Economics 704a Lecture 9: Optimal Policy in the NK Model II

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Optimal Policy in the NK Model: Outline

1. Optimal Monetary Policy Without Commitment
   - 1.1 Welfare
   - 1.2 The "Divine Coincidence"
   - 1.3 Breaking the Divine Coincidence and the $\pi - Y$ Tradeoff
   - 1.4 Principles of Discretionary Monetary Policy
2. Monetary Policy In Practice: 2021-22
3. Optimal Monetary Policy With Commitment
   - 3.1 Time Inconsistency and the Gains From Commitment
   - 3.2 Inflation Bias and Commitment
   - 3.3 The $\pi - Y$ Tradeoff With Commitment: A Simple Rule
   - 3.4 The $\pi - Y$ Tradeoff With Commitment: The General Case
   - 3.5 Policy Rules and Communication

Review: Monetary Policy Under Discretion

- Last class set up central bank's problem under discretion, when cannot make credible commitments about future actions.

$$\min_{\pi_t, x_t} \frac{1}{2}\left[\pi_t^2 + \vartheta x_t^2\right] + F_t \text{ s.t. } \pi_t = \kappa x_t + f_t$$

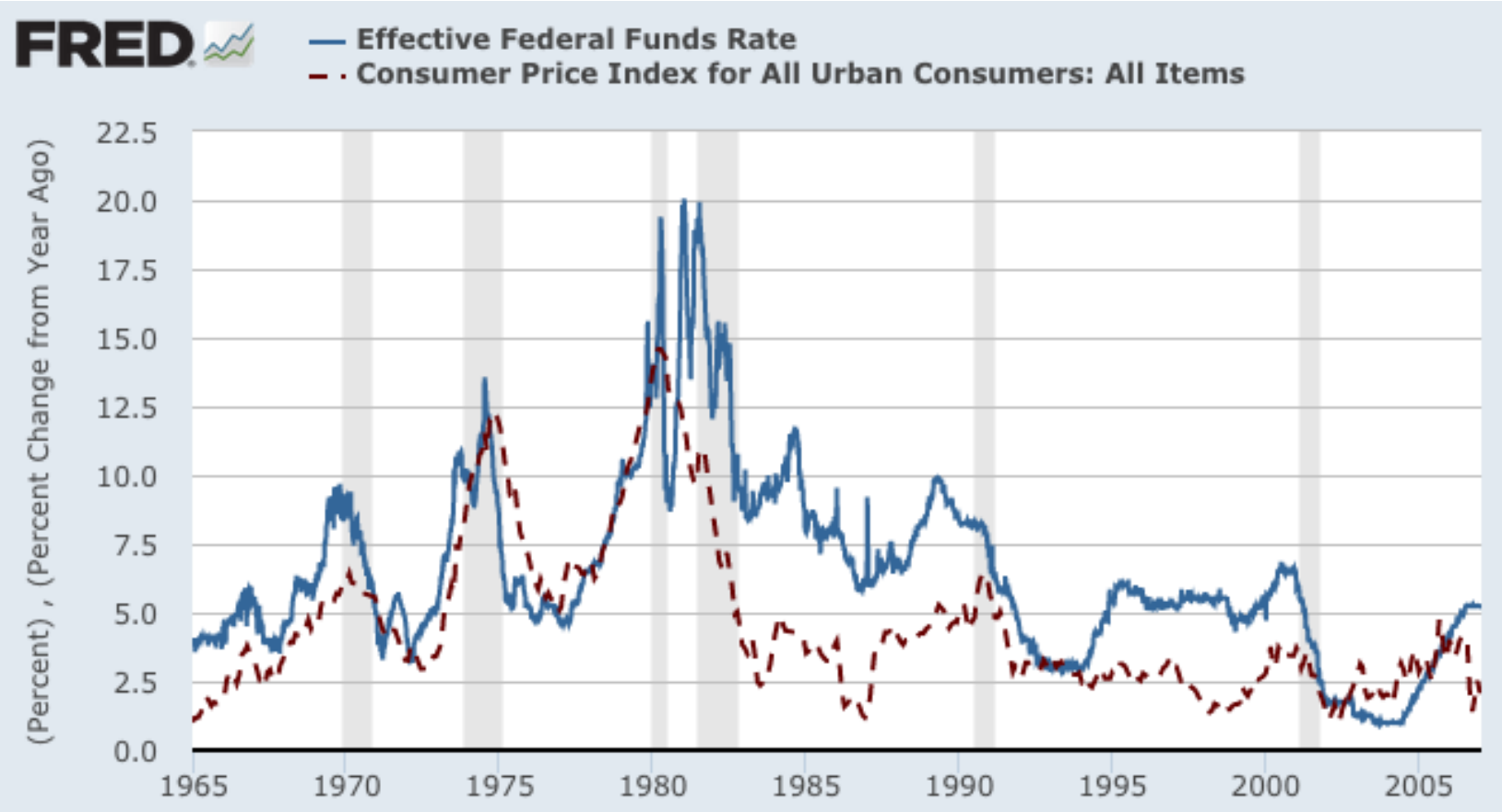
- "Lean Against the Wind" Policy:

$$x_t = -\frac{\kappa}{\vartheta}\pi_t$$

  - In face of inflationary pressures from cost push shocks, *drive output below its efficient level to dampen rise in inflation*.

- CGG's four principles:
  1. Short-run tradeoff between inflation and output volatility.
  2. Optimal policy incorporates flexible inflation targeting.
  3. Taylor principle: $\phi_\pi > 1 \Rightarrow$ real rates rises in response to $E[\pi]$.
  4. Offset demand shocks, accommodate supply shocks.

Volcker-Greenspan Policy and the Principles



Volcker-Greenspan Policy and the Principles

- Motivated by the theory, Clarida, Gali, and Gertler (1999) estimate a Taylor rule in spirit of Taylor (1993):

$$i_t^* = \alpha + \gamma_\pi \left(E_t \left\{ \pi_{t+1} \right\} - \bar{\pi} \right) + \gamma_x x_t$$

allowing for partial adjustment:

$$i_t = \rho i_{t-1} + (1 - \rho)\, i_t^*$$

	γ_π	γ_x	ρ
Pre-Volcker	0.83	0.27	0.68
	(0.07)	(0.08)	(0.05)
Volcker–Greenspan	2.15	0.93	0.79
	(0.40)	(0.42)	(0.04)

Volcker-Greenspan Policy and the Principles

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- Volcker and Greenspan aggressively follow Taylor principle.
- Explicit inflation target of 2% as use $\bar{\pi} = 2\%$.
- Try to figure out type of shock. For example, in 1990s with high productivity-driven growth, don't raise rates.
- End of this class: Should we adopt rules like this? Or other rules? What are the benefits of a rule?

Monetary Policy In Practice

- How does the Fed know everything it needs to know to set:

$$i_t = E_t\left\{r^e_{t+1}\right\} + \phi_\pi E_t\left\{\pi_{t+1}\right\} + \frac{g_t}{\sigma}?$$

  - It doesn't!
- Because of quadratic loss function and linear constraints, *everything holds in certainty equivalents*.
  - Fed should do the best it can using available information.
  - As long as on average correct, pursue optimal policy as if certain of r^e, π_{t+1}, g_t, etc.
  - Welfare is lower than case in which central bank knows parameters, but cannot do better *ex ante*.
- However, motivates policy instrument choice.
  - What matters for economy is i_t not money supply.
  - Use i_t as instrument so shocks to money demand do not cause fluctuations.

What About If Policy Has Lagged Effect?

- In data, we found that monetary policy has lagged effect on real economy, and even longer lag on inflation.
  - Suppose takes j periods for shift in interest rate to affect output and another k periods to impact inflation.
  - Let Fed's information set be Ω_t. Assume private agents have same info.
- Then

$$E_t\left\{x_{t+j}|\Omega_t\right\} = -\frac{\kappa}{\vartheta}E_t\left\{\pi_{t+j+k}|\Omega_t\right\}$$

  - Generalization of previous result: Certainty equivalence still holds, just now j and $j+k$ periods ahead.
- Similar results for inertial inflation.

Policy Persistence and Parameter Uncertainty

- What about if the imperfect information is not about the state of the economy, but the parameters of the model?
- Assume $\kappa_t = \kappa + \hat{\kappa}_t$ and $\sigma = \sigma + \hat{\sigma}_t$ where $\hat{\kappa}_t$ and $\hat{\sigma}_t$ are iid random variables of mean zero and known variance σ_σ^2 and σ_κ^2.
- Can show (with robust control):

$$x_t = \frac{-\kappa}{\vartheta + \kappa^2 \sigma_\kappa^2} \pi_t + \left(\vartheta + \kappa^2\right) \frac{\sigma_\sigma^2}{\sigma} \left(i_t - E_t \left\{\pi_{t+1}\right\}\right)$$

- Parameter uncertainty reduces the response of the policy instrument (relative to $x_t = -\frac{\kappa}{\vartheta}\pi_t$), motivating a smoother path for the interest rate.
  - Contraction of output below potential raises variability of inflation, so moderate doing this.
  - Also adjusting interest rate raises variability of output, moderating extent to which i_t is adjusted.

Conduct of Monetary Policy in Practice

- If look at central bank statements, can see them interpreting economic indicators through lens of model.
  - Gauging inflationary pressures relative to output to get sense of whether facing tech shock, demand shock, or cost push shock.
  - Indicating they will respond aggressively to inflation when it arises.
  - Referencing dual concern for inflation and output (in U.S., full employment by law).
  - Adjusting things slowly given uncertainty about how economy will respond.

Example: January 2020 Statement

Information received since the Federal Open Market Committee met in December indicates that the labor market remains strong and that 'economic activity has been rising at a moderate rate. Job gains have been solid, on average, in recent months, and the unemployment rate has remained low. Although household spending has been rising at a moderate pace, business fixed investment and exports remain weak. On a 12-month basis, overall inflation and inflation for items other than food and energy are running below 2 percent. Market-based measures of inflation compensation remain low; survey-based measures of longer-term inflation expectations are little changed.

