

CHAPTER FIVE

**INFLATION PAST, PRESENT,
AND FUTURE: FISCAL
SHOCKS, FED RESPONSE,
AND FISCAL LIMITS**

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As figure 5.1 reminds us, we are in the midst of an inflation surge that started in January 2021. Reaching an 8.5% inflation rate (March 2022) is unquestionably a major institutional failure, given that the Fed's first mandate is "price stability." What went wrong? What caused inflation? Will it continue, get worse, or subside? Why is the Fed reacting slowly? Will the Fed's slow reaction spur greater inflation? How will inflation end? What policies will work, and what will not?

I start by documenting the fundamental fiscal source of our current inflation. We had a \$5 trillion fiscal helicopter drop. Inflation need not have been a surprise. I also document that the Fed is, by historical standards, reacting very slowly to this inflation.

Does the Fed's slow reaction amount to additional stimulus, that will unnecessarily boost inflation beyond this initial impulse? Why do the Fed's projections indicate that inflation will fade away without sharp interest rate rises? I write a simple model that unites two views of this question. If expectations are adaptive, reacting to past inflation, then I replicate the traditional view that the Fed is horribly behind the curve and inflation will explode unless it raises interest rates swiftly. However, if expectations are forward looking, if the Phillips curve is centered on expected future inflation, then

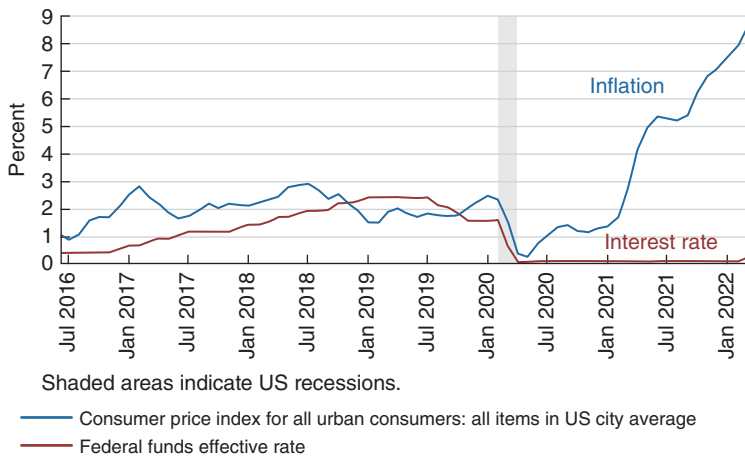


FIGURE 5.1. Inflation and Federal Funds Rate

Source: Bureau of Labor Statistics (BLS), Board of Governors via Federal Reserve Economic Data, Federal Reserve Bank of St. Louis (FRED).

I replicate the Fed's projections. Inflation may indeed fade on its own, without a period of high interest rates. The Fed's projections, and its relatively slow reaction to inflation are not, thus, inconsistent or incoherent. They come from a standard, well-developed view of the world, embodied in New Keynesian models for the last three decades. That view is also consistent with the zero-bound experience. By writing a model that encompasses Fed and traditional views, we can understand underlying assumptions and more productively debate which is right.

Next, I ask, how long will inflation persist? One might think that once the fiscal or monetary stimulus is over, inflation will end. I show that with sticky prices, inflation has considerable persistence. This persistence holds even with totally forward-looking sticky prices—it does not require indexation, slow pass-through, or other sources of momentum, although those features add to inflation persistence. The Fed's projections imply relatively flexible prices, a steep Phillips curve. With somewhat stickier prices, then, inflation can continue a good deal longer than the Fed's projections.

I then consider how Fed reaction might tame inflation. Given that inflation was sparked by fiscal policy, given the large amount of debt outstanding, and given persistent primary deficits, fiscal constraints on monetary policy and monetary-fiscal coordination will be crucial to answer this question.

I document a form of “unpleasant arithmetic” in interest-rate-based economic models. With no change in fiscal policy, by raising interest rates the Fed can lower inflation now, but only by raising inflation later. Rather than a short spike of inflation, the Fed can produce a longer period of moderate inflation. Such smoothing is valuable, and lowers the output impact of a fiscally inevitable inflation.

However, this discussion presumes there are no further shocks. War, a resurgent pandemic, or financial trouble can always boost inflation beyond such forecasts.

