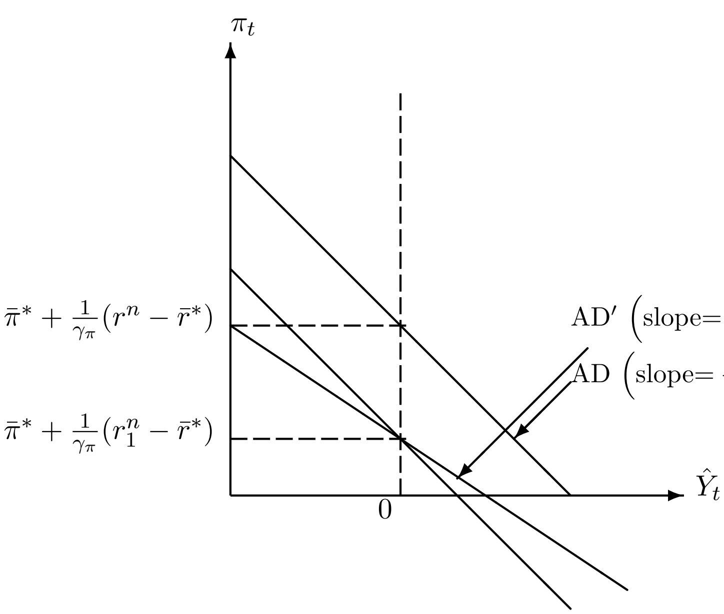
Case 3: An increase in t

- If t rises then the multiplier μ falls. This will make the AD curve steeper, based on what we discussed above.
- We also know that since $r^n = \frac{\bar{a}-1-ta_c}{b_I}$ so a rise in t will cause r^n to fall.
- So when t rises, the AD curve will BOTH shift in AND become steeper, exactly the same thing that happened to the IS curve.



Case 4: An increase in b_I

- If $b_I \uparrow$ then r^n will fall since $r^n = \frac{\bar{a}-1-ta_c}{b_I}$. Second, since the slope is $-\left(\frac{1}{\gamma_\pi}\right)\left[\frac{1}{\mu b_I} + \gamma_y\right]$, the AD curve becomes flatter.
- So the AD curve will BOTH shift in AND flatten out when b_I increases.



SUMMARY OF RESULTS

- The bottom line about how IS changes relate to AD changes is very straightforward: **the AD curve behaves exactly like the IS curve does**. Anything that shifts IS out, shifts AD out, anything that causes IS to be flatter will cause AD to be flatter, and anything that causes IS to both shift out and flatten out will do the same to AD.

How Changes in the MP curve affect AD

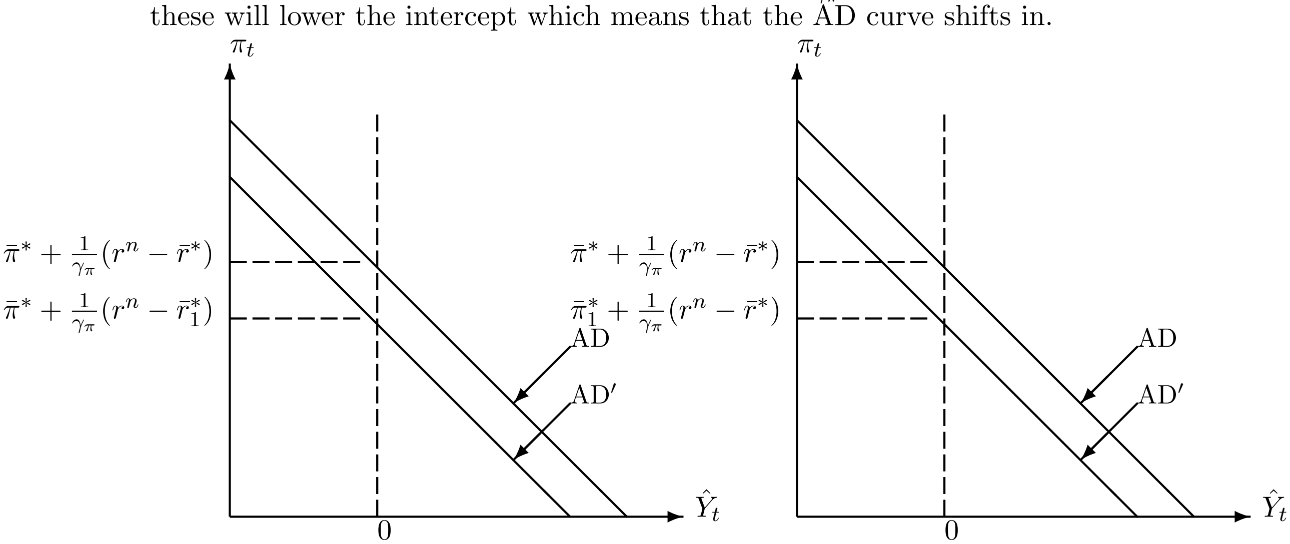
- In our discussion of the MP curve, we said the following (shift up is the same as shift in, shift down is the same as shift out)

  1. The MP curve would shift up when $(\bar{r}^*)$ rose.
  2. The MP curve would shift up when $(\bar{\pi}^*)$ fell.
  3. The MP curve would shift up when (π) rose.
  4. The MP curve would become steeper if γ_y rose.
  5. When $\gamma_\pi \uparrow$ the MP curve could shift up (if $\pi_t > \bar{\pi}^*$), stay the same (if $\pi_t = \bar{\pi}^*$) or shift down (if $\pi_t < \bar{\pi}^*$).

- The third one is the easiest to consider here. Now that π_t is actually on the vertical axis, a change in π_t is reflected as a movement along the AD curve.

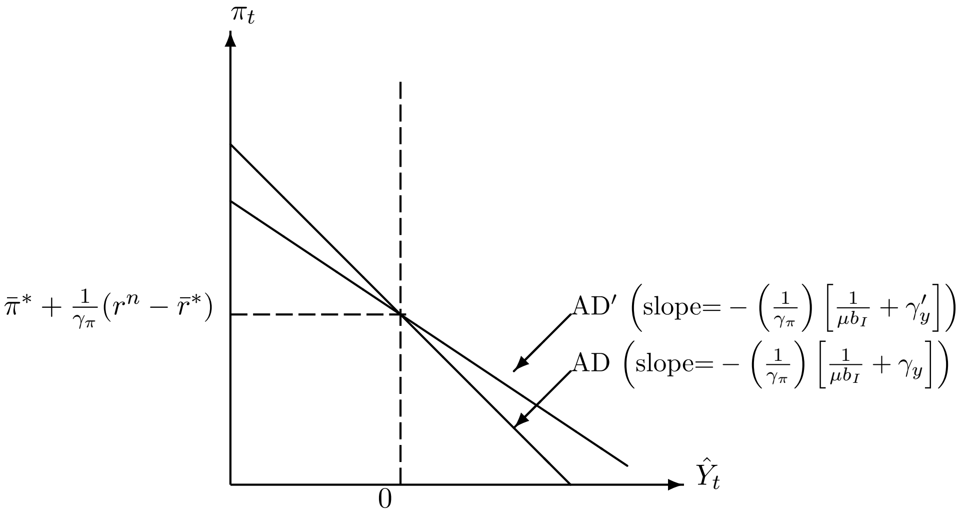
Case 1: An increase in $\bar{r}^*$ or a decrease in $\bar{\pi}^*$

- An increase in the desired real interest rate $(\bar{r}^*)$ or a decrease in the target rate of inflation $(\bar{\pi})$ will affect the intercept of the AD curve $(\bar{\pi}^* + \frac{1}{\gamma_\pi}(r^n - \bar{r}^*))$ but not the slope. Both of these will lower the intercept which means that the AD curve shifts in.



Case 2: An increase in γ_y

- An increase in how the Fed responds to output fluctuations $(\gamma_y \uparrow)$ will affect the slope of the AD curve $\left(-\left(\frac{1}{\gamma_\pi}\right)\left[\frac{1}{\mu b_I} + \gamma_y\right]\right)$ but not the intercept. A higher γ_y will cause the AD curve to be steeper.



Case 3: An increase in γ_π

- If γ_π rises both the slope and the intercept are affected. The slope $\left(-\left(\frac{1}{\gamma_\pi}\right)\left[\frac{1}{\mu b_I} + \gamma_y\right]\right)$ will be closer to zero when $\gamma_\pi \uparrow$, so the AD curve will definitely be flatter.

- The impact on the intercept $\bar{\pi}^* + \frac{1}{\gamma_\pi}(r^n - \bar{r}^*)$ is ambiguous. When $\gamma_\pi \uparrow$, the impact on the intercept will depend on the relationship between r^n and r^* which could be positive, negative or zero.

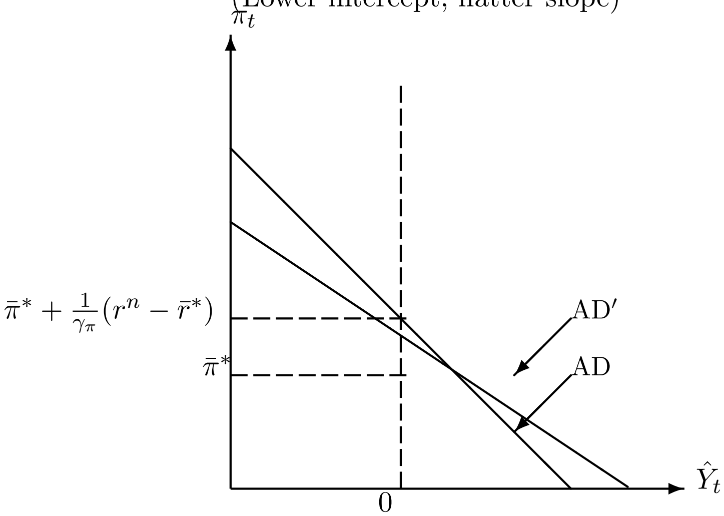
- It turns out that this is no different than what we had in the MP case where the impact of greater hawkishness depended on the relationship between π_t and $\bar{\pi}^*$

- We can verify this as follows:

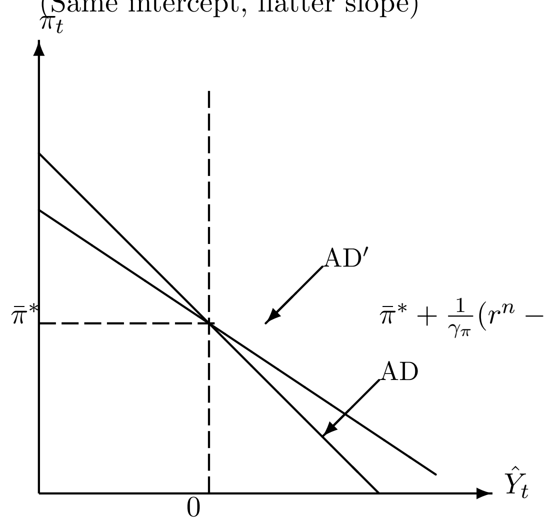
  1. If $r^n > \bar{r}^*$, then the intercept will be lower because the positive number $(r^n - \bar{r}^*)$ is multiplied by a smaller $\left(\frac{1}{\gamma_\pi}\right)$. From the intercept, $\pi_t = \bar{\pi}^* + \frac{1}{\gamma_\pi}(r^n - \bar{r}^*)$ note that $(r^n > \bar{r}^*) \Rightarrow (\pi_t > \bar{\pi}^*)$ So the AD curve will shift in when $\pi_t > \bar{\pi}^*$.
  2. If $r^n < \bar{r}^*$, then the intercept will be higher because the negative number $(r^n - \bar{r}^*)$ is multiplied by a smaller $\left(\frac{1}{\gamma_\pi}\right)$. From the intercept, $\pi_t = \bar{\pi}^* + \frac{1}{\gamma_\pi}(r^n - \bar{r}^*)$ note that $(r^n < \bar{r}^*) \Rightarrow (\pi_t < \bar{\pi}^*)$ So the AD curve will shift out when $\pi_t < \bar{\pi}^*$.
  3. When $r^n = \bar{r}^*$, then the intercept is unaffected because we are multiplying zero by a smaller $\left(\frac{1}{\gamma_\pi}\right)$. This also means that from the intercept, $\pi_t = \bar{\pi}^* + \frac{1}{\gamma_\pi}(r^n - \bar{r}^*)$ note that $(r^n = \bar{r}^*) \Rightarrow (\pi_t = \bar{\pi}^*)$ So the AD curve will not shift when $\pi_t = \bar{\pi}^*$.

- To summarize the AD curve will become flatter, but could shift up, down or not shift at all. The three possible cases for when inflation is at, above or below the target level are shown below.

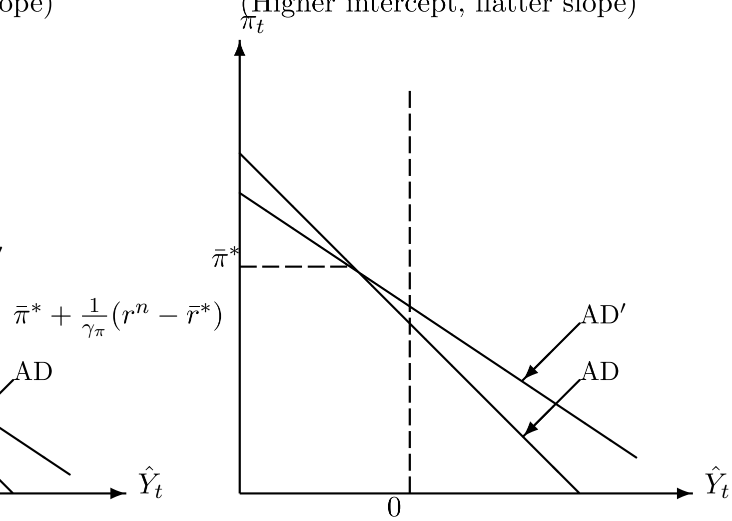
Sub Case 1: $(r^n > \bar{r}^*) \Rightarrow (\pi_t > \bar{\pi}^*)$
(Lower intercept, flatter slope)



Sub Case 2: $(r^n = \bar{r}^*) \Rightarrow (\pi_t = \bar{\pi}^*)$
(Same intercept, flatter slope)



Sub Case 3: $(r^n < \bar{r}^*) \Rightarrow (\pi_t < \bar{\pi}^*)$
(Higher intercept, flatter slope)



SUMMARY OF RESULTS

- The relationship between MP changes and AD changes is not quite as straightforward as with IS changes (recall that we showed that whatever happens to the IS curve is identical to what happens to the AD curve) but still fairly straightforward.

- One of the reasons for shifts in the MP curve was a change in the current inflation rate. For obvious reasons, this would be a movement along the AD curve.

- For changes in the inflation target rate, the desired real interest rate or the responsiveness of the Fed to output fluctuations, the behavior of the MP curve and the AD curve are identical: if MP shifts in, AD shifts in, if MP gets steeper, AD gets steeper etc.

- Changes in hawkishness could move MP in one of three ways depending on the relationship between π_t and $\bar{\pi}^*$. AD will also move in the same was as MP in those 3 cases. In addition though, more responsiveness to inflation means that the AD curve will be flatter (which was not an effect that showed up in MP).

- So the rule of thumb "What happens to AD is the same as what happens to IS or to MP" will get you very far indeed.

IV. THE INFLATION ADJUSTMENT LINE

- The AD curve shows the inverse relationship between a given inflation rate and the output gap but it does not actually tell us what determines the current rate of inflation is in the economy. The Inflation Adjustment line describes how inflation evolves in the economy.
- The IA line is characterized by the following equation

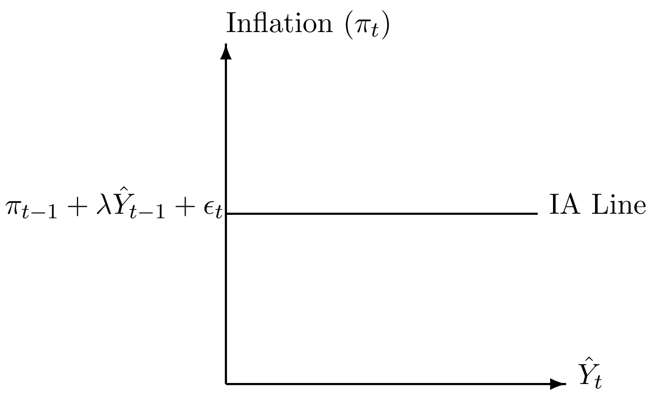
$$\pi_t = \pi_{t-1} + \lambda(\hat{Y}_{t-1}) + \epsilon_t$$

- In that equation π_t is the current rate of inflation, π_{t-1} is last period's inflation, $\lambda > 0$ is a parameter that describes how responsive inflation is to economic conditions, which are given by LAST PERIOD'S OUTPUT GAP ($\hat{Y}_{t-1}$), and ϵ_t indicates economy-wide supply shocks such as an oil price shock that can raise the rate of inflation immediately.
- The key assumptions (and justifications for the assumptions) underlying the above equation are

    1. There is staggered wage and price setting in the economy - this simply means that wages and prices are adjusted infrequently in the economy. In other words, for a given worker or a given firm these variables don't change day to day or week to week, and maybe not even month to month. However, on any given day or week or month, some fraction of workers have their wages adjusted and some fraction of firms adjust their prices.
    2. Wages adjust infrequently because workers in many industries have contracts that set their wage for a specific period of time. Firms adjust prices infrequently partly because they know because of wage contracts that their costs are under control, partly because they have entered into price contracts themselves (either to supply goods to retailers like Wal-Mart or to buy goods such as raw materials or energy) and partly because of menu costs (costs of adjusting prices). Menu costs refer to the physical cost of changing prices - restaurant menus, magazine and book covers, reprogramming vending machines etc.
    3. Because these wage and price contracts are adjusted infrequently, when they do adjust, expected inflation will play a big role in determining the size of the increase in wages and prices from one contract to the next. When firms enter into price contracts with suppliers or customers or when landlords set rents for their properties etc. they will adjust prices to increase by an amount that reflects the expected rate of inflation in the economy. If, for example, people expect inflation to be 10% a year next year, a 3 year teachers' union contract that comes up for renegotiation this year will build in a 10% per year nominal wage increase to keep up with expected inflation.
    4. Since modeling expected inflation can be complicated, we are initially going to assume that expected inflation is just last period's inflation. This is not necessarily a bad assumption, in many cases people do not have a sophisticated framework for thinking about what inflation is likely to be, so they use their most recent experience in forming expectations about the future. What this implies is that, typically, the actual level of inflation in the economy reflects what inflation was when they signed their contracts.

5. But this is only the starting point for the negotiations. If the output gap is positive, indicating a booming economy with output above potential, then unemployment is likely to be low and sales are likely to be strong so workers can ask for even higher wages and suppliers can ask for even higher prices than what would be needed to keep up with inflation. Since the wage and price contracts in operation today were negotiated in the recent past, we expect that the previous period's output gap is what matters - this is reflected by the $\lambda\hat{Y}_{t-1}$ term.
6. Finally, there are certain commodities - oil in particular - whose price has a significant effect on the price of most all goods and many services in the economy. Sharp increases in the price of oil can, and will, lead firms to raise prices even in the presence of menu costs and wage and price contracts. This is captured by the ϵ term in the equation.

- Therefore, we can model the IA line as a horizontal line that reflects the actual inflation level in the economy, which in turn is affected by people's expectations at the time contracts were signed, by the state of the economy in the recent past and shocks to key inputs.



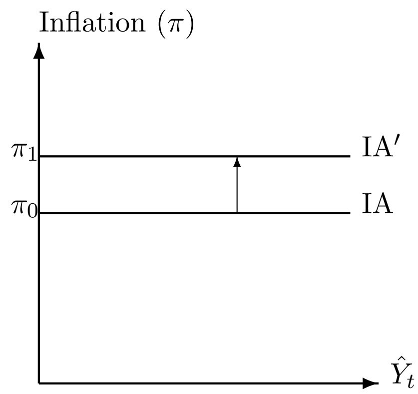
- The assumption that because of staggered wage and price setting, it's not the current state of the economy that influences the wage and price increases but rather the state of the economy in the previous period is a critical one because it delivers a horizontal IA line. Had it been $\hat{Y}_t$ appearing in the IA equation, we would have an upward sloping IA line. The results are not too different from the horizontal case, and the horizontal case is a lot easier to work with so we shall maintain that assumption.

V. SHIFTS IN THE INFLATION ADJUSTMENT LINE

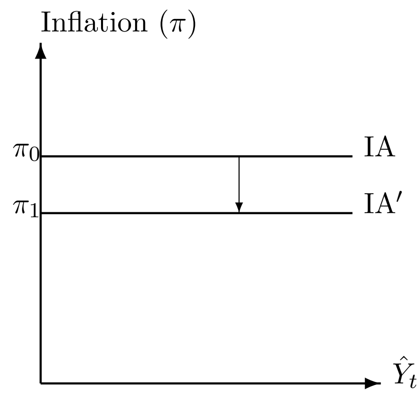
- From the equation $\pi_t = \pi_{t-1} + \lambda\hat{Y}_{t-1} + \epsilon_t$ we can see that inflation will not change in the short run unless there is a sharp change in the price of oil.

- A sudden jump in the price of oil will have an economy wide ripple effect in raising prices: prices of almost all goods are affected in some way by the price of oil. Therefore a sudden jump in the price of oil can cause prices to rise more sharply and thus inflation will be higher than it has been in the recent past - in other words, a sharp rise in oil prices can cause the inflation adjustment line to shift upwards.

Case 1: An Increase in Oil Prices



Case 2: A Decrease in Oil Prices

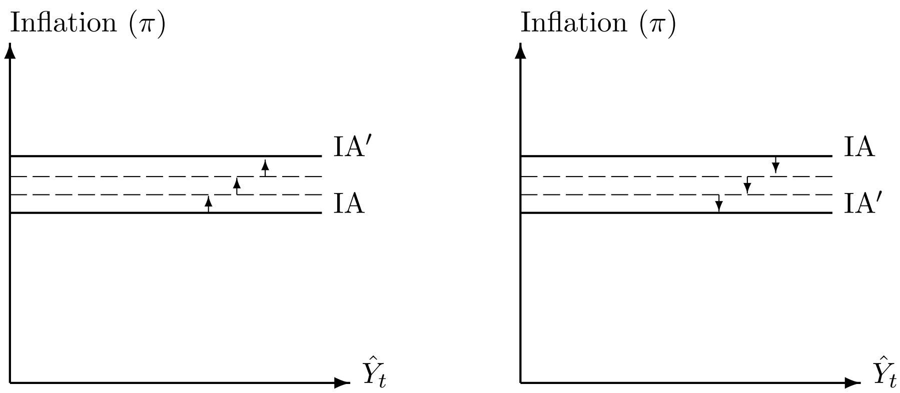


- Because of staggered price and wage contracts, the state of the economy this period ($\hat{Y}_t$) affects not the current inflation rate but the next period's inflation rate (π_{t+1}).

- Which direction the inflation adjustment line is likely to shift depends on whether the output gap is positive or negative, i.e. on whether output is higher or lower than potential GDP. Why? When $\hat{Y}_t > 0$, this means that the economy is doing better than typical - people are spending more on goods and services, incomes are higher and unemployment is lower. So wage and price contracts are likely to build in bigger increases than has been the experience in the recent past. As a result, inflation will rise (since prices rise by more than they have in recent times).

- Conversely, if $\hat{Y}_t < 0$, then inflation will fall over time. Why? If the economy is doing worse than typical - people are not spending on goods and services, incomes are lower and unemployment is higher. So wage and price contracts are likely to build in smaller increases than has been the experience in the recent past. As a result, inflation will fall (since prices rise by less than they have in recent times).

Case 1: $\hat{Y}_t > 0$ Case 2: $\hat{Y}_t < 0$



Lecture 5: Policy Analysis Using The AD-IA Model

I. OVERVIEW

- In the last lecture, we derived the AD-IA model which extends the short-run equilibrium of the IS-MP model to make inflation endogenous. The AD curve and the IA curve represent the complete model of the macroeconomy.
- In today's class, we derive the long-run equilibrium of the economy and then use this model to model policy interactions in the economy. This gives us a baseline framework for describing some of the challenges facing monetary policy makers whether it is a fall in consumer and investor confidence, a oil price shock, an overly expansionary or overly contractionary fiscal policy maker, etc.
- This sets the stage for what we will do in the rest of the class, which is to explore more complicated challenges facing the Fed that are NOT captured by this model.

II. THE LONG RUN EQUILIBRIUM

- Our AD-IA model consists of the following equations

$$\begin{aligned}
\hat{Y} &= \left(\frac{\mu b_I}{1+\mu b_I \gamma_y}\right)(r^n - \bar{r}^* + \gamma_\pi \bar{\pi}^*) - \left(\frac{\mu b_I \gamma_\pi}{1+\mu b_I \gamma_y}\right)\pi_t \rightarrow \text{AD Curve} \\
\pi_t &= \pi_{t-1} + \lambda_y \hat{Y}_{t-1} + \epsilon_t \rightarrow \text{IA Curve}
\end{aligned}$$

- The intersection of AD and IA indicates the short-run equilibrium of the economy. This is no different than what we established from the IS-MP model, after all the AD curve was derived from the IS-MP model. What we are more interested in is what the long run equilibrium looks like in this model.
- What is the definition of long run equilibrium? Well even if AD and IA intersect at some $\hat{Y}_0$ and π_0, that situation will not last because the IA line would shift over time. When would the IA line stop shifting? When $\pi_t = \pi_{t-1} \equiv \pi_{LR}$ after a certain point. This would only happen when there would be no oil shocks ($\epsilon = 0$) and GDP is at potential ($\hat{Y}$).
- If $\hat{Y} = 0$, we see from the AD curve that $0 = \left(\frac{\mu b_I}{1+\mu b_I \gamma_y}\right)(r^n - \bar{r}^* + \gamma_\pi \bar{\pi}^*) - \left(\frac{\mu b_I \gamma_\pi}{1+\mu b_I \gamma_y}\right)\pi_t$, which looks ugly but simplifies to $\pi_t = \bar{\pi}^* + \left(\frac{1}{\gamma_\pi}\right)(r^n - \bar{r}^*)$.
- Note also that when $\hat{Y} = 0$, the interest rate in the economy from the IS curve is $r_t = r^n$, what we termed the natural rate of interest defined as $r^n = \frac{\bar{a} - ta_c - 1}{b_I}$.
- So in general we will consider the stable long-run equilibrium of this model to be where

$$
\begin{aligned}
\hat{Y}_{LR} &= 0 \\
r_{LR} &= r^n \equiv \frac{\bar{a} - ta_c - 1}{b_I} \\
\pi_{LR} &= \bar{\pi}^* + \left(\frac{1}{\gamma_\pi}\right)(r^n - \bar{r}^*)
\end{aligned}
$$

- Note that this means that there is no guarantee that the inflation rate in the economy will equal the targeted inflation rate in the long run. The more weight the Fed puts on inflation in its policy rule (γ_π gets very large), then the equilibrium inflation rate approaches the target inflation rate, i.e.

$$\lim_{\gamma_\pi \to \infty} \pi = \bar{\pi}^*$$

- Alternatively, if the Fed set its desired real interest rate ($\bar{r}^*$) to equal the natural rate or alternatively if the government makes it fiscal policy decisions by choosing a_G such that the natural rate of interest would equal the Fed's desired rate then $r^n = \bar{r}^*$ and thus $\pi = \bar{\pi}^*$

- To summarize

  1. The model has a long-run equilibrium that is characterized by an output gap of zero, a constant real interest rate and a constant inflation rate.
  2. The constant inflation rate that prevails in the long run may or may not equal the target inflation rate of the Fed.
  3. If the Fed's desired real interest rate or the government's fiscal policy decisions are made in such a way that the natural rate of interest equals the Fed's desired real interest rate then the inflation rate that prevails in the long run will be equal to the target inflation rate.
  4. If $r^n \neq \bar{r}^*$, then how close the inflation rate will be to the target rate depends on how much weight the Fed places on deviations of inflation from the target (i.e. how hawkish the Fed is).

III. USING THE COMPLETE MODEL

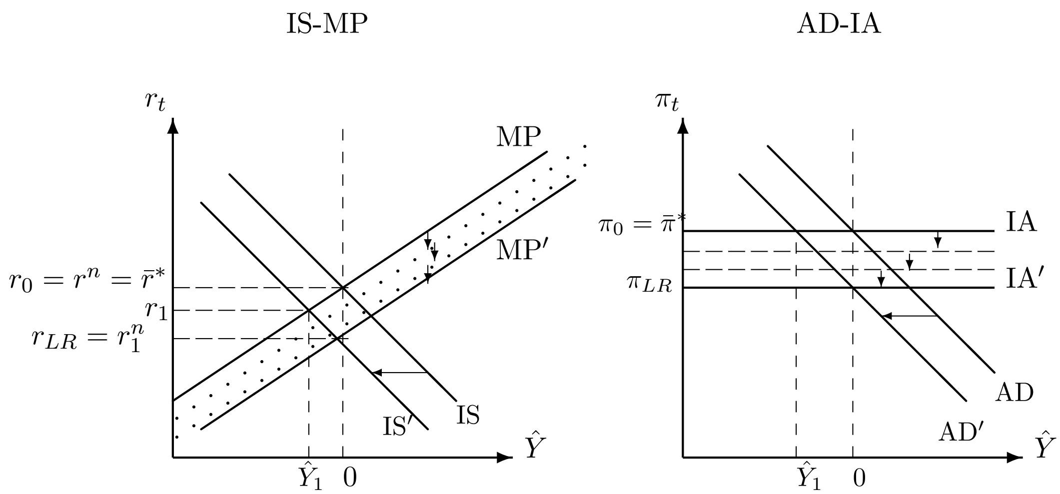
- Next, we will look at a few examples of how to work with the IS-MP, AD-IA apparatus we have developed in order to understand how to use this model for economic policy analysis. For simplicity we start the economy out at long-run equilibrium, and also assume that $\bar{r}^* = r^n$, which implies that inflation is equal to the targeted rate ($\pi_t = \bar{\pi}^*$).

Case 1: A decrease in consumer confidence

- First, we consider a fall in consumer confidence that lowers a_c and hence lowers r^n to r_1^n.

- What would happen to the economy as a result of the decrease in a_C? This will shift in the IS curve in the IS-MP program and the AD curve in the AD-IA diagram. The short run equilibrium is at an output gap of $\hat{Y}_1$, a real interest rate of r_1 and an inflation rate of $\bar{\pi}^*$. Over time, since $\hat{Y}_1 < 0$, inflation will begin to fall, shifting the IA line down. As inflation falls, the Fed will lower the real interest rate, which is shown on the IS-MP diagram as MP moving down.

- This process will continue until the economy has returned back to potential output (an output gap of zero), with an interest rate of $r_{LR} = r_1^n$ and an inflation rate of π_{LR}. Note that $r_1^n = \frac{\bar{a}' - t a_c - 1}{b_I} < \bar{r}^*$, which in turn means that $\pi_{LR} < \bar{\pi}^*$

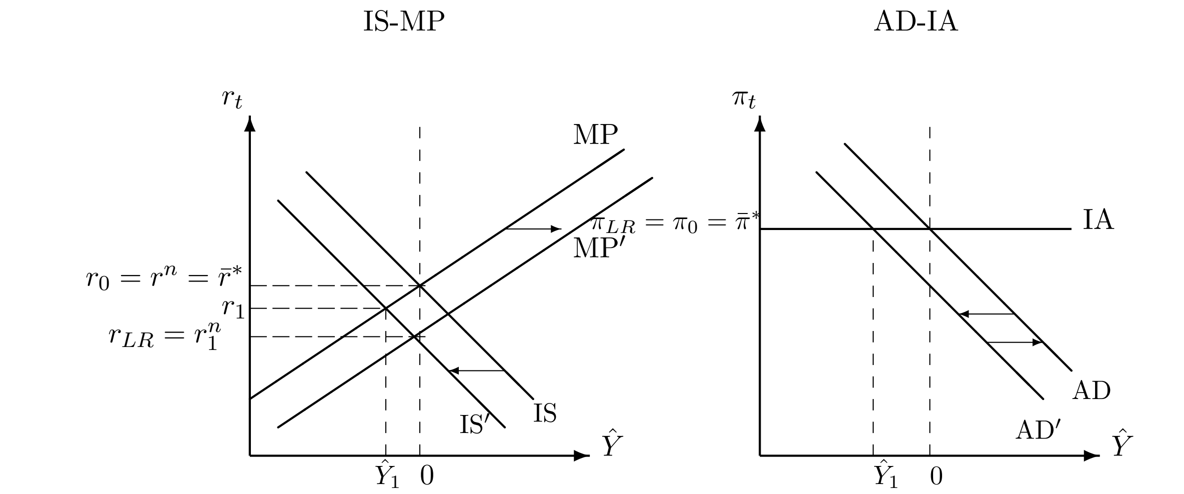


- In the example above, the monetary policymaker did play a role. When inflation fell, the policymaker responded to the fall in inflation by lowering rates as the economy returned to potential output. This endogenous response to changes in inflation and the output gap are built into the AD curve (since it is derived from the IS curve and the MP curve).

- When we look at what happened to the economy in the long run as a result of the decrease in a_C, we see that the natural rate of interest is now lower than the Fed's desired real rate and that the actual inflation rate is below the Fed's inflation target. The Fed could have done better via a more proactive approach that IMMEDIATELY responded to the fall in consumer confidence.