Example: January 2020 Statement

Consistent with its statutory mandate, the Committee seeks to foster maximum employment and price stability. The Committee decided to maintain the target range for the federal funds rate at 1-1/2 to 1-3/4 percent. The Committee judges that the current stance of monetary policy is appropriate to support sustained expansion of economic activity, strong labor market conditions, and inflation returning to the Committee's symmetric 2 percent objective. The Committee will continue to monitor the implications of incoming information for the economic outlook, including global developments and muted inflation pressures, as it assesses the appropriate path of the target range for the federal funds rate.

Example: January 2020 Statement

In determining the timing and size of future adjustments to the target range for the federal funds rate, the Committee will assess realized and expected economic conditions relative to its maximum employment objective and its symmetric 2 percent inflation objective. This assessment will take into account a wide range of information, including measures of labor market conditions, indicators of inflation pressures and inflation expectations, and readings on financial and international developments.

2020 Monetary Policy Review Changes (According to Fed)

- *On maximum employment, the FOMC emphasized that maximum employment is a broad-based and inclusive goal and reports that its policy decision will be informed by its "assessments of the shortfalls of employment from its maximum level." The original document referred to "deviations from its maximum level."*
- *On price stability, the FOMC adjusted its strategy for achieving its longer-run inflation goal of 2 percent by noting that it "seeks to achieve inflation that averages 2 percent over time." To this end, the revised statement states that "following periods when inflation has been running persistently below 2 percent, appropriate monetary policy will likely aim to achieve inflation moderately above 2 percent for some time."*
- *The updates to the strategy statement explicitly acknowledge the challenges for monetary policy posed by a persistently low interest rate environment. Here in the United States and around the world, monetary policy interest rates are more likely to be constrained by their effective lower-bound than in the past.*

Example: December 2020 Statement

The Federal Reserve is committed to using its full range of tools to support the U.S. economy in this challenging time, thereby promoting its maximum employment and price stability goals.

The COVID-19 pandemic is causing tremendous human and economic hardship across the United States and around the world. Economic activity and employment have picked up in recent months but remain well below their levels at the beginning of the year. Weaker demand and significantly lower oil prices are holding down consumer price inflation. Overall financial conditions have improved in recent months, in part reflecting policy measures to support the economy and the flow of credit to U.S. households and businesses.

The path of the economy will depend significantly on the course of the virus. The ongoing public health crisis will continue to weigh on economic activity, employment, and inflation in the near term, and poses considerable risks to the economic outlook over the medium term.

Example: December 2020 Statement

The Committee seeks to achieve maximum employment and inflation at the rate of 2 percent over the longer run. With inflation running persistently below this longer-run goal, the Committee will aim to achieve inflation moderately above 2 percent for some time so that inflation averages 2 percent over time and longer-term inflation expectations remain well anchored at 2 percent. The Committee expects to maintain an accommodative stance of monetary policy until these outcomes are achieved. The Committee decided to keep the target range for the federal funds rate at 0 to 1/4 percent and expects it will be appropriate to maintain this target range until labor market conditions have reached levels consistent with the Committee's assessments of maximum employment and inflation has risen to 2 percent and is on track to moderately exceed 2 percent for some time.

Example: December 2020 Statement

In addition, over coming months the Federal Reserve will increase its holdings of Treasury securities and agency mortgage-backed securities at least at the current pace to sustain smooth market functioning and help foster accommodative financial conditions, thereby supporting the flow of credit to households and businesses.

In assessing the appropriate stance of monetary policy, the Committee will continue to monitor the implications of incoming information for the economic outlook. The Committee would be prepared to adjust the stance of monetary policy as appropriate if risks emerge that could impede the attainment of the Committee's goals. The Committee's assessments will take into account a wide range of information, including readings on public health, labor market conditions, inflation pressures and inflation expectations, and financial and international developments.

Monetary Policy 2021-22

- Summer 2021 to Summer 2022 was a remarkable period for the Federal Reserve.
  - Went from needing to keep rates low for an extended period with rate hikes not being on their radar to some of the most aggressive rate increases in modern memory.
  - Speed is breathtaking: *E.g.*, went from "A 75-basis-point increase is not something the Committee is actively considering" to a 75 basis point increase in a span of 6 weeks.
  - Will be analyzed for a long time.
- Want to delve into what happened and why?
  - What did the Fed do and why?
  - What did the Fed get wrong?
  - What would you have done differently?

Primer: Where Fed Was in Summer/Fall 2021

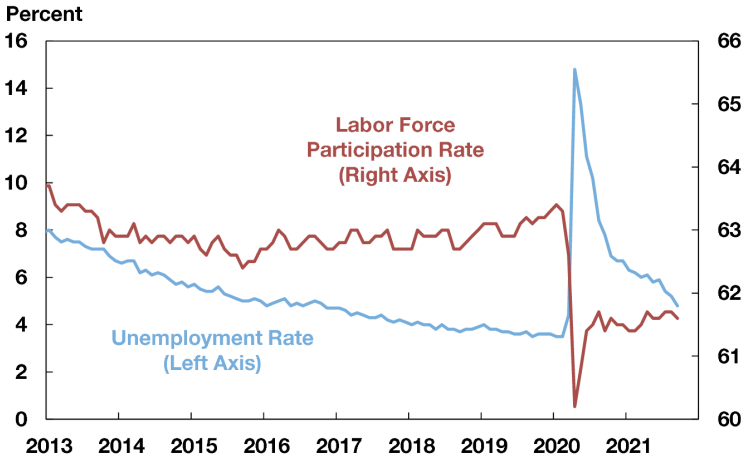
- Recovering from the COVID pandemic, the fastest and deepest recession in 90 years.
  - Labor market is recovering. Unemployment has fallen from 14.8% to around 5%.
  - Acceleration in inflation largely contained to supply-constrained sectors like cars, semiconductors, airfare, and hotels.
  - Biden signs $1.9T stimulus in March 2021 including checks.
    - Comes on heels of $2.2T in March 2020 and $900b in December 2020.
  - Fed has lowered rates to near 0 and actively purchases assets (Treasury bonds and mortgage-backed securities) to push down long rates. Has to "taper" this bond buying as part of any policy change.
    - Will discuss so-called quantitative easing in future classes.
- In October-November, decrease in inflation proves temporary. Inflation takes off and spreads to services and wages.

Changes in Monetary Policy 2021-2

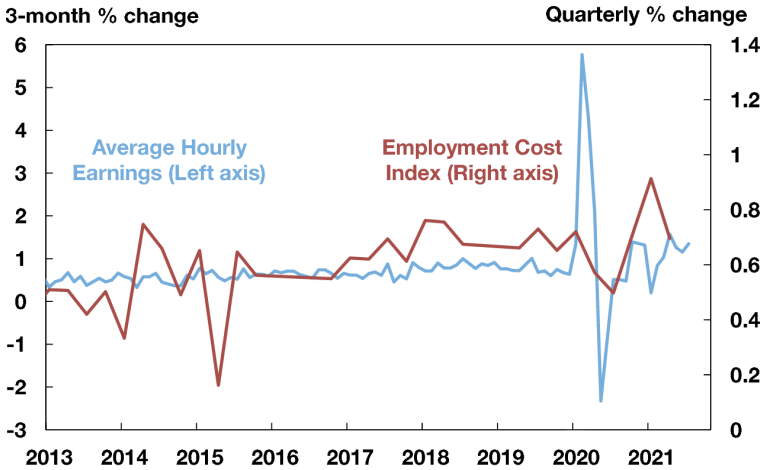
- July 2021: Keep rates at zero, maintain pace of asset purchases.
- Sept. 2021: Maintain policy.
- November 2021: Initiate taper of asset purchase program.
- December 2021: Accelerate taper of asset purchase program. Indicate expect to raise rates at some point next year.
- January 2022: Maintain taper to end asset purchases in March, indicate rate increase in March.
- March 2022: Raise rates 0.25%, indicate will sell assets soon.
- May 2022: Raises rates 0.5%, begins asset sales.
- June 2022: Raises rates 0.75%, continues asset sales.
- July 2022: Raises rates 0.75%, continues asset sales.