I then ask, what will it take to durably disinflate? Suppose, either by present dynamics or future shocks, we get to 1979. Can we and must we repeat 1980? Could it be worse this time? Or are there better options? Fiscal constraints will make a disinflation harder this time. In 1980, the debt-to-GDP ratio was 25% and the entitlement crisis was decades away. Now the debt-to-GDP ratio is 100%, the underlying inflation is more clearly fiscal, and we face large structural deficits and looming entitlements. Raising interest rates will increase debt service costs, and lower inflation will require a bondholder windfall. I show that without coordinated and durable monetary, fiscal, and microeconomic reform, a purely monetary stabilization will fail.

On the other hand, the lessons of the ends of hyperinflations, the lessons of the inflation target episodes, and the insights of economics since the 1980s suggest that such a stabilization can be much less painful than 1980.

However, once fiscal shocks are past, the very-long-run price level always remains in the Fed’s control.

WHERE DID INFLATION COME FROM?

In my view, the underlying source of the current inflation is straightforward: Our government printed about \$3 trillion in extra money, and sent it out as checks. It borrowed another \$2 trillion and sent more checks. (The figures are taken from Cochrane 2022a and Cochrane 2022b, which explore the argument in more depth.) It was a classic helicopter drop. Figure 5.2 illustrates these events.

It was a *fiscal* helicopter drop. Imagine that the Fed had increased the monetary base by \$3 trillion, by buying existing debt, and there was no deficit. Surely that would not have had the same effect. Inflation comes from the vast expansion in the overall amount of government debt, not just from a mistaken composition of that debt; not from too much overnight debt (reserves) and not enough longer-term debt (Treasury debt). Contrariwise, imagine that the Treasury had sent people shares in a mutual fund backed by Treasury debt, with thereby no direct increase in reserves or M2. Surely that would have had much the same effect.

This is not an outlandish view, nor one only available with 20/20 hindsight. For example, Summers (2021) wrote presciently the same view in early 2021. So did Cochrane and Hassett (2021), but our view is much less influential. Summers changed his mind from a decade of advocacy for greater fiscal stimulus in order to beat “secular stagnation.” His analytical framework was disarmingly simple: Multiply the deficit by something like 1.5, compare it to any reasonable estimate of the GDP gap, and you see inflation coming.

The reigning alternative theory is that inflation came from a “supply shock.” Much of this discussion confuses individual supply curves and relative prices with aggregate supply curves and overall inflation. A supply shock can raise the price of affected goods relative to others, and prices relative to wages. It does not raise all prices and wages together. At least not directly. One has to work the supply shock into a Phillips curve. It has to become part of the wage

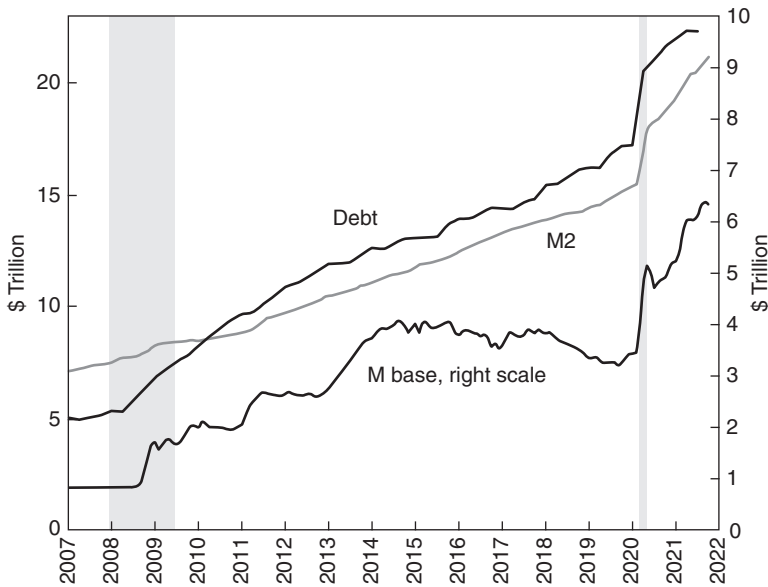


FIGURE 5.2. Money and Debt in the COVID Recession and Aftermath

Source: Reproduced from Cochrane (2022b).

and price stickiness of the economy. The obvious story—it’s hard to import chips so the price of chips goes up, causing inflation—is wrong. A shift in demand from services to goods raises the price of the latter, but lowers the price of the former.