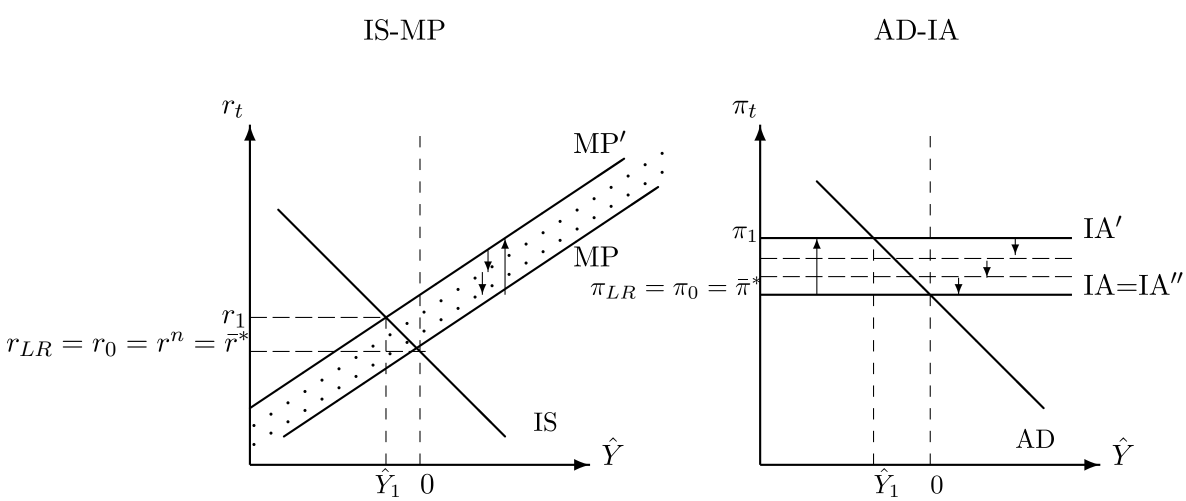
- Since the fall in consumer confidence would end up lowering the natural rate of interest, suppose the Fed lowered its desired interest rate to match the new natural rate. This will shift out the IS curve in the IS-MP diagram and the AD curve in the AD-IA diagram. The economy will move to potential output and stay there.

- The long run equilibrium has an output gap of zero, an interest rate of $r_{LR} = r_1^n$ and an inflation rate of $\pi_{LR} = \bar{\pi}^*$.



Case 2: An Oil Shock

- Next we consider the impact of an oil shock in an economy that starts out at potential output with inflation expectations equal to the target rate of inflation.
- The oil shock raises inflation in the economy, moving the IA line and the MP curve up. This will result in a fall of the output gap to $\hat{Y}_1$. Over time, since the output gap is negative, inflation will fall leading the Fed to lower interest rates and the MP curve will shift back down to the original MP curve as will IA, in returning the economy to potential output.



- Once again, the endogenous response of the policymaker is captured in the diagram above. When inflation rose, the policymaker responded by raising rates. Then as inflation eventually fell, the Fed lowered rates as the economy returned to potential output.
- When we look at what happened to the economy in the long run in this case, we see that everything is back to normal: the inflation rate is back on target and the desired interest rate has returned to the natural rate. Of course long-run normalcy came at the cost of a recession and a gradual recovery.

- Note that a proactive response is not as desirable here as in the previous case. The natural rate has not changed and thus if the Fed were to lower its desired interest rate to push the AD curve out and return the economy immediately to potential output then it would have to deal with the fact that inflation would be locked in at a higher rate $\pi_{LR} > \bar{\pi}^*$.

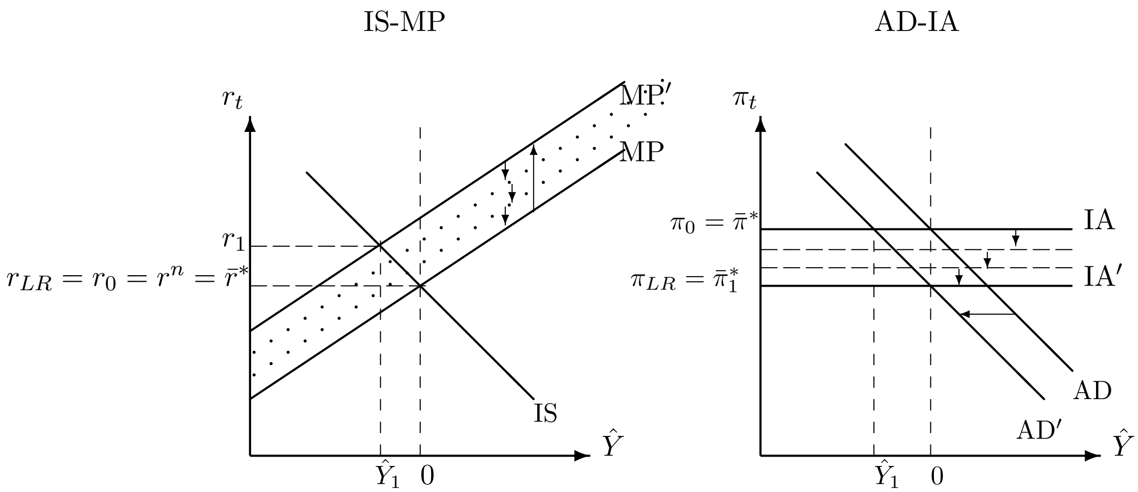
- This is why oil shocks are feared by central bankers. They cause stagflation (an unwelcome combination of a recession and higher inflation) and the Fed either had to accept higher inflation in the long run or a recession, it simply can't fight both.

Case 3: A decrease in the target rate of inflation

- We can also use the model to think about monetary policy changes of various stripes. Suppose the Fed decided to aim for a lower inflation target. This would cause the Fed to raise interest rates even though the state of the economy has not changed, and shifts the MP curve and the AD curve in. This will result in a fall in the output gap and a rise in the real interest rate.

- Over time, since $\hat{Y}_1 < 0$, inflation will begin to fall, shifting the IA line down. As inflation falls, the Fed will lower the real interest rate, which is shown on the IS-MP diagram as MP moving back down gradually.

- This process will continue until the economy has returned back to potential output (an output gap of zero), with an interest rate of r_0 and an inflation rate of π_{LR}. Note that since $r^n = \bar{r}^*$, $\pi_{LR} = \bar{\pi}_1^*$



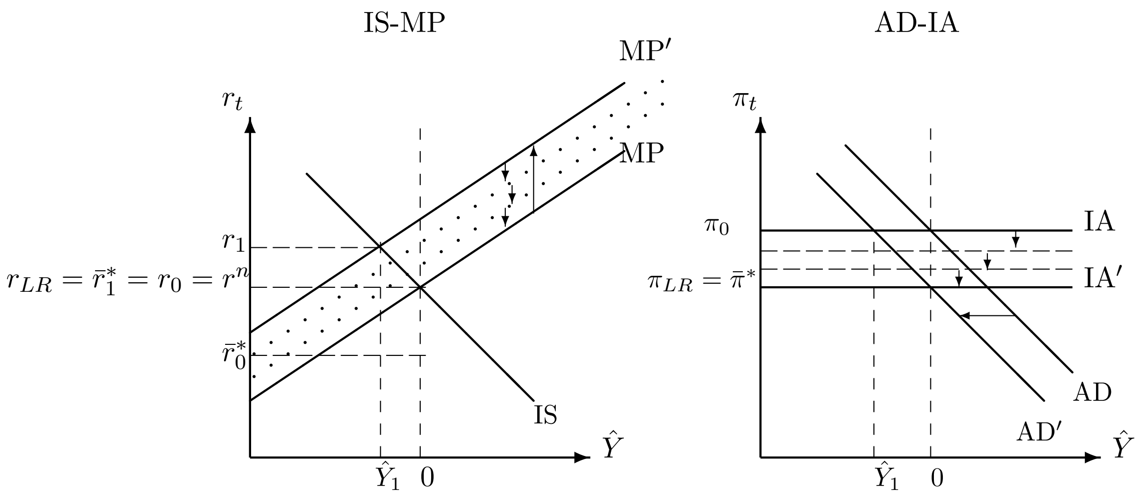
Case 4: An increase in the desired real interest rate ($\bar{r}^* \uparrow$)

- Suppose the Fed decided to aim for a higher desired real interest rate of its own volition. One reason it may do so is if the economy is at an inflation rate that is higher than the Fed's target inflation rate. Recall that the analysis we have been doing far assumed that inflation was equal to the targeted level but there was no reason why that had to be the case.

- So initially since $\pi_t > \bar{\pi}^*$, it must be the case that $r^n > \bar{r}^*$, as shown in the diagram below.

- In this case, a higher desired real interest rate would cause the Fed to raise interest rates even though the state of the economy has not changed, and shift the MP curve and the AD curve in. This will result in a lower output gap and a rise in the real interest rate.

- Over time, since $\hat{Y}_1 < 0$, inflation will begin to fall, shifting the IA line down. As inflation falls, the Fed will lower the real interest rate, which is shown on the IS-MP diagram as MP moving down.
- This process will continue until the economy has returned back to potential output (an output gap of zero), with an interest rate of r^n and an inflation rate of π_{LR}. Note that since $\pi_{LR} < \bar{\pi}^*$, $r_{LR} = r^n < \bar{r}_1^*$,



- These examples should provide you with a good idea of how to use this model to examine the short-run and long-run impact of macroeconomic changes as well as to assess appropriate monetary policy responses. The best way to think about the appropriate monetary policy response can be distilled down to a single sentence:

  "**Keep the economy at $\hat{Y} = 0$ and keep $\bar{r}^* = r^n$**"

Lecture 6: Weaknesses/Limitations of the AD/IA Model

I. OVERVIEW

- In the last few lectures, we developed and worked with the AD-IA model. In this model, we attempted to provide a simple but realistic model of a central banker who set interest rates in response to fluctuations in the output gap and deviations of inflation from the central bank's target. The central banker was also assumed to have a desired real interest rate, which was the real interest rate chosen when inflation and output gap were on target.

- We then discussed the response of monetary policymakers to various economic scenarios. If the economy was hit by a negative spending shock when inflation and the output gap were on target, then the Fed would not wait to is respond as inflation went down gradually. Instead, they would intervene and move proactively to cut rates and move the output gap back to zero.

- The challenge would be much greater if the recession was caused by an oil price shock - a case of stagflation. In that case the central bank can't deal with both the recession and the higher inflation. It would either have to cut rates now and avoid a recession, while making the higher inflation permanent. Or she would have to wait for inflation to come down, leaving the economy in a recession.

- We summarized the central banker's philosophy in the following succinct way "try to keep the economy at $\hat{Y} = 0$, with a desired interest rate equal to the natural rate". In today's lecture we use the AD-IA model to further develop some core principles of good monetary policy making. We also discuss some shortfalls and limitations of the simple AD-IA approach, setting the stage for what comes next in this course.

II. GOOD MONETARY POLICYMAKING

- Let's summarize some key results that came out of the AD-IA model. These will help form the basis for much of the analysis that follows in this course.

  1. **No Long Run Tradeoff Between Inflation and Unemployment**
     - The long run equilibrium in the AD-IA model is at $\hat{Y} = 0$. In the long run, monetary policymakers recognize that no matter what they do they cannot keep output above potential output.
  2. **Inflation Rates "That Are Too High" Are Costly So Keep Inflation Predictably Close to the Target**
     - There is empirical evidence that more volatile inflation can lead to greater uncertainty and less investment in the economy. Recall from Econ 102 that inflation, particularly unexpected inflation, redistributes income from creditors to debtors and from earners of fixed incomes to payers of fixed incomes. It can also lead to financial inefficiencies by making people focus more on sheltering their gains from inflation instead of making productive investments.

- A good monetary policymaker will therefore strive to make inflation more predictable by keeping the actual inflation rate close to some target rate. The target rate is typically non-zero for a variety of reasons. Reasons why a zero target is rarely chosen include fear that when inflation is set to be zero in normal times then every recession would lead to deflation, fear that the CPI is overestimating inflation so zero CPI inflation is actual deflation experienced by consumers and also a feeling that it is easier to reduce real wages rather than nominal wages (e.g. a 1% wage hike in a 2% inflation environment is equivalent to a 1% wage CUT in a zero percent inflation environment but workers are more likely to accept (and minimum wage legislation more likely to permit) the former than the latter.
- The target rate will also differ across countries. So a policymaker taking over in Argentina may announce (or act according to) a target rate that is much higher than a German central banker would recognizing that predictability around the target is more important than the level itself.

3. **Recognize That Inflation Expectations Can Become Entrenched in an Economy**
   - We described how expected inflation gets built into the IA curve. This shows that inflation can become entrenched in the economy via expectations. As a famous macro saying goes, "when people expect inflation they get inflation and when they get inflation they expect inflation".
   - So if a central banker overstimulated the economy and causes inflation to rise from 2% to 5%, then that 5% will get built into expectations and become very difficult to dislodge. The converse is also true, a central banker who wants to lower their inflation target and is willing to put the economy into a recession to achieve this goal will find that once the lower inflation is achieved, it is easier to maintain it than it was to achieve it.
4. **Good Central Banks Should Be Independent**
   - Notice that the central banker was modeled as caring only about deviations of output from potential output and deviations of inflation from targeted inflation. There was no advantage to a central banker from creating a trade-off of a higher output gap today in exchange for higher inflation in the future.
   - Appointing central bankers who can function independently of the whims and electoral circumstances of politicians, makes it much less likely that central bankers chase short-term gains (such as getting the government re-elected) at the expense of adverse longer-term outcomes.
5. **The Actions of Central Bankers Should Be Predictable, Within and Outside the Central Bank**
   - In Janet Yellen's speech, she talked about the importance of the central banker's actions being well understood by the agents in the economy. It is also important that the central bank have a good internal guide to policy making.
   - One way to do this is to have a nominal anchor for monetary policy, some variable that the monetary policy maker can use as a guide in making policy decisions, where the use of the guide brings better outcomes.
   - Typical nominal anchors have included a fixed money supply (monetarism) or a fixed exchange rate.

- These days,the favored nominal anchor is called inflation targeting: essentially setting a weight of $\gamma_\pi \to \infty$ over an appropriate horizon.
- We do not have a nominal anchor explicitly in our AD/IA model nor does the Fed use one in its decision. Instead, we do model the behavior of a good policymaker as following a monetary policy rule that helps guide the basic path of interest rates given various outcomes for the key macro variables.

III. WEAKNESSES/LIMITATIONS OF THIS APPROACH

- Now that we have developed even more of an understanding of some fundamental aspects of good monetary policymaking, let's see what is omitted/ignored/glossed over in this approach.

1. **Where is $\hat{Y} = 0$?**

   - We summarized the central banker's philosophy in the following succinct way "try to keep the economy at $\hat{Y} = 0$, with a desired interest rate equal to the natural rate". The difficulty of assigning such a critical role to $\hat{Y}$, is that it is very hard to pin down what the level of potential output (Y^*) is.
   - Disgruntlement with the Fed is often rooted in disagreements about potential output. In the dot-com boom of the late 1990s, when the Fed was raising rates, some people believed that potential output had increased as well: this would lower $\hat{Y}$ so there was little need for the Fed to raise rates.
   - On the other hand, some economists think that Fed policy was too loose during the 1970s, which contributed to the high inflation rates seen during the decade. They claimed that the Fed should have realized that potential output had fallen (as a result of high oil prices driving manufacturing plants out of business by making them uneconomical), and thus raised interest. In essence, Y had fallen (which led the Fed to ease interest rates) but Y^* had fallen as well (which should have made it far less likely that the Fed should lower rates).
   - This lack of knowledge about where potential output is exactly can explain why the Fed moves in small increments of policy when it typically does. Move rates up or down by 25 basis points over 2-3 meetings instead of making large changes.
   - Potential output is the economy's long run ability to produce goods and services. In reality, what type of changes in fiscal or monetary policy affect the level of potential output? Fiscal policy can affect Y^* only if the productive capacity of the economy is increased by the policy, i.e. the expansionary fiscal policy leads to more labor, technology or capital.
   - Possible candidates are increased spending on research and development, establishing a system of property rights, on public infrastructure or on job training programs that reduce the time spent between jobs etc.
   - Economists generally assume that monetary policy cannot affect the economy's long run ability to produce. In other words monetary policymakers can only affect $\hat{Y}$ in the long run, not Y^* itself.

2. **Policy Lags**

- In drawing AD/IA diagrams we assumed that the policymaker can adjust interest rates in either direction to move the economy where it wants to go. However, this is by no means something we can take for granted. In a 10 trillion dollar economy can changing one inter-bank interest rate really move output instantaneously?
- The answer is clearly no. Monetary policy has fairly long impact lags, it may take 6-9 months or even longer for policy to have an impact on the economy. In that time, lots of things can change about the economy making the initial policy adjustment not quite right. Alan Blinder has a wonderful analogy about monetary policy being like changing temperature settings in a hotel in an unfamiliar country and waking up six hours later either freezing or sweating.

3. **Transmission Channels**

- Another complication is how exactly changes to the overnight interest rate get transported to the rest of the economy. In our model, there was one clear channel via which this happened, namely, a change in the real interest rate. When the Fed lowers or raises the real interest rate investment either rose or fell in response to that.
- In the real world, however, there are many other channels via which policy can affect the economy. Monetary policy will affect stock markets, it can affect exchange rates, it can affect banks willingness to lend etc.

4. **The Real Interest Rate in IS and MP May Not Be the Same**

- In the real world, what the MP curve's real interest rate is analogous to is the real Fed Funds rate, which is an overnight interest rate that banks charge each other for loans.
- Similarly, in the real world, what the IS curve's real interest rate is analogous to is a long-term real interest rate that drives spending decisions: examples include a 30-year mortgage rate, a 10-year student loan rate or a 5-year auto loan.
- We assumed these rates were the same in the IS-MP model, but an important complication is how exactly changes to the overnight interest rate get transformed into changes in much longer interest rates., which in turn have important roles to play in driving key economic spending decisions.

5. **The Zero Lower Bound**

- We summarized good monetary policy as moving the output gap to $\hat{Y} = 0$ and moving the desired real interest rate to $\bar{r}^* = r^n$. We already discussed the complications of achieving the output gap goal when potential output is unknown but there are additional complications with the second as well.
- Recall that $r^n = \frac{\bar{a}-1-ta_C}{b_I}$. Soa big negative spending shock ($\bar{a} \downarrow$) will drive r^n down. Suppose, for example, that the new r^n was calculated to be -4%. What our description of good policy suggests is that the Fed should therefore lower its desired real interest rate to -4%.
- Keep in mind, however, that in the real world the nominal interest rate has a lower bound of zero. So the lowest real interest rate that the Fed can achieve, given $r = i - \pi$ is $r = -\pi$. If we assume a 2% inflation target, for instance, this means that even though good policy would require that the Fed try to move real interest rates to -4% they can

only go to -2%. In other words, going directly back to potential output following the negative shock is impossible.

- Then things begin to unravel. If $\hat{Y} < 0$ as it would be following an inadequate policy response, then inflation falls over time. But if $r = -\pi$ then falling inflation actually raises real interest rates!!! This causes spending to fall, and the recession gets worse and worse over time.
- Similarly, in the real world, what the IS curve's real interest rate is analogous to is a long-term real interest rate that drives spending decisions: examples include a 30-year mortgage rate, a 10-year student loan rate or a 5-year auto loan.

6. **Differences in Expectations Formation**

- In our model we assumed that expected inflation was simply last period's inflation rate, in other words the inflation that prevailed at the time the contracts were signed.
- But in the real world, we can't definitively say how expected inflation is formed. People may use the worst rate they experienced in their lifetime, a forecast of a future inflation rate, the average over the last 3 years, etc. to form expectations. Since this expectations term is a critical piece of how inflation will evolve this makes the task of a policymaker a very challenging one.

Spring Semester '13-'14
Akila Weerapana

Lecture 7: The Phillips Curve

I. OVERVIEW

- Over the last few lectures we first developed, then worked with a simple model of the macroeconomy: the AD-IA model. We used this model to derive some core principles of monetary policymaking such as a monetary policy rule and the notion that a good policymaker will strive to keep an output gap at zero and inflation at the targeted rate by choosing her desired real interest rate to equal the natural rate of interest.

- We also discussed some key limitations of the model such as uncertainty about $\hat{Y}$, lags in policy impact, the difference between the real interest rate influenced by the Fed and the real interest rate that affects spending decisions, and the different ways in which we could model expected inflation. We then said that the rest of this class would tackle monetary policy in more depth and nuance using academic research papers.

- In today's class, we begun this process by discussing Robert Gorden's paper on the history of the Phillips Curve. We discuss this in two lectures: first the history and underlying theory, then the empirical work.

- These research papers are a real challenge to read: they are dense, not exactly targeted at a non- academic economist audience and not very keen on providing background and explanation. My goal is to help you get the most you can from these papers via three separate processes. The first is to provide you with study questions to guide your reading of the paper. These questions are designed to get you to focus on the important parts of the paper and ignore the minutia. The second is through classroom lecture and discussion where we talk about the paper using the study questions as a guide. The third tool are these lecture notes.

- In the notes, I will not be rehashing the paper page by page or section by section. Instead I will be providing you with background for the paper, using simpler examples and clarifications of key points and concepts to supplement the paper.

- The first part of the Gordon paper discusses the intellectual evolution of the Phillips Curve. The Phillips Curve is a key component of the toolkit that macroeconomists use to analyze/explore/understand the economy. It is also a very controversial one .In addition to discussing the Gordon paper, I will also point out how we have incorporated one version of the Phillips Curve into our analysis thus far via the AD/IA model.

II. ORIGINS OF THE PHILLIPS CURVE

- In 1958, the economist A.W. Phillips pointed out an important empirical regularity using British data. Basically, Phillips showed that there was a strong negative correlation between wage inflation and unemployment. Using half a century of data from 1860 onwards, Phillips showed that the data fit a strong negative relationship between wage inflation and unemployment, a relationship that was highly non-linear. Phillips then showed that this estimated model could be used to predict how inflation responded to unemployment fluctuations in the next four decades up to the mid 1950s when his paper was published.

- The accuracy of the predictions of the Phillips Curve seemed to indicate that there was a stable relationship between inflation and unemployment. In turn, such a stable relationship would imply that policymakers could choose the desired tradeoff between unemployment and inflation: the curve would guide them as to the inflation consequences of making different choices about the unemployment level.

- The excitement generated by the Phillips Curve spread beyond the United Kingdom. The economic advisors of Pres. John F. Kennedy argued that the United States move "Northwest on the tradeoff because they were too much to the Southeast", in effect saying that the U.S. should choose a lower unemployment/higher inflation combination than the high unemployment/low inflation position they found themselves in.

- The original Phillips Curve used wage inflation, rather than price inflation, and was non-linear: the slope was steeper at low levels of unemployment and flatter at high levels of unemployment. The intuition behind this was that wage inflation was asymmetric in that workers would resist nominal wage cuts at high rates of unemployment so it was more likely for wages to rise sharply when unemployment was low than fall sharply when unemployment was high.

- If the tradeoff was stable, then the government could figure out where they were on the curve, calculate the slope and figure out the inflationary consequences of active fiscal policy.

- For the rest of the analysis in this chapter, I will use a linear Phillips curve since it is easier to draw and do analysis with. The general tenor of the results that I derive are not limited to the linear case, however.

- We can model the original version of the Phillips Curve with a simple relationship of the form:
$$\pi_{t+1} = \lambda_0 - \lambda_1(u_t)$$

- In the above,π_{t+1} is the percent change in price from time t to time $t+1$ (in other words next period's inflation) and λ is a parameter that measures the sensitivity of inflation to movements in unemployment (i.e. the slope of the Phillips Curve).

III. THE CRITIQUES OF FRIEDMAN, PHELPS AND LUCAS

- Gordon describes the next key event in the evolution of the Phillips Curve being the 1960 presidential address to the American Economic Association by Milton Friedman. Milton Friedman's speech was a powerful and influential talk in which he outlined several key problems with the Phillips Curve. It is important to realize that these were problems that ran counter to conventional wisdom about the Phillips Curve and also that the Friedman speech was prophetic in foreseeing some of the problems that would emerge in the 1960s in how well the data matched the story of the Phillips Curve.

- Friedman's speech focused on two important omissions from the Phillips Curve analysis. First, Friedman argued that there was no long-run tradeoff between inflation and unemployment. In the long run policymakers could not choose the level of unemployment they wanted, instead the economy would converge to the "natural rate of unemployment", which was the rate of unemployment "ground out" by the microeconomic interactions of firms and workers in the economy.

- Second, Friedman argued that the conventional analysis ignored the role of expectations. When policymakers lower unemployment fully intending to raise the inflation rate, then agents in the economy will notice that inflation has risen and then revise their expectations accordingly. With higher expectations, inflation would have to rise more now to reduce unemployment to the desired level. Friedman also used expectations to define the natural rate as being the unemployment rate that set the actual inflation rate to be consistent with the expected date.

- Friedman's work was formalized and presented by another Nobel Prize winning economist Edmund Phelps. The Friedman-Phelps version of the Phillips Curve can be seen in a simplified form in the following equation:

$$\pi_{t+1} = E_t\pi_{t+1} - \lambda_1(u_t - u^n)$$

- Notice the two key differences: the inclusion of the expected inflation term and the natural rate term. The original version of the Phillips curve would essentially assume that expected inflation was fixed, i.e. that people did not revise their inflation expectations. The contrast between these two approaches was striking as you can see in the examples below that show a policymaker who wants to push unemployment one percentage point below the natural rate.:

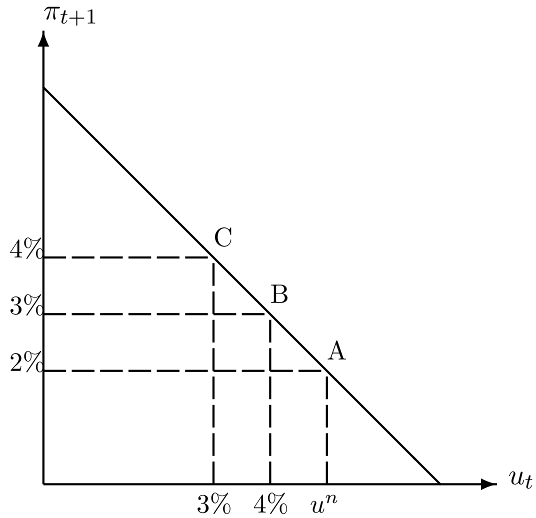
Case 1: The Original Phillips Curve

- Consider the Phillips Curve to be of the form $\pi_{t+1} = 2\% - \lambda(u_t - 5\%)$ and let's assume a slope of $\lambda = 1$.

- A graph of this Phillips Curve is given below. Suppose also that unemployment is at the natural rate, and hence inflation is 2%.

- Now suppose that the policymaker wants to reduce unemployment below the natural rate of unemployment in this period to say 4%. Because expectations do not change, if she does so then next period's inflation will rise to $\pi_{t+1} = 0.02 - (0.04 - 0.05) \equiv 3\%$. This is represented as point B in the diagram below.

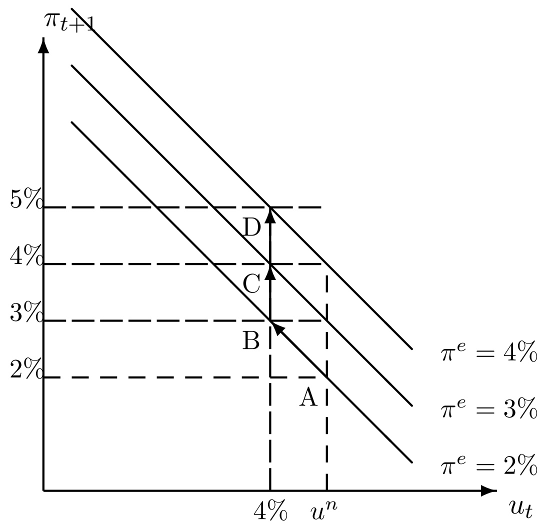
- Similarly, if she wants to reduce unemployment in this period to 3%. This can be found either graphically or by looking at the Phillips Curve to see that the consequence of this would be that next period's inflation rate will be $\pi_{t+1} = 0.02 - (0.03 - 0.05) \equiv 4\%$. This is represented as point C in the diagram below.



Case 2: The Friedman-Phelps Phillips Curve

- What if expectations were not constant, but instead revised to reflect the actual circumstances that agents in the economy were facing? We can capture that with a simple modification to the above curve $\pi_{t+1} = \pi_t - (u_t - 5\%)$
- Suppose again that the current inflation rate π_t was 2% and that unemployment is currently at the natural rate, $u_t = 5\%$.
- The Phillips Curve can be graphically displayed in the figure below,with the initial point represented as point A. Note on my diagrams that I am using π^e as short hand for expected inflation. Thus $\pi^e_{t+1} \equiv E_t\pi_{t+1}$ and $\pi^e_{t+2} \equiv E_{t+1}\pi_{t+2}$ etc.
- Now suppose, as before, that the policymaker wants to reduce unemployment at time t to 4%. She can do so if she's willing to tolerate an increase in next period's inflation to $\pi_{t+1} = 3\%$. [Point B on the graph]
- If expectations are adaptive, however, the expected value of inflation won't be constant. In the next period, since actual inflation turned out to be $\pi_{t+1} = 3\%$, people will revise their expectations upwards to 3%. This causes the Phillips Curve to shift upwards.
- In period $t + 1$ the policy maker will have to be willing to tolerate an inflation rate for the following year of $\pi_{t+2} = 4\%$ just to keep unemployment at $u_{t+1} = 4\%$. [Point C on the graph]. The tradeoff has become more unfavorable (4% inflation for 4% unemployment instead of 3% inflation for 4% unemployment).
- The tradeoff will continue to become more unfavorable because in period $t+2$ expected inflation will now be 4%. This causes the Phillips curve to shift upwards again. The policymaker has to be willing to tolerate an inflation rate of $\pi_{t+3} = 5\%$ in order to keep unemployment at $u_{t+2} = 4\%$. [Point D on the graph].

- This shift up of the Phillips Curve will continue and make the long run tradeoff seem very unattractive since very high inflation rates are needed to keep unemployment below the natural rate.



- The only way to stop the shift is if $u = u^n$, that was the only way in which inflation and expected inflation would coincide. Hence, Friedman argued, there would only be one possible long-run equilibrium unemployment rate, which was the natural rate.

Case 3: The Lucas Rational-Expectations Critique of the Phillips Curve

- As I mentioned earlier, Friedman's cirque resonated because in the late 1960s, U.S. inflation rose faster than what the stable Phillips curve relationship would predict. In the early 1970s, the relationship seemed to have completely disappeared from the data as the U.S. economy experienced episodes of stagflation: ac combination of a stagnant economy and high inflation that would not be predicted by the Phillips Curve.

- An even stronger attack on the Phillips curve came from the Nobel Prize winning economist Robert Lucas and his application of the concept of rational expectations. Rational expectations basically states that people form expectations based on all available information including the past history of the economy. In other words, it is impossible to systematically fool people with rational expectations.

- If expectations were rational in the country described in the previous example, π^e will be formed on all the information available to the agents in the economy, not just the history of inflation.

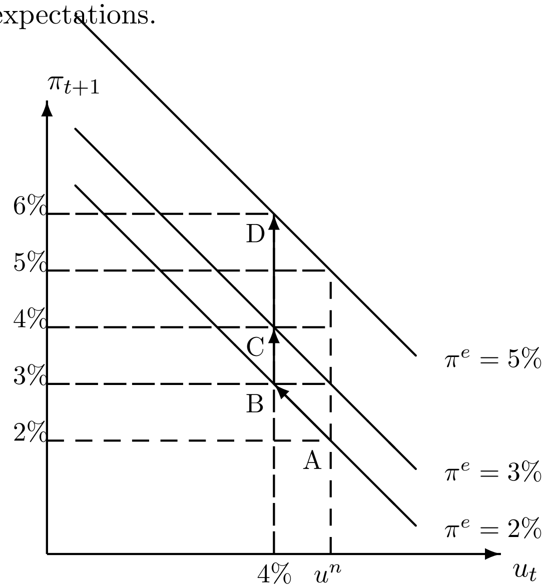
- We can show that under rational expectations the tradeoff between inflation and unemployment will be even worse than in the previous case. Suppose that inflation had been constant at 2% for a while so that we start at point like A with inflation equal to 2%.

- As in the previous case, we move to point B when the government reduces unemployment to $u_t = 4\%$, resulting in an inflation rate of $\pi_{t+1} = 3\%$.

- Going into period $t+1$, people had expected 2% inflation but the government gave them 3% inflation as a byproduct of their quest to reduce unemployment. Therefore, agents may revise their expectations upwards to 3% in the next period. If the government wants to keep the economy at 4% unemployment ($u_{t+1} = 4\%$), then inflation will rise to 4% ($\pi_{t+2} = 4\%$) [Point C].

- So far the analysis is similar to the adaptive expectations case. But things may start to diverge very soon. In the adaptive expectations case people automatically revised their expectations upwards to 4%, since actual inflation in period $t+2$ was 4%. However, agents who are rational may not behave in the same manner. For example, they may think in the following way: "hmm, when I expected 2% inflation, the government gave me 3% and when I expected 3% inflation, they gave me 4%. So if I expect 4% they will most likely give me 5% so I should just make all my decisions with an expected inflation rate of 5%". In other words they may set their expectations to 5%

- This causes the Phillips Curve to shift upwards by more as expected inflation increases to 5% instead of 4%. Then the government needs to tolerate $\pi_{t+3} = 6\%$ to keep the economy at the current level of unemployment. [Point D on the graph]. In the next period, expected inflation may climb even higher and the tradeoff becomes untenable much more rapidly. One could even argue there is no tradeoff beyond more than a couple of periods under rational expectations.



- Lucas argued that this meant that there was no possibility for monetary policymakers to move the economy when their actions were anticipated by a rational public. Only unanticipated policy could move the economy.

- The Lucas/Friedman/Phelps critiques led to the bifurcation in 1975 of what had seemed like consensus at the time of AW Phillips in 1960. Gordon describes the two schools of thought that emerged as the "Left Fork" and the "Right Fork" in the road. The primary difference between the two camps came form how they treated expectations in their analysis.

IV. THE LEFT FORK IN THE ROAD

- One of the key figures in the left fork in the road was Gordon himself. Gordon's work provided a resurrection of the Phillips curve by explicitly incorporating supply shocks into the Phillips curve analysis. The version of the Phillips curve that this branch of the literature uses is called the "triangle model", and can be described by the following specification

$$\pi_{t+1} = E_t \pi_{t+1} - \lambda(u_t - u^n) + \epsilon_{t+1}$$

- The reference to the triable comes from the three parts of the relationship, representing expectations, demand and supply respectively. Another key part of the triangle model was to replace expectations of inflation with lagged values of inflation: essentially saying that the economy was stable enough for past inflation to offer a guide to the formation of future inflation expectations. A simple example would be $E_t \pi_{t+1} = \pi_t$

- The triangle model incorporated the Friedman critique of expectations, acknowledged the Lucas critique of policy irrelevance but overruled that by assuming that expectations would be connected to past data (by the stability of inflation and by staggered wage and price contracts that tied future inflation to past inflation), and used oil shocks to explain the terrible performance of the Phillips Curve in the early 1970s, which led to the Lucas arguments about policy irrelevance.