State of the Economy, 2021-2

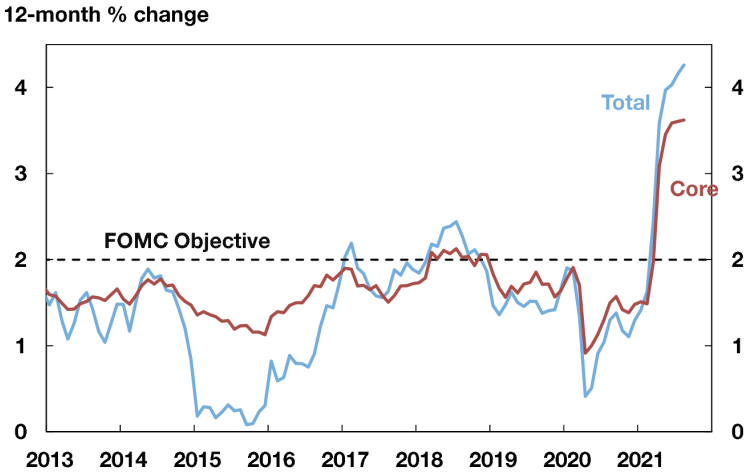
Labor Market, October 2021



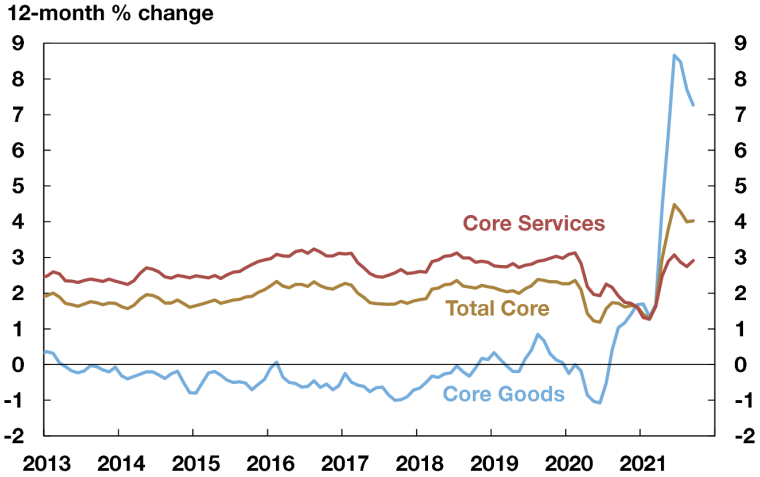
Emp Costs, October 2021



PCE Deflator, October 2021



CPI, October 2021



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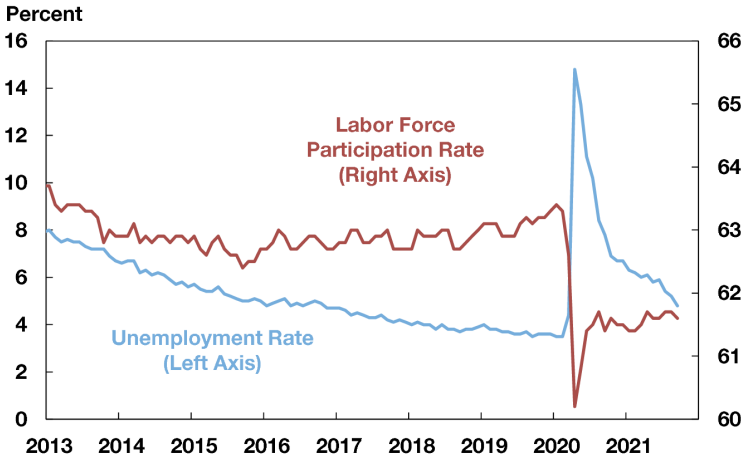

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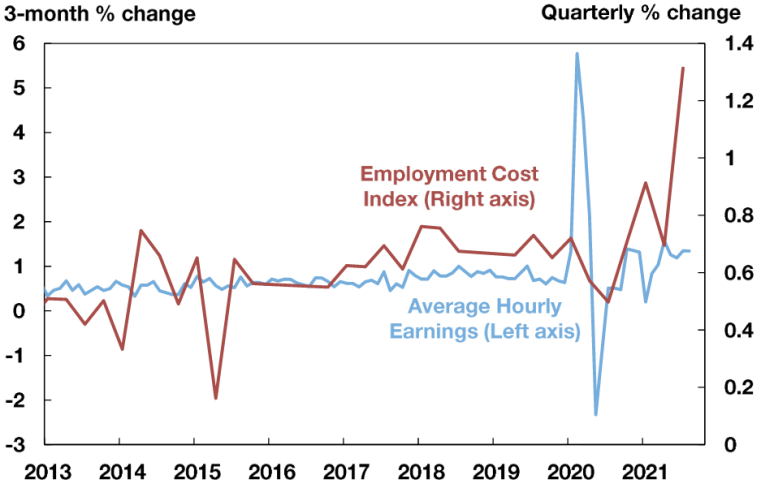

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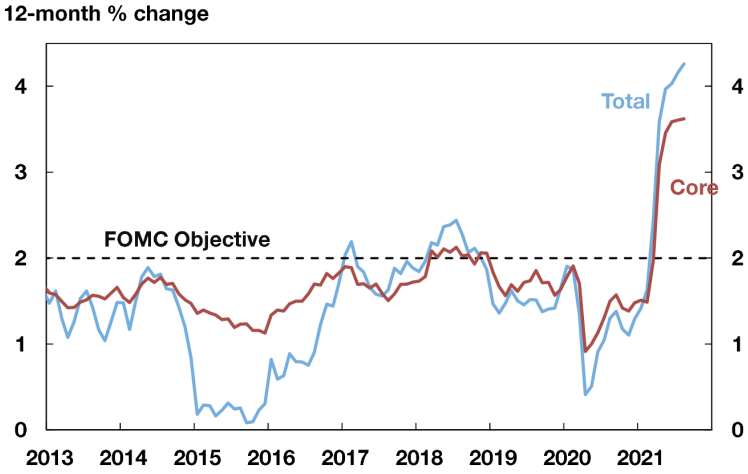

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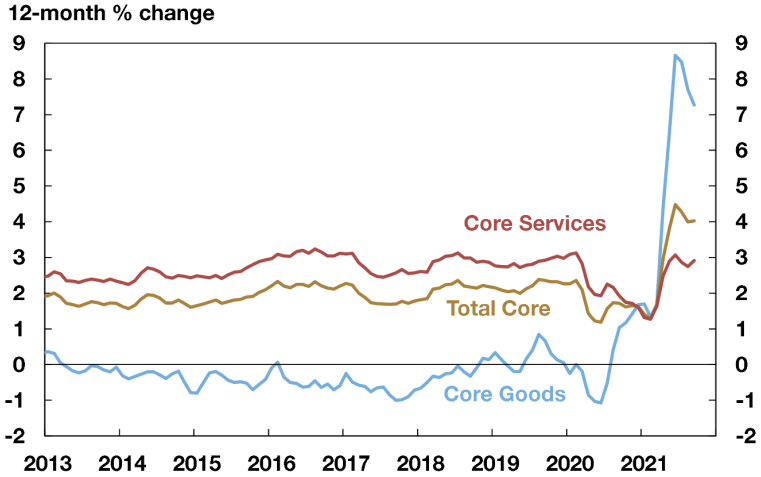
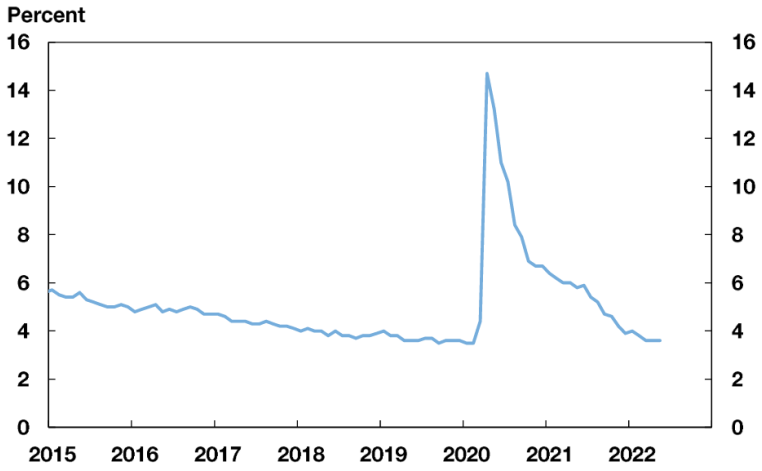
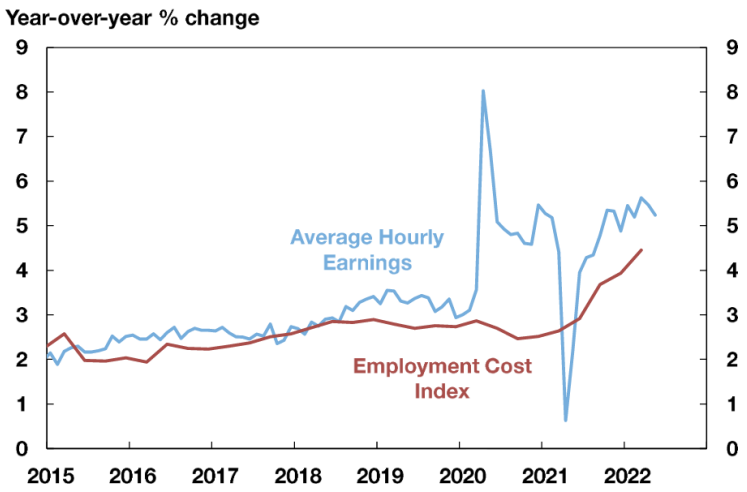


State of the Economy, 2021-2

Labor Market , June 2022



Emp Costs , June 2022



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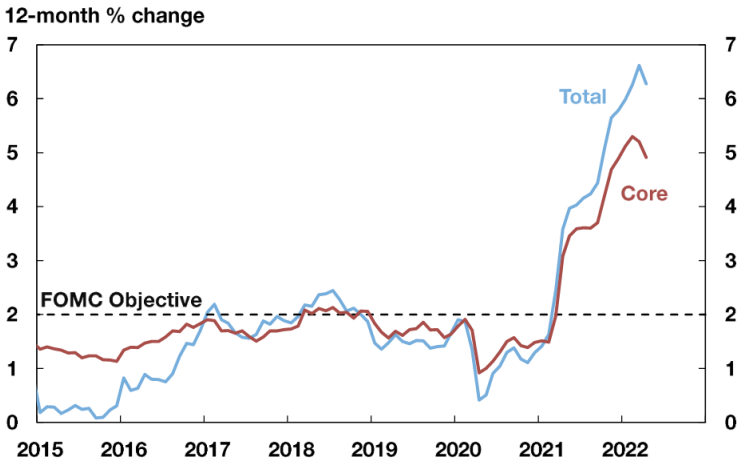