There is nothing unusual about the interest-rate part of monetary policy until inflation broke out in January 2021. It’s hard to make a case that interest rate policy *sparked* this inflation.

“Monetary policy” is responsible to the extent that the Fed participated in the creation and helicopter drop of \$3 trillion of reserves. Here, one may fault the Fed along with the Treasury for misdiagnosing the recession as a “demand” shortfall, rather than the “supply” effects of the pandemic. Restaurants were not closed because people didn’t have enough money to go out to dinner, but because a pandemic was raging. Likewise, once the pandemic eased, the economy bounced back faster than any previous recovery. It was

the economic equivalent of a snowstorm, not a repetition of 1933 on a grand scale. Here, one may fault the Fed for not “normalizing” interest rates more quickly; or for not following a Taylor rule that reacts more promptly to unemployment. But this is really just a restatement of the joint fiscal-monetary shock view of what got inflation going.

Shocks and Forecasts

The Fed’s failure to control inflation was undeniably partly due to a failure of perception: The Fed failed to see inflation coming, and through the year 2021, the Fed failed to see that inflation would endure.

But whether the cause was fiscal policy or pandemic-related supply shocks, inflation was not *unknowable*. The fiscal shock was known. Pandemic-induced supply shocks should not surprise the largest and most sophisticated inflation-forecasting institution in the world. If the Fed was surprised that TVs could not get through the ports, it wasn’t looking.

If inflation was indeed foreseeable—whether it came from a supply shock or from fiscal stimulus that ran into the aggregate supply constraint—clearly the Fed’s inflation forecasting procedures need to think harder about what external shocks can cause inflation, where supply constraints are, and monitor their state. Summers suggests that the Fed, like any other institution suffering a major failure, begin a formal after-action inquiry into just what is wrong with its forecasting procedures.¹ The Fed seems uninterested in that project, but it is open to us.

1. “Soft Landing: Larry Summers on Inflation, Debt and a Looming Recession,” an interview with John H. Cochrane, Niall Ferguson, H.R. McMaster, Bill Whalen, and Larry Summers on *GoodFellows: Conversations from the Hoover Institution*, April 13, 2022, <https://www.hoover.org/research/soft-landing-larry-summers-inflation-debt-and-looming-recession>.

Perhaps inflation *was* unknowable, and those of us who forecast it just got lucky. Perhaps six percentage point forecast errors are inevitable. In that case, the Fed should be rethinking its procedures to rely less on projections and more on timely real data. Why is the Fed speaking confidently today of policy based on its projections for inflation, given the massive failure of those projections only last year?

IS THE FED BEHIND THE CURVE?

The main issue for Fed policy in the last year and today is not root cause or shock, and not its failure to forecast inflation and react ahead of time, but whether its slow response is making inflation worse. The issue is largely whether the Fed should have, and should still react more and more promptly to observed inflation, no matter what is the shock that set inflation off.

A Slow Response

By historical standards, the Fed is moving quite slowly. Inflation broke out in February 2021. The March 2022 CPI was 8.5% and core CPI was 6.5%. Yet the Fed waited until March 2022, budging the interest rate up to 0.33%, moving again in May with an additional half a percentage point.

The Fed is even slow by contrast with the late 1960s and 1970s, as shown in figure 5.3. In each of the four surges of inflation, the Fed raised interest rates one-for-one or more with inflation. The 1970s Fed is generally criticized because it *only* raised rates one-for-one. But even in the 1970s, the Fed never waited a whole year, or let inflation get 8% above the federal funds rate. In the four tightenings since 1980, the Fed raised interest rates promptly and more than one-for-one with inflation.