- I like to think of the triangle model as an empirical rebuke to Lucas: "Yes, you may be right in your theory, but in practice, I can get a stable and useful relationship that contradicts your theory by linking expectations formation to the past"

- In your next p-set, I will ask you to estimate a triangle model and see how it can predict inflation in more recent times. In other words, I will ask you to test if the Phillips Curve really did die out in the 1970s as Lucas claimed or whether it has survived to more recent times. If the triangle model is stable then it can be used to demonstrate how policy can have an impact by utilizing both the expectations and the demand channels.

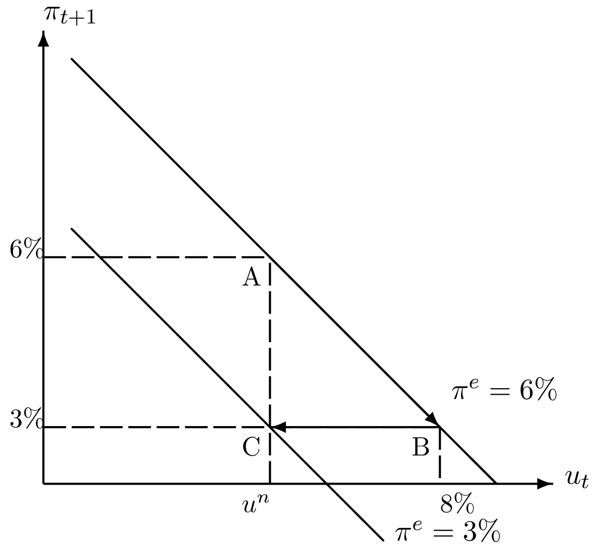
- Let me illustrate with an example. Assume a Phillips Curve of the for $\pi_{t+1} = E_t \pi_{t+1} - (u_t - 5\%)$ and suppose the economy is at the natural rate, with an inflation rate of 6% and where the policymaker is given the task of reducing inflation to 3%. Expectations were backward looking (or adaptive), as in the triangle model, so let's use a simple version of the form $E_t \pi_{t+1} = \pi_t$.

- From the setup below, notice that to lower inflation by 3 percentage points, requires that the unemployment rate this year be raised by 3 percentage points, from 5% to 8% [Point B on the graph]

- Since inflation was only $\pi_{t+1} = 3\%$, expected inflation will now fall to 3% as well - the Phillips Curve shifts down.

- As a result, we no longer need to raise the unemployment rate and we can move back to the natural rate [Point C].

- At Point C, inflation and expected inflation are both now at 3%, unemployment is at the natural rate and we have permanently reduced inflation after a severe, yet short recession.

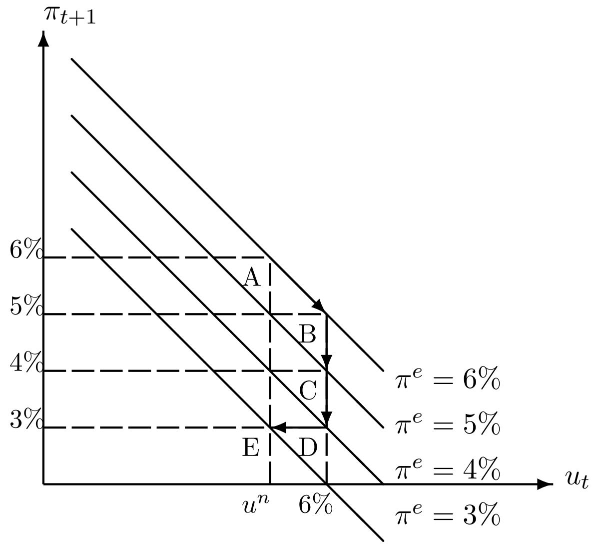


- It turns out we can also accomplish the same task without putting as many people out of work. Suppose that instead of raising the current unemployment rate by 3 percentage points, we instead raised it by 1 percentage point, from $u_t = 5\%$ to $u_t = 6\%$. This would lower next period's inflation rate by 1 percentage point (given the slope of 1 on the Phillips Curve) from $\pi_{t+1} = 6\%$ to $\pi_{t+1} = 5\%$ [This would move us to Point B in the Figure below]

- Since actual inflation is only 5% instead of 6%, expected inflation for next year will also be 5%. The Phillips Curve will shift down.

- Now, if the policy maker keeps unemployment next period at $u_{t+1} = 6\%$ then inflation in the following period will fall to $\pi_{t+2} = 4\%$. [Point C on the graph]. Furthermore, in the next period expected inflation will now be 4%, so the Phillips curve will shift down again.

- The policymaker can keep this up until expected inflation has come down to 3%, at which point we can move the economy back to the natural rate [Point E on the graph] at which point the economy will remain at 3% inflation, since expected inflation and actual inflation now coincide again resulting in no further shifting of the Phillips Curve.



- So by increasing unemployment by 1 percentage point above the natural rate and keeping it there for 3 periods, we managed to reduce inflation by 3 percentage points. Compare that to the previous case where we raised unemployment by 3 percentage points (a sharper recession) but only kept it there for 1 period (a shorter recession).

- BOTH the expectations and demand channels play a role here. The policymaker gets to choose what she thinks is best for the economy. The more she moves demand, the more expectations will respond and the less she moves demand, the less expectations will respond.

- It is also important to keep in mind that Gordon himself believes that while the left fork in the road is the right way to think about this issue in the U.S. context, for other central bankers with more volatile inflation histories, its the right fork in the road that is more appropriate.

- Notice also that the IA curve is essentially the triangle model. It is important therefore to gain an understanding of the other side of the fork, not just the side of the fork that we adopted for the AD-IA model.

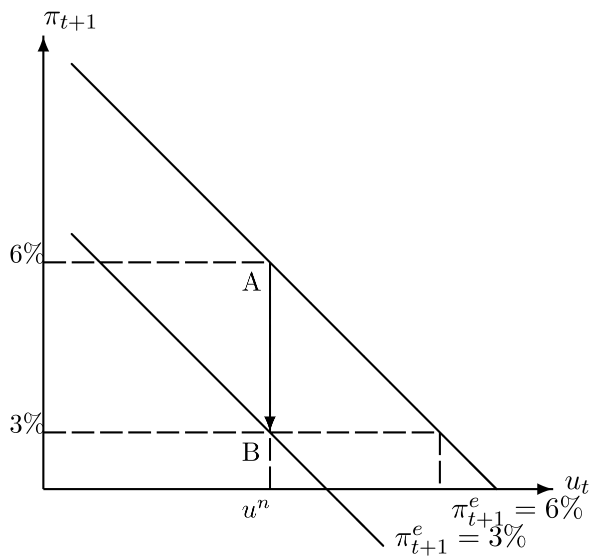
V. THE RIGHT FORK IN THE ROAD

- The right fork in the road was a modeling approach that paid much more attention to the notion that expectations would change dramatically in response to policy. Gordon argues that these models are more suited than the triangle model for countries like Argentina where inflation has a more volatile history.

- In these models, credibility and reputation play a very important role, particularly in helping stabilize and reduce inflation in the economy. A classic work in this branch of the literature was a study by yet another Nobel Prize winning economist Tom Sargent on how four episodes of very high inflation in various countries across the world came to an end when expectations were brought under control.

- Again, let me use a simple example to highlight why this branch of the literature is so focused on expectations and the role of concepts like credibility and reputation. Assume a Phillips Curve of the for $\pi_{t+1} = E_t\pi_{t+1} - (u_t - 5\%)$ and suppose the economy is at the natural rate, with an inflation rate of 6%.As in the triangle model, suppose the policymaker is given the task of reducing inflation to 3% but now suppose that expectations were rational.

- Under rational expectations people no longer are dependent on a formula from past observations to model expectations. Instead they form their expectations based on all available information. This means that a policy maker who is able to convince the agents in the economy that she represents a clean break with the past can reduce inflation without a demand-side intervention at all.
- For example, suppose the central banker can credibly convince people to reduce their inflation expectations to $E_t\pi_{t+1} = 3\%$.
- Then, as can be seen in the graph below, the central banker can deliver an inflation rate of 3% inflation without any unemployment, as the Phillips Curve shifts down [go from Point A to Point B in the graph below].



- Even if only half the population believed you, expectations would fall and thus the task of the policymaker is greatly enhanced by manipulating expectations.
- Another key approach in this branch of the literature is the New Keynesian Phillips Curve (NKPC). The NKPC thinks of expectations as a forward-looking process rather than a formulaic backwards looking process. It however, put amore emphasis on demand (hence the "Keynesian" part of NKPC) than some of the other approaches on the right fork.
- We will study New Keynesian models later in this class but for now we can think of it as an equation that looks like the following $\pi_{t+1} = E_t\pi_{t+1} - (u_t - 5\%) + epsilon_{t+1}$, where expectations are forward-looking rather than backward-looking.
- Gordon argues that this branch is appropriate for thinking about countries with high inflation episodes in its past as opposed to the triangle model, which is more appropriate in the U.S. context.

Lecture 8: The Empirical Stability of the Phillips Curve

I. OVERVIEW

- In the last lecture we looked at a paper by Robert Gordon in which he traced out the intellectual history of the Phillips Curve. We learned how the Phillips Curve had initially emerged as a stable inverse relationship between inflation and unemployment that created the possibility of a tradeoff between higher inflation and lower unemployment. Gordon then discussed how the work of Milton Friedman and Edmund Phelps showed that the tradeoff would be short-lived in the presence e of changing expectations. The apparent nail in the coffin of the Phillips Curve came from Robert Lucas' work on rational expectations, in which he showed that not only would there be no long-run tradeoff between inflation and output (as hypothesized by Friedman), there would be no role for predictable monetary policy even in the short run.

- After Lucas' work, the research on the Phillips Curve bifurcated. What Gordon called the left branch, added supply shocks, postulated that expectations were a backward looking function of lagged actual inflation rates and worked with the resulting "triangle model" that specified a three-pronged impact on inflation coming from expectations, demand and supply. The right branch, according to Gordon, emphasized the formation of rational expectations and paid more attention to how policy could impact expected inflation. The sub-branch of New Keynesian Phillips Curve (NKPC) struck a middle ground by combining forward-looking expectations with some of the demand-side forces from the triangle model.

- Today's lecture focuses on the rest of the Gordon paper, specifically, the empirical validity of the Phillips Curve. Gordon argues that the triangle model of the Phillips Curve is a robust economic relationship that outperforms the NKPC and the expectations based models for the United States.

- The bottom line is that (a suitably modified) Phillips Curve remains a valid and useful tool with which we can understand macroeconomic policy for the United States.

II. READING ACADEMIC RESEARCH PAPERS

- Before we discuss the Gordon paper, let's take a step back and discuss how one should go about reading an academic research paper. We will be reading almost two dozen papers, some more tractable than others. It is important to realize that these papers are written for a peer audience: academic economists writing for the benefit of other academic economists, which makes the papers more than a little dense for undergraduates, even excellent economics majors like you.

- Second, academic economists are also not the most accomplished writers nor are they connoisseurs of good writing. Therefore, the articles are by no means light and easy reading, which means that a 20 page Economics paper will take you more time to read than a 150 page History or English reading.

- With that in mind, I will be summarizing the readings in my Lecture Notes to help you wade through the morass of material contained in the paper. However, it is important to realize that reading Lecture Notes is not a substitute for reading the paper. If I find out that you are ignoring the paper for the Cliff Notes version in my Lecture Notes, I will abandon this practice and force you to learn everything directly from the paper. Trust me when I say that this is not what you want to happen.
- So, how does one go about reading these papers? Well for starters, you need to have some structure in reading the paper. In every paper, you should be able to identify the following four elements:

  1. Research Question. What is the (preferably well-defined and narrowly focused) research question that the paper is attempting to answer?
  2. Motivation: In other words, why is the question an important one? So a paper that says "we are developing g a model to better understand the link between income inequality and economic growth" is better than "the literature previously has only dealt with models that have 3 equations, I want to write a model that has 4 equations".
  3. Findings. What exactly does the author find as answers to the question? Are the authors results definitive, or are they dependent on certain assumptions? Is the applicability of the results limited to a particular country or to a particular era or can we generalize?
  4. Methodology. This section covers the bulk of the paper and will usually be the hardest. What methodology does she use to get to the findings? Is the paper a theoretical one or an empirical one? If it is a theoretical model, what are the main equations that characterize the model? If it is an empirical one, what regression equations are being used, what data is being used? Note that you do not need to follow every step of algebra along the way, that would be counter-productive. You should instead be able to follow the gist of the author's argument and learn something about the approach she takes to answer what is hopefully an interesting question.

- I will try to follow this framework in my discussion of the papers and I hope you will do so as well. So even for the most complicated papers, you should be able to accomplish the first three and have a vague idea of the 4th. For the easiest papers, you should be able to do all 4 tasks easily.

III. THE TRIANGLE MODEL OF THE PHILLIPS CURVE

- The triangle model is a version of the Phillips curve allowing for oil shocks and stable, backwards looking modeling of expected inflation.
- The version of the triangle model that Gordon uses is

$$\pi_t = \sum_{i=1}^{12} \alpha_i \pi_{t-i} - \lambda(u_{t-1} - u^n) - \beta(u_{t-1} - u_{t-2}) + \gamma \text{oil shock}_t$$

- In the above, the $\sum_{i=1}^{12} \alpha_i \pi_{t-i}$ is expected inflation (proxies by past inflation), a negative effect from both the level and change of unemployment, and supply shocks. The change in unemployment is included to show that a rise in unemployment may have effects that are distinct from the level of unemployment.

- To estimate the above model, we typically use a regression of the form:

$$\pi_t = a_0 + \sum_{i=1}^{12} a_i \pi_{t-i} + b_1 u_{t-1} + b_2 u_{t-2} + b_3 po_t + \eta_t$$

- If we open up the triangle model we see that the coefficient in front of u_{t-1} is $-(\lambda+\beta)$, which means that our regression coefficient b_1 is an estimate of $-(\lambda+\beta)$. The coefficient in front of u_{t-2} is β, which means that our regression coefficient b_2 is an estimate of β. The constant a_0 is the estimate of $(\lambda)u^n$ from the true model.

- We can therefore use our regression coefficients and map the following:

$$\begin{aligned} b_2 &\to \beta \\ -(b_1+b_2) &\to \lambda \\ \frac{a_0}{-(b_1+b_2)} &\to u^n \end{aligned}$$

- In a triangle model, we also constrain the α_i coefficients in the expected inflation term to sum to 1. This reflects the idea that in the long run (i.e. when $u = u^n$), in the absence of supply shocks, inflation should be equal to expected inflation $\pi = \pi^e$. Given our specification of $\pi_t^e = \sum_{i=1}^{12} \alpha_i \pi_{t-1}$, the only way inflation and expected inflation will be the same (constant) value in the long run is if $\bar{\pi} = \sum_{i=1}^{12} \alpha_i \bar{\pi} = \bar{\pi} \sum_{i=1}^{12} \alpha_i$ which simply implies that $\sum_{i=1}^{12} \alpha_i = 1$

- The basic argument of Gordon is that in spite of Robert Lucas's claims, the Phillips Curve is a stable economic relationship. Lucas argued that relationships, like the expected inflation term, described by past data would not necessarily hold in the future, especially when there had been substantial changes in economic policies that would affect expectations of individuals in the economy.

- In the triangle model, $\pi_t^e = \sum_{i=1}^{12} \alpha_i \pi_{t-1}$, the α parameters signify the weight, or importance, attached to each month's observation in forming current expectations. Lucas' argument is that there is no guarantee that these parameters would remain constant over time. For example, suppose that a country has had a stable history and that each period should be weighted the same: $\alpha_i = 1/12$ for all $i = 1 \ldots 12$. Now suppose that some big economic change happens (e.g. a war in the Middle East, a firing of the Fed Chairman etc.) resulting in high inflation in one particular month. In the future, then individuals may pay more attention to that period (increase the parameter for that period) and downgrade other periods. In this case, the model with fixed weights (the triangle model) is not informative in predicting future inflation expectations.

- Gordon's argument is that whether or not we should accept what Lucas says is an empirical issue not a theoretical one. The Phillips Curve, it will continue to be useful unless the shifts in the way in which people form expectations has been dramatic. If the manner in which people form expectations has not changed dramatically over time, then the resulting estimated Phillips Curve is robust and can be used in economic policy making despite the theoretical objections.

Estimation

- Gordon uses quarterly data from 1962 to 1997 to estimate the regression coefficients for a triangle model and then compares the predictions of the model for the 1998-2007 period against reality. He discusses the possibility that the natural rate of unemployment may not be a constant, in which case you would want to estimate the system of equations

$$\pi_t = \sum_{i=1}^{12} \alpha_i \pi_{t-i} - \lambda(u_{t-1} - u_t^n) - \beta(u_{t-1} - u_{t-2}) + \gamma \text{oil shock}_t$$
$$u_t^n = u_{t-1}^n + \eta_t$$

- This specification of a non-constant natural rate is called the time-varying NAIRU (or TV-NAIRU). Looking at the data provided in Figure 5, it is clear that an assumption of a constant NAIRU in the period leading up to 1994 and an allowance for a one-time shift down in that constant NAIRU in the 1990s would generate an (almost) constant NAIRU estimate that matches up well with the TV-NAIRU. I am not going to ask you to estimate TV-NAIRU for the empirical exercise I ask you to do.

- The rest of Gordon's paper is devoted to a discussion of how to estimate the NKPC. This is more challenging since instead of past values of inflation (for which we have data), it is future expectations of inflation that play the key role. In addition, a pure NKPC will not even include supply shocks but as one of Gordon's tables shows, the predicted inflation rate would do much worse if supply shocks were ignored. We will defer the discussion of NKPC estimation to later in the semester.

- In practice, the triangle model continues to play an important role. The modern macro models used by the Federal Reserve will typically be a hybrid of the triangle and NKPC approaches, with future expectations, past inflation experience and oil shocks all playing a role.

Lecture 9: The Channels of Monetary Transmission

I. OVERVIEW

- In the AD-IA model short-term real interest rates are assumed to be the mechanism by which the monetary policy maker is assumed to affect the real economy.
- Although such a model is good enough for basic analysis, it ignores many important details about how monetary policy works in reality.
- Today's lecture looks at different channels, other than through short-term interest rates, through which monetary policy affects the real economy.

II. OVERVIEW OF THE MISHKIN PAPER

- The basic motivation behind the Mishkin paper is that monetary policy is THE primary tool in minimizing economic fluctuations in the economy, thus, it is necessary to have a good understanding of how exactly monetary policy affects the real economy: in other words, when the Federal Reserve pursues expansionary or contractionary monetary policy, how exactly do those policy changes affect real economic variables like GDP.
- Unless they know more about the different ways in which monetary policy affects the real economy, monetary policy makers will always be facing uncertainty about how much or how little to move their policy tools. Accordingly, this uncertainty will lead the monetary policy maker to move these policy tools by too much or too little, to move too early or too late adding uncertainty into the economy.
- So the goal of Mishkin's paper is to provide an overview of these different channels, and identify important lessons for the conduct of monetary policy that can be drawn from the different channels of transmission
- Keep in mind that the Mishkin paper is not a recent one but the channels that it illustrates are general enough concepts that we can continue to find it useful. In the paper, Mishkin identifies the following channels:

  1. Interest Rate Channels
  2. Asset Price Channels (including Exchange Rates, Equity Prices, Real Estate)
  3. Credit Channels (including the Bank Lending Channel and the Balance Sheet Channel)

III. CHANNELS OF TRANSMISSION

The Interest Rate Channel

- The most commonly discussed channel, in which an increase in the money supply lowers the real interest rate, which in turn stimulates investment and therefore GDP.
- The first thing to keep in mind is the relationship between the nominal and real interest rate. This relationship is most often expressed as the *ex-ante* real interest rate = nominal interest rate - the expected rate of inflation: $r = i - \pi^e$. In other words investment decisions are based on the real cost of borrowing, which depends on the (known) nominal interest rate and the (uncertain) inflation rate.
- Since expected inflation is not always easy to measure, we sometimes work with the *ex-post* real interest rate. This is further simplified as $r = i - \pi$ where we use the actual inflation rate rather than the expected inflation rate. This would also work if the current inflation rate is a good proxy for expected inflation.
- We can summarize the relationship as

$$M \rightarrow i_{FF}^{T} \rightarrow i_{FF} \rightarrow r_{FF} \rightarrow r \rightarrow I, C \rightarrow Y$$

- This is a very complicated relationship that we glossed over in constructing the IS-MP/AD-IA model. The first step of the relationship is that to stimulate (contract) the economy the central bank increases (decreases) the money supply (M), lowering (raising) its target (i_{FF}^{T}) for a short-term nominal interest rate, such as the Federal Funds rate (i_{FF}). The change in the targeted rate (or more accurately) the open market operations accompanying the changed target will affect the actual Fed Funds rate. The assumption here is that the Fed has the capability to conduct open market operations such that it can vary the money supply to move the Fed Funds rate in the desired direction, even though it does not directly control the Fed Funds rate (which is the rate that banks charge each other for overnight loans).
- The next step is that lower (higher) short-term nominal interest rates result in lower (higher) short-term real interest rates (r_{FF}). This of course depends critically on the assumption of inflation being slower in the short-run.
- The third step is that lower (higher) short-term real interest rates result in lower (higher) long-term real interest rates (r). The IS-MP/AD-IA model glosses over the fact that the real interest rate that matters for consumers and investors is typically a long-term real interest rate. The link between short-term interest rates and long-term interest rates is also an important concept to understand: we will cover this in a subsequent lecture.
- Finally, the changes in long-term interest rates must, in turn, stimulate (depress) consumer (C) and, more importantly, investor (I) spending raising (lowering) GDP (Y).
- Even if the nominal interest rate can't move, the interest rate channel may still be active. An increase in money supply can increase expected inflation (because there is more money chasing the same quantity of goods) and lower real interest rates leading to more spending and output.

- Paradoxically then creating higher inflation expectations can be *beneficial* for an economy undergoing a deflationary episode. Even though it seems counter-intuitive it really is not: the core feature of a deflationary trap is that the possibility of lower prices in the future leads firms and consumers to delay spending, this drives the economy deeper into recession making the deflation worse. Creating inflationary expectations reverses that contraction in spending.

The Exchange Rate Channel

- Another channel through which monetary policy can affect GDP, and one that is sometimes modeled in the IS-LM model, is through the impact on exchange rates.
- The basic idea is as follows: when the central bank increases the money supply, it lowers short-term nominal interest rates and thus lowers short-term real interest rates as well. Lower short-term real interest rates imply that dollar denominated assets are less attractive than foreign assets leading to a decrease in demand for dollars.
- The subsequent depreciation of the dollar makes domestic goods cheaper than foreign goods and leads to an increase in Net Exports, and therefore in GDP as well.
- We can summarize the relationship as

$$M \to i \to \text{Nominal Exchange Rates}(e) \to NX$$

- For small open economies with flexible exchange rates, this can be a particularly important channel of transmission.

The Equity Price Channel

- Mishkin emphasizes two equity price channels: Tobin's Q and wealth effects. Tobin's Q is a widely used theory of investment, which states that $Q = \frac{\text{Market Value of Capital}}{\text{Replacement Cost of Capital}}$
- When Q is high, firms will invest more either because adding capital is cheap or because the value of installed capital is high. Conversely when Q is low they will invest less
- Expansionary monetary policy can lead to a higher Q - either because people who have more money to spend buy more stocks or because falling market interest rates lower the replacement cost of capital. A higher Q and more investment. For example, in the dot-com boom in the late 1990s, the incredible stock valuations of technology companies encouraged lavish spending by these firms. A similar pattern holds in Silicon Valley today as rising expansion by firms such as Google, Apple, Facebook, Twitter etc. drive up rents in the San Francisco office space market and lead to cries of gentrification and crowding out as affordable housing becomes more and more scarce a resource in the city.
- The wealth effect describes how the increase in asset markets that follows a monetary expansion raises household wealth and leads individuals to spend more money. The most obvious example of a wealth effect is the large increase in housing prices in the period following the 2001 recession.

- As Mishkin points out, one of the most important wealth effects comes from the real estate market. The Fed under Alan Greenspan kept interest rates very low. Lower interest rates mean lower mortgage rates which in turn make the demand for houses, and house prices higher. Since the biggest chunk of wealth owned by families is their house, this is an important channel of transmission for creating wealth effects.
- The real estate market can work in the opposite direction as well. As we found out in 2007 when the Fed began raising interest rates it contributed to a dramatic fall in the real estate market, which in turn led to substantial decreases in wealth and reduced spending that have depressed the economy even today.

The Bank Lending Channel

- Some combination of the above channels are what are typically discussed in undergraduate economics courses. There are two other important channels which do not get as much attention in undergraduate economics courses but are as, if not more, important. These two channels are the bank lending channel and the balance sheet channel.
- The bank lending channel arises from a market failure related to information asymmetries between borrowers and lenders. The basic intuition is as follows: borrowers and lenders have a hard time matching up because information about each other is very costly to verify. In particular lenders have a very hard time evaluating the viability of an investment project run by a borrower about whom they know very little. Similarly, borrowers may have a hard time finding lenders who are looking for projects similar to their own to invest in.
- In this type of world, banks become valuable financial intermediaries: bringing together borrowers and lenders. Lenders only need to have information about the viability of the bank because that is where they are putting their money, and banks have more resources and better ability to screen borrowers, some of whom are repeat customers. This channel becomes especially vital for small firms, which are unable to offer shares on the stock market or issue their own bonds to raise money.
- In this type of a world, an expansionary monetary policy leads to more reserves and deposits at the bank, which in turn makes more loans available. The increased supply of loans implies that many more smaller firms can get access to loans and therefore undertake more investment projects leading to more investment and higher GDP.

The Balance Sheet Channel

- The balance sheet channel is similar to the bank lending channel in that it is related to information asymmetries: namely the problems of moral hazard and adverse selection in financial markets.
- The basic gist of the argument is as follows: lenders are always concerned that borrowers may be unable to repay their loans. This problem is most acute for firms with low net worth: the lender has to wonder if the reason that a low net-worth borrower is coming to him is because no one else is willing to lend to a borrower who may go under at any time (the adverse selection problem).

- The lender also has to wonder whether giving an increased loan to a low net-worth form may make that firm pursue risky investment projects, increasing the likelihood of project failure since the owner of the firm has little to lose if the firm goes under (the moral hazard problem).

- In this type of world, expansionary monetary policy can affect the balance sheets of firms in numerous ways: lower interest rates which increases cash flow, higher equity prices, inflation that reduces value of liabilities, higher aggregate demand which raises business revenues and profits etc. Enhanced balance sheets reduce the moral hazard and adverse selection problems and lead to more access to funds for borrowing firms and therefore stimulates more economic activity.

- Mishkin also examines the possibility of balance sheet effects on households: consumer cash flow and balance sheets should improve when credit card, student loan, and mortgage interest rates fall, thus enabling consumers to invest more in items like consumer durables and housing which are generally considered to be illiquid and "big ticket" items to be avoided in times of financial uncertainty.

- These credit channels often come into heightened interest in periods following financial crises. The importance of cleaning up the lingering fallout from defaulting mortgagesl in the United States, the impact of bank failures and contractionary monetary policy in creating the Great Depression, the failure of Japan to clean up their banking sector are all rooted in credit channel related concerns.

- After identifying these myriad different channels, Mishkin assesses the logical follow up question: how important are these channels relative to each other? The economic research on this question is by no means conclusive. Mishkin suggests that some authors believe in a strong interest rate channel but other authors do not believe this to be the case. Some have argued that the right way to think about this question is that the credit and asset channels magnify and propagate the interest rate channels.

- Mishkin believes that the credit channel is very important in propagating monetary policy decisions to the real economy. In my opinion, there is no conclusive proof refuting any of these channels so we have to remain open to all of them. At different points in time channels like the equity price channel, housing wealth, exchange rate etc. have all proved to be important factors in determining the impact of monetary policy on the real economy.

IV. LESSONS FOR MONETARY POLICY MAKERS

- Mishkin's paper concludes by drawing four lessons for monetary policy makers.

  1. Don't focus only on nominal interest rates
  2. Asset prices are important indicators of the stance of monetary policy
  3. Monetary policy can work even in a zero nominal interest rate environment
  4. Price stability should be the goal of monetary policy makers.

- Let's do a quick overview of these 4 arguments. The first is that policy makers should be careful to think about real interest rates and not just nominal interest rates. He cites examples of the 1970s where nominal rates were high and the Great Depression where nominal rates were near zero. This does not indicate much information about the stance of monetary policy because the high inflation in the 70s meant that real interest rates were in fact negative whereas the deflation of the Great Depression meant that real interest rates were in fact positive. So sometimes, high nominal rates can be associated with a loose monetary stance and low nominal rates with a tight monetary stance.

- The second point is that at different times various asset prices: the stock market, the housing market, the exchange rate, etc. have been important determinants of the real economy and the effect of monetary policy on these asset markets is an important channel of transmission. So even though we think of the interest channel as the main channel in setting up models like IS-LM or AD-IA, reality is much more complicated.

- The third point is one that we will return to at the end of the semester, it basically states that just because nominal interest rates are zero, does not mean that monetary policy is impotent. With basic IS-MP type analysis, we would have to conclude that expansionary monetary policy is ineffective in an economy with a nominal rate of zero because interest rates could not fall below this floor. However, the existence of the other channels of transmission, as well as the impact of expected inflation on the real interest rate mean that the real economy can be stimulated by monetary policy makers even when interest rates are near zero; policies that affect long-term interest rates and expected inflation matter.

- The final point is that price stability is very important because it reduces uncertainty and helps minimize fluctuations in output. Mishkin points out that fluctuations in prices (whether inflationary or deflationary) are important influences on the real economy.

Lecture 10: The Impact of Monetary Policy on the Economy

I. OVERVIEW

- In the last lecture, we looked at the different methods by which monetary policy actions are transmitted to real variables in the economy. In today's class we ask a fundamental question: what is the impact of monetary policy on the economy.

- Why is "Does Monetary Policy Matter?" an important question? Well, if it didn't then Econ 331 will have to pack up and dismantle itself. We believe that monetary policy matters in terms of minimizing economic fluctuations and keeping inflation under control. Establishing empirically that policymakers' actions do matter, then is vital before we proceed any further.

- In addition, not only must policymakers' actions matter, they should also work in the direction that the policymaker intends it to work. Suppose a policymaker makes a decision to raise interest rates to slow down the economy and reduce inflation. We hope that the rise in interest rates should not only impact the economy but should also reduce GDP and lower inflation over time, as she intended.

- As befitting a fundamental question, there have been a plethora of papers written on this subject. Some of the most innovative work on this topic has come from David and Christina Romer, and this paper is a great example.

II. IDENTIFYING THE EFFECT OF MONETARY POLICY ON THE ECONOMY

- The main obstacle to the strand of research that examines the impact of monetary policy on the economy is the difficulty of separating the reaction of policy to changes in the economy from the reaction of the economy to policy decisions.

- For instance, we said that a booming economy and rising inflation may cause the Federal Reserve to raise interest rates. So in a crude statistical study, one may find that rising interest rates are associated with a booming economy and higher inflation, whereas theory tells us that higher interest rates should reduce inflation and slow down the economy.

- This may seem like a petty argument, because the problem here was that we ignored the timing. Since the higher inflation and the booming economy preceded the rise in interest rates, it seems clear that higher inflation caused the rise in interest rates instead of vice versa.

- However, simply taking into account timing does not help us sort out issues of causation. For example, if one looks at a graph of short-term interest rates in the United States in the post-war period, one would notice that rates seem to rise before recessions and fall afterwards. This does not, however, imply that interest rate increases cause recessions in the economy. On the contrary, if the Fed anticipated the path of the economy - raising interest rates expecting an unsustainable boom and cutting interest rates fearing a recession - it will create the misleading impression that rising interest rates are responsible for recessions.

- This is called the "Post hoc ergo propter hoc" fallacy, which is fancy Latin for the "after this, therefore because of this fallacy. In plain English, when we see that movements in variable A preceding movements in variable B, we tend to (incorrectly) think that A causes B.

- Economists have come up with very sophisticated econometric techniques to sort out the problem of causation. In particular they use a technique called Vector Auto Regressions. These techniques, while helpful, often create just as many disputes as they resolve. Instead of studying these techniques, we will study the attempt by Romer and Romer to identify the effect of monetary policy in the economy.

- Romer and Romer use what they term the "narrative approach", in which they first use historical records (descriptions of policy making decisions) of the Fed to identify shifts in monetary policy. They then purge this shift of the influence stemming from responses to actual or anticipated economic events using the Greenbook forecast of the Fed. Finally, they use this newly constructed measure to examine how the economy did in fact change in response to these policy changes.

- The first question to resolve is what variable best captures the policy intentions of the central banker. In today's Fed the answer is obvious because the Fed openly discusses its target for the Federal Funds rate as a means of describing its policy intentions. However, the target Fed Funds rate has not always been known, especially prior to the early 1990s. So instead, what Romer and Romer (henceforth RR) do is to get a value for the Federal Funds rate heading into a FOMC meeting and then get a value for the Federal Funds rate coming out of the FOMC meeting and use the change in the funds rate as the intended policy action of the Fed.

- They describe this process in more detail in the paper. Essentially RR draw on the quantitative data about the Federal Funds Rate published in *the Weekly Report of the Manager of Open Market Operations* along with more narrative records of FOMC discus- sions contained in the *Record of Policy Actions of the Federal Open Market Committee* and the *Minutes of the Federal Open Market Committee.*

- They discuss some challenges such as a period in the late 1970s when the Fed paid little attention to the Fed funds rate, episodes when the policy change coming out of the FOMC was for delayed implementation and meetings where no policy action was taken but there was clear intimation that a change was coming. In the latter case, RR actually assign a movement of one-half of a typical change for the policy period to that meeting, even though no actual policy decision was made.

- After obtaining the policy change, RR then have to purge this measure of endogenous and anticipatory responses to macroeconomic variables. They regress the policy change on the level of the funds rate; the most recent past GDP growth, the current GDP growth and two forecasts (one and two-periods ahead, respectively) of GDP growth; changes in the above GDP growth rates and forecasts; last period, current period and two forecasts of inflation; and changes in the above inflation rates and forecasts. They also add in contemporaneous unemployment, just to be sure. The specification is in Equation (1)

- The residual from equation 1 is RR's key variable. It represents a policy change that is not endogenous and not anticipatory. The next task is to use it in a regression framework to estimate what the economic impact is. The sick is given in Table 2 and the upper panel of Figure 1. The lower panel of Figure 1 compares it to the actual Fed Funds rate, and you can see that the measures are clearly different at certain points. RR talk about the Carter presidency as a good example of the differences. Their measure shows negative values for the 1975-79 period indicating that the Fed was expansionary while the actual Funds rate change shows positive values. The interpretation here is that the Fed during the Carter administration raised interest rates but when you factor the endogenous response (particularly to rising inflation), the Fed should have raised them by more. The decision not to raise rates by as much as they would normally have done, shows up as a negative value in the RR measure.