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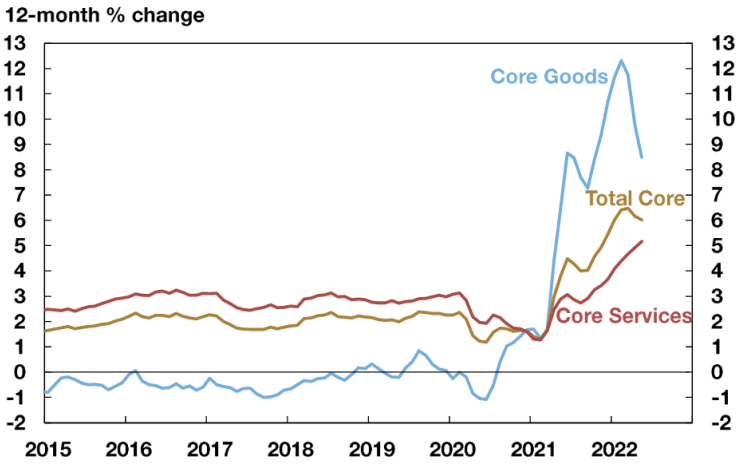
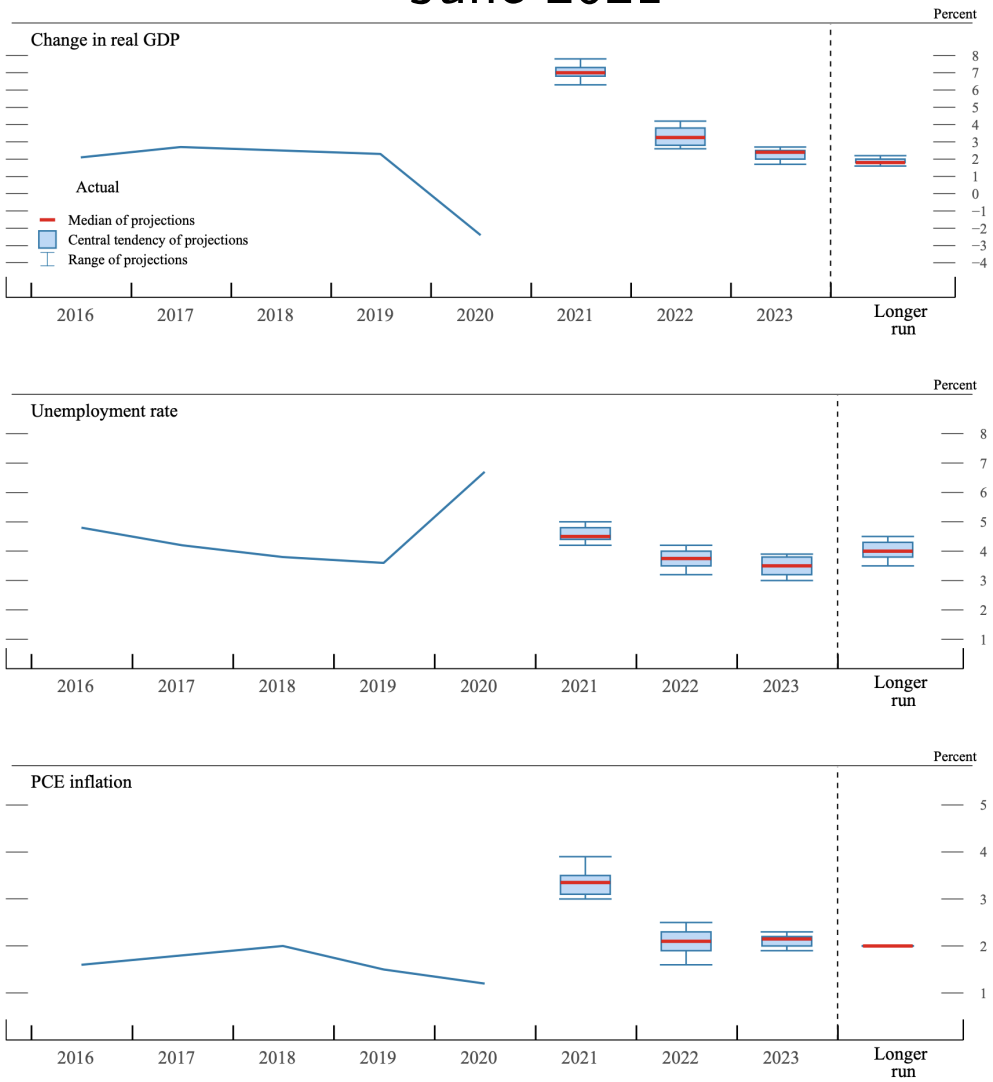