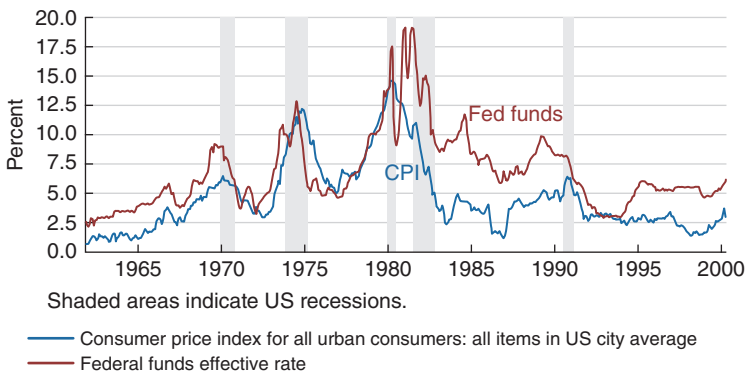


FIGURE 5.3. Inflation and Federal Funds Rate in the 1970s

Source: BLS, Board of Governors via FRED.

The Fed is even slow by comparison with its last tightening starting in 2016, shown in figure 5.1. In that event, the Fed started gently tightening as inflation broke its 2% target, with a view that low unemployment might signal inflation ahead. The Fed now sees that event as its institutional failure, because inflation did not break out. The event provoked the Fed’s strategy change to average inflation targeting with forward guidance. I remain puzzled by this reaction. Why does the Fed not declare that its prescient tightening forestalled inflation, and pat itself on the back for a perfect soft landing?

Why did the Fed react so slowly in 2021–22? In part, the Fed clearly misperceived inflation and thought inflation would go away on its own, despite the experience with “transitory” and “supply” shocks in the 1970s. In part, the Fed may have been worried about its reputation. Having made forward guidance promises not to raise rates, having announced a new strategy focused on employment and waiting for a long time to react to inflation, the Fed would have looked foolish if it abandoned that strategy quickly. Perhaps the new strategy was a grand Maginot Line exquisitely constructed to combat deflation, but like the original lacking a contingency plan for an unexpected attack from a different direction. If so, moving to state-based rather than time-based guidance, adding that contingency

plan—doing any contingency planning for unforecasted outcomes rather than making projections and acting as if they are known—and rethinking the strategy are in order.

But I want to consider a different, radical possibility. Perhaps reacting slowly makes sense given the Fed's current view of the economy, which is shared by the equations of essentially all modern macroeconomic models. (I write "the equations," as authors' intuitive views are often quite different from the equations of the models.)

A Model Justifying Slow Response

Does the slow response matter? History provides us with the Fed's past habits, but not with counterfactuals. Suppose inflation broke out for whatever reason; fiscal shocks or supply chain shocks. Suppose that "stimulus" or shock is over. Will the Fed's historically slow *response* act as additional monetary stimulus, driving up inflation even further? When we look for reasons for the Fed's slow action, must we jump immediately to its failure to see inflation emerge to a policy mistake? Yes, if the slow response spurs more inflation, but perhaps not if there is a sensible view of the world in which the Fed's slow reaction does *not* spur inflation ever higher. There is.

What does the Fed think will happen? Figure 5.4 presents the Fed's projections from the March 15, 2022, outlook.²

This projected scenario is dramatically different from a repetition of the 1970s with surging inflation, or of 1980 in which inflation went away after a sharp rise in interest rates. *The Fed believes inflation will almost entirely disappear on its own, without the need for any period of high real interest rates to bring inflation down.*

The Fed's inflation projection continues through 2022 and a bit into 2023. Thus, we cannot understand the Fed's projections as simply a onetime price level shock, a view that expected future

2. Board of Governors of the Federal Reserve System, "March 16, 2022: FOMC Projections," accessible at: <https://www.federalreserve.gov/monetarypolicy/fomcprojtable20220316.htm>.