The Impact of the RR Shocks on the Real Economy

- RR then use regressions to estimate the impact of these policy changes on output and prices in the economy. The regression equation used by RR to look at the impact of monetary policy on output is given in equation (2).

$$\Delta y_t = a_0 + \sum_{k=1}^{11} a_k D_{kt} + \sum_{i=1}^{24} b_i \Delta y_{t-i} + \sum_{j=1}^{36} c_j S_{t-j}$$

  where D is a monthly dummy, and S is the policy variable. Policy has a very complex effect here: it can impact the output growth rate for 36 distinct periods directly (via the c coefficients) but also indirectly by changing the past output growth rates (via the b coefficients).

- Interpreting the impact of monetary policy by simply examining the regression coefficients is challenging, given the somewhat complex relationships described above. Instead, after estimating the a, b and c parameters we would simulate how a monetary shock affects the path of output. RR use industrial production, a data series available at a monthly frequency, to measure output. I can show you how to do this (ignoring the monthly dummies) below.

- First, you would begin by setting $\Delta y_{t-1} = \Delta y_{t-2} \cdots = \Delta y_{t-24} = 0$ and $S_{t-1} = S_{t-2} \cdots = S_{t-36} = 0$. Then not only will $\Delta y_t = 0$ but all subsequent growth rates will also be zero. In other words we have set up a baseline (counterfactual) path of zero. Its easiest to set the constant to zero as well.

- Now we tweak the model by setting S_t to 1, i.e. we institute a monetary policy change this period. Then you can see that $\Delta y_t = 0$ since there is no contemporaneous S, but that $\Delta y_{t+1} = c_1$.

- Going forward,

$$\Delta y_{t+2} = b_1 \Delta y_{t+1} + c_2 = b_1 c_1 + c_2$$

- Repeating for period t+3we get

$$\Delta y_{t+3} = b_1 \Delta y_{t+2} + b_2 \Delta y_{t+1} + c_3 = (b_1)^2 c_1 + b_1 c_2 + b_2 c_1 + c_3$$

- By continuing this exercise, we can trace out the full effect of the one time monetary policy change. Calculating all of these coefficients by hand is arduous but fortunately we can use EXCEL or STATA to do this for us. The result is a graph like the one provided in Figure 2. Keep in mind though that the Figure they show is for output, what I was showing you above was for the growth rate of output.

- RR show that a one percentage point increase in their policy measure lowers GDP by a maximum of 4.3 percentage points, with the peak effect coming after about two years and the first significant effects taking about 6 months. This means that a typical 25-basis point (one quarter of a percentage point rise in the Federal Reserves intentions for the funds rate) move by the Fed will lower output by one percentage point.

- RR then show how their results match up to a similar exercise using less carefully thought out measure of monetary policy. In Figure 3, they show the results using the actual Fed Funds rate and find a one percentage point rise in the Funds rate associated with only about 2.5 percentage point change in output. RR use two other "intermediate measures" of policy. The first such measure uses the change in the intended funds rate without controlling for forecasts and then changes in the actual funds rate controlling only for the forecasts. Purging either endogeneity or anticipatory movements but not both results in impacts that are similar to using the actual Funds rate rather than the more dramatic results presented here.

The Impact of the RR Shocks on Prices

- RR then provide a similar analysis for inflation and show the impact on the price level in Figure 4. They estimate that it takes almost wo years after the contractionary policy shock before policy has an impact, only then do prices begin to fall substantially. The biggest effect is around a 6 percent change after 4 years. So a typical quarter percentage point move by the Fed would drive the price level down by 1.5 percent.

- These results are much more striking than when using other less well thought out measures where we would instead find that prices rise when the Fed raises interest rates, a puzzling result that has appropriately been labeled "the Price Puzzle" in the literature.

- RR conclude with the following:

> *Qualitatively, our findings are very consistent with textbook views of the effects of monetary policy. Contractionary monetary policy reduces both output and inflation. Both effects occur with a lag, with output moving before inflation. Quantitatively, the results suggest that the lags in the output effects are fairly short, while the lags in the inflation effects are harder to determine. More importantly, the results indicate that the impacts of monetary policy on both output and inflation are large.*

Lecture 11: The Term Structure of Interest Rates

I. OVERVIEW

- In a previous class, we looked at a paper by Rick Mishkin that delineated the different channels through which monetary policy can affect the real economy.
- Even though these other channels are important, the interest rate channel is still thought of as the most important channel through which monetary policy affects the real economy. However, a key issue that gets glossed over is that the interest rate that the Fed influences (the Fed Funds rate) is quite different from the interest rate that governs most spending decisions (e.g. 30-year mortgage rates)
- Today's lecture focuses on the interest rate channel by examining the relationship between short and long-term interest rates in the economy, a relationship known as the term structure of interest rates.

II. BOND REFRESHER

- The relationship between short and long-term interest rates, also known as the term structure of interest rates is one of the most important, and relevant for day-to-day life, economic relationships.
- The monetary policy maker typically influences short-term interest rates by his/her actions: in the United States the Federal Funds rate is the rate most directly influenced by the Fed and the Fed Funds rate is an interest rate at which banks lend and borrow money overnight. However, most consumer and investor decisions deal with much longer term interest rates: car loans are for 4-6 years, student loans are for 5-15 years, mortgage loans are for 30 years, business loans can be for 1-10 years etc.
- Therefore, to understand the impact of monetary policy on the real economy we need to better understand the relationship between short-term interest rates and long-term interest rates in the economy. The goal of the next 2 lectures is to introduce basic concepts regarding the term structure of interest rates and discuss recent academic research about these concepts.

What is a Bond?

- A **bond** is a financial instrument in which the buyer pays the seller a sum of money now in exchange for the right to receive a *pre-specified* stream of future money payments from the issuer. Bonds can be bought and sold on a secondary market so the seller of the bond and the issuer of the bond don't have to be the same entity.
- Most bonds have a **face value**, or par value, which is the amount that the holder of the bond is entitled to at the end of the specified period. The length of time to that final payment is the **maturity** of that bond.

- Some bonds also have a **coupon rate**, which is the amount of money a person will receive in a year divided by the face value of the bond.
- For example, a new $10,000 10-year government bond with a coupon rate of 5% is a bond that pays the holder $10,000 at the end of 10 years but also pays $500/year in interest in the interim period. In order to acquire this bond, one pays a price today, say $8000. If so, then what we are doing is exchanging $8000 today for the promise of a stream of $500/yr in interest payments and a principal payment of $10,000 10 years down the road.
- In the United States, bonds are issued by the U.S. government, by various state and local governments, by government agencies like Fannie Mae and Freddie Mac as well as by corporations. Bonds issued by the U.S. government fall into three categories: Treasury Bills, Treasury Notes, and Treasury Bonds. Treasury Bills, or T-Bills as they are popularly known, have durations of 13 weeks, 26 weeks, and 52 weeks. Treasury Notes come in durations of 2 years, 5 years, and 10 years. Treasury bonds have a 30-year term.
- All these bonds are traded on a bond market. You can buy bonds directly from the issuer: the U.S. government, for example, holds auctions in which they sell bonds, or on a secondary bond market.
- What affects the price of bonds? The worst enemy of bond investors is inflation. Higher inflation reduces the face value and the value of the stream of interest payments of the bond. So the price of bonds will start falling.
- A fall in the price of bonds can also be linked to higher market interest rates. Higher market interest rates increase the value of alternative investments, and therefore make the return from bonds less attractive (The coupon rate on most bonds is fixed, although the U.S. government now issues a bond which corrects for inflation.)
- For the rest of this lecture we'll think of a specific class of bonds: zero coupon bonds with no default risk.
- A **zero coupon** bond is a bond that only pays off its face value at maturity: it has no interim interest payments. A bond that has no default risk is a bond that is guaranteed to pay the face value at maturity with no uncertainty.
- Long term U.S. government bonds fall into the zero coupon, no default risk bonds. Coupon bonds can be thought of as a series of zero coupon bonds of different maturities.

Bond Yields

- The **yield** of a bond is the interest rate that we effectively earn if the bond makes its promised payments. For a zero coupon bond, yield is easy to calculate and express. For a generic risk-free, zero coupon bond with a face value of $1000, the yield can be written as

$$P_{m,t}(1 + Y_{m,t})^m = 1000$$

- Often, we find it easier to define the **continuously compounded yield** $y_{m,t}$. Think of this as the continuously compounded interest rate you would earn by buying a bond that made it promised payments. This can be defined as

$$P_{m,t}e^{my_{m,t}} = 1000$$

- Taking natural logs on both sides of $P_{m,t}e^{my_{m,t}} = 1000$, results in the following equation $\ln P_{m,t} + my_{m,t} = \ln 1000$, which simplifies to $y_{m,t} = \left(\frac{1}{m}\right)(\ln 1000 - \ln P_{m,t})$
- Example: suppose a 10-year zero coupon Treasury bond with a face value of \$1,000 sells for $P_{10,t} = \$600$. The yield of the bond can be solved as $y_{10,t} = \left(\frac{1}{10}\right)(\ln 1000 - \ln 600) = 5.11\%$
- Notice that the price of the bond and the yield of the bond move in opposite directions: the higher the price of the bond, the lower the yield and vice versa.
- For instance, suppose the price of the above bond rose to \$750. The new yield of the bond solves $y_{10,t} = \left(\frac{1}{10}\right)(\ln 1000 - \ln 750) = 2.87\%$
- Now that we have the core concepts are understood, we can build a relationship between short-term and long-term interest rates in the economy, also known as the **term structure of interest rates**.
- We derive the relationship between yields of zero coupon bonds of different maturities. Other interest rates in the economy are typically set off of government bond yields, which are less risky than other bonds issued by agencies like Fannie Mae, cities or municipalities or by corporations.

III. THE EXPECTATIONS HYPOTHESIS

- We can build simple models of the term-structure of interest rates using this relationship. The core of these models is the idea that investors can choose between bonds of a similar type but with different maturities to put their money in. Such investors will arbitrage away any excess returns they can get by putting money in one type of bond instead of another.
- Suppose there were two types of bonds in the economy - ten year bonds and five year bonds. An investor who needs \$1000 ten years from now can choose to buy a 10 year bond costing $P_{10,t}$.
- A perfectly valid alternative to buying a \$1000 zero coupon ten-year bond would be to buy a \$1,000 five-year bonds five years from now, which will guarantee a \$1,000 payment at the end of 10 years. The price of such a bond would be $P_{5,t+5}$.
- Working backwards, now ask yourself how much would you have to put into a 5 year bond to get $P_{5,t+5}$ in five years. The answer is that paying $P_{5,t}$ will give us \$1,000 in 5-years time so we would need to spend $P_{5,t}\left(\frac{P_{5,t+5}}{1000}\right)$.
- Since buying these two 5 year bonds in succession or buying a single 10 year bond are both perfectly adequate ways of getting \$1 in ten years time, we would expect that arbitrage would hold and that $P_{5,t}\left(\frac{P_{5,t+5}}{1000}\right) = P_{10,t}$. [It is CRITICAL to note that this does not mean that any 5 year bond is equal to any 10 year bond in price, we are talking about very precisely defined bonds (paying the same amount at the same time) here].

- We know from the definition of yield that $P_{m,t}e^{my_{m,t}} = 1000$, which means that $P_{m,t} = 1000e^{-my_{m,t}}$. We can then rewrite the above equation as

$$\begin{aligned} P_{5,t}\left(\frac{P_{5,t+5}}{1000}\right) &= P_{10,t} \\ \frac{\left(1000e^{-5y_{5,t}}\right)\left(1000e^{-5y_{5,t+5}}\right)}{1000} &= 1000e^{-10y_{10,t}} \\ y_{10,t} = \frac{1}{2}\left(y_{5,t} + y_{5,t+5}\right) \end{aligned}$$

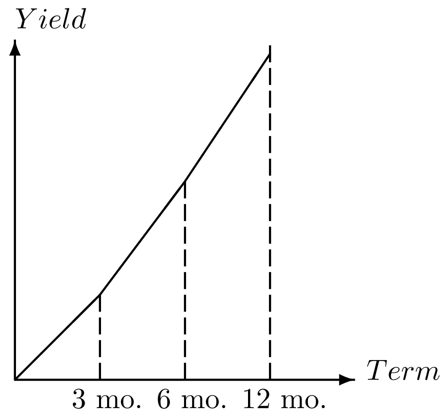
- Given that this future yields are not known with certainty, it may be more accurate to write this as $y_{10,t} = \frac{1}{10}\left[y_{5,t} + E_t y_{5,t+5}\right]$, where E_t is our expectations at time t.
- So if we assume that people are indifferent between buying a 10 year bond or 2 successive 5 year bonds that provide the same payoff at the end of 10 years, we can derive a simple relationship: the return on the 10 year bond is the average of the expected return on two successive five year bonds.
- We could have just as well have calculated the cost of buying 10 successive 1 year bonds to guarantee us \$1 at the end of 10 years. In that case, we would get the following relationship $y_{10,t} = \frac{1}{10}\left[y_{1,t} + y_{1,t+1} + \cdots + y_{1,t+9}\right]$, or in other words the interest rate on the 10 year bond would be the average of the interest rates on 10 successive 1 year bonds.
- This relationship is known as the "Expectations Hypothesis": it basically gives us a way of understanding the term structure of interest rates by stating that long-term interest rates are equal to the average of expected short-term interest rates.
- The expectations hypothesis is useful because it helps show the relationship between short-term and long-term interest rates but it also provides an indication about how anticipation of future monetary policy decisions are built into the economy. Consider the following example taken from a paper by John Campbell where there is a 4 percent yield on a 1 year bond and a 7 percent yield on a 30 year bond. According to our analysis, if the expectations hypothesis holds, then we know that

$$y_{30,t} = \frac{1}{30}E_t\left[y_{1,t} + y_{1,t+1} + \cdots + y_{1,t+29}\right]$$

- Using the numbers above: $0.07 = \frac{1}{30}E_t\left[0.04 + y_{1,t+1} + \cdots + y_{1,t+29}\right]$ Doing some algebra, we can show that $2.10 = 0.04 + \left[y_{1,t+1} + \cdots + y_{1,t+29}\right] \Rightarrow 2.06 = \left[y_{1,t+1} + \cdots + y_{1,t+29}\right]$
- Rearranging, we get that $\frac{2.06}{29} = \frac{1}{29}\left[y_{1,t+1} + \cdots + y_{1,t+29}\right] = 7.1\%$. In other words, in the remaining 29 years, one year bonds will pay a yield of 7.103%: much higher than the current yield of 4%. To put it more clearly, another way to describe the expectations hypothesis is that if short bond yields are expected to rise over time, then long bond yields would exceed short bond yields. In contrast, if short bond yields are expected to fall over time, then we would expect to find that long bond yields are lower than short bond yields.

Yield Curve

- The relationship between short rates and long rates in the economy can be summarized by a yield curve: which is a graph of bond yields against bond durations. The shape of this yield curve has important implications for the path of monetary policy. Suppose the yield curve looks as follows



- Since long rates exceed short rates, the expectations hypothesis states that short rates are expected to rise over time. Similarly, if the yield curve were flat, then short rates are supposed to be constant and if the yield curve slopes down, then short rates are supposed to decrease over time.

- How does this all relate to monetary policy? Suppose the Fed announces that they are lowering short-term interest rates today with more interest rate cuts to follow in the near future. If short rates are expected to decline over time, then we would expect that long-term interest rates will fall as well. This implies that the yield curve will slope downwards as long as rates are not expected to come back higher.

- Lower long rates will mean that all the interest rates that are relevant to consumers will fall, and as a result, the economy will benefit from extra spending by firms and consumers. So the Fed is able to transmit its policy actions, which affect very short term rates, to the real economy, which depends on long-term interest rates, by creating expectations about the path of interest rate movements.

- Understanding the expectations hypothesis and the term structure of interest rates is therefore an important component of understanding how monetary policy decisions are transmitted to the real economy.

Term Premia and Risk Premia

- In general borrowers would like to borrow for long-terms while lenders would like to lend for shorter terms. This means that all else equal, there would be a greater demand from lenders to buy short-term bonds and a greater desire by borrowers to issue long-term bonds. All else equal this will make it more likely for the price of short-term bonds to rise (lowering short-term yields) and for the price of long-term bonds to fall, raising long-term rates. This creates the notion of term premie: longer-term bonds have a higher yield or the default is for the yield curve to shape upwards.

- A more important concept is the idea of a risk premium. Consider the pricing of a risky bond with the same \$1000 face value and maturity as a U.S. government bond. Clearly, investors will shy away from paying as much for this bond as they would for the U.S. government bond because of its riskiness. Since the price of this risky bond is lower, its yield is higher than the safe bond. In fact the riskier the bond is, the lower its price and the higher the yield.

Term Premia and Risk Premia

- The above concepts carry enormous implications for monetary policymakers. In order to affect spending decisions, the Fed has to influence longer-term interest rates but the current short-term rate does not have a very big role to play in driving the value of the current long-term rate. What matters instead is the forward-looking aspect here: what people think the Fed is going to do to interest rates in the future. So when the Fed announced in 2011 that it is keeping interest rates (FF rate) low till 2014, then it is basically going to drive most of the intermediate-term rates like the 3-month rate, the 6-month rate and the 1 year rate to zero.
- It is even harder to get very long-term interest rates down via this strategy so the Fed may instead resort to other methods: via reducing term-premia and risk-premia to get more economic activity. For instance, if the Fed starts buying longer-term assets instead of short-term assets, then that would raise the demand for long-term bonds, raise their price and lower the yield. Similarly if the Fed buys student loans, commercial paper or mortgage backed securities, then it will raise the price of securities that are backed by such assets and drive down risk-premia over the safer assets.

Lecture 12: Central Bank Independence

I. OVERVIEW

- As the recent appointment of Janet Yellen showed, there is considerable interest in learning more about a newly appointed Fed Chair. Obviously, one of the reasons behind this interest is the vast power that the Chair of the Federal Reserve holds in the U.S. economy. A lot of that power comes from the operational independence that the Fed is granted: essentially, Janet Yellen and the FOMC can make monetary policy decisions they deem appropriate for the United States economy without needing to seek congressional approval.

- There is widespread belief that the appropriate institutional setting for a central bank is to insulate it from government intervention. This is evident, for example, in the 14-year terms granted to a Fed governor and the staggering of the terms of the Fed chair such that their reappointment comes in the middle of a presidential term; this implies that their job is not dependent on the current administration returning to power at the next election.

- Even though this belief that more independent central banks perform better is a widely-held one, it is in fact an empirical question. This lecture examines the empirical evidence on the relationship between central bank independence and the level and variability of inflation. We draw on two papers, only one of which is to be discussed in class. The classic, but dated, paper in this section is by Cukierman, Webb and Neyapti (1992), who construct a index of central bank independence (CBI) as well as present alternate measures of CBI. The paper we examine in more detail is a paper by Mats Landstrom, which appears in the *International Journal of Banking, Accounting and Finance*

II. MEASURING CENTRAL BANK INDEPENDENCE

- The Cukierman, Webb and Neyapti (CWN) paper presents a detailed description of how one might go about measuring CBI: CWN present three different measures of CBI: an index of legal independence, a measure of the rate of turnover of governors of central banks, and an index based on the answers to a questionnaire that CWN constructed and administered to monetary policy makers in a sub-sample of countries.

- CWN point out that this is often needed because an index that is only based on legal measures of CBI are flawed because they either are not implemented in the same manner as the laws appear in the books or because the written law is incomplete: they do not specify the exact nature of the institutional structure of the central bank.

- CWN measures of legal CBI follows two basic principles: they concentrate on the letter of the law and not the application of the law; second they looked at a few narrowly defined categories relating to the CEO of the bank, the formulation of policy, the goals of the central bank and the relationship between the central bank and the public sector, in particular the area of lending.

- CWN look at the answers to 16 questions. The 16 questions fall into 4 categories as follows:

  1. Questions about the Chief Executive Officer of the central bank (4)
  2. Questions about formulating monetary policy (3)
  3. Questions about the objectives of monetary policy (1)
  4. Questions about lending practices (8)

- Each of the answers to these 16 questions is given a point value ranging from 0 to 1. For example, the answer to question 1 in the CEO category can be 1 (if the CEO serves > 8 year term), 0.75 (6-8 year term), 0.50 (5 year term), 0.25 (4 year term) or 0 (under 4 year term). Specific details for the other variables can be found in Table 1 of the CWN paper, which I handed out to you in class.

- The answers to these 16 variables are then aggregated and collapsed into a single measure of legal CBI. The highest value for the CBI index is 1 (indicating a very independent central bank), while the lowest value is zero (indicating a very non-independent central bank).

- The ranking of countries according to legal CBI is presented in Table 2 of the paper. The highest rating is given to Germany (0.69) followed by Switzerland (0.64), Austria (0.61), Greece (0.55), Denmark (0.50) and Egypt (0.49). The lowest ratings are given to Poland (0.10), Morocco (0.14), Yugoslavia (0.17), Belgium (0.17) and Norway (0.17).

- Some of the results are very surprising and may be indicative of the problems of legal CBI. For example, Kenya (0.44) and Turkey (0.46) have central banks that are almost as independent as the U.S. (0.48). Similarly, Egypt's central bank seems to be more independent than the U.S. central bank is. This is very surprising to anyone who has any anecdotal evidence about the conduct of monetary policy in these countries.

Turnover

- Given the potential problems faced by CWN's measures of legal CBI, they turn to measuring the actual turnover rates for central bank governors in these countries. CWN cite the classic example of Argentina, where the legal term of office for the governor is 4 years but where the actual term of office is about 1 year because governors typically leave when the government or the minister of finance changes.

- Therefore an alternative to the legal measure of CBI would be to concentrate on actual frequency of change of governors of central banks. The prior belief about the relationship between the turnover of the governor of the central bank and central bank independence is a fairly complex one.

- For example, frequent turnover certainly seems to indicate a less independent central bank: either because the government is firing central bankers who do not accede to their will or because they get plenty of opportunities to find bankers who are willing to by sympathetic to the government.

- Furthermore, a shorter actual term of office will destroy the central bankers ability to have a longer horizon and make her less interested in acquiring a good reputation: both results that have deadly consequences for inflationary performance in the economy.

- However, the converse (a low turnover means a more independent central bank) does not always hold true. For example, if a government finds a relatively servile central banker it may want to keep him around for many years. It may even be possible that the central banker survive several changes of government if he is particularly dependent on the government for non-ideological reasons.

- CWN provide the actual turnover rates for governors of the central banks of different countries in table 3. The results are presented for the period 1950-80 as well as for 4 different sub periods within. The range is large: Iceland has a turnover rate of 0.034 indicating an average tenure rate of 29 years (average tenure is the reciprocal of the turnover rate). Argentina has the highest turnover rate of 0.93, indicating an average tenure of about 1 year.

- There is a clear difference between developed and developing countries: developing countries have much higher turnover rates on average. CWN also point out that the spread is much narrower among developed countries: indicating that tenure rates are similar. Therefore, CBI may not depend much on tenure in developed countries. However, for the developing countries, where some of the most puzzling indicators of legal CBI emerged, there is a much wider range of turnover figures indicating that actual turnover may be a more realistic indicator of CBI than the legal measures.

- For example, countries like Turkey have an average tenure of about 2.5 years vastly different from the value of 7.5 years in the United States even though the legal measures of CBI for the two countries seemed much closer.

Questionnaire

- The final measure of CBI is constructed using the results from a questionnaire administered by CWN to a selected group of monetary policy makers in 23 different countries. The questions are focused on the practice rather than the letter of the legal variables described earlier.

- Specific details of the questions are provided in Table 4, which I also handed out in class. The answers to the questions are assigned a numerical score and tallied up in a fashion similar to the legal index.

- The actual ranking of countries according to the questionnaire index is provided in table 5. The values range from 1 for Germany (the most independent) to 0.14 for Ethiopia (the least independent). The questionnaire has many potential problems including the fact that there may be incentive for policy makers to exaggerate the level of independence they have, especially if the administering of the test is being done by World Bank researchers doing a study on central bank independence!

III. IMPACT OF CBI ON MACROECONOMIC PERFORMANCE

The Differences-in-Differences Framework

- Having constructed a measure of CBI, the next task is to examine if CBI has a causal impact on microeconomic performance, specifically on inflation performance. This is a very challenging empirical exercise. The best way to evaluate the impact of a program or a policy is a randomized control trial (RCT).

- RCTs are hard to do in macro but practically impossible when it comes to CBI-related questions. No country will allow an experiment to be carried out using the central bank. In the absence of RCTs, we sometimes turn to natural experiments, but those are also hard to come by in the CBI literature because a country only has one central bank and we do not get to observe any within-country differences between an independent and a non-independent central bank operating in similar circumstances.

- The Landstrom paper uses a differences-in-differences (DD) framework to examine how changes in CBI affects inflation, the macroeconomic variable that is most closely tied to central bank behavior. Before discussing the Landstrom paper, let's take a closer look at the DD framework.

- In the most basic setting, a DD regression looks like the following, where $Treat$ is a dummy variable indicating whether the observation was in the treated group and $Post$ is a dummy variable indicating whether the observation is in the period after the treatment.

$$Y_{it} = \alpha_0 + \alpha_1 Treat_i + \alpha_2 Post_t + \alpha_3 Treat_i * Post_j + \epsilon_{it}$$

- We can construct a simple table that illustrates the basic idea behind the DD framework

Differences-in-Differences Framework

	Pre	**Post**	Difference
Treatment	$\alpha_0 + \alpha_1$	$\alpha_0 + \alpha_1 + \alpha_2 + \alpha_3$	$\boldsymbol{\alpha_2 + \alpha_3}$
Control	α_0	$\alpha_0 + \alpha_2$	$\boldsymbol{\alpha_2}$
Diff-in-Diff			$(\alpha_2 + \alpha_3) - \alpha_2 = \boldsymbol{\alpha_3}$

- The coefficient of interest is α_3, which shows the differential impact of the policy change. What makes the DD technique very powerful is that it accounts for many problems associated with purely cross-sectional specifications and with purely within-country specifications. What do I mean by that? Well suppose we just had observations at a point in time across countries that had received the treatment, and countries that did not. This would be like having just the POST observations. The difference between the treatment and control groups in the POST period is $\alpha_1 + \alpha_3$. As you can see α_1 reflected the *pre-policy differences between the two groups* so we would be attributing that to the policy. Of course we could eliminate some of those by controlling for appropriate factors but we always run the risk of having unobservables affecting our estimates.

- Suppose instead, that you had observations only on countries that had received the treatment. When we compare the post-treatment outcomes to the pre-treatment outcomes (the first row of the table above), we see that the difference for the treated group across the two periods is $\alpha_2 + \alpha_3$. But α_2 reflected the changes that happened over time which affected the control group as well! So we are attributing that to the policy.

- The DD framework is powerful because it washes out any effect common to both treatment and control groups over time (α_2) as well as any effects common to the treated groups ($\alpha_0+\alpha_1$), leaving only the impact that captures how the difference between the post and pre periods (the first D in DD) is different for treated groups vs. control groups (the second D in DD).

- This does not mean that DD will correctly identify the causal impact of a policy always. Any change that would differentially affect the treated group in the period after the treatment will be attributed to the policy, so we need to be sure that no such other change took place. A more simple way to understand when DD works is often presented as the "parallel trends" assumption: in the absence of the policy, we would expect that treatment and control groups behave similarly in the post-policy period. Otherwise, any difference would become attributed to the policy.

The Differences-in-Differences Framework in the Landstrom Paper

- The Landstrom paper uses a variant of the above framework. Consider the following two equations, one for pre-policy observations and one for post-policy observations

$$\begin{aligned}\pi_{i,pre} &= \alpha_0 + \alpha_1 Treat_i + \epsilon_{i,pre} \\ \pi_{i,post} &= \alpha_0 + \alpha_1 Treat_i + \alpha_2 + \alpha_3 Treat_{ij} + \epsilon_{i,post} \\ \Delta\pi_i &= \alpha_2 + \alpha_3 Treat_{ij} + \Delta\epsilon\end{aligned}$$

- So running the original DD specification in levels, is akin to running a regression of the post-pre differences with a dummy variable for treated that captures the coefficient of interest. This is what Landstrom does.

- To collect the data, Landstrom proceeds to contact central banks and verify the information they provide. More specifically

  > *The dates of CBI-reforms were obtained by contacting, by e-mail, all central banks listed in the Morgan Stanley.s Central Bank Directory 2004. The e-mail contained the following questions: (i) Has your country implemented any institutional reforms that grant your central bank more independence from elected policymakers?, (ii) If yes, when?, (iii) Where can we find more information about this? The reason for using this approach for data collect- ing is to be able to, as far as possible, treat all countries with central banks equally, at least initially. From a total of 162 central banks contacted, 95 central banks finally answered the questionnaire, corresponding to a a respondent rate of 59 percent. For the countries that did not provide any answer, the dates of CBI-reforms were obtained by using other information channels (e.g., central bank acts, central bank publications, and scientific articles). These kind of sources were also used to validate the answers obtained by e-mail.*

- They obtain data for over 125 countries over a 25-year period. They then estimate the above DD specification and find that countries that implemented a CBI reform experienced an 8.25 percentage point drop in inflation. This is a pretty striking effect and Landstrom is skeptical that this is THE causal effect of CBI on inflation. One reason that this is not all attributable to CBI is because of mean-reversion in inflation. A country that experiences an unexpected inflation shock, would (in the absence of anything else) experience a decline in inflation over time (think back to a oil shock that pushes the IA line up in the AD-IA framework, gradually inflation will creep back down). If a country that experiences such a shock is more likely to adopt a CBI reform (perhaps because politicians are more receptive to such a change when the public is disgruntled by higher inflation), then we would see the parallel trends assumption being violated: the CBI reform countries would expect to see greater declines in inflation but not as a result of the reform, simply as a result of the inflation shock working its way out of the system.

- To tackle this problem, Landstrom suggests modifying the original regression to include initial inflation as a control variable.

$$\Delta\pi_i \quad = \quad \alpha_2 + \alpha_3 Treat_{ij} + \beta\pi_{pre} + \Delta\epsilon$$

- The next potential problem is that even after controlling for mean reversion there may be other omitted factors that create a problem for our estimates. Recall from Econ 203 that if an omitted variable (which will be in the residual) is correlated with one of your X variables (in this case the adoption of CBI enhancing policies), the coefficient estimates will be biased. Intuitively, what this means is that if some other factor (say a set of political and legal reforms) that affected inflation were adopted around the same time that CBI was enhanced, we would mistakenly attribute the impact of those changes to CBI instead.

- To correct for endogenous regressors, we need to find an appropriate instrumental variable. An appropriate instrument for CBI reforms in this regression would be some variable(s) that are BOTH correlated with CBI and uncorrelated with the error term (i.e. would only affect inflation via variables already in the regression).

- If such instruments exists, we can do a IV (one instrument per endogenous variable) or a two-stage least squares (multiple instruments per endogenous variable) estimation. Essentially, what the procedure does is to run a first-stage regression of the endogenous variable (CBI-reform) on the instruments and use the predicted value from that regression in the main regression in place of actual CBI. Intuitively, what we are doing is extracting the portion of CBI that is exoegnous and using that exogenous portion in our regressions.

- The instruments that Landstrom uses are whether or not the country is an English speaking country, past levels of CBI, the degree of political fragmentation in parliament, and per-capita GDP. The authors do a very poor job of explaining why these are good instruments since they only make the argument that the instruments are not likely to be correlated with the error-term. But a good instrument ALSO needs to be correlated with the thing you are instrumenting for and little theoretical justification is provided with regard to why English speaking countries are more likely (or less likely) to adopt CBI reforms.

- They also estimate the 2SLS model for high and low inflation economies separately and find some confusing results. First, they find that for low inflation countries (countries with around 3% inflation), CBI reform was associated with an INCREASE in inflation. The authors do not have a compelling story about why this may be the case. For high inflation countries, they find that that the CBI dummy is positive and significantly determined at the 10% level for all but the highest inflation countries (top two deciles).

- Even though the y interpret this as evidence that CBI reforms work unless you have very low or very high inflation, we should be cautious about the results for a variety of reasons. First, because of the weakness of the instrument and second because as inflation rates get higher, a given percentage point decline ceases to have much economic meaning (does reducing inflation from 55% to 48% matter as much as reducing inflation from 10% to 3%)?

- Other researchers working on this question use the **depreciation rate of money**, $\frac{\pi}{1+\pi}$, as a measure of inflation because it has a compressed range of values, allowing for easier comparison of high and low inflation countries.

- An intuitive way to understand the depreciation rate of money is as follows. Given a price level of P_t, \$1 will buy you $\frac{1}{P_t}$ units of goods at time t. It will buy you $\frac{1}{P_{t+1}}$ units of goods at time t+1. So the percentage loss of purchasing power of money from today to tomorrow by $\frac{\frac{1}{P_t}-\frac{1}{P_{t+1}}}{\frac{1}{P_t}}$. This simplifies to $1-\frac{P_t}{P_{t+1}}$, which given that $\pi_{t+1}=\frac{P_{t+1}-P_t}{P_t}$ collapses to $1-\frac{1}{1+\pi_{t+1}}$, which in turn is the same as $\frac{\pi_{t+1}}{1+\pi_{t+1}}$. In other words, the depreciation rate of money is just the percentage loss of purchasing power over time. A high depreciation rate corresponds to a serious loss of purchasing power.

- When inflation is zero, the depreciation rate is 0, as inflation increases, the depreciation rate of money increases. When inflation becomes very large, the depreciation rate of money approaches one.

- Basically, the depreciation rate of money is used because it has a compressed range of values, allowing for easier comparison of high and low inflation countries. For example, think of two countries one that has an inflation rate of 10% and another with an inflation rate of 100%. The depreciation rate of money for the two economies are 0.0909 and 0.5, a much smaller range. A decrease from 10% to 5% will lower the depreciation rate of money from .0909 to .0476, a decline of around .0433. To get a similar reduction in the depreciation rate of money, the high inflation country would have to drop inflation from 100% to 84.06%.