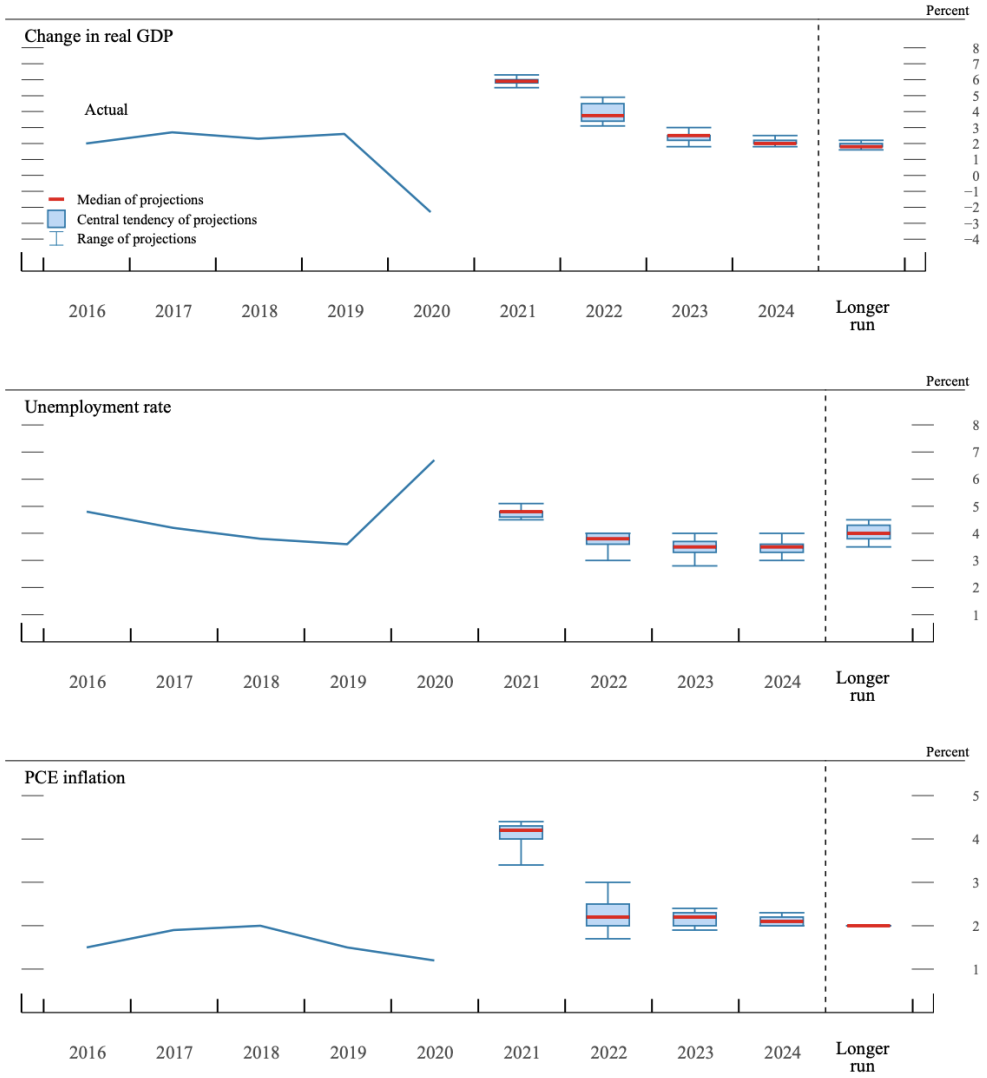
Survey of Economic Projections, 2021-2

June 2021



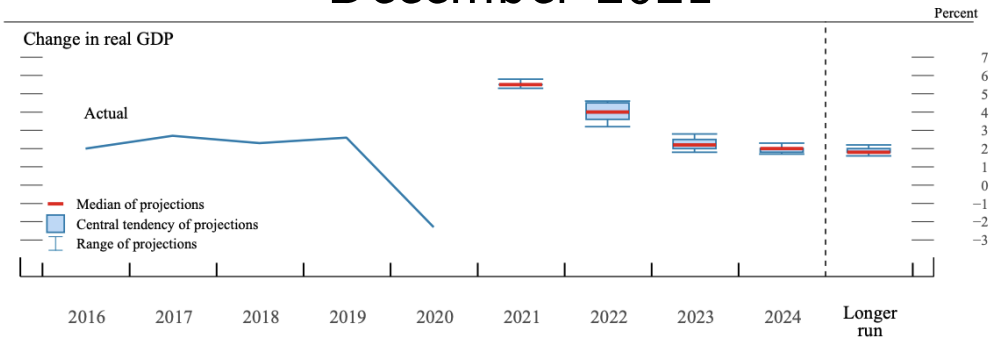
Survey of Economic Projections, 2021-2

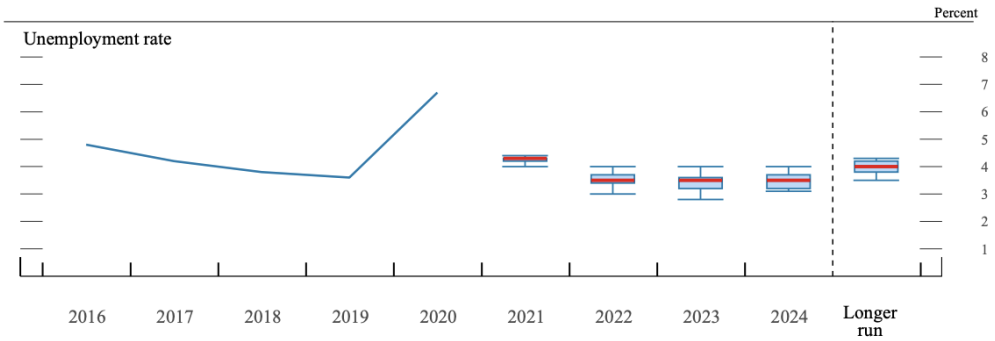
September 2021

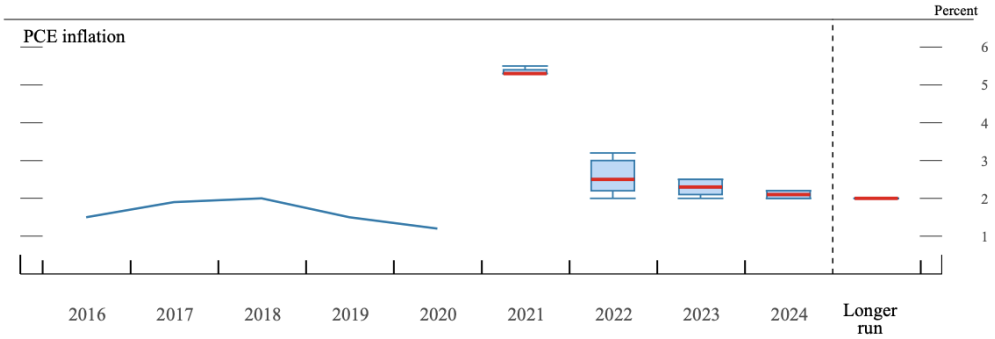


Survey of Economic Projections, 2021-2

December 2021

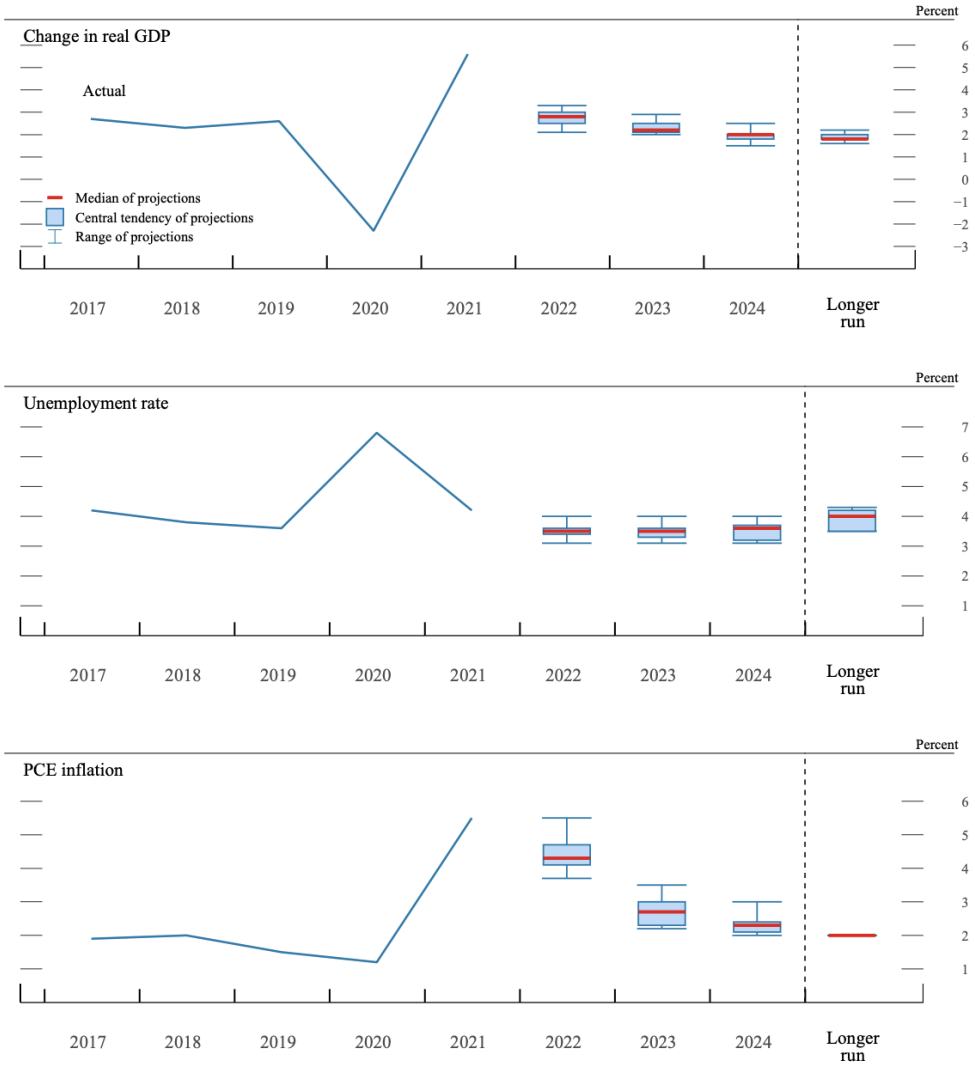






Survey of Economic Projections, 2021-2

March 2022



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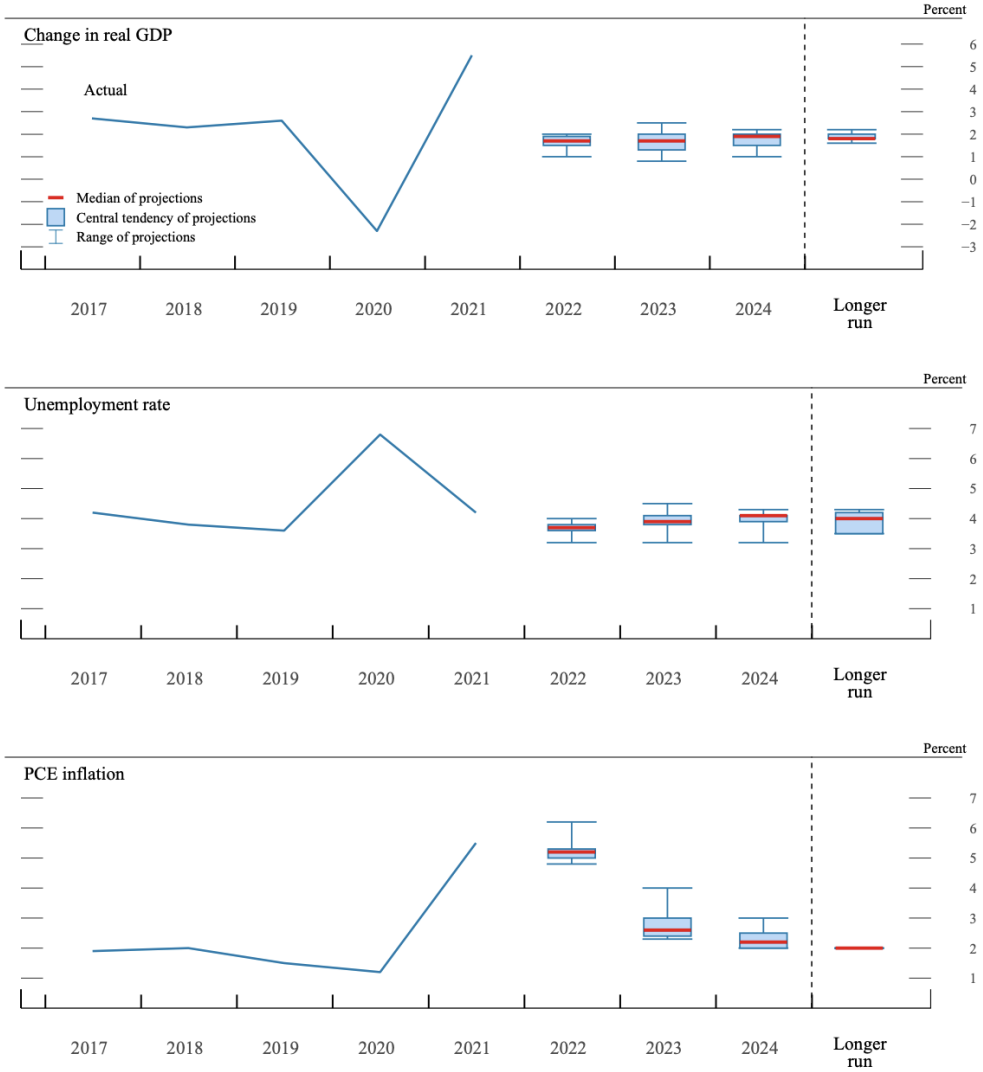

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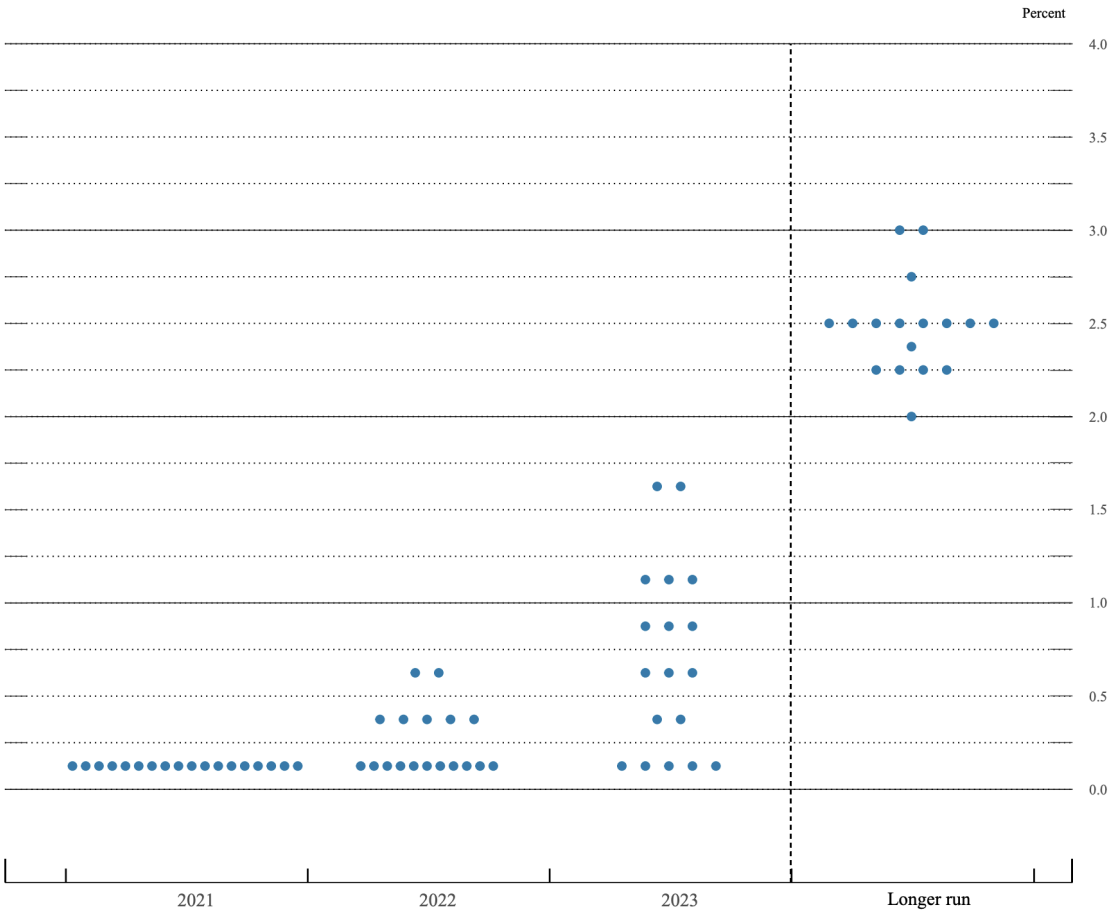