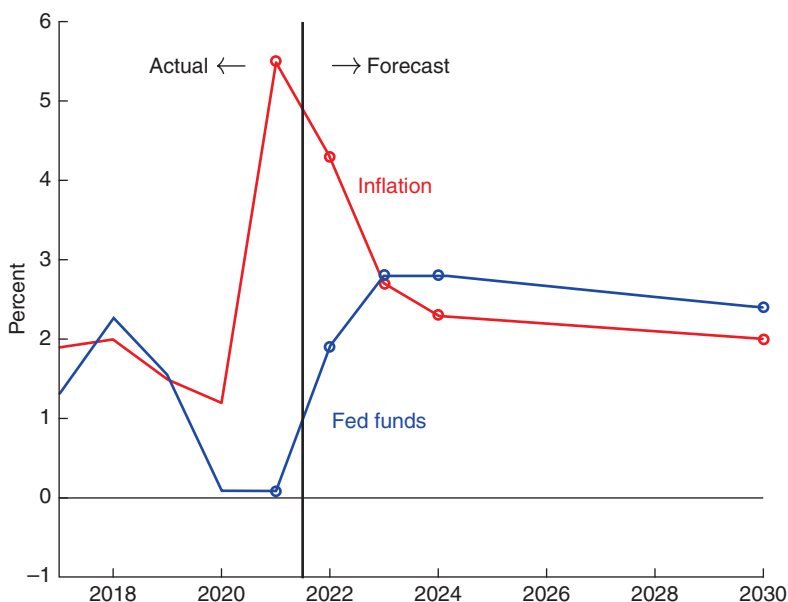


FIGURE 5.4. Federal Reserve Projections March 15, 2022. I plot the Fed's "Long-Run" Projection at 2030.

Source: Federal Reserve, March 16, 2022: FOMC Projections materials, accessible version at: <https://www.federalreserve.gov/monetarypolicy/fomcprohtable20220316.htm>.

inflation has not moved so the Fed can leave the nominal interest rate alone and the true real rate of interest, measured by expected future inflation, will not be that low. We cannot say that the Fed is following a Taylor rule that responds to expected future inflation rather than past inflation, $i_t = \phi E_t \pi_{t+1}$, and the Fed just happens not to forecast any future inflation. (As natural as such a rule may sound, it has some unpleasant dynamic properties. The conventional Taylor rule responds to current inflation for a reason.)

Before we make too much fun of the Fed's projections, note the market seems to believe much the same thing—this period of interest rates below inflation will not stoke further inflation. Figure 5.5 presents the 5-year Treasury and 5-year breakeven rates. If anything, the recent rise in Treasury and breakeven rates seems most

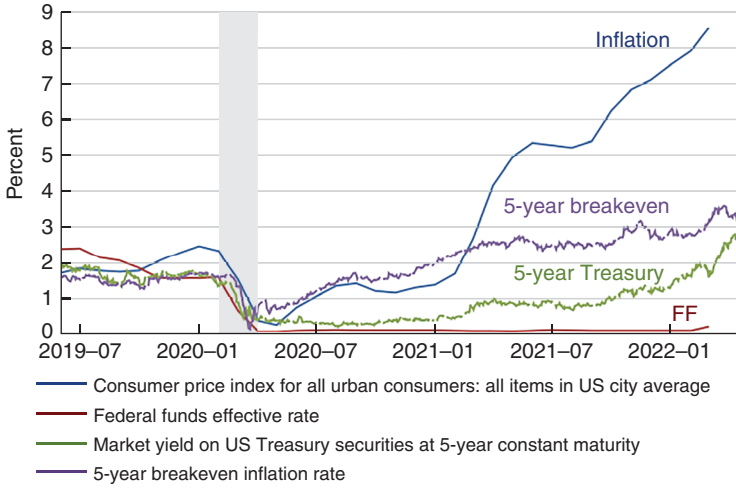


FIGURE 5.5. Market Forecasts

Source: BLS, Board of Governors via FRED.

likely to be a reaction to the Fed's announcements that it is going to start raising interest rates, and is not connected to inflation. Professional forecasters' job may be to forecast the Fed's forecasts in order to forecast interest rates, not actually to forecast inflation.

Where does the Fed's projection come from? What logic does the Fed use? Might it be right?

To address this question, I write a simple model, consisting of a static IS curve and a Phillips curve (Cochrane 2022b, section 17.1.):

$$x_t = -\sigma(i_t - r - \pi_t^e) \quad (1)$$

$$\pi_t = \pi_t^e + \kappa x_t \quad (2)$$

where x =output gap, π =inflation, i =interest rate, and r =steady state real rate. There are two variants: adaptive expectations $\pi_t^e = \pi_{t-1}$ and rational expectations $\pi_t^e = E_t \pi_{t+1}$. A model with a dynamic IS curve gives much the same result, but I can solve the simpler model with a line or two of algebra.