Lecture 13: Rules vs. Discretion

I. OVERVIEW

- The discussion about the Phillips Curve showed that expectations about future inflation, and the manner in which those expectations are formed have a critical role to play in determining macroeconomic outcomes in the economy. In other words, the current state of the economy depends on expectations of future inflation, which presumably would be affected by expected policy changes in the future.
- The impact of expected future policy changes on current macroeconomic variables led to the idea that there were clear gains to transparency in conducting monetary policy: the less uncertainty there was about future policy, the easier it would be for agents to form expectations about the future. Furthermore, policy makers would not be able to systematically pursue policies that produced unexpected inflation because individuals would quickly catch on.
- The increased role of expectations led to some economists arguing that it would be best to force monetary policy makers to commit to following a policy rule instead of allowing them to pick the appropriate policy at their discretion. The basic intuition was that under a rule, the policy maker would be able to credibly commit to a sequence of policy decisions that would bring about the best long run outcome.
- Under discretion, the policymaker could always deviate to satisfy some short run objective, hence it would be harder for individuals to form expectations about policy decisions in the future.

II. INTRODUCTION TO THE RULES vs. DISCRETION DEBATE

- Even though we have thought of providing more independence to Central Banks as being a good thing, historically there have been many countries where central bankers had a tendency to pursue "activist monetary policies" whereby they used that independence and discretion to further their own agenda, not always with good results.
- In such cases, the economic outcomes may be improved if we took policy making discretion away from the central bank and made them follow a rule. If the policy maker can credibly commit to a specific rule, then the expectations of individuals will also be consistent with the rule, and policy makers recognize this when forming policy decisions. The resulting outcomes could be more beneficial to the economy if it prevents the central bank from pursuing less desirable policies.
- In more simple terms think about the following scenario. Suppose that 0% inflation is the optimal inflation rate for the economy, but that policy makers would prefer to create more inflation (to try and exploit the short run output-inflation tradeoff) whenever individuals expect 0% inflation. The only way for the economy to obtain 0% inflation is if the monetary policy maker credibly committed to following a rule that produced 0% inflation. Discretionary policy would not work: people will not continue to expect 0% inflation because they know the policy maker has incentive to deviate from the chosen policy.

- I will formalize this in a simple model below. The model is drawn from a famous paper by Barro and Gordon, but there version is more complicated than the simplified version presented here. I will be asking you to read a different paper by Barro and Gordon for the next class that adds to the Rules vs. Discretion debate by bringing in the reputation of the central banker.

- Suppose the monetary policy maker's preferences given by a loss function $Z_t = a\pi_t^2 + b(u_t - ku^n)^2 +$ that she tries to minimize. In this function, the parameters a and b are the weights that the policy maker attaches to unemployment fluctuations and inflation fluctuations respectively. In addition we assume that $0 < k < 1$.

- This equation is usually interpreted as telling a story where both inflation and deflation are deemed costly by the policymaker, i.e. a situation where the policymaker's bliss point is zero inflation and any inflation or any deflation is deemed to be costly. Similarly, the bliss point for unemployment is to reach an unemployment rate that is LESS than the natural rate. If $k = 1$ then we would say that the policy maker is just trying to keep unemployment at the natural rate. However, in this case $k < 1$. This means that the unemployment rate that the policymaker is targeting is actually lower than the natural rate of unemployment, i.e. the policy maker is concerned about keeping fluctuations of unemployment to a minimum, but that the mean she is shooting for is an unemployment rate that is below the natural rate of unemployment.

- Essentially, in this setup the monetary policy maker is always assumed to try and drive the economy below the NAIRU. This is not how we typically think of the actions of the Fed today, and is a very strong assumption. In fact, this assumption turns out to be critical in driving the conclusions we reach in the rest of this lecture. To justify the assumption that $k < 1$, we would have to appeal to the idea that the government, not the monetary policy maker, is trying to push unemployment lower than the natural rate. The monetary policy maker then has to take this value of k as an external constraint in picking monetary policy decisions.

- The policymaker cannot independently choose both inflation and unemployment. We assume that the policymaker chooses inflation, with unemployment determined by the following equation: $u_t = u^n - \alpha(\pi_t - \pi_t^e)$. Note that this is just a rearranged version of the expectations augmented Phillips curve: $\pi_t = \pi_t^e - \lambda(u_t - u^n)$ where $\alpha = \frac{1}{\lambda}$. So we could just as easily have assumed that the policymaker was choosing unemployment, with inflation determined by the Phillips Curve. This approach with the policymaker choosing inflation is better here because we can relate the choice of the policymaker to the expectations of inflation.

The Rule Solution

- The general problem faced by the monetary policy maker can be described as the following:

$$\text{Min}_{\pi_t} Z_t = a\pi_t^2 + b(u_t - ku^n)^2$$

- By substituting in for the unemployment rate from the Phillips Curve equation, we get the following problem for the monetary policy maker

$$\text{Min}_{\pi_t} Z_t = a\pi_t^2 + b\left[u^n - \alpha(\pi_t - \pi^e) - ku^n\right]^2$$

- If the policy maker can credibly commit to a rule that commits the policy maker to produce a given rate of inflation $\pi_t = \pi^R$ (R for Rule) in the economy, the individuals in the economy will anticipate this perfectly. Therefore, when policy makers decide on the optimal policy, they recognize that $\pi_t = \pi^e = \pi^R$. This simplifies the policy maker's decision to

$$\text{Min}_{\pi^R} Z_t = a\left(\pi^R\right)^2 + b\left[u^n - ku^n\right]^2$$

- The first order condition for this maximization is $0 = 2a\pi^R$. Define π^* as the solution to this first order condition, in which case $\pi^* = 0$
- When the policy maker can commit to a specific rule, then she will choose to commit to a rule where she picks an inflation rate of zero every period. Individuals expect the zero inflation that the policy maker supplies.
- The value of the objective function of the policy maker is given by

$$Z_t^* = +a(0)^2 + b\left[u^n - ku^n\right]^2 = b(1-k)^2\left(u^n\right)^2$$

- Note that this solution is dependent upon the existence of a commitment mechanism. Given that the individual expects 0 inflation, the policy maker is tempted to give surprise inflation. So individuals will not expect zero inflation unless they can be credibly convinced that the policy maker can't deviate from this value. This solution is calculated in the section below.

The Cheating Solution

- Suppose the policy maker can promise but does not have to commit to a rule that produces a given rate of inflation $\pi_t = \pi^P$ (P for Promise). Suppose that when the promise is made, consumers believe the promise and set $\pi^e = \pi^P$. Therefore, when policy makers decide on the optimal policy, they will

$$\text{Min}_{\pi_t} Z_t = a\left(\pi_t\right)^2 + b\left[u^n - \alpha(\pi_t - \pi^P) - ku^n\right]^2$$

- The first order condition for this maximization is $0 = 2a\pi_t + 2b\left[u^n - \alpha(\pi_t - \pi^P) - ku^n\right](-\alpha)$. Define $\tilde{\pi}$ as the solution to this first order condition, in which case

$$\tilde{\pi} = \left(\frac{\alpha b}{a + \alpha^2 b}\right)\left(u^n(1-k)\right) + \left(\frac{\alpha^2 b}{a + \alpha^2 b}\right)\pi^P$$

- What this means is that, for instance, if the policymaker pledges that she will achieve an inflation rate of $\pi^P = 0$, she will actually find it optimal to achieve an inflation rate of

$$\tilde{\pi} = \left(\frac{\alpha b}{a + \alpha^2 b}\right)\left(u^n(1-k)\right) > 0$$

- So unless the policymaker is bound by the rule, she has no incentive to follow a given rule. Similarly, there is no reason for the public to believe the policymaker when she says she will achieve a rule of zero even though that may clearly be the best outcome for the economy.

- We can calculate that the only credible promise that the policymaker can make is where the inflation rate she will choose for a given promise π^P, matches π^P, i.e. when

$$\pi^P = \left(\frac{\alpha b}{a+\alpha^2 b}\right)(u^n(1-k)) + \left(\frac{\alpha^2 b}{a+\alpha^2 b}\right)\pi^P$$

- This simplifies to

$$\pi^P = \left(\frac{\alpha b}{a}\right)(u^n(1-k))$$

- This solution is what would prevail without a credible commitment mechanism. A zero inflation promise is not credible because, given that the individual expects 0 inflation, the policy maker is tempted to give surprise inflation. So individuals will not expect zero inflation unless they can be credibly convinced that the policy maker can't deviate from this value.

- We next show that this also turns out to be the outcome under discretion, i.e. the outcome that prevails when the policymaker understands that they can choose policy freely and that because they can choose policy freely, people have no incentive to expect any particular value of inflation.

The Discretion Solution

- If the policy maker can't influence expected inflation, she has to take their expectations of inflation as given in picking the best policy. So her decision becomes

$$\text{Min}_{\pi_t} Z_t = a\pi_t^2 + b\left[u^n - \alpha(\pi_t - \bar{\pi}^e) - ku^n\right]^2$$

- The key difference from before is that the policy maker can no longer expect that expected inflation would equal any announced rate of inflation, hence the bar over the expected inflation term (to denote it is exogenous to the policymaker).

- The first order condition for this maximization is $2a\pi_t + 2b\left[u^n - \alpha(\pi_t - \pi^e) - ku^n\right](-\alpha) = 0$,

- Define $\hat{\pi}$ as the solution to this model. Individuals in the economy, being rational, understand that policy makers choose inflation according to this first order condition. So they set $\pi^e = \hat{\pi}$. Therefore the equilibrium inflation rate in the economy is the solution to $2a\pi_t + 2b\left[u^n - ku^n\right](-\alpha) = 0$,

$$\hat{\pi}_t = \left(\frac{b\alpha}{a}\right)(1-k)u^n$$

- So when the policy maker can't commit to a specific rule, then she will choose an inflation rate that is > 0 every period. Individuals expect that the policy maker will supply this positive inflation rate as well.

- The value of the objective function of the policy maker is given by $\hat{Z}_t = a\left[\frac{\alpha b(1-k)u^n}{a}\right]^2 + b\left[(1-k)u^n\right]^2 +$ This simplifies to

$$\hat{Z}_t = b\left[(1-k)u^n\right]^2\left(1 + \frac{b\alpha}{a}\right)$$

- So the policy maker is worse off: the loss function is higher under discretionary policy.
- Note that the rate of inflation that prevails in the economy under discretionary policy $\hat{\pi}_t = \frac{b\alpha(1-k)u^n}{a}$ is an increasing function of $\frac{b}{a}$.
- The more weight the policy maker attaches to unemployment (the higher b is) and the less weight she attaches to inflation (the lower a is) the higher the inflation rate that prevails in the economy. This makes sense because the policy maker will be much more willing to undertake discretionary policy that moves inflation around to try and achieve the required unemployment rate when this is the case.
- Note also that all the conclusions of the model rest on the assumption that $k < 1$. If $k = 1$ then the discretionary solution and the rules solution are the same.
- We have restricted our focus to situations where we ignored the fact that policy makers may suffer a reputational cost from extra inflation. So even under discretion, we can think of the policy maker as having incentive to provide 0 inflation because to not do so would destroy her reputation. We explore the reputational issue in greater detail in a famous paper by Barro and Gordon, which we will study in more detail next class.

Lecture 14: Rules, Discretion & Reputation

I. OVERVIEW

- In our last lecture, we focused on the Barro/Gordon paper that showed that policy makers could achieve a better outcome under a policy rule than they could achieve under discretion. The primary intuition for this finding was that under discretion, in the Barro/Gordon model, the policy maker always had incentive to try and create surprise inflation: promises of zero inflation, for example, would not be believed by rational individuals. Since these individuals expect higher inflation, the end result was a rate of inflation greater than zero.

- This result was dependent upon some of the assumptions in the model, in particular the claim that policy makers were trying to push the economy to a level of unemployment lower than the natural rate. Nevertheless, the conclusions of the model are extremely important: BG seem to provide a convincing intuitive reason for why discretion may lead to worse outcomes than rules: namely that the policy maker will systematically try to create surprise inflation.

- However, that paper ignored an important feature of the relationship between a central banker and individuals in the economy, namely, the importance of reputation. A monetary policy maker, even under discretion, may not try to fool individuals in order to safeguard his reputation as being tough on inflation. Furthermore, individuals may not automatically perceive a discretionary monetary policy maker as being inclined to create surprise inflation; instead they may factor his reputation (based on past actions, in this case) in forming expectations.

II. INTRODUCTION TO THE SECOND BARRO/GORDON PAPER

- The motivation of this paper is to explore the importance of reputation in determining the level of inflation in an economy. The authors speculate that the reputational cost from creating surprise inflation may constrain policy makers from creating such inflation even under the case of discretion.

- In particular, the authors want to know whether incorporating the impact of reputation into the model enables us to achieve the rule outcome even under discretion. BG find that the optimal rule can't be achieved under discretionary policy even after factoring in reputation. They do show however, that the rate of inflation that is achievable under reputation is in between the rule solution and the discretionary solution. Furthermore, the less the policy maker discounts the future, the lower the rate of inflation that prevails under reputation; in the limit the reputation solution approached the rule solution.

- The model that BG use in this paper is a simpler version of the model in their first paper. In particular, they do not explicitly provide an equation that describes the structure of the economy. Instead, they assume that the policy maker minimizes a loss function of the form

$$Z_t = \frac{a}{2}\pi_t^2 - b\left(\pi_t - \pi_t^e\right)$$

- Note that BG actually allow b to vary over time. But in the bulk of their analysis, the variation of b does not matter. So you may as well treat b as a constant to get the basic jist.

- A macroeconomic model, similar to the first Barro/Gordon paper is implicit in this loss function. The policy maker is assumed to treat the fluctuation of inflation as a cost and surprise inflation as a benefit.The fact that surprise inflation is treated as a benefit implies that the policy maker still is trying to push unemployment below the natural rate. Recall that the first BG paper, described a relationship of the form $u_t = u_t^n - \alpha(\pi_t - \pi_t^e)$ for unemployment. So surprise inflation, by reducing real wages would push u below the natural rate. The fact that surprise inflation is a benefit, therefore, implies that the policy maker finds it desirable to push u below the natural rate, i.e. its the equivalent of the $k < 1$ assumption in the last paper.

- As always, the loss function should be treated as a metric, some measure that captures the cost to the policy maker and that can be used for relative comparisons.

III. THE DIFFERENT SOLUTIONS OF THE BARRO/GORDON MODEL

- In this section we explore the 3 solutions that will help us think about the importance of reputation. We will first describe the discretionary solution, then the discretionary solution and finally something called the "cheating solution" which describes the outcome when the policy maker promises a certain rate of inflation and then deviates from it.

The Discretionary Solution

- Recall that under discretionary policy, the monetary policy maker has no way of pinning down the expectations of individuals in the economy. Therefore, they have to treat the expectations as given in calculating their optimal rate of inflation. Rational individuals then make their expectations consistent with the rate of inflation that satisfies the policy maker first order condition.

- The policy maker's decision becomes

$$\text{Min}_{\pi_t} Z_t = \frac{a}{2}\pi_t^2 - b\left(\pi_t - \pi^e\right)$$

- The first order condition for this maximization is $a\pi_t - b = 0$, which simplifies to $\hat{\pi}_t = \frac{b}{a}$ where $\hat{\pi}_t$ is the rate of inflation that prevails in the economy under discretion.

- Since individuals in the economy are rational, they understand that policy makers choose inflation according to this first order condition. So $\pi_t^e = \hat{\pi}_t = \frac{b}{a}$. The loss function of the policy maker, which we denote $\hat{Z}_t$ becomes

$$\hat{Z}_t = \frac{a}{2}\hat{\pi}^2 - b\left(\hat{\pi} - \hat{\pi}\right) = \frac{b^2}{2a}$$

The Rule Solution

- When the policy maker is following a given rule, expectations are always consistent with that rule $\pi_t^e = \pi_t$. The general problem faced by the monetary policy maker can then be described as the following:
$$\text{Min}_{\pi_t} Z_t = \frac{a}{2}\pi_t^2$$
- This, of course, leads to a FOC of $\pi_t = 0$.
- So the optimal rule for the policy maker to follow is a rule where she sets inflation to be zero. If we use π_t^* to denote the inflation rate that prevails in the economy under a rule and Z_t^* to denote the corresponding loss function, we get the following results $\pi_t^* = 0$ and $Z_t^* = 0$.

The Cheating Solution

- The cheating solution is the final piece of the puzzle. This is the case where the policy maker succeeds in getting you to expect a certain promised rate of inflation and instead tries to "cheat" you by creating surprise inflation. Suppose the policy maker promised a rate of inflation $\bar{\pi}$ that people believe in.

Carrying out the Promise

- If the policymaker carries out the promise, it is as if she's following a rule, except that the rule is no longer necessarily the optimal rule of $\pi^* = 0$.
- In general, if the policy maker follows a rule of the form $\pi_t = \bar{\pi}$ then expectations are always consistent with that rule $\pi_t^e = \bar{\pi}$. Therefore the loss function of the policy maker is $\bar{Z}_t = \frac{a}{2}\bar{\pi}^2$
- Note that this is an expression that gives you the value of the loss function for a given rule. The optimal rule remains a rule with an inflation rate of zero.

Reneging on the Promise

- Keep in mind, however, that the policy maker wants to create surprise inflation once she gets individuals locked into these expectations.
- So her decision becomes
$$\text{Min}_{\pi_t} Z_t = \frac{a}{2}\pi_t^2 - b\left(\pi_t - \bar{\pi}\right)$$
- The first order condition for this maximization is $a\pi_t - b = 0$, which simplifies to $\tilde{\pi}_t = \frac{b}{a}$ where $\tilde{\pi}$ is the rate of inflation that prevails in the economy under cheating (note that this is identical to the discretionary solution but that it does not have to be the case always, it just happens to be the case here).
- The loss function of the policy maker, which we denote $\tilde{Z}_t$ becomes $\tilde{Z}_t = b\bar{\pi} - \frac{b^2}{2a}$

IV. THE REPUTATION SOLUTION OF THE BARRO/GORDON MODEL

- To summarize, we have four solutions: the Rule Solution (π^*), where the policymaker MUST deliver the specified inflation); the Discretion Solution ($\hat{\pi}$), where the policymaker has to treat expected inflation as given); the Cheating Solution ($\tilde{\pi}$) where the policymaker makes a promise and then reneges on it; and the Promise solution ($\bar{\pi}$) where the policymaker makes a promise and then sticks to it.

- Now that we have these four solutions, we can calculate the reputation solution. When we are thinking about the reputation solution, we have to find some way of describing the expectations of individuals in the economy, i.e. are individuals likely to trust the policy maker as long as she never cheats them, how long will it take for them to trust her again after she cheats them once etc.

- Possible examples are individuals who don't trust policy makers ever again after the first instance of cheating, policy makers who trust policy makers as long as they didn't cheat them in the near past regardless of what they may have done before then.

- The particular form of expectations that BG use is the following

$$\begin{aligned} \pi_t^e &= \bar{\pi} \text{ if } \pi_{t-1} = \pi_{t-1}^e \\ \pi_t^e &= \hat{\pi} \text{ if } \pi_{t-1} \neq \pi_{t-1}^e \end{aligned}$$

- This basically implies that individuals will believe the policy maker as long as she has not cheated them last year. If she does cheat them, then they would think that she is acting in a discretionary fashion and basically form expectations that way. Note that the punishment period is only 1 period long: if the policy maker cheats in period 1, then in period 2 individuals form expectations according to the discretionary solution; they will go back to expecting the promised rate of inflation in period 3, since in period 2 $\pi_{t-1} = \pi_{t-1}^e = \hat{\pi}$.

- Given that individuals from expectations this way we can then calculate the reputation solution. A policy maker will choose to deviate from the announced inflation path if the benefit from cheating individuals in this period is worth the cost of cheating individuals. The cost applies only for 1 period, since individuals only punish you for 1 period. Of course, if the structure of the expectations were different then the punishment would last longer.

- We can then calculate the gain from cheating. If the policy maker does not cheat, i.e. carries out her promise, her loss function in a given period is $\bar{Z}_t$. If she cheats, then her loss function (which is lower) is $\tilde{Z}_t$. The gain from cheating is then $\bar{Z}_t - \tilde{Z}_t$; basically the difference between the loss you would suffer anyway and the lower loss you suffer by cheating. [NOTE: Barro/Gordon report this as $Z_t^* - \tilde{Z}_t$ since initially they are considering a promise of zero, i.e. the rule].

- Similarly, we can also calculate the loss from cheating. The loss from cheating is incurred in the next period where instead of incurring a loss of $\bar{Z}_{t+1}$, the policy maker is forced to adopt the discretionary solution and incur a (higher) loss of $\hat{Z}_{t+1}$. So the loss from cheating, appropriately discounted back at a rate $0 \leq q \leq 1$ to the present, will be $q\left(\hat{Z}_{t+1} - \bar{Z}_{t+1}\right)$ [NOTE: Barro/Gordon report this as $\hat{Z}_{t+1} - Z_{t+1}^*$ since initially they are considering a promise of zero, i.e. the rule]

- Given that individuals from expectations this way we can then calculate the reputation solution. A policy maker will choose to deviate from the announced inflation path if the benefit from cheating individuals in this period is worth the cost of cheating individuals. The cost applies only for 1 period, since individuals only punish you for 1 period. Of course, if the structure of the expectations were different then the punishment would last longer.

- Expressions for the cost and benefit for any given rate of inflation $\bar{\pi}$ can be calculated as follows. The cost incurred by the policy maker (what BG call "enforcement") is given by the expression

$$\text{Cost } = q\left(\frac{b^2}{2a} - \frac{a}{2}\bar{\pi}^2\right)$$

- Correspondingly, the benefit to the policy maker from cheating, as a function of $\bar{\pi}$ (which BG term "temptation") is given by the expression

$$\text{Benefit } = \frac{a}{2}\bar{\pi}^2 - \left(b\bar{\pi} - \frac{b^2}{2a}\right) \equiv \frac{a}{2}\left(\frac{b}{a} - \bar{\pi}\right)^2$$

- Based on these answers, the only rates of inflation that can occur under reputation are values of $\bar{\pi}$ for which the costs exceed the benefits: i.e. values for which

$$\frac{a}{2}\left(\frac{b}{a} - \bar{\pi}\right)^2 < q\left(\frac{b^2}{2a} - \frac{a}{2}\bar{\pi}^2\right)$$

- We can simplify this expression and show that this inequality holds true when $\left(\frac{b}{a} - \bar{\pi}\right)^2 < q\left(\frac{b^2}{a^2} - \bar{\pi}^2\right)$. This further simplifies down to

$$\left(\frac{b}{a} - \bar{\pi}\right)^2 < q\left(\frac{b}{a} - \bar{\pi}\right)\left(\frac{b}{a} + \bar{\pi}\right) \Rightarrow \left(\frac{b}{a} - \bar{\pi}\right)\left[\left(\frac{b}{a} - \bar{\pi}\right) - q\left(\frac{b}{a} + \bar{\pi}\right)\right] < 0$$

- This corresponds to the following range of inflation values

$$\frac{(1-q)b}{(1+q)a} < \bar{\pi} < \frac{b}{a}$$

- As you can see, this range of inflation values shows that the outcome under reputation is better than under discretion but not as good as under a rule: the lowest possible value of

$$\bar{\pi} = \frac{(1-q)b}{(1+q)a}$$

- Furthermore, notice that the rule of 0 is not attainable. If the policy maker announced a desire to achieve a zero rate of inflation, her "temptation" would be $\frac{b^2}{2a}$, while her "enforcement" would be $q\left(\frac{b^2}{2a}\right)$. Thus a zero inflation promise is not credible.

- As Figure 1 of BG show, this rate is in between an inflation rate of zero and the discretionary rate of inflation. An important feature to note is that the more heavily you discount the future ($q \to 0$) the reputation solution approaches the discretionary solution $\bar{\pi} \to \frac{b}{a}$. The less you discount the future ($q \to 1$) the reputation solution approaches the rules solution $\bar{\pi} \to 0$.

- This result makes intuitive sense: basically it states that by factoring in the reputation of the policy maker, we can achieve an outcome better than discretion but not as good as a rule. However, the more the policy maker cares about the future (in some sense, the more her reputation matters) the closer the economy gets to the rule outcome. The less the policy maker cares about the future (the less she cares about her reputation), the more incentive she has to cheat and the closer the economy gets to the discretionary outcome.

Spring Semester '13-'14
Akila Weerapana

Lecture 15: Inflation Targeting

I. OVERVIEW

- This lecture begins the transition from the monetary theory portion of the course to the monetary policy portion of the class. In the monetary theory portion of the class, we studied a simple model of the macroeconomy that gave us the insight that the Fed should try to keep the output gap at zero and set its desired interest rate to match up to the natural rate of interest in order to keep inflation at the targeted inflation rate. We then studied many subtleties that were not evident in this model such as expectations formation, the lags associated with monetary policy and the magnitude of impact of monetary policy on the economy, channels of monetary transmission, how monetary policy affects other interest rates in the economy, the importance of central bank independence and whether monetary policy outcomes would be better under a rule or under policy discretion with a policy maker who cares about reputation.

- So how do these lessons translate into practical monetary policymaking? That is what we explore in the next few lectures in the class. We begin today with a focus on inflation-targeting, potentially the most important practical innovation in monetary policymaking in recent times. Beginning in 1990, inflation targeting has spread over the past 25 years to more than 25 countries ranging from rich countries like Sweden to poor countries like Ghana, from small countries like Guatemala to large countries like Brazil or Mexico.

- In today's lecture, I will show you how the inflation targeting framework incorporates many of the lessons that come from the credibility and independence papers we read over the last few weeks. But we will also focus on the range of possible approaches to inflation targeting that countries practice and potential variants that they could adopt, some of which arguably may have led to better policy responses to the Great Recession.

II. THE CORE FEATURES OF INFLATION TARGETING

- Before describing inflation targeting its good to place inflation targeting as system of monetary policymaking in a historical context. Economists and monetary policy makers have long believed that successful monetary policy should have a "nominal anchor", a variable that the central bank could use to discipline their policy decisions and convince agents in the economy that the central bank was disciplined.

- Historically, when commodity money was used there was no need to worry about an anchor for monetary policy because the central bank did not control how much gold or silver was produced in the economy. But when paper money became the medium of exchange, then instead of using gold, the economy was on the gold standard: paper money was backed by gold reserves held at the central bank. Even there, the central bank did not have to worry about a nominal anchor because the amount of paper money that could be issued was determined by the gold reserves.

- After the gold standard collapsed in the 1930s, and after the war years had ended, there was a need for a new nominal anchor and it took the form of a fixed exchange rate system known as the Bretton-Woods system. Under Bretton-Woods, the U.S. dollar was (implicitly) backed by gold but other countries had their currency fixed to the dollar. So the rate at which their currencies were fixed to the dollar acted as a nominal anchor: you could not print too much of your own currency because you also had promised people that your currency could be converted into dollars at a fixed rate.

- The Bretton-Woods system collapsed because the United States was unanchored: even though the dollar was supposed to be backed by gold, there was no legal restriction on how many dollars the Fed could print. As war-time expenditures in Vietnam mounted, the U.S. printed more dollars and when asked to convert dollars to gold, refused to do so, resulting in the end of the Bretton-Woods system in the early 1970s.

- After the collapse of Bretton-Woods, there was a search for a new nominal anchor. Many countries chose to fix their currency to the dollar and continued to use the exchange rate as an anchor. But many others remained unanchored and this led to much of the theoretical work on central bank independence, reputation, rules vs. discretion etc. as some central banks (U.S., Germany) were able to build the type of independent, politically-insulated structure that allowed them to use their policy discretion wisely whereas others (Brazil, Argentina, Turkey) were unable to overcome the loss of a nominal anchor and took advantage of their new found license to print money freely.

- By the end of the 1980s there was widespread interest in a nominal anchor that was the best of both worlds: a framework that would ensure that the policymaker would not behave irresponsibly and create high inflation and unpredictable inflation expectations but also allowed the policymaker the flexibility to intervene in the economy and smooth out fluctuations. The fixed exchange rate anchor would only do the former (in some cases not even that) but not the latter. That was where inflation targeting came into the picture.

- Beginning in the early 1990s, many countries in the world moved towards a system/framework of conducting monetary policy known in academic and policy circles as "Inflation Targeting". As the name indicates, the nominal anchor is the inflation rate: the central bank is supposed to follow a monetary policy that is designed to achieve a stated objective with regard to the inflation rate.

Basic Features of Inflation Targeting

- Inflation targeting is a system of conducting monetary policy that has the following features:

  1. The announcement of official targets for inflation at certain horizons.
  2. Explicit acknowledgement that the goal of monetary policy is the stabilization of inflation.
  3. Holding the central bank accountable for achieving the stated goals.
  4. Increased communication with the public about the plans and objectives of monetary policy as well as about forecasts for meeting the target.

- Inflation targeting has been adopted by over two dozen countries including Canada, the U.K., New Zealand, Australia, Brazil, Mexico, Sweden and Israel. Within the basic features of inflation targeting, as described above, there is a wide range of systems practiced by these countries. I provided you with a handout in class that lists the countries that have adopted inflation targeting as well as the targets they have adopted.

- Some important similarities and differences can be gleaned by looking at this table. In all the countries, inflation is usually defined as a range of permissible values (e.g. 1%-3%) rather than as a point value (e.g. 2.4%). The actual range varies dramatically, no doubt as a result of differences in the country's recent inflation experiences. For example, Ghana has chosen a high inflation target of 13.5% to 15.5%, while New Zealand has chosen a very low inflation target of between 1 and 3 percent. Similarly, Serbia has a wide inflation target of 4% to 8% while Australia has a very narrow target of 2% to 3%.

- Why this difference? It is because central bankers want to provide a inflation target that is realistically achievable (hence the higher target for Ghana and the wider target for Serbia). The target can change over time, for example, Israel, which historically has had bouts of very high inflation initially had an inflation target of between 8 to 11% but now has reduced it to 1% to 3%.

- The definition of inflation also varies from country to country, some countries exclude the prices of volatile components like food and energy, others allow the central bank to deviate from the set target in the vent of an unforeseen adverse shock etc. The consensus of seems to be to focus on a measure of core CPI (excluding volatile food and energy prices).

- Note also that the inflation target is always a non-zero value. The economic arguments against a zero inflation target are that

  1. Measures of inflation are biased upwards so that 0% inflation as measured with a conventional tool like the CPI or the GDP deflator may in fact be deflation for the economy.
  2. Wage flexibility may be affected as well. Interesting economic research has shown that workers are willing to accept 2% wage hikes in an environment of 3% inflation (a 1% real decrease) but not 1% wage cuts in 0% inflation (also a 1% real wage decrease). In other words workers have an important psychological barrier against nominal wage reduction although not necessarily against real wage reduction.
  3. Unanticipated negative shocks in a zero inflation environment can lead to deflation, deflation is an important factor in precipitating financial crises.

- Another, and perhaps the most important, common feature of inflation targeting programs is that no country asks the central bank to achieve the inflation target over the short run. This implies that monetary policy makers will not care only about inflation: at short horizons output fluctuations will clearly come into play. Since monetary policy is assumed to not have any effect on output in the long run, it makes sense to think of the sole long-run objective of the policy maker as being to stabilize inflation.

- The degree of accountability also varies: New Zealand explicitly links the tenure of the governor of the Central Bank to the ability to achieve the specified targets, while none of the others explicitly do so. Having a stated target even without explicit sanctions may discipline the central banker because there is a loss of reputation and prestige and the need to clarify why the bank had so badly missed the inflation target.

- Finally, in most of these countries, care has been taken to avoid creating the impression that the government is tampering with the central bank. While the inflation targets are laid out by elected officials, they are not usually tampered with, and the central banker is allowed greater independence in deciding what policies to pursue in order to achieve the stated goals. Basically, the politicians do not tell the central bank how to achieve a target, they just delineate the target to be achieved and leave the rest up to the bankers.

Misconceptions about Inflation Targeting

- Inflation targeting does not imply that the monetary policy maker's "hands are tied": forcing them to adhere to a strict rule and taking away their power to discretionarily choose appropriate policy.

- Most inflation targeting countries only lay out the goals and not the operating procedures: the central bank does have operational independence. Second, the targets for the central bank are defined over intermediate term horizons. The central bank is given the freedom to respond to short-term disruptive shocks and, in some countries, allowances are made for deviation from the targets in the face of extremely adverse shocks.

- Also, inflation targeting does not mean taking away all of the policy maker's discretion: it is simply what Ben Bernanke once called "constrained discretion", the policymaker is free to act on a day to day or month to month basis while having his/her longer-term performance be required to meet specified expectations.

- In fact, one could argue that inflation targeting enhances central bank independence instead of reducing it. For example, the government could not force the central banker to undertake policies that have positive short run and negative long run effects because the central banker has to make public all information about the ability to reach the long-term target. This provides insurance to the central banker against being arm-twisted by politicians.

- A slight digression: mathematically, we described the behavior of the monetary policy maker in the form of the MP curve $r_t = \bar{r}^* + \gamma_\pi(\pi_t - \bar{\pi}^*) + \gamma_y \hat{Y}$, Inflation targeting does NOT necessarily imply a loss function with $\gamma_y = 0$. As long as the central bank achieves its longer term goals it is free to pursue other objectives it may desire in the short run: stabilize the exchange rate, pop a stock market bubble, cool down an overheated economy, jump start a sluggish economy, etc.

- This is why Bernanke described inflation targeting as "controlled discretion": it is a system that provides a anchor for monetary policy makers, while allowing them the freedom to react to shocks that hit the economy in the short run. It furthers increased accountability of central banks, makes them act in a more transparent manner towards the public and also helps make them more independent from government interference.

- Perhaps the most important question that remains is why countries should aim for explicit inflation targeting. Why do they not adopt a system of responsible, discretionary monetary policy making like the Federal Reserve in the United States.

- A couple of answers emerge to this question. The first thing to keep in mind is that the Fed under Yellen (presumably), Bernanke, Greenspan, and to a lesser degree Volcker, is very different from the Feds that preceded it in the 1970s. So while having a responsible, respected policy maker operating in a discretionary environment can give good policy results, the good work could easily be undone by a bad policy maker operating in the same environment.

- Second, you should think about the extent to which the inflation targeting mechanism does in fact describe the policy of the Federal Reserve in the U.S. On the surface some important elements of inflation targeting are missing in the U.S. arena: no explicit inflation target is set for the Fed, no accountability if it fails to achieve a target. On the other hand, almost everyone believes that the Fed aims for low inflation in the long run of around 2%, even though a specific rate is not mandated.