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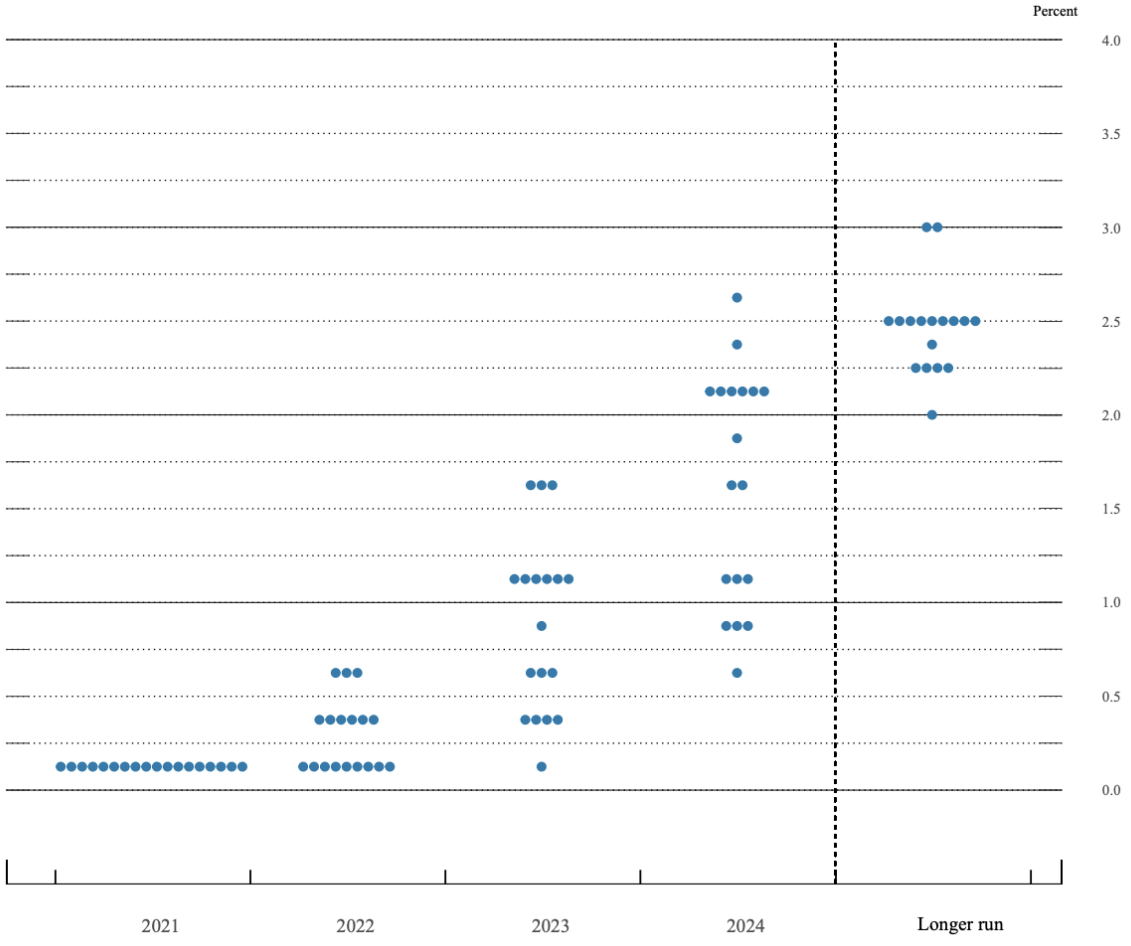

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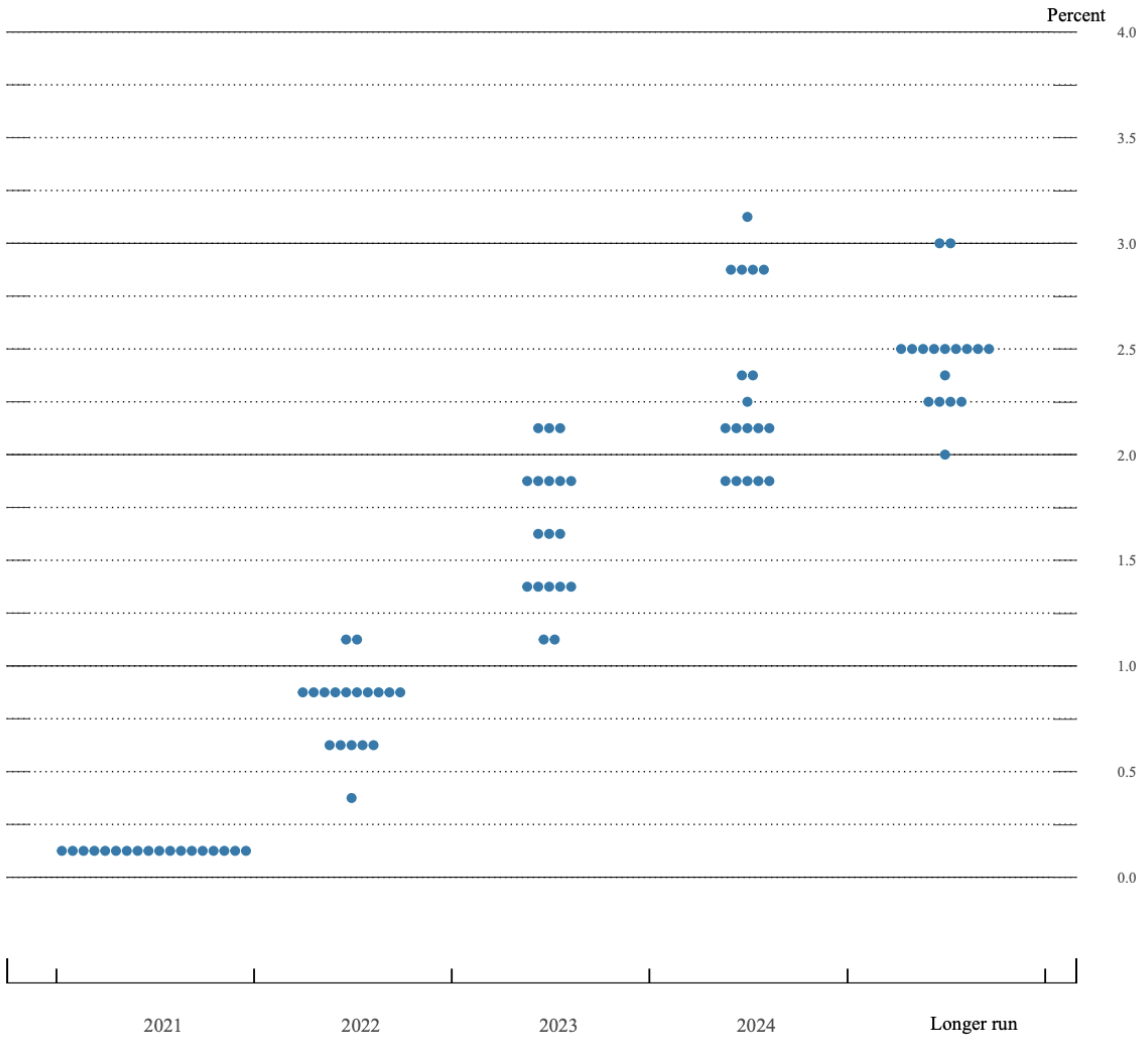