The model's equilibrium condition is

$$\pi_t = -\sigma\kappa(i_t - r) + (1 + \sigma\kappa)\pi_t^e. \quad (3)$$

With adaptive expectations the equilibrium condition is

$$\pi_t = (1 + \sigma\kappa)\pi_{t-1} - \sigma\kappa(i_t - r).$$

With rational expectations, the equilibrium condition is

$$E_t\pi_{t+1} = \frac{1}{1 + \sigma\kappa}\pi_t + \frac{\sigma\kappa}{1 + \sigma\kappa}(i_t - r).$$

I calculate unemployment via Okun's law as $u_t = 4 - 0.5x_t$.

Now, fire up each model, start with last year's 5.5% inflation, put in the Fed's projected interest rate path, and let's see what inflation comes out.

The top panel of figure 5.6 plots the result for the adaptive expectations model. I think this model captures the widespread intuition behind Fed criticism. Wherever it came from, the inflation shock creates a period of negative real interest rates as long as the Fed does not move. A negative real interest rate boosts inflation further, and around we go. If the Fed follows its current trajectory, inflation spirals out of control. Eventually, of course, the Fed will give in, raise rates in a hurry, and cause a large recession, something like a repetition of 1980 or worse.

The bottom panel of figure 5.6 makes the same calculation with rational expectations. The inflation that defines the real rate in the IS and Phillips curves is now the next period's expected inflation. Picking $\sigma = 1$, $\kappa = 0.5$, I match quite well the Fed's forecasts. The Fed, and markets, seem to believe the rational expectations, New Keynesian version of the model.

The central intuition comes down to the Phillips curve: Hold the unemployment rate and output gap fixed, and recognize we are in a bit of a boom, with positive output gap x and below-natural

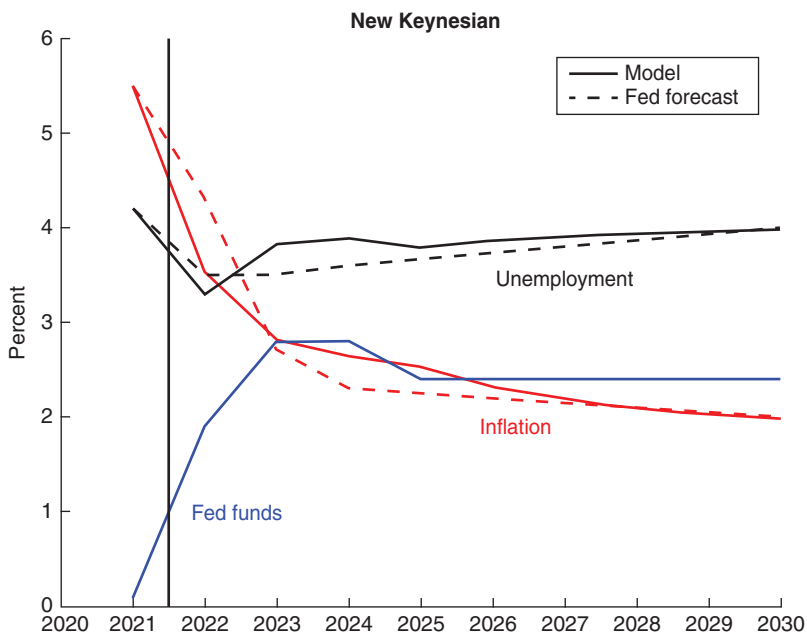
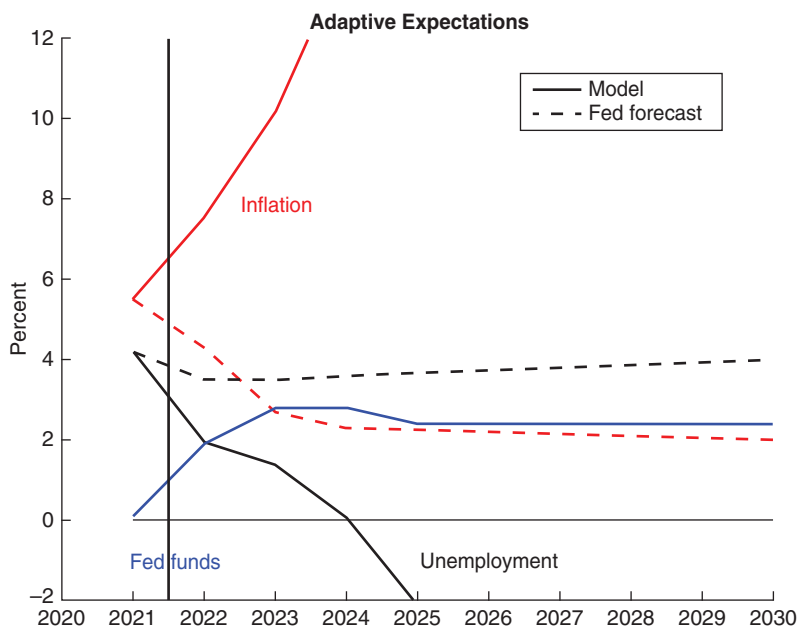