- Furthermore, the Fed practices constrained discretionary monetary policy. It functions independently of the government but is somewhat accountable to the government in that the chair of the Fed has to be reappointed every 4 years; were Yellen to go nuts and drive inflation to 20% a year she would most likely not be reappointed for having violated an unstated goal.

III. VARIANTS OF INFLATION TARGETING

- In recent times there has been an interesting discussion about whether the target should be about growth rates or levels. Consider the following two targeting regimes: a) an inflation target of 2% a year or b) a price level target where the price level rises by 2% a year. On the surface, these two may seem identical because inflation after all is the percentage increase in the price level.

- In normal circumstances, these two are indeed identical. Suppose the price level in 2005 was 100. Then under inflation targeting, we would see the following sequence:

Year	2005	2006	2007	2008	2009	2010
Inflation Target	2%	2%	2%	2%	2%	2%
Price Level Needed	100	102	104.04	106.12	108.24	110.41

Year	2005	2006	2007	2008	2009	2010
Price Level Target	100	102	104.04	106.12	108.24	110.41
Inflation Needed	2%	2%	2%	2%	2%	2%

- Suppose a negative shock hit the economy in 2007 and inflation fell to -2%. But other than that year we were able to meet the target. Then under inflation targeting we have

Year	2005	2006	2007	2008	2009	2010
Inflation Target	2%	2%	2%	2%	2%	2%
Price Level Needed	100	102	104.04	106.12	108.24	110.41
Actual Inflation	2%	2%	-2%	2%	2%	2%
Actual Price Level	100	102	104.04	101.96	104	106.08

- Under price-level targeting, again assuming prices fell by 2% in 2007 but that we were able to achieve our target otherwise, we have

Year	2005	2006	2007	2008	2009	2010
Price Level Target	100	102	104.04	106.12	108.24	110.41
Inflation Needed	2%	2%	2%	2%	2%	2%
Actual Price Level	100	102	104.04	101.96	108.24	110.41
Actual Inflation	2%	2%	2%	-2%	6.16%	2%

- Notice the difference. Under inflation targeting, following an unexpected bout of deflation, all we have to do to get back on track is to restore 2% inflation. But under price level targeting, we have to actually have a HIGHER inflation rate in order to get the price level back on track. This is why some economists believe that price level targeting would have made the Fed more aggressive after the financial crisis in order to restore the predictable long-run path of 2% price growth.

- Similar arguments appear with regard to choosing a different variable to target. For example, we can consider the current approach of the Fed in the United States, which we modeled as keep $\hat{Y} = 0$ and $\pi = \bar{pi}^*$ as being basically a target for the **growth rate of nominal GDP**. Why? Because to keep $\hat{Y} = 0$, we have to keep real GDP growing at the rate of potential GDP and keep inflation at the desired target so thus nominal GDP growth, which equals real GDP growth + inflation would have to be constant.

- So for instance, if potential output grew at 3% a year and the inflation target 2% a year, keeping the economy at $\hat{Y} = 0$ and at the inflation target would require nominal GDP growth rate of 5% a year. But once again there is a difference between a **growth rate target** for nominal GDP of 5% a year and **a level target** for nominal GDP of having the level of nominal GDP increase by 5% a year.

- In the financial crisis of 2008, real GDP growth was -2.5% and inflation was 0%. Under a nominal GDP growth target, we would aim to restore nominal GDP growth rate of 5%, ideally by bringing real GDP growth back to 3% and inflation back to 2%. However under a nominal GDP LEVEL target, we would have to increase nominal GDP by a staggering 13% to overcome the 2.5% fall in nominal GDP in 2008. This again means that the Fed would be MUCH more tolerable of high inflation until it gets the economy back on track and would not view the world within the narrow confines of never exceeding the 2% inflation target.

- The danger here is of course that inflation expectations could spiral out of control if agents are unable to view this as simply a temporary move to bring the economy back to the mandated growth path. Suppose that a combination of 10% inflation and 3% real GDP growth rate gets us the requisite 13% increase in nominal GDP to get back on track. But now suppose inflation remains stubbornly high at 10% a year. Then the only way to hit the nominal GDP target of 5% a year increase is to use monetary policy to LOWER real GDP by 5%! This would obviously not be a good outcome for the economy.

Lecture 16: An Empirical Assessment of Inflation Targeting

I. OVERVIEW

- In the last class, we examined a framework of conducting monetary policy known as inflation targeting. Because countries had moved away from fixed exchange rate systems, and also because of the difficulty of finding the right measure of money to target in an increasingly complex financial system, many countries in the world have moved towards a system where they follow a monetary policy that is designed to achieve a stated objective with regard to the inflation rate.

- In that lecture, we described some of the key features of an inflation targeting system: explicit goals of stabilizing inflation, accountability, and transparency being among the key features. The central bank is also allowed independence for achieving the stated inflation targets and allowance is made for dealing with short-term shocks and other policy objectives that do not interfere with the overall target.

- Now that we understand some basic features about inflation targeting, let's change our focus to how effective inflation targeting has been in some of the countries that have adopted the system. The paper assigned for today's class, by Ball and Sheridan is an empirical examination of the effectiveness of inflation targeting.

II. THE BALL/SHERIDAN PAPER

- The basic motivation of the Ball/Sheridan paper is to take a closer look at how effective inflation targeting, which has become "increasingly popular in recent times" and been adopted by several other nations, has been as a system of conducting monetary policy.

- The overall goal is to use a differences-in-differences methodology in which the change in economic outcomes from the pre-IT period to the post-IT period (the first difference) for inflation targeting countries is compared to the corresponding change for non inflation targeters (the second difference).

- The hypothesis is that inflation targeters should see a greater improvement in their outcomes than the non-targeters do, if we are to conclude that IT is a superior system of monetary policy making.

- One can think of Ball and Sheridan's methodology as mimicking a classic treatment/control experiment with some countries getting the treatment and others not getting it. But of course, as we shall see, the key difference is that in an experimental setting the assignment is random, whereas here the decision to receive the "treatment", i.e. to adopt inflation targeting is completely up to the country.

- Ball and Sheridan conclude that both inflation targeting countries and non-targeting countries saw significant performance improvements with no statistically significant effects being attributable especially to IT.

- In cases where IT countries seem to have done better than non-IT countries, Ball and Sheridan claim that the effect is entirely because of regression to the mean - once one controls for differences in initial inflation levels there is no difference in outcomes between the targeting and non-targeting countries.

III. THE DIFFERENT REGRESSION SPECIFICATIONS USED BY BALL AND SHERIDAN

- Ball and Sheridan's empirical work involves running two specifications on a variety of samples and a variety of dependent variables.

- The basic specification is
$$X_{\text{post}} - X_{\text{pre}} = a_0 + a_1 D + e$$
where X is a dependent variable that is expected to be impacted by inflation targeting and D is a dummy variable that is set to 1 if the country is in the 'treatment group' and 0 otherwise.

- There are two different treatment/control groups in their study. The first treatment group is the seven countries that adopted inflation targeting (Australia, Canada, Finland, New Zealand, Spain, Sweden, United Kingdom) while the corresponding control group is the thirteen non-targeters (the U.S., Japan, Denmark, Austria, Belgium, France, Germany, Ireland, Italy, Netherlands, Portugal, Norway, Switzerland). The second treatment group is the countries that adopted constant inflation targets (Australia, Finland, Sweden and the U.K.) to the non-constant inflation targeters (New Zealand, Spain and Canada).

- For the IT vs non-IT comparison, the post-treatment period is defined as the period from 1994Q4 to 2001Q4. The authors consider two pre-treatment periods, one from 1960Q1-1994Q2 and the other from 1985Q1-1994Q4. The reason for taking a longer and a shorter pre-period is to allow for the possibility that the outcomes of the 60s and 70s were not sufficiently representative of the circumstances prior to the introduction of IT.

- For the constant IT vs. non-constant IT comparison the post-treatment period has been defined for the non-constant IT countries is the average start date for the constant targeting countries.

- Finally, Ball and Sheridan consider several different outcome variables including the average rate of inflation, the standard deviation of the inflation rate, the standard deviation of a long-term inflation trend, average annual growth rate of GDP, the standard deviation of GDP growth, long-term interest rates and the standard deviation of short-term interest rates.

- The hypotheses being tested are that IT leads to lower and less volatile inflation rates, potentially also to higher and less volatile GDP growth, lower long-term rates and less fluctuations in short-term rates. Tables III-IX report summary stats and regression results for the basic specification.

Problems with the Basic Regression Specification

- The core problem with the basic specification is that the decision to adopt IT is not an exogenous one. As long as D is correlated with the error term, OLS estimation of the above equation will provide biased estimates of the true impact of IT.

- Ball and Sheridan consider one key source of correlation, the idea of mean reversion. Countries with higher inflation rates are more likely to adopt IT while countries with lower inflation rates are less likely to stick with what they have been doing. if there is mean reversion, inflation targeting would likely seem to be the primary reason for the improvement in performance ($a_1 < 0$) although in reality it has nothing to do with the improvement.

- While this is an interesting argument, I think it the analogy is a little flawed in that there is little reason to believe that after 34 years of pre-treatment information, mean reversion has not had an effect yet. Another way to challenge the analogy is to say that there is no reason to think that the treatment and the control groups have the same means that they are reverting to.

- However, mean reversion is just one way in which the regression is problematic, it only requires that the error term and the IT dummy be correlated in some way. This is almost invariably true. Suppose for example that for some unobservable reasons (incompetence of the policy maker, weak CB institutions) some countries have had higher inflation rates. This will raise π_{Pre} and lower $\pi_{\text{Post}} - \pi_{\text{Pre}}$. You will then see that countries with $D = 1$ are likely to have a lower $\pi_{\text{Post}} - \pi_{\text{Pre}}$, i.e. IT will seem to have more of a beneficial effect than it really does.

How to Fix the Basic Regression Specification

- This is where the distinction between the correlation between the error term and the IT dummy coming from mean reversion or from unobserved factors becomes critical.

- If the reason for the correlation is mean reversion then all you would need to do to fix the bias is to include the Pre-value of the dependent variable as an additional regressor on the RHS.
$$X_{\text{post}} - X_{\text{pre}} = a_0 + a_1 D + a_2 X_{\text{pre}} + e$$

- For everyone of their regressions, Ball and Sheridan report the results of the above specification and contrast it with the baseline regression. They show that once you control for prior conditions, IT does not seem to have a positive impact.

- However, if the source of the problem is general correlation between the unobserved variables and the decision to adopt IT then the above fix will only work if ALL correlation between e and D works through X_{Pre}.

- This may not be the case, for example a country may choose to adopt IT for reasons other than a high rate of pre-existing inflation (say because a neighboring country adopted IT) or because a wise central banker who had delivered good inflation performance wanted to solidify the institutional foundations of her policies.

V. BIVARIATE REGRESSIONS

- Finally, Ball and Sheridan also test some bivariate relationships that they think could be affected by the decision to adopt IT. The three relationships are

  1. The Slope of the Phillips Curve: $\Delta\Pi = a(Y - Y^*)$
  2. The Impact of Supply Shocks on the Economy: $\Delta\Pi = K_0 + b(\Delta\text{Commodity Prices})$
  3. The Impact of Inflation on Expectations: $\Delta\Pi_t^e = K_1 + c(\Pi_{t-1})$

- The hypothesis is that inflation targeting should reduce c because inflation expectations are anchored by the adoption of IT.

- Furthermore, the effects of supply shocks (b) should also fall because the lingering impact of such a shock will diminish as expectations are anchored.

- Finally, the impact on the slope of the Phillips curve (a) is ambiguous because it could fall reflecting the fact that inflation is less influenced by economic fluctuations or it could rise indicating that disinflation is easier for the Fed.

- The results here are also similar to what was found earlier. Inflation expectations do seem to have become more anchored over time and commodity prices seem to have had less effect on inflation over time. However, there is no evidence that IT adopters have done better on this dimension than non-It adopters over time.

- Overall, the results show that IT does not seem to have had an especially beneficial effects but we would need to treat these results with caution both because of potential sources of remaining bias but also because it does not mean that for developing countries IT is not a good strategy. What the results show is that countries that adopted IT did improve performance just like other countries that conducted more discretionary policy. A country that finds it harder to create a discretionary environment suited for delivering good outcomes may still end up doing better by adopting IT.

Lecture 17: Simple Monetary Policy Rules

I. OVERVIEW

- The last two lectures focused on practical aspects of monetary policy, specifically the decision by over two dozen countries to adopt a new method of conducting monetary policy known as inflation targeting. We also looked at an empirical paper by Ball and Sheridan summarizing the practical consequences of inflation targeting. We learned that inflation targeting emphasized the advantages of "constrained discretion": allowing policymakers flexibility in the short-run while providing a nominal anchor for policy in the intermediate to long-run.

- Another important practical development of the last 25 years has been the widespread application of "simple monetary policy rules". Simple monetary policy rules are built on the idea that monetary policy should have a significant endogenous component. If policymaker's decisions are built around a simple policy rule, it will enhance the transparency of policymaker's actions.

- The key feature to remember is that a simple policy rule is not a "rule" in the Barro-Gordon sense. Policymakers are allowed to deviate from the rule if they desire. A simple monetary policy rule is a way of describing that endogenous component.

- We incorporated a simple monetary policy rule into our derivation of the MP curve in the AD/IA model. Such rules have been incorporated into theoretical models of much greater complexity but their real value has been in how they can be used as a rule of thumb guide to what the monetary policymaker should do when behaving appropriately.

- Today's lecture will introduce you to the topic of simple monetary policy rules. I will use some diagrams taken by a Federal Reserve paper by Sharon Kozicki that provides an overview of the topic; however, I am not asking you to read the Kozicki paper yourself.

II. INTRODUCTION TO SIMPLE MONETARY POLICY RULES

- What is a simple monetary policy rule? Well, it is basically an equation that relates movements in the Federal Funds rate to movements in a few common macroeconomic variables. The idea is that a well-founded monetary policy should react in an economically sensitive manner to movements in key macroeconomic variables and have relatively few unexplainable deviations. Therefore, even under discretion, a good monetary policy maker's behavior can be *mostly* captured by examining movements in key macroeconomic variables like inflation and unemployment.

- The last point is key: the study of simple monetary policy rules does not require the existence of a formal commitment mechanism that forces a monetary policy maker to follow a strict rule for setting policy. It merely captures the fact that, even under discretion, the majority of policy decisions may be well described using a simple policy rule.

- The recent interest in policy rules stems from a famous article by John Taylor in 1993, in which he described a simple formula for estimating the behavior of the Federal Reserve. The specific rule that he identified became widely known in academic and policy circles as the "Taylor Rule". Today, it is used as a reference point for policy discussions; most simple monetary policy rules are now known as "Taylor Rules" or "Taylor-type Rules" in the literature.

- The popularity for these simple monetary policy rules are two fold: first, they provide an economically intuitive, yet transparent, description of monetary policy that appeals to economists and policy makers; second, several studies have shown that variants of these simple "Taylor-type" rules have provided a good description of the behavior of the U.S. Fed under Greenspan, the Bundesbank and other developed-country central banks in recent times.

- Even when the rules do not accurately predict movements in policy, they serve as effective reference points for understanding the existing policy stance. In some sense, we can think of the policy rule as describing the normal behavior of the policy maker. When the policy variable diverges from that predicted by the policy rule, one can then search for the underlying reasons of that deviation: example include: the lowering of rates following the East Asian crisis in 1997, the raising of rates in the face of relatively low inflation in 1999 and 2000 and the lowering of rates in the face of the stock market crash of 1987.

- At other times, the policy rule raises questions about a path of policy such as why Alan Greenspan kept interest rates low in the period following the 2001 recession. It also helps illustrate important policy dilemmas: in the aftermath of the 2008/09 recession, the Taylor Rule recommended a negative nominal interest rate which we were unable to follow because of the zero lower bound. Subsequently, the Taylor Rule has recommended positive nominal interest rates for some time now but the Fed is keeping rates at zero: its an open question whether keeping rates zero when they should be positive can make up for keeping rates at zero when they should have been negative.

The Taylor Rule

- The original Taylor Rule described a relationship between the Federal Funds rate, the current output gap and the current rate of inflation. It was presented in a number of different formats, all of which have the same interpretation. The two most well-known versions (equivalent to each other) are

$$\begin{aligned} i_t^{TGT} &= 4\% + 1.5(\pi_t - 2\%) + 0.5(\hat{Y}_t) \\ r_t^{TGT} &= 2\% + 0.5(\pi_t - 2\%) + 0.5(\hat{Y}_t) \end{aligned}$$

  where i^{TGT} is the targeted nominal Fed Funds rate, r^{TGT} is the targeted real Fed Funds rate defined as $i = r - \pi$, $\hat{Y}_t$ is the output gap, i.e. the percent deviation of output from steady state output. [Note that the actual Fed Funds rate i_t can deviate from the value described by the simple policy rule i_t^{TGT}, there is no binding constraint on the policy maker to follow this rule]

- In the above equation, Taylor described the behavior of the Fed as follows. He assumes that the Fed sets the nominal Fed Funds rate to be around 4% a year if everything else was normal (i.e. no output gap and inflation was at the targeted value); this could equivalently be interpreted as the Fed shooting for a real Fed Funds rate of 2% a year if everything else was normal.

- The Fed funds rate would be raised when either inflation or the output gap increased, and the Funds rate would be lowered when either inflation or the output gap decreased. This is similar to the behavior we described when we laid out the foundations of the AD/IA model early on in the class. Taylor assumed that the nominal Fed funds rate would be raised by 50 basis points (0.5 percentage points) for every 1 percentage point increase in the output gap and by 150 basis points (1.5 percentage points) for every 1 percentage point increase in inflation.

- Once again the analysis could be done in terms of the real Fed Funds rate in which case the Fed would raise the real funds rate (by manipulating the nominal funds rate) by 50 basis points (0.5 percentage points) for every 1 percentage point increase in the output gap and by 50 basis points for every 1 percentage point increase in inflation [Note that a 150 basis point increase of the nominal funds rate in response to a 1 percentage point increase in inflation, effectively works out to be a 50 basis point increase of the real funds rate in response to a 1 percentage point rise in inflation.]

- Since Taylor's original paper, researchers have modified this type of policy rule and examined the performance of many different "Taylor-type" rules. In general, a Taylor-type rule can be described by an equation of the form

$$\begin{aligned} i_t^{TGT} &= \bar{r}^* + \bar{\pi}^* + (\gamma_\pi + 1)(\pi_t - \bar{\pi}^*) + \gamma_y(\hat{Y}_t) \\ r_t^{TGT} &= \bar{r}^* + (\gamma_\pi)(\pi_t - \bar{\pi}^*) + \gamma_y(\hat{Y}_t) \end{aligned}$$

  where $\bar{r}^*$ is the equilibrium real interest rate, $\bar{\pi}^*$ is the targeted inflation rate. γ_y is the "output reaction coefficient" and γ_π is the "inflation reaction coefficient": parameters that describe the magnitude of the response of the nominal funds rate to movements in the output gap and inflation.

- Typically, $\gamma_\pi > 0$: this captures the idea that the Fed would typically raise (or lower) the real interest rate when inflation rises (or falls). This is called the "Taylor Principle" and requires that the Fed change the nominal Fed Funds rate by more than the change in inflation so as to affect the real funds rate.

- When the Fed can't follow the Taylor Principle, weird stuff happens to the economy (see Question 1 on your midterm exam).

- Taylor's exposition of the above policy rule spawned a huge research agenda. Applications include trying to estimate Taylor-type rules for the actual behavior of the Fed, testing to see how a particular policy rule describes the behavior of the Fed, examining alternative variables that could be added to such rules, examining the performance of different policy rule using macroeconomic models to look at alternative policy choices etc.

- I will show you some diagrams taken from a paper by Sharon Kozicki of the Kansas City Fed. This paper provides a nice overview of simple policy rules and addresses important issues such as the timing of the variables, the measures of inflation and the output gap and how well these rules match or describe the behavior of the Fed in the period 1983 to date. I will not ask you to read the paper but instead will draw on it to construct the notes for this lecture.

III. COMPLICATIONS OF TAYLOR-TYPE RULES

- Kozicki raises three primary problems that researchers working with Taylor rules have to deal with. Each of these issues will be discussed below.

  1. Timing
  2. Reaction Coefficients on Inflation and Output.
  3. Reaction to other variables.

- **Timing** The basic Taylor rule, and most Taylor type rules, assume that the Fed Funds rate for the current period (the period is usually a quarter) is set according to the output gap and the deviation of inflation from target in the current quarter: in other words interest rates react contemporaneously to movements in inflation and the output gap. Kozicki points out that this may not be a realistic assumption since GDP data is only published with a lag, so it is at least a quarter late. Therefore the appropriate policy rule may have lagged macroeconomic variables rather than contemporaneous variables on the RHS.

- Furthermore the data is revised at the end of the year resulting in a different value for GDP than in the quarter released. This poses a problem for researchers and policy makers: policy makers may not have access to the appropriate current quarter data in forming their policy decisions; researchers describing the behavior of policy makers will use revised data that may not reflect the data that the Fed had when they made their decision. In other words, behavior that seems unusual given the revised data, may not be unpredictable if viewed within the context of the unrevised data.

- **Magnitude of Reaction Coefficients** Taylor suggested weights of 0.5 and 1.5 on inflation and the output gap, however this is far from being a consensus. There have been several studies that find that theoretically, higher weights on the output gap (closer to 1) and inflation (closer to 2) yield better performance.

- Furthermore, estimating reaction functions for the Fed yield different estimates from the 0.5 and 1.5 found by Taylor once we change the sample period to span periods before or after the 1980s and 1990s.

- **Reaction to Other Variables** There has also been disagreement on what variables should be included in a simple monetary policy rule in the first place. Kozicki makes a strong argument for including last period's interest rate as an right hand side variable: basically the Fed tends to be very cautious in moving interest rates at any given point, and even if economic conditions change dramatically, they may only make small rate changes.

- Other variables that have been bandied about include exchange rates, the value of the stock market, etc.

- A related problem is deciding which of the competing measures to use, even when we can all agree on what variable should go on the right hand side. For example, the literature has reached a consensus that inflation and the output gap belong on the RHS of the policy rule. However, it is not immediately clear what measure of inflation should go there: CPI, core CPI, GDP deflator etc. Nor is it immediately clear how to measure potential output: do we use a linear trend, a split linear trend etc.

- These different possibilities imply a range of different recommendations that one gets from a Taylor Rule depending on what measures one uses for the macroeconomic variables.

- Chart 1 (class handout) summarizes the values of the four different measures of inflation and Chart 2 summarizes the values of the 6 different output gap measures that Kozicki uses.

- Chart 3 tracks the range of predicted values of the different rules, along with a specific graph of the original Taylor Rule with reaction coefficients of 0.5 and 1.5, and the actual Fed Funds rate. The funds rate falls within the predicted range for the period 1987-1998 (with a few minor exceptions in the early 1990s). It does a decent job in 1985 and 1986 but does less well in the early 1980s.

- The Taylor Rule itself does a stellar job between 1987 and 1991 but has done less well since then. Interestingly, the original Taylor paper describing the predictability of the Fed circulated around the time that Fed policy began to diverge from the Taylor Rule: some people form their own conspiracy theories about the behavior of the Fed as a result!

- Charts 4 and 5, examine the "robustness" of the Taylor Rule to different measures of inflation and the output gap individually. Basically Chart 4 uses the GDP deflator to measure the inflation rate in the economy and examines the range of values that one would get for different inflation rates. Chart 5, on the other hand, picks a single measure of the output gap and examines the range of recommended values for the funds rate based on different measures of inflation. The gist of the results remain: the policy rule works well for 1987-1992, less well since then or before then.

- Finally, Kozicki estimates reaction coefficients econometrically using data from the period 1983-1998. The results are presented graphically in Chart 6, and numerically in Table 3. The coefficients numerically differ from the values in the Taylor rule but statistically can't be differentiated.

- The predictions of this model follow the basic pattern of the previous results: the period before 1987 and 1991 are not very good fits, even though the last few years of her study (1995-1997) are not wildly off. So the most favorable interpretation is that a simple policy rules provides a good first pass at estimating movements in the Fed Funds rate, except for the period before 1985 and in general provides a decent description of movements in the funds rate if not quite able to track the level of the funds rate.

- Kozicki runs a final set of studies where she adds an interest rate smoothing term to the policy rule. This means a policy rule of the form $i_t^* = \rho i_{t-1} + (1-\rho)\left[\bar{r} + \bar{\pi} + \gamma_\pi(\pi_t - \bar{\pi}) + \gamma_y(y_t - y_t^*)\right]$ where ρ is the degree of smoothing in the economy. So a high value of $\rho \approx 1$ indicates a policy maker who is relatively cautious about adjusting interest rates while a low value of $\rho \approx 0$ indicates a policy maker who is relatively more likely to adjust interest rates

- Kozicki then estimates policy rules of the above form to see if they improve the fit. She finds that econometric estimates of the degree of smoothing differ significantly from 0, indicating that central banks do tend to move cautiously and that the current interest rate in the economy is very closely related to last period's interest rate. She finds that estimates of the reaction coefficients on inflation and output are now very close to the 1.5 and 0.5 values used in Taylor's original rule. These results are presented numerically in Table 5 and graphically in Chart 6. The policy rule with smoothing does better than the rule without smoothing although it still does not well pre-1985 and in the period 1992-1994.

- Overall, Kozicki provides evidence showing that the Taylor rule or variants of it do a good job of predicting the behavior of the Fed from the mid 1980s to the late-1990s but that before and after that period, these rules do less well in predicting the Fed.

- However, its important to realize that the simple policy rule is not something the Fed must follow. Instead, it serves as a useful baseline for evaluating policy decisions. IIf the policy rule did not work well in the early 2000s and the late 2000s, this then leads us to the interesting question of why policy may have deviated from this predictable rule: we expect that in normal times the Fed would act accordingly and when the need arises, deviate from the rule with good reason.

Spring Semester '13-'14
Akila Weerapana

Lecture 18: Monetary Policy Rules in an International Setting

I. OVERVIEW

- Today's lecture looks at a paper by Clarida, Gali & Gertler that analyzes monetary policy making in six major economies: the United States, Germany, Japan, France, Britain and Italy.
- The period that they study precedes the formation of the Euro and focuses on a period when each country had its own monetary policy or currency rather than being in the Eurozone. Nonetheless, the lessons from the paper are important even today as we think about the Eurozone crisis.
- It is also relevant in the light of the midterm exam where you studied the consequences of choosing a fixed exchange-rate nominal anchor for the exchange rate. When the exchange rate is fixed, the monetary policymaker is no longer able to follow the Taylor Principle of raising or lowering real interest rates as inflation rises or falls because the nominal interest rate is constrained by the nominal rate in the country you fix to.

II. BASICS OF THE EXCHANGE RATE MECHANISM

- In order to understand the CGG paper, a little bit of background on the system of fixed exchange rates known as the ERM is needed. The ERM was an exchange rate system where the currencies of participating countries were allowed to fluctuate within pre-specified bands.
- There were 8 original participants in the ERM: France, Germany, Italy, Belgium, Denmark, Ireland, Luxembourg and the Netherlands. Other countries, Spain (1989), Britain (1990) and Portugal (1992) joined at subsequent times. Under the "hard" version of the ERM, each country's exchange rate was effectively allowed to fluctuate band of $\pm 2.25\%$ against a central rate vis-a-vis the German Mark. Since this is a fairly narrow band, the countries were following an effective fixed exchange rate system.
- Under such a system, the monetary policy maker does not have complete autonomy because she has to follow monetary policy that is consistent with the band. For example, suppose that economic conditions in France were weak, warranting an interest rate cut. Suppose that Germany suddenly raised its own interest rates: this would lead to a switch away from French assets to German assets, causing the Franc to depreciate. If the French Franc was reaching the edge of their currency band then the French Central Bank would in fact have to raise interest rates, when they wanted to lower interest rates.
- In other words, being in a fixed exchange rate system means that the country in question may have to respond more to movements in the other country's interest rate rather than to their domestic macroeconomic conditions. So a monetary policy rule describing the behavior of the policy maker would include foreign variables as well as domestic variables.

III. INTRODUCTION TO THE CLARIDA/GALI/GERTLER PAPER

- CGG have two research questions. The first is to analyze what types of policy rules have helped the world's major economies achieve greater economic stability in the post-1979 period. The second is to identify the pressures that a fixed exchange rate system puts on the economies that adopt such systems.

- In order to do the study, CGG use data on two sets of countries: the G3 (the U.S., Germany and Japan) and the E3 (France, Britain and Italy) for the period since 1979. The G3 countries have central banks that conduct monetary policy relatively free of international considerations. On the other hand, the E3 countries' monetary policy over this period was extremely constrained by external factors, specifically the ERM system under which their currency was effectively fixed to Germany.

- The paper is extremely useful because we can identify both the negative aspects of a fixed exchange rate system and the positive aspects of a flexible exchange rate system; the results will help us understand why the European nations chose, in 1999, to move from a fixed exchange rate system to a single currency with an independent monetary policy maker but also highlight why that decision may still not bring the desired outcomes for the Eurozone countries.

- The findings of CGG confirm that policy makers in the G3 have followed a monetary policy that can be well characterized using a Taylor-type rule, where interest rates are being set in response to movements in forecasted domestic macroeconomic variables like inflation and unemployment. However, the policy of the E3 cannot be explained using a similar rule: interest rates in the E3 are driven significantly by movements in German variables: specifically by the German interest rate and the value of the German Mark.

- The findings confirm that the ERM acted as a significant external constraint on monetary policy in the E3 countries. In particular, CGG show that the interest rates in the E3 countries were higher, given the domestic conditions, than what the Bundesbank would have adopted in the face of similar economic conditions.

- So higher German interest rates, forced policy makers in the E3 countries to keep rates high even when domestic economic conditions were weak. The high interest rates put great pressure on these economies, and eventually forced some of them out of the fixed exchange rate system. The resulting turmoil may also have persuaded some of the countries (e.g. France, Italy) to adopt a different route to a more financially unified Europe under the single currency approach of the EMU. It also may have inspired the reluctance of the U.K. to join the EMU, and instead prefer to stay on the sidelines.

IV. METHODOLOGY OF THE CLARIDA/GALI/GERTLER PAPER

- CGG estimate forward-looking reaction functions to describe the behavior of monetary policymakers in the G3 and E3. They begin with a reaction function of the form

$$i_t^* = \bar{r} + \bar{\pi} + \beta\left(E[\pi_{t+n}|\Omega_t] - \bar{\pi}\right) + \gamma\left(E[y_t|\Omega_t] - y^*\right)$$

- Note that I have used notation that is slightly different from CGG in order to better match up with our notation. In the above equation Ω_t is the set of information available at time t and y, y^* are the logs of output and potential output respectively. i^* is the interest rate that the central bank would like to set based purely on macroeconomic considerations, the central bank will also have an interest in smoothing interest rates, which we will bring in later.

- The basic reaction function states that the targeted interest rate is dependent on the inflation target, the equilibrium real interest rate and expectations of the output gap and inflation. So it can basically be characterized as a forward-looking Taylor-type rule.

- We would expect that for countries with monetary policy autonomy, the value of $\beta > 1$ and $\gamma > 0$. In the Taylor Rule, $\beta = 1.5$ and $\gamma = 0.5$. Here we would expect γ to be smaller since we are already reacting to the inflation forecast. Part (or most?) of the reason why we have the $\hat{Y}$ in the Taylor Rule is to account for future inflation consequences of the current output gap.

- By combining various terms, the reaction function can be written as $i_t^* = \alpha + \beta\left(E[\pi_{t+n}|\Omega_t]\right) + \gamma\left(E[x_t|\Omega_t]\right)$ where x_t is the output gap and the constant term is a function of the equilibrium real rate and the inflation target $\alpha = \bar{r} + (1-\beta)\bar{\pi}$. The inflation target and the equilibrium rate cannot be independently estimated, we need one to calculate the value of the other.

- The next step is to allow for the possibility that variables other than inflation and output forecasts enter the reaction function. This is done by adding an extra-term, Z_t, to the policy rule, so that it looks like the following: $i_t^* = \alpha + \beta\left(E[\pi_{t+n}|\Omega_t]\right) + \gamma\left(E[x_t|\Omega_t]\right) + \xi\left(E[Z_t|\Omega_t]\right)$

- Possible variables that could be included here include exchange rates, money supply or foreign interest rates.

- Finally, CGG take into account the possibility that the policy maker smoothes interest rates, so that the actual interest rate ends up being a function of both the desired rate and last period's interest rate. So the actual rate can be expressed as $i_t = \rho i_{t-1} + (1-\rho)i_t^*$. This is the final equation that CGG estimate.

- The details of CGG's analysis are thoroughly presented in their paper. I will only highlight the basic findings here.

Policy in the G3

- The reaction functions for the G3 are very similar to a Taylor Rule. The reaction coefficients on inflation and output are:

	Bundesbank	Fed	Bank of Japan
Inflation	1.31	1.83	2.04
Output	0.25	0.56	0.08

- Note that the Fed reaction function, reported here, is for post-1982 while the other two are for the post 1979 period. CGG show that money growth seemed to have an important role to play in the early period of Paul Volcker's chairmanship, a feature that has been well documented in the literature.

- So the basic result of this section is that the behavior of G3 policy makers can be well explained by a Taylor-type rule. Furthermore, all 3 policymakers clearly take inflation very seriously: a 1 percentage point increase in inflation leads the Bundesbank to raise interest rates by 131 basis points, the Federal Reserve to raise by 183 basis points and the Bank of Japan to raise by a whopping 204 basis points.

- The reaction to output is different: clearly the Fed reacts more to output fluctuations than either of the other two central banks, which is consistent with its mission which requires it to pay attention to price stability and full employment. The Bundesbank, and in particular, the Bank of Japan do not react very much to output fluctuations.

- In Tables 1, 2 and 3, CGG also show that the addition of other external variables do not change the reaction coefficients very much; indicating that G3 policy makers are primarily concerned with their own economic conditions. In Figure 2, CGG also show that the policy rule does not fit very well in the pre-1979 period, when most of these countries had greater macroeconomic volatility.

Policy in the E3

- The reaction functions for the E3 are very different from what we found in the previous section. Tables 4-6 in CGG clarify the results for each country separately. Keep in mind that Britain, France and Italy were all part of the Exchange Rate mechanism, a system of fixed exchange rates when the currencies in these countries were de-facto tied to the German Mark. Britain was in the system from 1990-1992, France and Italy were part of it much earlier although they truly were bound to the fixed exchange rate in the period following 1990.