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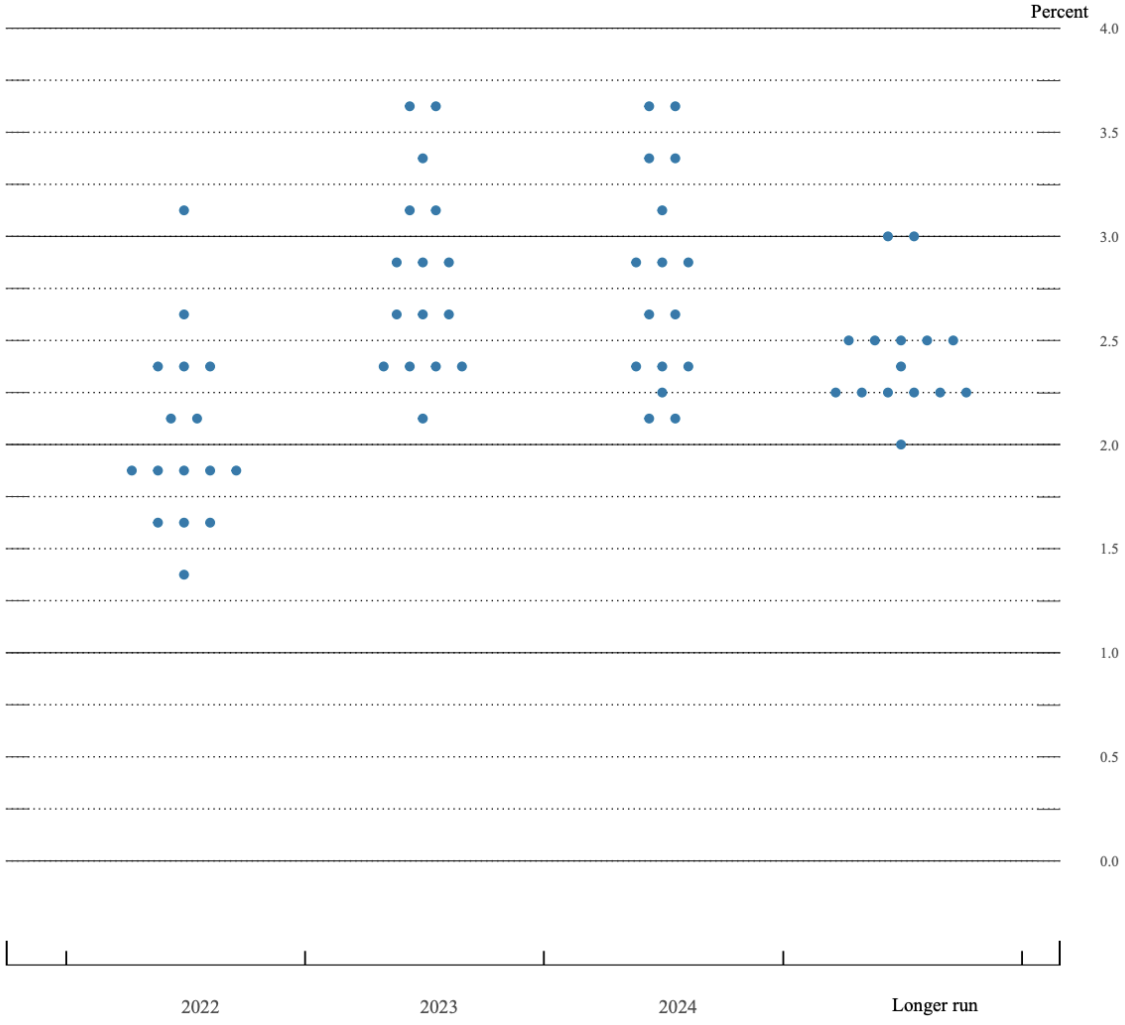
March 2022



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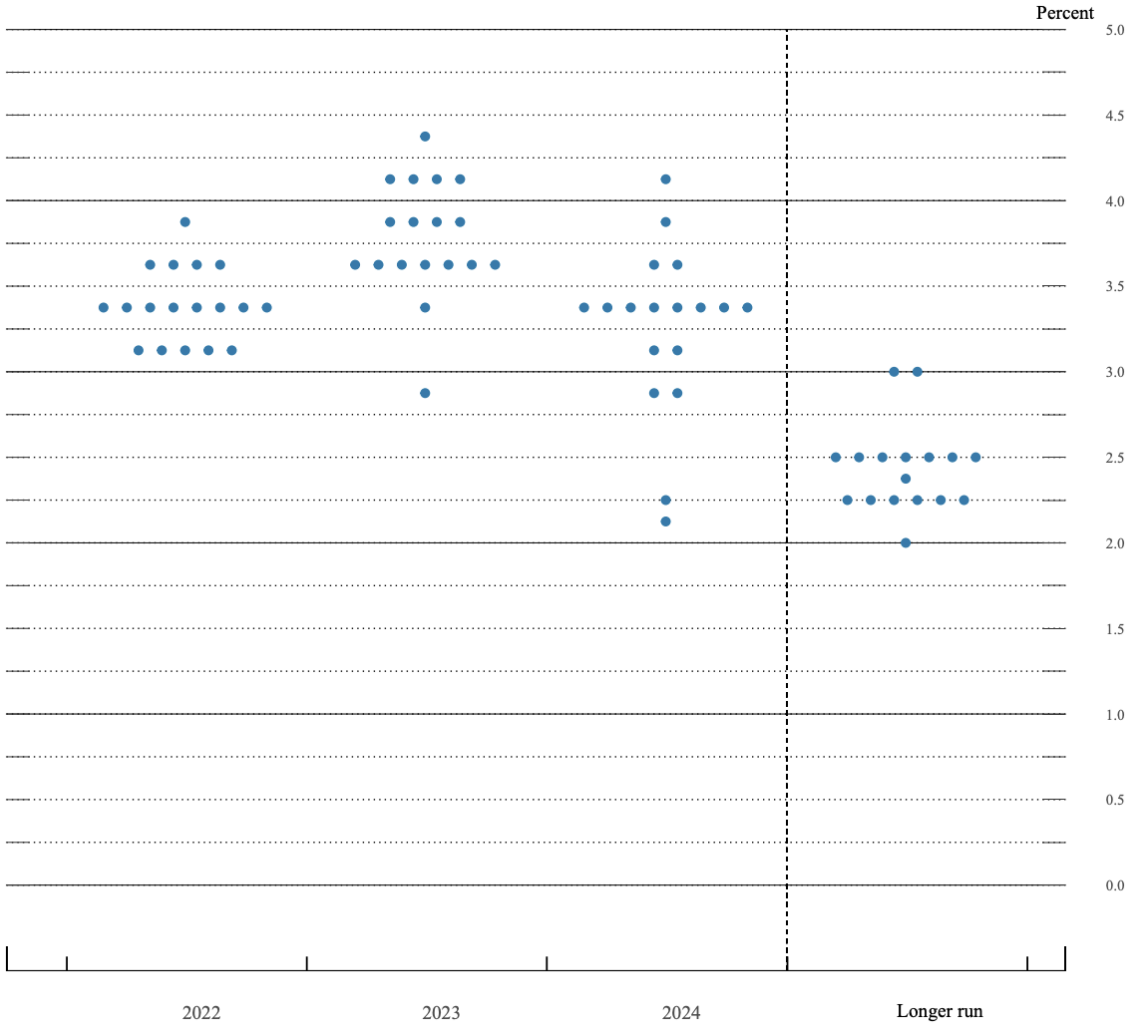

Two View on Inflation in 2021 (Per Jason Furman)

- **"Micro" View (Transitory)**: "Bottlenecks and shortages" in particular sectors. As pandemic eases, anomalies will go away.
  - Supply chains (especially microchips and shipping), coupled with Pandemic shift from services to goods.
  - Ex: Used cars.
    - Two typical suppliers: Rental fleets and new car purchasers.
    - But rental companies dump fleets in 2020 and not selling, and nobody can buy new cars due to chips and supply chain issues.
- **"Macro" View (Persistent)**: Inflation is caused by high aggregate demand and constrained aggregate supply.
  - Summers: Biden stimulus was too big relative to output gap (controversial) and would cause inflation.
  - Other factors push aggregate demand higher: Reopening, savings from pandemic, wealth effect due to house prices.
    - Ex: Yes ports are constrained, but by Summer 2021 processing 20% more than pre-pandemic!
    - Ex: Inflation spreading to services, shelter lagging.
  - SOMC: Labor market strong, inflation accelerating with upside risk. Have made transitory vs. persistent mistake in past.

Discussion

- What did the Fed do and why?
- What did the Fed get wrong?
- What would you have done differently?
- Remember hindsight is 20/20.
  - Want to think about what you would have done differently *in real time* and *given the available data*.

Why Didn't the Fed Move Faster?

In the middle of last fall, there was a time when our policy stance was still pretty much in sync with what the data were saying....inflation. . . had come down till September, a few months in a row, stayed low. And then around the end of October, we got three or four really strong readings that just said, no, this is a much stronger economy. And . . . with the restatement of the jobs numbers, it looked like the job market was much more even and stronger in the second half of the year. But that hadn't happened yet. Anyway, we got an ECI reading—. . . [employment cost] index reading—the Friday before the November meeting. Then we got a really strong jobs report. Then we got a really high CPI report. And so I think it became clear to the Committee that we needed to adjust and adapt. And . . . the Committee moved by the time of the December meeting to a median [in participants' 2022 projections] of three rate increases, then to a median of seven increases at the March meeting....it's just us adapting to the data.

Why Didn't the Fed Move Faster?

1. What Fed officials say: Moved quickly given need to announce taper, taper fully, and then gradually raise rates.
   - Scarred by past "taper tantrums" where yields rose sharply in response to tapering announcement, leading to a contraction.
   - Felt like they could not go faster than they promised the market they would.
     - Said would take six months.
     - Said wouldn't raise rates until taper is complete.
     - If not extremely urgent, do a gradual turn for an economy like an aircraft carrier.
   - Very lawyerly approach (Powell's background).

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   - Scarred by past "taper tantrums" where yields rose sharply in response to tapering announcement, leading to a contraction.
   - *We got the ECI reading on. . . the Friday before the November meeting—and it was very high, 5.7 percent reading for the employment compensation index for the third quarter, not annualized... And I thought for a second there whether we. . . should increase our taper. [We] decided to go ahead with what we had—what we had "socialized." Then, right after that, we got the next Friday after the meeting, two days after the meeting, we got a very strong employment report and, you know, revisions to prior readings and, and no increase in labor supply. And the Friday after that, we got the CPI, which was a very hot, high reading.*

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   - Scarred by past "taper tantrums" where yields rose sharply in response to tapering announcement, leading to a contraction.
2. Uncertainty over pandemic: Delta and Omicron
3. Politics:
   - It's a pandemic! Only tighten if you really have to.
   - Powell and Brainard reappointed in late November in May and April. They say no role, but are only human.
   - Sense that Fed has to guard its independence for the future.
4. Overconfidence in "transitory" story. Not acting as Bayesians.
5. Role of 2021 "Framework" which introduces average inflation targeting and allows for some overshooting of inflation.
   - Was this just communication or did it have actual bite?
   - Active debate over framework and whether it was a mistake.