- So in estimating reaction functions for these E3 countries, CGG have to be careful. In the period 1990-1992, there was no effective monetary autonomy in the E3 countries. So they estimate reaction coefficients for the period leading up to the period when they joined the "hard" ERM. They then look at what the interest rates would have been in the period when these three countries were part of the "hard" ERM if they had continued to act with the same degree of monetary autonomy they had before. This is a neat trick that enables CGG to identify exactly how being in the ERM constrained the behavior of the E3 countries.

- The results in Tables 4-6 indicate that the reaction coefficients for the E3 countries were much lower than for the G3 countries. In particular, they are not much higher than 1, which is the bare minimum required to keep real interest rates constant in the face of rising inflation. So the E3 countries did not seem to be doing very much to fight inflation, at least not to the extent that the G3 countries were doing.

- So for example, a basic specification, omitting the Z variables, finds that British interest rates are high, yet react very little to British inflation. This would have to then be attributed to a high value of the constant α, signifying either that the British were shooting for an unusually low inflation target or had an unusually high equilibrium real interest rate. CGG come up with a third explanation: they add the German interest rate as another explanatory variable, CGG find that a 1 percentage point increase in the German interest rate leads to a 60 basis point increase in the British interest rate. Similar results hold for France and Italy as well: French interest rates rise by 114 basis points, and Italian interest rates by 59 basis points in response to a 1% increase in German interest rates.

- So what do these results show? Well, they show relatively weak reaction to domestic economic conditions and a substantial tendency to react to German interest rate movements. In other words, monetary policy in these countries mostly seemed to track German monetary policy, thus by extension, British, French and Italian monetary policy makers were responding more to German economic conditions than they were to their own economic conditions.

- The consequence of reacting to German variables as well as to their own economic conditions are best summarized by Figure 4, which compares the actual interest rate chosen by each country to German interest rates. Through most of the late 80s, and in particular, during the early 90s, the E3 had interest rates that were much higher than Germany.

- CGG carry out an interesting thought experiment in Figure 5. They compare the interest rate path chosen by each of the E3 countries, to what the interest would have been if they had chosen to follow the Bundesbank policy rule, which is considered to be representative of good policy making. The results in Figure 5 show that for most of the late 80s, and in particular, during the early 90s, the E3 had interest rates that were much higher than were consistent with "good" monetary policy given the existing domestic macroeconomic conditions.

- CGG then conclude that the ERM acted as a significant constraint on the monetary policy of the E3 countries: more specifically, it forced the E3 countries to adopt rates that were higher than warranted by domestic macro conditions. The basic reason was German reunification, which led the Bundesbank to significantly tighten interest rates in an attempt to control inflation. Figure 3 shows a tightening of the German interest rate in the period between 1989 and 1991. Since the E3 countries reacted substantially to German interest rates, they ended up raising interest rates as well: the effect being particularly pronounced in the hard 'ERM' period.

- The higher interest rates far exceeded what domestic macroeconomic conditions would dictate and the resultant downward pressure on the economy may have helped explain why these countries chose to drop out of the ERM.

Measuring Stress in the E3

- CGG also calculate something called the "stress indicator" to measure how much pressure each country in the ERM was operating under. The measure of stress they use is very simple: it is simply the difference between the actual interest rate they chose (i) and the interest rate that they should have chosen if they had been following the Bundesbank's reaction function (i^*), i.e. $s_t = i_t - i_t^*$

- Given this definition we can decompose stress into three terms: $(i_t - i_t^g) + (i_t^g - i_t^{g^*}) + (i_t^{g^*} - i_t^*)$ where i_t^g is the German interest rate and $i_t^{g^*}$ is what the Germans should have chosen according to their reaction function (Note that the actual rate chosen may differ slightly from the reaction function, which is estimated using a regression).

- The first term is the interest rate differential between the country and Germany, the second is the German stress level (how much Germany was forced to deviate from its ideal policy) and the third term is the difference between the interest rates attributable to differences in macroeconomic conditions.

- The final set of figures 6 through 8, report the stress in each of the E3 countries, and the components of that stress. In all 3 countries, the stress level was very high at the moment they chose to leave the ERM. One of the reasons that stress is high in these countries is because German stress was also high. What is German stress under this definition? It is the difference between the actual interest rate that Germany chose and the interest rate that Germany would choose if it followed its typical policy rule. The period of German reunification made the German central bank behave very differently than it typically was doing - because it was integrating East Germany into West Germany it could no longer look only at West German macroeconomic variables in making their decisions. This in turn means that German rates were higher than they needed to be putting more pressure on the E3 countries.

- Furthermore, the stress in Britain was also attributable to asynchronized output: Britain was in a recession and did not need such high interest rates, while the additional stress in France comes from asynchronized inflation: low inflation in France meant that they did not need such high interest rates. In contrast, the additional stress in Italy comes mostly from the interest rate differential. In other words Italy had to maintain a high interest rate in order to honor their commitment to a fixed exchange rate.

- In summary, CGG show that the G3 countries seemed to follow monetary policy rules with strong reaction to inflation: rules that may explain why inflation was so low in these countries following 1979. In contrast the E3 countries seemed to follow rules that reacted more to German economic conditions than to their own. As a result, the E3 consistently picked interest rates higher than what "good" policy would dictate resulting in high "stress" levels during the ERM crisis of 1992. The high stress levels helped explain why they chose to drop out of the Erm because the system was forcing them to keep interest rates higher than what they would have liked.

- Overall, the results from CGG can also help explain why the search for a financially unified Europe had to take a path that did not involve tying the currency to Germany. That search, led us to the single currency, single European monetary policy maker system that we see today with the European Central Bank and the European Monetary Union.

Spring Semester '13-'14
Akila Weerapana

Lecture 19: The Zero Lower Bound (ZLB)

I. OVERVIEW

- Having discussed the theory and practice of monetary policy in conventional settings, we now turn to monetary policy in unconventional settings, namely, what happens when the nominal interest rate equals zero and the Fed is limited in its ability to pursue expansionary policy.
- This is obviously not a mere academic exercise: he Federal Reserve has moved interest rates to unprecedentedly low levels for unprecedented levels of time. The Fed funds rate is now in its FIFTH year at zero, and is likely to stay at zero at least till the end of this year.
- In economics, when the Fed is constrained in not being able to push rates lower to boost the economy we say that the Fed was hampered by the zero lower bound (ZLB). In today's class, we explore this idea of a constraint on interest rates falling below zero in the context of the AD/IA model. As we have seen in the United States over the past few years, when monetary policy hits that zero lower bound, economic recovery becomes a real challenge. The purpose of this lecture is to develop the implications of this zero lower bound for our baseline model of the macroeconomy.
- In future lectures we tackle the policy implications of the ZLB and discuss academic papers that examine the effectiveness of the policy responses that the Fed has actually put into place.

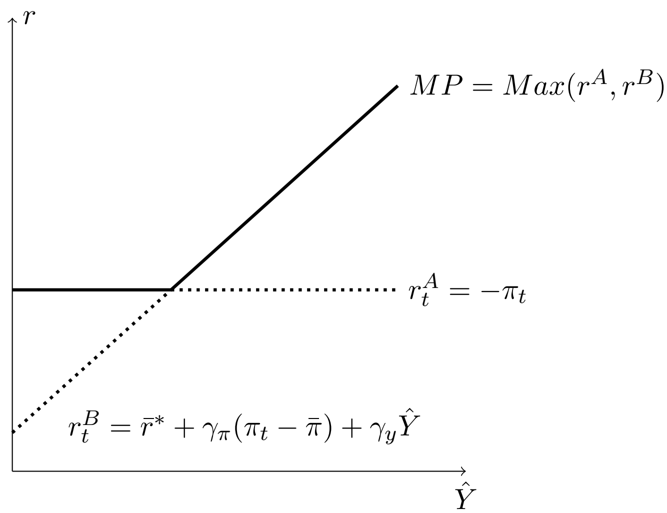
II. IMPLICATIONS OF THE ZLB FOR THE MP CURVE

- In our MP curve we specified that the central bank chooses the real interest rate to satisfy a policy rule of the form
$$r_t = \bar{r}^* + \gamma_\pi(\pi_t - \bar{\pi}) + \gamma_y\hat{Y}$$
- Keep in mind that the Central bank chooses this real interest rate by manipulating the nominal interest rate, i.e. since $r = i - \pi$, we can describe the central bank's behavior using the following policy rule for the nominal interest rate of $i_t - \pi_t = \bar{r}^* + \gamma_\pi(\pi_t - \bar{\pi}) + \gamma_y\hat{Y}$, which simplifies to
$$i_t = \bar{r}^* + (1 + \gamma_\pi)\pi_t - \gamma_\pi\bar{\pi} + \gamma_y\hat{Y}$$
- In reality, the Fed is choosing a nominal interest rate using a rule like the above. Since we need the real interest rate (which is what drives spending behavior in the IS curve in our model), we find it easier to describe the Fed behavior in terms of the real interest rate.
- But the Fed can't lower nominal interest rates once the nominal interest rate reaches zero. So in fact the setting of the nominal interest rate is given by
$$i_t = max(0, \pi_t + \bar{r}^* + \gamma_\pi(\pi_t - \bar{\pi}) + \gamma_y\hat{Y})$$

- When the nominal interest rate is constrained at zero, the real interest rate becomes equal to $r_t = -\pi_t$, so the MP curve is given by the equation

$$r_t = max(-\pi_t, \bar{r}^* + \gamma_\pi(\pi_t - \bar{\pi}) + \gamma_y \hat{Y})$$

- A graphical description of this relationship is given below.



III. IMPLICATIONS OF THE ZLB FOR THE AD CURVE

- We can also think of the implications of the ZLB line for the AD curve's shape. Mathematically, we derived the AD curve by substituting in an expression for r from the MP curve into the IS curve. Now we have two different MP curves, and hence two different r values to substitute in.

- In the typical setting, $r_t = \bar{r}^* + \gamma_\pi(\pi_t - \bar{\pi}) + \gamma_y \hat{Y}$ and plugging into the IS curve $\hat{Y}_t = -\mu b_I(r_t - r^n)$ gives us the typical downward sloping AD curve

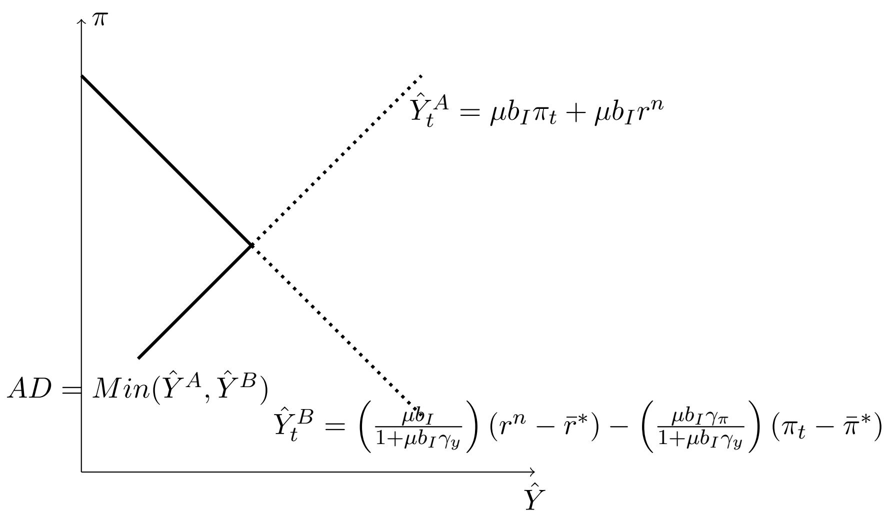
$$\hat{Y}_t = \left(\frac{\mu b_I}{1 + \mu b_I \gamma_y}\right)(r^n - \bar{r}^*) - \left(\frac{\mu b_I \gamma_\pi}{1 + \mu b_I \gamma_y}\right)(\pi_t - \bar{\pi}^*)$$

- But when the ZLB binds, $r = -\pi_t$, so plugging into the IS curve we get the AD curve to be

$$\hat{Y}_t = \mu b_I \pi_t + \mu b_I r^n$$

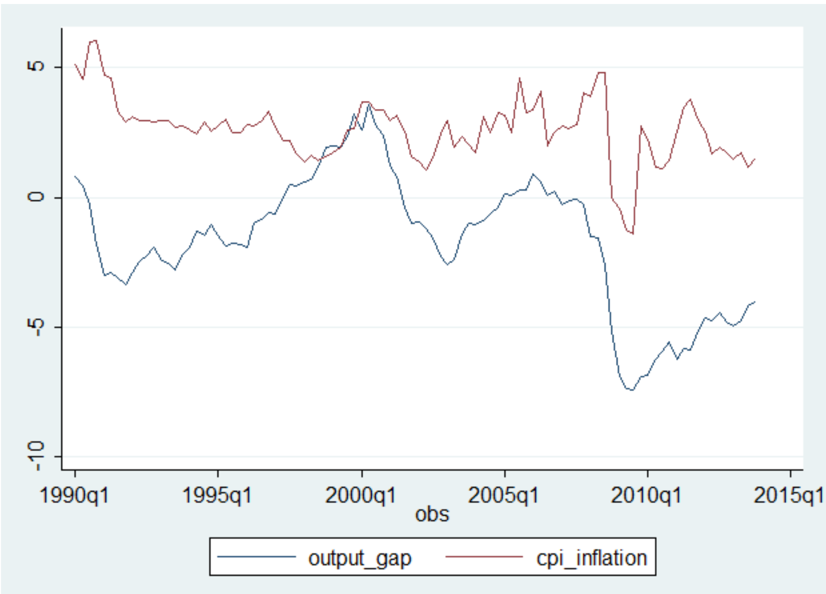
- Note that in this relationship lower inflation implies a lower output gap, i.e. we would have a backward bending AD curve. If we are picking r to be the maximum of the two MP curves, then since $\hat{Y}$ and r are inversely related, we have that the AD curve will be

$$\hat{Y}_t = Min\left[\left(\frac{\mu b_I}{1 + \mu b_I \gamma_y}\right)(r^n - \bar{r}^*) - \left(\frac{\mu b_I \gamma_\pi}{1 + \mu b_I \gamma_y}\right)(\pi_t - \bar{\pi}^*), \mu b_I \pi_t + \mu b_I r^n\right]$$

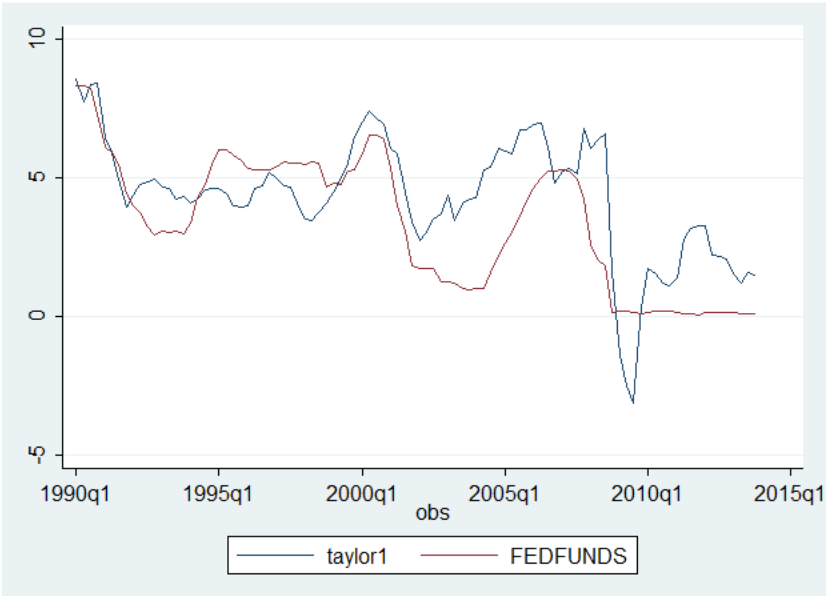


IV. WHAT DETERMINES WHERE ZLB KICKS IN?

- As inflation and the output gap falls, the nominal interest rate chosen by the Fed also falls. At some point when inflation and the output gap are both low, the nominal interest rate will hit the lower bound of zero.
- We can illustrate this with the following two diagrams. The first figure shows how the output gap and the inflation rate have evolved in the United States over the past two decades. As you notice, both values fell sharply during the most recent recession.



- The second figure uses values from the Taylor Rule ($\gamma_\pi = \gamma_y = 0.5$ and $\bar{\pi} = \bar{r}^* = 2\%$) to illustrate what that Rule would have required nominal interest rates in the United States to be during this period. When you compare to the actual Federal Funds rate you can clearly see that the zero lower bound was a significant problem during this downturn and recovery.



- So if lower inflation rates and lower output gaps are what drives the nominal interest rate lower, then at some point one or both of these variables will fall to a point such that the nominal interest rate is zero. We can then identify the set of points where the ZLB kicks in, which we call the ZLB line, by solving for

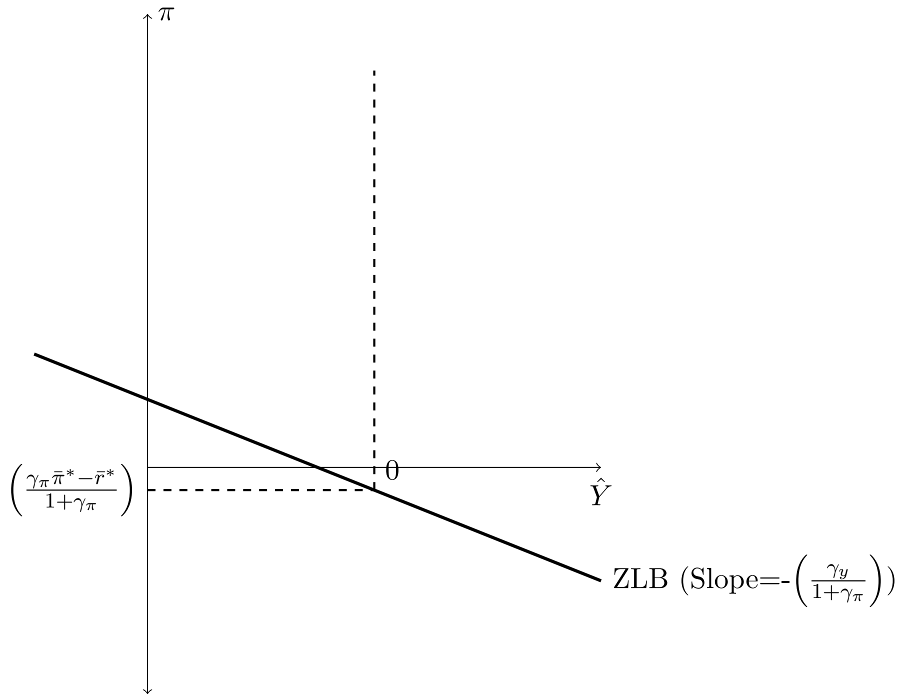
$$\begin{aligned} i_t &= \bar{r}^* + (1+\gamma_\pi)\pi_t - \gamma_\pi\bar{\pi} + \gamma_y\hat{Y} \\ 0 &= \bar{r}^* + (1+\gamma_\pi)\pi_t - \gamma_\pi\bar{\pi} + \gamma_y\hat{Y} \\ (1+\gamma_\pi)\pi_t &= -\bar{r}^* + \gamma_\pi\bar{\pi} - \gamma_y\hat{Y} \\ \pi_t &= \left(\frac{\gamma_\pi\bar{\pi}^* - \bar{r}^*}{1+\gamma_\pi}\right) - \left(\frac{\gamma_y}{1+\gamma_\pi}\right)\hat{Y} \end{aligned}$$

- We can show the ZLB line on the same space that we show AD/IA. The ZLB line has the following properties

  1. It is downward sloping - you can see that the slope is negative in the equation above. You can also see this intuitively, if the output gap is positive and large then inflation has to be very low for the Fed to hit the ZLB; conversely, if the inflation rate is high then the output gap has to be quite negative for the Fed to be affected by the ZLB.
  2. The intercept (where $\hat{Y} = 0$) is equal to $\pi_t = \left(\frac{\gamma_\pi\bar{\pi}^* - \bar{r}^*}{1+\gamma_\pi}\right)$. This value is lower than the target rate of inflation ($\bar{\pi}^*$). Furthermore, it can be, but need not be, negative.
  3. The slope of this ZLB line is $-\left(\frac{\gamma_y}{1+\gamma_\pi}\right)$. This means that the ZLB line is flatter than the AD line. The AD curve was given by the equation

$$\hat{Y}_t = \left(\frac{\mu b_I}{1+\mu b_I\gamma_y}\right)(r^n - \bar{r}^*) - \left(\frac{\mu b_I\gamma_\pi}{1+\mu b_I\gamma_y}\right)(\pi_t - \bar{\pi}^*)$$

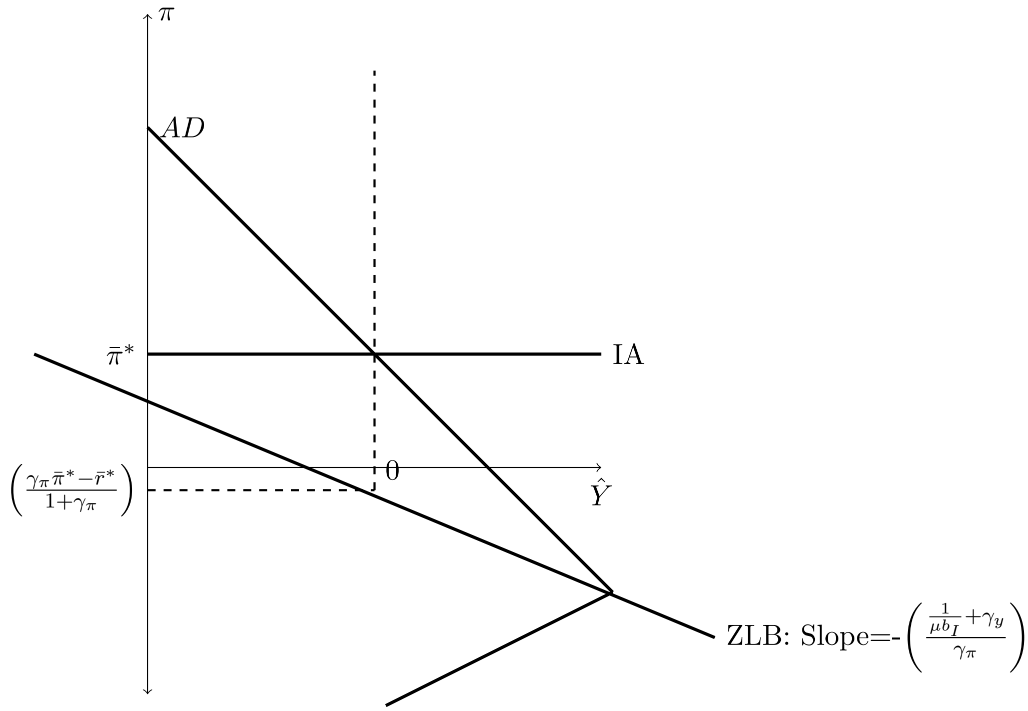
  so it has a slope of -$\left(\frac{1+\mu b_I\gamma_y}{\mu b_I\gamma_\pi}\right)$, which simplifies to -$\left(\frac{\frac{1}{\mu b_I}+\gamma_y}{\gamma_\pi}\right)$. The numerator is larger and the denominator is smaller than in the ZLB line's slope, which means the AD curve is steeper than the ZLB line.



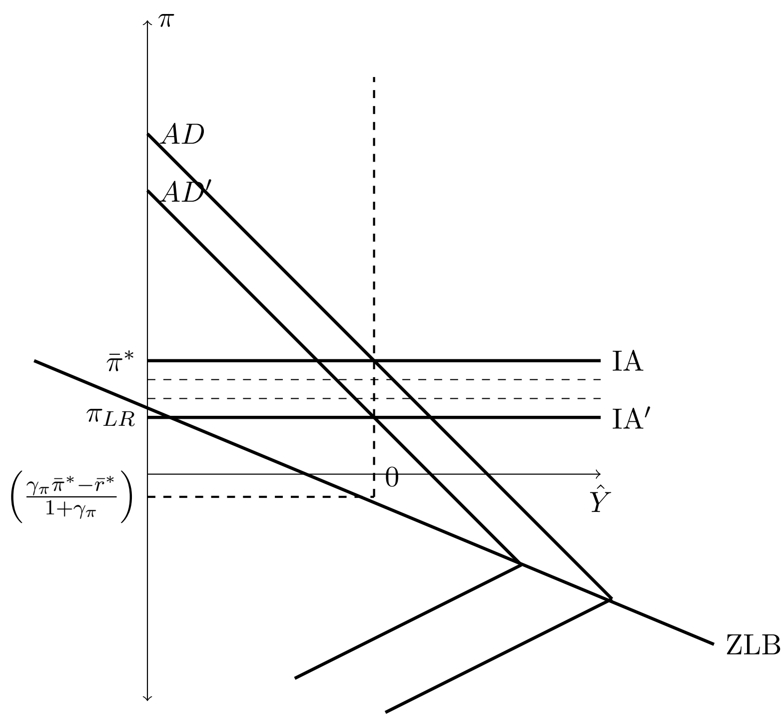
- Keep in mind that we always have a ZLB line in an AD-IA diagram. But if IA and AD intersect well above the ZLB line then its existence does not change the analysis we have been doing thus far. But the ZLB remains hidden beneath the surface, almost like a hidden reef or a hidden iceberg that only threatens a ship when the ocean becomes shallow.
- Note also from the ZLB line that the inflation rate where the zero lower bound kicks in need NOT be a rate that is consistent with deflation. If the output gap is negative enough then the ZLB can be reached even at positive levels of inflation.

V. WHEN DOES THE ZLB LINE MATTER?

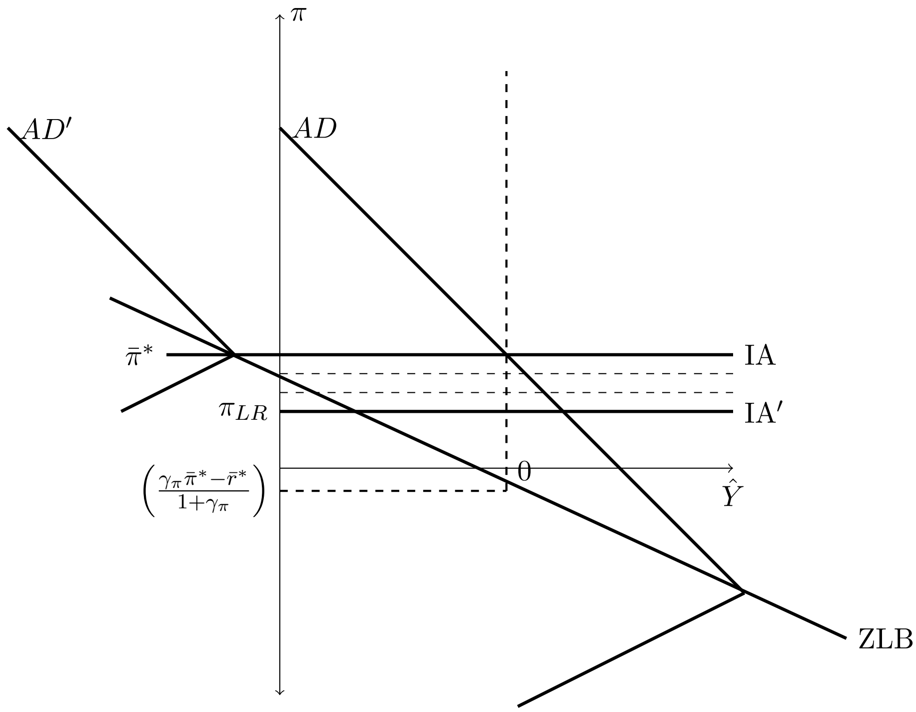
- Let's begin from our default position where inflation is at the target level and the output gap is zero. We can show the AD curve looking normal until the ZLB line is reached at which point it bends backwards.



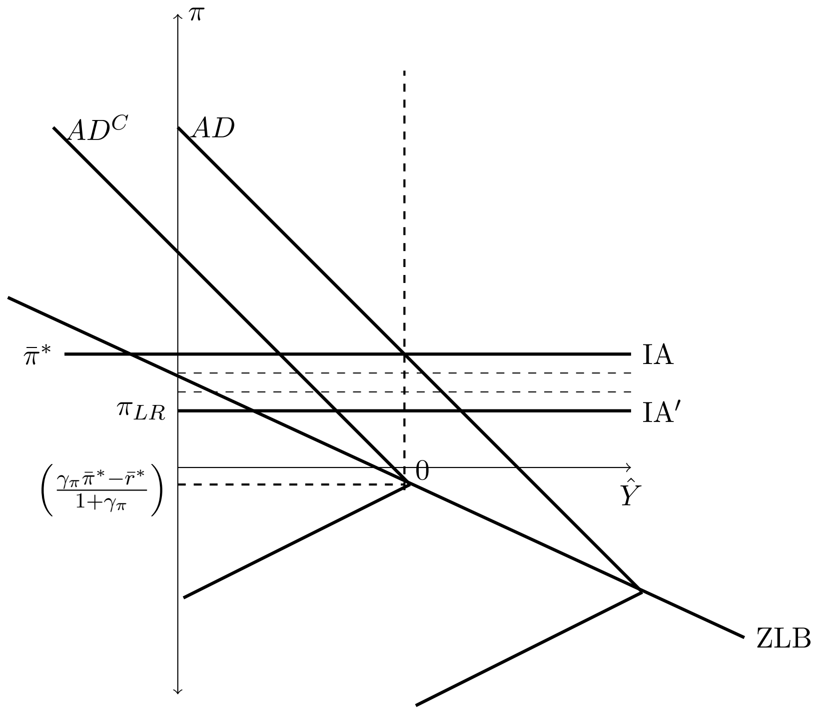
Then consider an adverse shock that shifts the AD curve in. The short run output gap falls to $\hat{Y}_1$ and over time inflation falls moving us back to potential output. In this case even though inflation has fallen to zero, the economy still is able to return to long run equilibrium



- The danger of the zero lower bound shows up when the economy gets hit by a more severe shock that moves AD to AD$''$ in the diagram below. In that case the zero lower bound is reached at the current rate of inflation and the economy gets trapped in a recession where inflation keeps falling, potentially moving into deflation, while making the economy worse off rather than better off. This can be seen in the diagram below where as IA falls, the output gap becomes more negative which leads to a further fall in inflation till in the end the economy is trapped in a deflationary recession where the monetary policymaker is powerless to intervene, this is called a **liquidity trap**.



- Notice that you do not need the shock to be that severe. Any negative shock that forces us to hit the ZLB before we get to zero will leave the economy in a liquidity trap. Any AD shift greater than the one shown below will suffice to put the economy in a liquidity trap (I use AD^C as short-hand for the critical value of AD.



- In such a situation, conventional monetary policy cannot work so the policymaker has to resort to other means such as quantitative easing, for example, to get the economy moving back towards potential.
- In such a setting, because of the relative impotence of monetary policy, fiscal policymakers need to play a big role in getting the economy to move back towards the long-run equilibrium. Keep in mind that they have to push the AD curve out by enough to avoid the ZLB or else the expansionary fiscal policy may have been in vain

Lecture 20: Macroeconomic Policy and the ZLB

I. OVERVIEW

- In the last lecture, we looked at how monetary policymakers can be constrained by the presence of the zero lower bound (ZLB). The ZLB is always present but is rarely a concern since its very rarely that the economy suffers a recession deep enough and has an inflation rate low enough for it to become relevant.
- When the economy reaches the ZLB, we showed that the AD becomes backward-bending - falling inflation now results in higher real interest rates and worsening output gaps. We also discussed that these effects are more likely to take place when the output gap is very low and when inflation is very low, much like the conditions that the U.S. economy has been experiencing.
- In today's class, we will take an illustrative look at how an economy can fall into the clutches of the zero lower bound and end up in a "liquidity trap", a situation where the economy is caught in a deflationary recession and monetary policy makers are seemingly powerless to move it out of that recession. We will then discuss some policy options available to a government that finds itself in this situation as well as discussing ways to avoid getting into such a situation.