The Return of Team Transitory

- Fed moved very aggressively in early summer 2022.
  - 0.75% rate increases very aggressive.
  - Fed Funds rate raised 4% in under a year.
- Inflationary pressures have eased, yet Fed still sees inflation as an upside risk
  - Indicating it will keep FFR around 5% for a prolonged period.
- Recently, story of transitory inflation has returned.
  - New story: We were right, just transitory inflation lasted longer. But no evidence inflation is becoming entrenched.
  - Fed should not risk a recession to fight off ghost of inflation.
- Will be a lot of research and punditry in coming years on what happened, role Fed played, and what counterfactual economy would have looked like without aggressive Fed action.
  - My view: We were getting to point where inflation could have become entrenched if Fed had not acted aggressively. Risk of stagflationary equilibrium was too high.

How Will History Judge the Powell Fed?

- Were slow from October to March, but then moved as quickly as they could – and quicker than most thought possible.
  - Consensus is has gotten things right since Summer 2022.
- How important were those 3-6 months?
  - Sense they lost control. Perception of fed is at risk.
  - Had to be more aggressive than would have if moved earlier.
  - This aggressiveness had consequences: Financial risks to moving that quickly, froze the housing market, etc.
- How history judges their actions probably depends on if they nail the "soft landing."

Reminder: Planning Problem With a $\pi - Y$ Tradeoff

$$\min_{\{i_{t+s},x_{t+s},\pi_{t+s}\}_{s=0}^{\infty}} \frac{1}{2} E_t \left\{ \sum_{s=0}^{\infty} \beta^s \left[\vartheta \left(x_{t+s} - k \right)^2 + \left(\pi_{t+s} - \pi^* \right)^2 \right] \right\}$$

subject to

$$\begin{aligned} x_t &= -\sigma E_t \left\{ \hat{i}_t - \hat{\pi}_{t+1} - \hat{r}^e_{t+1} \right\} + E_t \left\{ x_{t+1} \right\} + g_t \\ \hat{\pi}_t &= \kappa x_t + \beta E_t \left\{ \hat{\pi}_{t+1} \right\} + u_t \end{aligned}$$

- Solve in two steps
  1. Minimize objective subject to NKPC.
  2. Use IS to find interest rates consistent with optimal $\{x_{t+s}, \pi_{t+s}\}_{s=0}^{\infty}$
- Under discretion with $k = 0$, $x_t = -\frac{\kappa}{\vartheta}\pi_t$
  $\Rightarrow$ "lean against the wind policy"

The Time Inconsistency Problem

- What if CB could make promises? Would policy change? Are the promises credible, or would they want to renege on them?
- Iterating forward, we have

$$\pi_t = E_t \left\{ \sum_{s=0}^{\infty} \beta^s \left(\kappa x_{t+s} + u_{t+s} \right) \right\}$$

$$x_t = E_t \left\{ \sum_{s=0}^{\infty} \left[-\sigma \left(\hat{i}_{t+s} - \hat{\pi}_{t+s+1} - \hat{r}^n_{t+s+1} \right) + g_{t+s} \right] \right\}$$

- Central bank can reduce inflation today by *promising negative output gaps in the future*.
  - This mitigates tradeoff today.
  - But when tomorrow comes around, central bank will want to make same promise tomorrow. "Tomorrow never dies."
  - We call this a *time inconsistency problem*.

The Time Inconsistency Problem

- In general, a *time inconsistency* problem simply means that the optimal dynamic policy differs today and tomorrow.
  - Want to promise things today that then renege on tomorrow.
  - This makes any promises non-credible, motivating the discretionary policy.
- But what is the central bank could "tie itself to the mast" and commit to a rule?
  - This will bring gains.
  - Why? Because can influence expectations, and by doing so mitigate the output-inflation tradeoff.
- We will examine rules in two different cases:
  - $k > 0$
  - $k = 0$

Policy Problem With Positive Target Output Gap

- Start with $k > 0$.
  - This is the case of a "distorted steady state."
  - There are persistent inefficiencies (e.g., markups) that monetary policy would like to correct.
  - Or we have a central banker who just wants a higher than zero output gap.
  - Note: I follow CGG. Gali does differently.
- Policy problem under discretion:

$$\min_{\pi_t, x_t} \frac{1}{2}\left[\pi_t^2 + \vartheta\left(x_t - k\right)^2\right] + F_t \text{ s.t. } \pi_t = \kappa x_t + f_t$$

- Optimality condition:

$$x_t = -\frac{\kappa}{\vartheta}\pi_t + k$$

Inflation Bias

$$x_t = -\frac{\kappa}{\vartheta}\pi_t + k$$

- Plugging into Phillips (assuming $\beta = 1$ to simplify algebra)

$$\begin{aligned} \hat{\pi}_t^k &= \frac{\vartheta}{\kappa}k + \hat{\pi}_t \\ x_t^k &= x_t \end{aligned}$$

  where $\hat{\pi}_t$ and x_t are the optimal policy under $k = 0$.

- In other words, we obtain no improvement in output and higher inflation.
  - This is known as *inflation bias*.
  - It is a classic problem when $k > 0$.

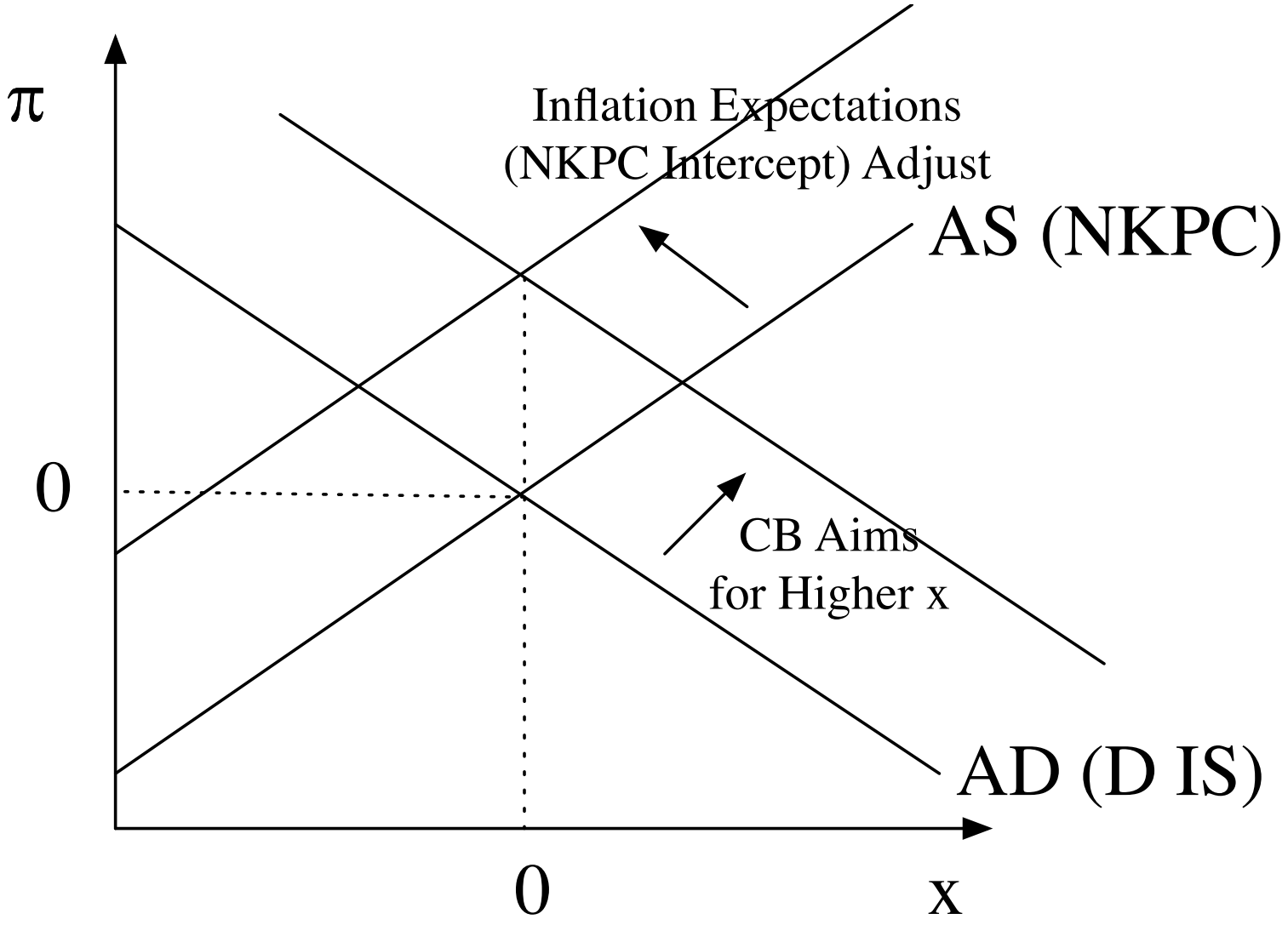
Inflation Bias: Intuition

- Phillips creates tradeoff between *unexpected* inflation and output gap:

$$x_t = \frac{\hat{\pi}_t - E_t\left\{\hat{\pi}_{t+1}\right\} - u_t}{\kappa}$$

  - Comes from increase in output gap driving up real marginal costs as nominal wage rises but price fixed so real wage rises.
  - If expect higher output gap and inflation, set higher prices in anticipation and when nominal wage rises, real wage is at "correct" level.
  - So get inflation but no output gap benefit.
- This is story of what happened in 1960s and 1970s.
  - Keynesian central bankers did not realize Phillips Curve was expectations-augmented.
  - Pursue easy monetary policy to get higher output at cost of inflation.
  - End up with stagflation: no higher output and inflation.

Inflation Bias: Diagrammatic Treatment



Into the Land of Rules

- Next class, we will consider the $k = 0$ case.
- In this case, commitment can still be useful.
  - By taking advantage of way that expectations affect output and inflation, can *improve output-inflation tradeoff*.
  - Will lead us to thinking about how rules-based monetary policy should be.