II. AN ILLUSTRATIVE EXAMPLE OF HOW AN ECONOMY CAN FALL INTO A LIQUIDITY TRAP?

- In the last class, we showed that the ZLB line is given by the equation

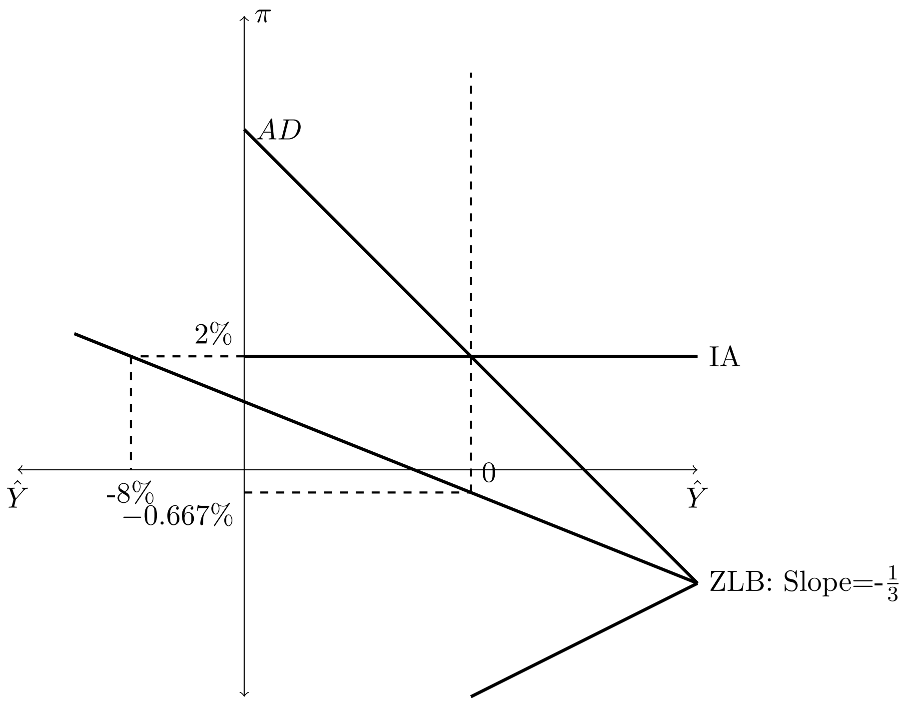
$$\pi_{ZLB} = \left(\frac{\gamma_\pi}{1+\gamma_\pi}\right)\bar{\pi}^* - \left(\frac{1}{1+\gamma_\pi}\right)\bar{r}^* - \left(\frac{\gamma_y}{1+\gamma_\pi}\right)\hat{Y}$$

- Now consider an economy in which the behavior of the policymaker in this economy can be characterized by the following parameters: $\bar{r}^* = 2\%$, $\bar{\pi}^* = 2\%$, $\gamma_\pi = \gamma_y = 0.5$, which are the parameters for the Taylor Rule that we discussed earlier. Assume also that the economy is currently in long-run equilibrium with inflation at the target level.
- Plugging those in to the above equation we get the ZLB $\pi_t = \left(\frac{0.5}{1.5}\right)2\% - \left(\frac{1}{1.5}\right)2\% - \left(\frac{0.5}{1.5}\right)\hat{Y}_t$, which gives us

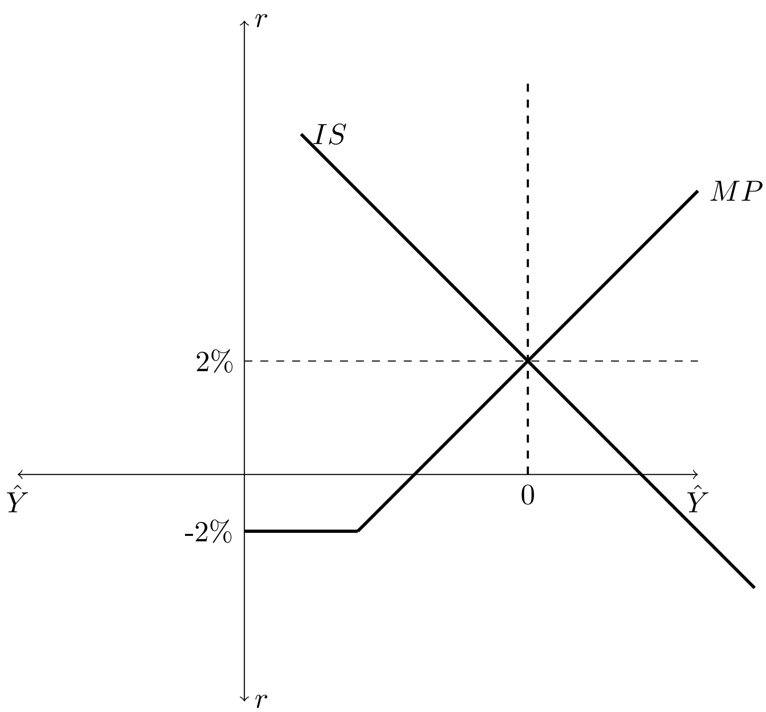
$$\pi_t = -0.667\% - 0.333\hat{Y}_t$$

- We can use this equation to find two key points: at the current output gap, how far does inflation have to fall before we hit the ZLB line? The answer is that inflation would have to fall to -0.667% (plug in $\hat{Y} = 0$ into the above ZLB equation. The second point is to ask at the current inflation rate how much of an output gap is needed before we hit the ZLB? The answer is -8% (plug in $\pi = 2\%$) into the above equation).

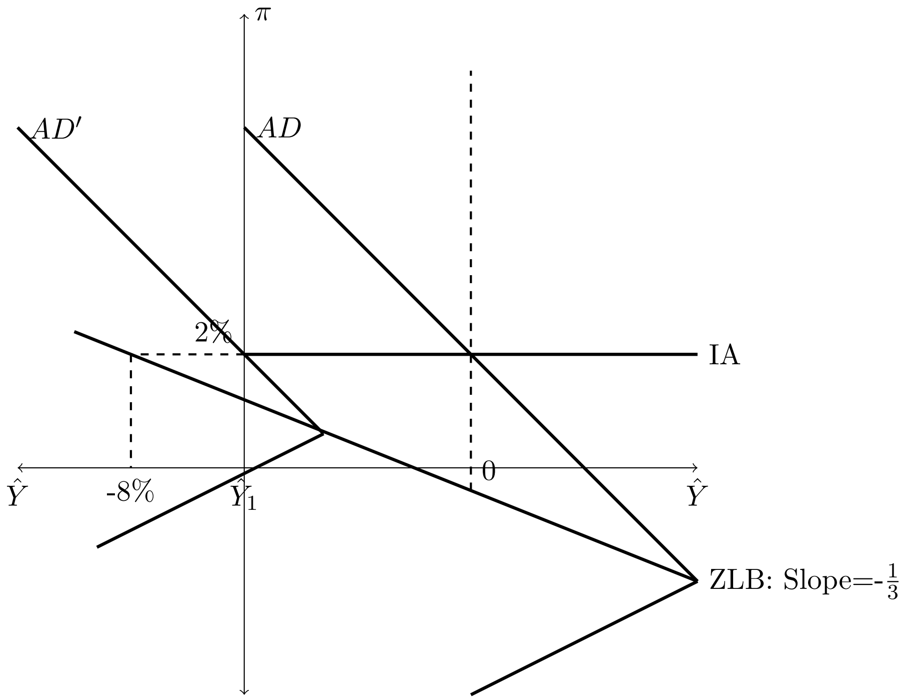
- So the economy is well clear of the danger zone currently. This is shown in the diagram below.



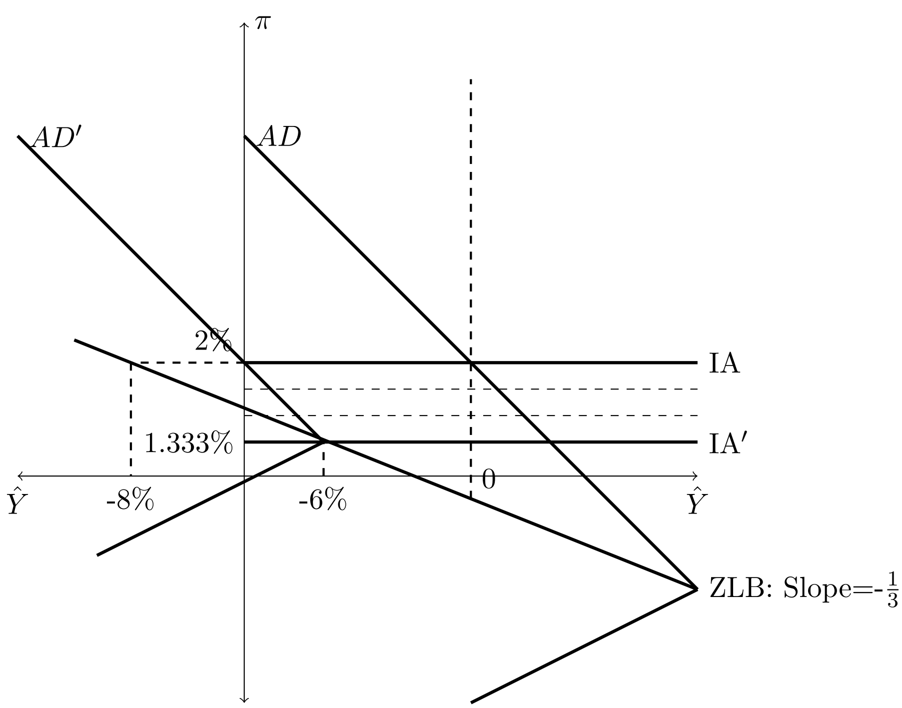
- We can also show the corresponding IS-MP diagram below as

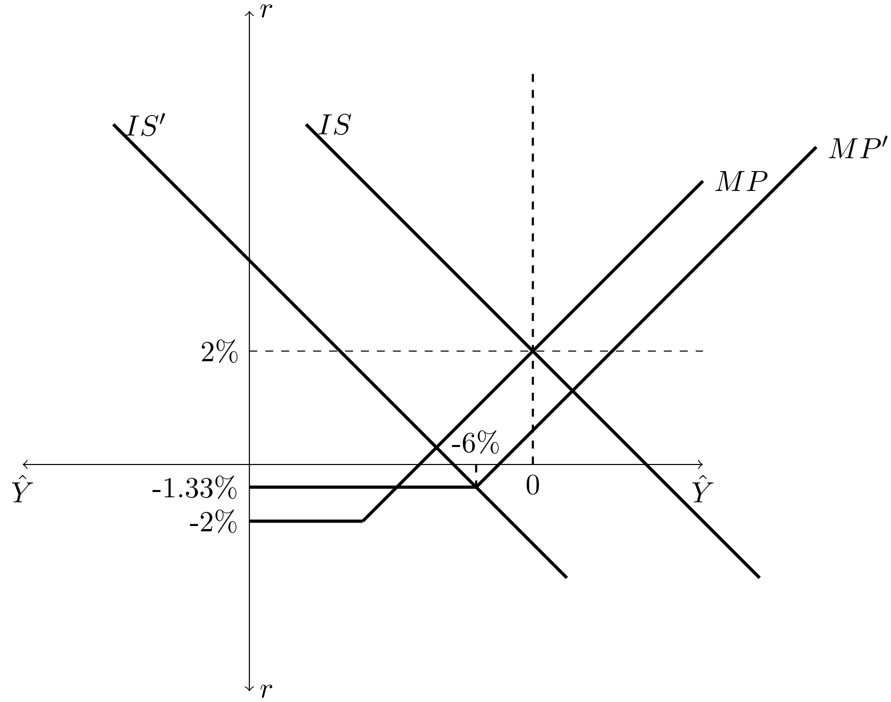


- Now suppose this economy gets hit by a negative spending shock that moves the AD curve into AD′



- What we will see then is that inflation will fall over time until the ZLB binds. Suppose that happens at $\hat{Y} = -6\%$, where the ZLB line shows that inflation is 1.33%. We can depict the AD/IA and IS/MP pictures at this situation as follows





- The economy is in real trouble now. Over time since $\hat{Y} < 0$, inflation will fall so the IA line will move down. As the IA moves down along AD′, we will be moving away from potential output rather than towards it, so deflation will accelerate. Soon the economy will be caught in a liquidity trap, a deflationary recession where the monetary policymaker is powerless.
- On the IS-MP diagram, the horizontal part of the MP curve will be shifting up so the intersection with IS will now move back along the IS curve. The output gap will get worse as inflation falls.

III. POLICY RESPONSES TO A LIQUIDITY TRAP?

- The best way to get out of the liquidity trap is to push the AD curve out. As the AD curve gets pushed out, the AD curve will start to become backward bending at lower and lower inflation rates, which implies that the likelihood that the ZLB is going to bind before we get back to potential output gets lower and lower. In other words, it will be like the process we have analyzed thus far in reverse: if we can push the output gap back to 0%, then the cutoff will slip back to -0.667% and everything will be fine.
- We don't actually have to push it all the way out to that point. The key is that we need to push the AD curve out to the critical point we indicated in the last lecture: the point where the AD curve intersects the ZLB at an output gap of zero. Any policy that pushes the economy to that point or beyond would get the economy out of the liquidity trap.
- What kind of policies would work?
  1. Expansionary fiscal policy
  2. Quantiative Easing

- If we are in the backward bending part of the AD curve, we have two more counter-intuitive policy recommendations

  1. Moderate oil price shocks
  2. Higher expected inflation

- In the backward bending portion of AD, higher inflation will lower real interest rates and raise output. However, this is not always a good idea, since once we are in the regular section of the AD curve higher inflation is contractionary.

IV. AVOIDING A LIQUIDITY TRAP?

- The best way to get out of a liquidity trap is not to get into one in the first place. If you look at the ZLB line $\pi_{ZLB} = \left(\frac{\gamma_\pi \bar{\pi}^* - \bar{r}^*}{1+\gamma_\pi}\right) - \left(\frac{\gamma_y}{1+\gamma_\pi}\right)\hat{Y}$ notice that there is a significant component that is determined not by the state of the economy but by the policymaker's own preferences.

- The slope of the ZLB line is $-\left(\frac{\gamma_y}{1+\gamma_\pi}\right)$ and the intercept is $\left(\frac{\gamma_\pi \bar{\pi}^* - \bar{r}^*}{1+\gamma_\pi}\right)$.

- Now consider what happens to the ZLB as parameters change

  1. $\bar{\pi}^* \uparrow$: As $\bar{\pi}^* \uparrow$, the intercept rises, which means that the ZLB line shifts up, moving us closer to the danger zone.
  2. $\bar{r}^* \uparrow$: As $\bar{r}^* \uparrow$, the intercept falls, which means that the ZLB line shifts down, moving us away from the danger zone.
  3. $\gamma_y \uparrow$: As $\gamma_y \uparrow$, the slope becomes steeper, which means that the ZLB line becomes more of a factor when $\hat{Y} < 0$
  4. $\gamma_\pi \uparrow$: As $\gamma_\pi \uparrow$, both the slope and the intercept are affected, which makes it more complicated. The slope becomes flatter, and the intercept rises.

     But we have seen this before: greater hawkishness matters, not on the output dimension but on the inflation dimension. Instead of asking at what inflation line the ZLB line passes through $\hat{Y} = 0$, think about at what output gap the ZLB line crosses the target inflation rate. The answer is
     $\bar{\pi}^* = \left(\frac{\gamma_\pi \bar{\pi}^* - \bar{r}^*}{1+\gamma_\pi}\right) - \left(\frac{\gamma_y}{1+\gamma_\pi}\right)\hat{Y}_{ZLB}$.
     This simplifies to

     $$\hat{Y}_{ZLB} = \frac{-\bar{r}^* - \bar{\pi}^*}{\gamma_y}$$

     Note that a change in γ_π has no effect on this point, which means that the ZLB line is flattening around the inflation target.

- What can we take away intuitively? Think about it this way. What factors make the ZLB LESS of a threat? We would need $\bar{\pi}^* \downarrow$ or $\bar{r}^* \uparrow$ (both of which would shift the ZLB down).

- Alternatively, $\gamma_y \downarrow$, which makes the ZLB flatter and hence less of a threat when $\hat{Y} < 0$. Note that $\hat{Y} < 0$ is the relevant area to be concerned about the ZLB

- Last but not least we would need $\gamma_\pi \downarrow$, which would make the ZLB steeper around the inflation target. This would make the ZLB less of a threat when inflation is below the target rate (which again is what we care about most).

- Intuitively, what this means is that any change that makes the Fed less likely to lower rates (or more likely to raise rates) will make the ZLB less of a threat. In hindsight this is obvious, the ZLB is a constraint on rate reductions so a central bank that is raising rates most of the time will not find the ZLB a problem.

- It is important to keep in mind that changing these preferences is something we should do BEFORE we get into a liquidity trap. Raising the desired real interest rate, lowering the inflation target, reducing γ_y when $\hat{Y} < 0$, and reducing γ_π when $\pi < \bar{\pi}^*$are ALL contractionary since they cause $r \uparrow$ which means that they will shift the AD in. You can verify this by thinking about MP: $r = \bar{r}^* + \gamma_\pi(\pi - \bar{\pi}^*) + \gamma_y \hat{Y}$. By making the downturn worse, we may end up in a worse predicament than when we started.

Spring Semester '13-'14
Akila Weerapana

Lecture 21: Empirical Evidence On Monetary Policy at the ZLB

I. OVERVIEW

- In the last two lectures, we learned about the ZLB, about the unusual behavior of the economy at the ZLB as shown by the backward bending AD curve and the horizontal MP curve, and discussed the policy options in an economy caught in a liquidity trap. We broadly broke them down into three categories: fiscal policy, unconventional monetary policy, and policies designed to ensure that we would not fall into the ZLB in the first place.
- In today's class, we study a paper by Bernanke, Reinhart and Sack (BRS) who look at the unconventional monetary policy options available at the ZLB to policymakers and examine the empirical evidence on the effectiveness of these policies. This paper was written in 2004, before the 2008/09 recession brought the ZLB to prominence in the U.S. so the empirical evidence comes from Japan and from the 1% interest rates in the early 2000s and other relevant episodes in the United States.
- The paper is long, and the methodology is challenging but I assigned you the paper for three reasons. First, it is an important paper that virtually everyone writing about liquidity traps cites because it tackled both the theory and empirics before they became hot topics. Second, the paper was written by Ben Bernanke, the very same man who would have to put the ideas in the paper to use five years later. Third, it sets the stage for thinking about how we would proceed to evaluate some of the extraordinary measures that the Fed undertook in the Great Recession, in a period where data (and interventions) were more plentiful.
- As with all papers, use the study questions as a guide. But more than in most papers, the details of the methodology can be ignored here. What I need you to get out of this paper are i) an understanding of the different policy choices available; ii) a big picture idea of how BRS find empirical evidence for the effectiveness of these policies; and iii) the empirical conclusions they reach.

II. THE POLICY CHOICES AVAILABLE AT THE ZLB

- BRS focus on the monetary policy choices available to the central bank at the ZLB, not on fiscal policy or on the policies that may have helped the central bank avid the ZLB in the first place. They group these unconventional policies into three categories.

  1. Using communications to provide guidance about the future course of interest rates
  2. Increasing the size of the central banks balance sheet (Quantiative Easing)
  3. Changing the composition of the central banks balance sheet by buying different asset classes to bring down specifically targeted longer-term interest rates.

- All three of these should be pretty familiar to you by now but BRS provide a nice discussion of the details of these policies that is helpful to a student of Econ 331. BRS also provide specific historical episodes from the United States and Japan when such policies were implemented.

- Although BRS do not focus on the actions that policymakers could use to prevent the ZLB form biting in the first place, they do begin by noting that central banker's success in lowering inflation in the latter part of the 20th century did play an important role in leaving the economies vulnerable to the ZLB. For any given desired real rate, lower inflation means a lower nominal rate that is closer to the ZLB.
- They also begin by noting something we have discussed in this class, that even though the ZLB binds the nominal rate, the real interest rate is what effectively captures policy so ZLB and falling inflation is actually a contractionary policy since the real interest rate is rising.

Forward Guidance

- But in addition to the short-term real interest rate, the path of future short-term rates matters since investment decisions are long-term borrowing decisions. So what matters more than the short-term real rate is the shape of the yield curve: low short-term rates and a steep yield curve would not be as stimulative as somewhat higher short-term rates and a flat yield curve.
- Influencing expectations is always a challenge. Some researchers argue for following policy rules that bind the policymaker but while these work well in theory they are not well-suited for policy in practice, particularly since the ZLB represents the type of unusual economic situation where the central banker will be most tempted to deviate from the rule.
- The real answer then is increased communication about the future path of interest rates. The Fed can communicate to the public how long they expect interest rates to remain low. Such communications could indicate an unconditional commitment (e.g. "Fed will keep rates at zero until 2016") or conditional (e.g. "Fed will keep rates at zero as long as the downside risks to growth remain"). BRS say that the Fed engages in conditional commitment but in the great recession, the Fed engaged first in unconditional commitment and then an even more stringent action that made a conditional commitment to a specific target (i.e. keep rates low until unemployment reaches 6.5%) This is even more unusual because its essentially an unconditional commitment where the future date is not specified.
- At the time BRS wrote, the most striking example is the Bank of Japan (BOJ)'s zero interest rate policy (ZIRP). According to BRS, the BOJ moved interest rates to zero in early 2009 and announced that the BOJ would keep the policy rate at zero until deflation was no longer a threat to the economy.
- In the United States the closest example was the early 2000s where the Fed committed to keeping rates low (at 1 percent) "for a considerable period, linking its decision to conditions in the labor market and to the low inflation rates then prevailing in the economy.
- One part of the BRS paper that I did not discuss in class is an interesting digression into the idea that maybe the central bank can switch to focusing on the exchange rate as their policy tool when the ZLB binds. This is based on work by the Swedish economist Lars Svensson. This does not completely get rid of the ZLB problem, exchange rate behavior is strongly linked to the nominal interest rate differential between two countries, but the idea is that communication is easier if expressed in terms of the future path for exchange rates that the central bank is targeting. This is unlikely to be effective in the United States where the importance of the external sector is small, and people don't really pay attention to the value of the dollar but perhaps more relevant in small open economies like Canada, Sweden or New Zealand.

Quantitative Easing

- QE refers to the decisions by the central bank to increase the size of its balance sheet, which is a fancy way of saying that the central bank is going to engage in open market operations at a scale much larger than required to bring the nominal rate to zero. As an illustrative example, BRS cite Japan which grew its money base by 2/3rds after announcing its QE policy. More recent examples of course is the quadrupling of the money base in the United States, from just under 1 trillion to just under 4 trillion dollars.

- The key problem with QE in a time of ZLB is now familiar from the experience of both Japan and the U.S. If the ZLB arises from a crisis in the banking/financial sectors, then an increase in the money base does not actually how much of an economic impact since banks tend to hoard reserves rather than using the enhanced reserves to increase lending activity.

- BRS discuss the mechanisms by which QE can boost the economy. Broadly speaking the arguments are

  1. Because historically high money growth and high inflation are correlated, QE will raise inflation and lower real rates. Higher inflation will also reduce the real value of the government's debt obligations and hence serve as a source of revenue (inflation tax) for the government perhaps enabling them to be more expansionary. This channel is limited if people see the injections of money as being temporary (as they almost surely will) since the process will reverse and the government will have to undo any tax cuts they gave once the additional inflation tax revenue goes away.
  2. People will use the additional money to buy other assets, raising their price and lowering yield. Even if short-term government bond yields go to zero, stocks, long-term bonds, non-government bonds etc. will be purchased.
  3. What BRS call the signaling channel. QE provides concrete proof about the central bank's intentions and since reducing the balance sheet is a costly activity (how should the Fed sell 3 trillion in additional securities without disrupting markets?), once a central bank engages in QE, it is a strong signal of its future policy path.

- Evidence for QE in this period comes mostly from Japan although BRS suggest some past episodes such as President Roosevelt's decision to abandon the gold standard and let the dollar devalue was effectively an example of QE since it meant the central bank was no longer limited in its balance sheet by having to maintain a peg to gold.

Altering the Composition of the Balance Sheet

- The third category of policy is to alter the types of assets that the central bank holds. By buying and selling a particular type of treasury bond (or non-treasury bond), the Fed could use its dramatic scale of asset holdings to influence prices and yields.

- As BRS put it "the Feds action might be able to influence term, risk, and liquidity premiumsand thus overall yields."

- It is also interesting that BRS say that the Fed can only stick mostly to treasuries unless they invoke special powers that were dormant since the 1930s. These were of course the same powers that Bernanke invoked after the financial crisis to expand the Fed's balance sheet in a host of unconventional ways.

- The Bank of Japan during this period was less constrained than the Fed and it expanded from buying Japanese government bonds to buying "commercial paper, various asset-backed securities, and equities (from commercial banks)."

- A historical episode was the use of rate pegs, whereby the central bank would announce a binding ceiling for a long-term bond's yield and would therefore be committing (potentially unlimited) resources to buying this long-term bond at the price consistent with the announced ceiling on the yield.

- The problem with this type of commitment is that, as BRS put it, the targeted security becomes "detached from the term structure". In other words, rather than bringing other assets yields down with it, this interest rate is the only one to fall because its the only one being singled out for special treatment by the Fed

- Another historical episode with more contemporary echoes cited by BRS was the early 1960s "Operation Twist", which like the modern day operation twist was designed to have the Fed switch away from short-term bonds to long-term bonds. In 1961 the goal was to actually raise short-rates while lowering long-rates but in 2010, the goal was more to bring long-term rates down (the Fed believed that forward guidance alone would ensure that short-rates would not rise when they announced plans to sell short-term bonds from their portfolio and replace with longer-term bonds.

III. EMPIRICAL EVIDENCE ON THE EFFECTIVENESS OF THESE POLICIES

- The second key contribution of the BRS paper is to provide empirical evidence for both the United States and Japan about the effectiveness of these non-traditional policies. BRS use two broad approaches to find empirical evidence.

- The first is what they call event-study analysis. This basically means focusing on a fairly narrow window in which they know a policy decision was made and trying to quantify the impact of the decision. For instance, when the Fed issues a statement after the FOMC meeting, what impact did that have on interest rates at longer maturities in the period shortly following the announcement. By keeping the window narrow, there is more confidence that the impact being estimated is a causal effect rather than a response to other developments.

- The second approach is to estimate a macro-finance model of the term structure i.e. model that integrates macroeconomics into a model relating the inter-relationship between long and short-term rates in the economy and then asking how actual interest rates differ from the predictions of this model in periods where the central bank is engaging in unconventional policy.

- The specifics of this second method in particular are really challenging and I do not expect you to grasp those details. The focus is on the big picture conclusions that BRS reach for the United States and Japan.

Event Study Analysis of How FOMC statements Influence Policy Expectations

- BRS use FOMC statements to examine how they affect the expectations regarding the future path of policy. They point out that since May 1999, the FOMC releases a statement after every policy meeting and that communications by the Fed whether it be in press conferences, speeches, lectures or statements is carefully observed and reported on.

- They also point out that FOMC statements describe both the current state of the economy and the near-term outlook for the economy as well as what the Fed thinks the "balance of risks" is: future growth problems or future inflation problems.

- For data BRS use three measures of forward guidance. First, they look at whether or not a statement was issued in a particular month. Second, they look at whether the announcement contained a policy surprise, a subjective judgment they reach by reading the decision and the discussion prior to the decision. Accordingly they define the following dummy variables. The dummy variable STATEMENT is set to one on any date on which the FOMC released a policy statement, zero otherwise. Of the 116 policy decisions in their sample, which begins in 1988, 56 were accompanied by statements (recall that statements were only always issued after 1999).

- They define a second dummy variable (STATEMENT SURPRISE) that equals one on dates on which the issued statement included important information about the state of the economy or the path of monetary policy that was not expected by a substantial portion of market participants (this is a subjective assessment drawn up by reading articles written before and after each statement was released to determine whether the statement was a surprise to the markets.

- The third dummy variable they use (PATH SURPRISE) focuses on those statement surprises where there was new information about the likely future path of monetary policy (BRS report nine statements among the 31 surprise statements).

- They look at the impact of the announcements on three different variables. First, the difference between the decision made by the FOMC and the value of the fed funds futures contract. A futures contract is a derivative that buyers and sellers use to place a bet on the future price of some asset, so in this case it represents the consensus bet about what the market thought the fed funds rate would be prior to the FOMC meeting. This is a measure of the surprise change in the short-term rate.

- The second is the change in the Eurodollar futures contract, i.e. the change in what markets think the eurodollar rate will be one year from now. The eurodollar rate is the rate that prevails on dollar denominated bank accounts held outside the United States. Since these accounts are not regulated by the Fed and because data is available, they tend to be used as proxy for market expectations about the path of interest rates over the next year.

- The third outcome is the change in the five year treasury bond yield. They focus on movements in the three market-based indicators over the one-hour window (from fifteen minutes before to forty-five minutes after) surrounding the policy announcements

- There is one technical problem that BRS need to resolve which is that these 3 are correlated, i.e. the movement in the Eurodollar futures rate is partly related to the movement in the Fed Funds futures rate and the movement in the 5 year bond-yield is related to both the change in the Fed Funds rate and the change in the one year rate. So they have to convert their three outcomes into three "factors" before they can assess empirical evidence.

- The first factor is the Fed Funds rate change, the second factor is the portion of the one year Eurodollar change that is not explained by the Fed Funds rate (intuitively imagine running a regression of the change in the one year rate on the change in the Fed funds rate and taking the residual) and the third factor is the change in the 5 year rate that is unrelated to both the fed funds rate change and the one year rate change.

- This particular exercise of extracting the uncorrelated parts of the policy surprises sets the stage for the eventual key result which is that the one year rate surprise is the key variable in terms of what is most strikingly affected by the Fed's announcement. In other words, forward guidance has its biggest impact at a one year horizon rather than a 5 year horizon (cf. the comment "in terms of standard deviations, the contribution of the second factor to the variation in the five-year yield is about twice that of either the first or third factors. ")

- The first set of regression results presented in Table 2, regresses the square of the three different rate changes on the dummy variables. Why the squares? That basically can be interpreted as a broad test on how much interest rates move (so a downward and upward movement of an identical magnitude count the same). To put it a different way, this is a table that shows how the policy surprises affect the volatility of interest rates.

- In Table 2, when we look at the first column: STATEMENT appears with a positive and significant coefficient indicating (unsurprisingly) that surprise changes in the Fed Funds rate are more likely on days when a statement was issued, no great surprise since statements were issued at FOMC meetings. There is a surprisingly large negative coefficient on STATEMENT SURPRISE which BRS kind of gloss over with a unconvincing explanation that the Fed does not issue surprising statements on dates with surprise policy moves.

- Column 3 looks at the second factor (the independent surprise to the one year rate). Here the STATEMENT is not what matters but STATEMENT SURPRISE is what matters. The regression implies that a surprise statement raises the variance of the second factor by around 200 basis points (about 2 percentage points).

- The third factor (the surprise in the 5 year rate) is unaffected by these surprises. Keep in mind that this is the uncorrelated piece, the 5 year rate is still affected by the one year rate movement.

- The same story is true for PATH SURPRISE dummy, which significantly affects only the variance of the second factor. Bottom line is that statements providing new information about the prospective path of policy have a powerful effect on year-ahead policy expectations. Any effect on five-year rates working through the one year rate.

- The next set of regression results look at the impact of the statements on the direction of movements rather than on the squared value. This is to ask if the change moves rates in the intended direction. In this case, instead of a dummy variable indicating whether or not a statement was issued, the statement takes on +1 for hawkish (tightening), 0 for neutral and -1 for dovish (loosening) statements. The same is true for the SURPRISE and the PATH measures.

- Again the results show that signed surprises have "a large and highly statistically significant effect on the second factor, with hawkish (dovish) statements pushing up (down) year-ahead policy expectations by 12 basis points, on average (column 3.) The effects are even larger (16 basis points) when we restrict our attention to the 9 policy path surprises (column 4)."

- Since the one year yield surprise affects the five year yield surprise, they also find that "a surprisingly hawkish statement raises the five- year yield by about 8 basis points and a hawkish statement about the policy path raises the five-year yield by about 10 basis points." but again keeping in mind that this is working though the one year yield.

- They also provide some interesting corollary evidence. During the early 2000s, a lot of the Fed's policies were conditioned on the labor market so surprises in the Fed's actions were often a result of surprise developments in the labor markets. BRS show that the responsiveness of yields to surprises in the jobs report increased in this period (although their graph is labeled incorrectly).

- They also do a similar exercise for Japan,

Using a Macrofinance Model to Estimate How FOMC statements Influence Policy Expectations

- BRS argue that while event studies are useful, by construction they can only look at the impact in a short interval. So they sue a second method which is to use a macro finance model of the term structure. In plain English, they develop a model that explains the term structure of interest rates then use the model to predict the path of interest rates in the period that the Fed issued forward guidance. They attribute the difference between the actual path of interest rates and the model predictions to the impact of the Fed policy guidance.

- Construction of the term structure model is beyond the scope of our class. Suffice to say it is a complicated dynamic model that relates a variety of macroeconomic variables to current and lagged values of other macro variables. To draw a simpler parallel, think of the Phillips Curve you estimated in PS2, which related current inflation to lagged values of inflation and lagged values of unemployment and used that to predict the path of future inflation. The BRS approach is a more complicated version of this model.

- The macro model they use looks at the interrelationships between 5 macroeconomic variables - the employment gap (employment levels - trend), inflation over the past year, expected inflation (from survey based forecasts), the Fed Funds rate and the one year ahead Eurodollar rate. They use a model of these 5 variables to predict the behavior of the one month federal funds rate and then from that extract a prediction for the path of the one year interest rate (which will be what the expected value of the next 12 one month rates will be).

- Figure 4 in BRS shows that the model does a nice job of predicting the two-year and ten-year Treasury yields. They then use the model to study the period, August 2003 to December 2003, where, according to the event study, FOMC communications pushed down the Eurodollar futures rate by a cumulative 19 basis points. They find that the model predicts an effect ranging from about 20 basis points at the two-year horizon to about 7 basis points at the ten-year horizon.

Estimating the Impact of Changing Asset Composition

- For the United States there were no good examples of changing the size of the balance sheet in this period so BRS focus on the effects of changing the composition of the central banks balance sheet.

- They identify three episodes in the past five years in which market participants in the United States came to anticipate significant changes in the relative supplies of Treasury securities.

These are natural experiments that can help us understand what the impact of a more direct intervention may be. The three episodes they consider are

1. The Treasurys announcement in 1999 of a plan to use budget surpluses to pay down government debt
2. Foreign exchange rate intervention by Asian central banks that affected the demand for dollars and the demand for Treasuries.
3. An apparent expectation that the Fed would intervene an buy long term bonds in 2003 to stave off deflation.

- They use the same two techniques: event study and macro model simulation to examine the impact of these episodes on long-term bond yields.
- BRS describe the first episode, the budget surpluses of the late 1990s. As the surplus rose, the Treasury cut back on the issuing of longer-term securities and announced that they would buy back some of the older long-term bonds. In particular there was widespread speculation that the thirty year bond would be discontinued, which was in fact confirmed in 2001.
- As the Treasury moved away from issuing long-term securities, reducing supply and raising prices for bonds thus lowering yields. Figure 6 provides the long-end of the market was the more dramatically affected by this announcement. The 30 -year bond held fell 27 basis points.
- Another piece of evidence is that the difference between Treasury yields and other risky asset yields also appears to be much more dramatic at the long end of the spectrum, which is consistent with the long-run rates falling sharply.
- A second natural experiment was the decisions taken by foreign central banks to increase their holdings of U.S. dollars in order to stop their currencies from appreciating. BRS point out that securities held in custody at the Federal Reserve Bank of New York on the behalf of foreign official institutions totaled over a trillion dollars in 2003. Japanese intervention purchases totaled \$177 billion in 2003 and \$138 billion in the first quarter of 2004.
- Some of these purchase will be held as cash but others will be converted into treasuries. TBRS note that Japanese had increased holdings by \$300 billion. BRS regress the change in Treasury yields on the volume of intervention and find that (Table 7) two-, five-, and ten-year Treasury yields all fell significantly on dates around Japanese interventions, and the estimated coefficients are highly statistically significant.
- BRS are careful to point out that this could be endogenous, perhaps weak economic data "could cause Treasury yields to fall and the dollar to weaken, with the latter prompting foreign exchange intervention by the MOF." BY taking out major U.S. macro news releases, they blunt this effect and find that both five-year and ten-year Treasury yields remained below the models predictions by an average of 50 to 100 basis points over this period.
- The bottom line for the U.S. is that forward guidance can have significant effects on the 1 year Eurodollar rate and a much smaller independent effect on the 5 year rate. The impact is in the range of 20-30 basis points, nothing earth shattering but nothing to sneeze at either.