FIGURE 5.6. Fed Projections and Model Forecasts Given the Projected Funds Rate
Source: Author's calculations.

unemployment. In the adaptive expectations model, $\pi_t = \pi_{t-1} + \kappa x_t$, output is high when inflation is high *relative to past inflation*. Output is high when inflation is *increasing*. In the rational expectations model, $\pi_t = E_t \pi_{t+1} + \kappa x_t$, output is high when inflation is high *relative to expected future inflation*. Output is high when inflation is high but *decreasing*. That's the Fed's view of the current situation.

By starting this impulse-response function with observed 2021 inflation, I avoid all the initial condition and equilibrium selection issues of New Keynesian models, and the New Keynesian vs. Fiscal Theory question. If we ask any model for the response to any shock, there is a big issue of how does inflation react at the moment of the shock. But we observe that response, 5.5%. So now we can compute the rest of the projection (impulse-response function) taking this initial inflation response from the data, and neatly avoid all those controversies.

The rational expectations logic works from future to past. If people expected really high inflation in the future, then inflation would be even higher today. The fact that inflation was *only* 5.5% in 2021 despite low unemployment tells us that people expected less inflation in 2022 and beyond.

This is really the core issue. Forward-looking or rational expectations mean that we solve models backwards in time, that today's inflation reveals expectations of tomorrow's inflation, just as today's stock price reveals expectations of tomorrow's stock price. Unwillingness to follow that logic accounts for most of the divergence of opinion about Fed policy.

Figure 5.7 presents the point in another way: To attain the Fed's projected path for inflation, starting with 5.5% inflation in 2021, what *should* the interest rate projection be? To make this calculation, I solve the equilibrium condition (see equation 3 above) for the interest rate

$$i_t = r + \frac{1 + \sigma\kappa}{\sigma\kappa} \pi_t^e - \frac{1}{\sigma\kappa} \pi_t.$$

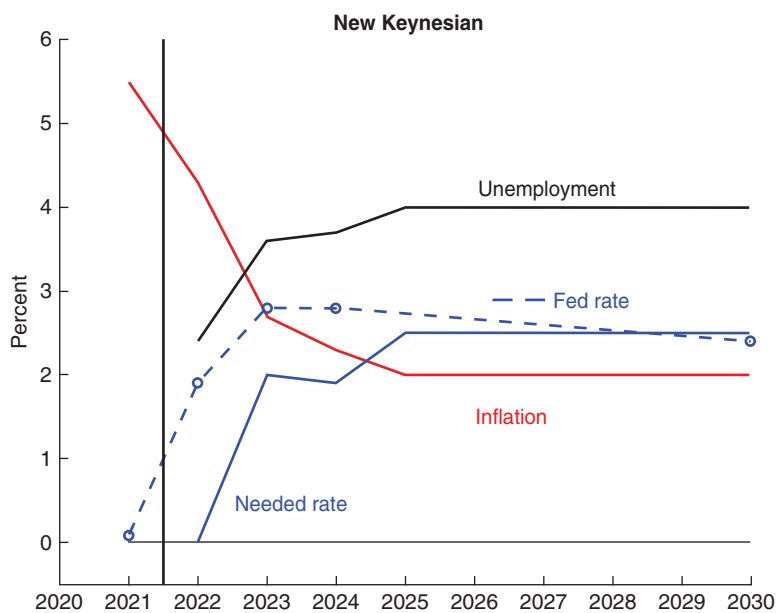
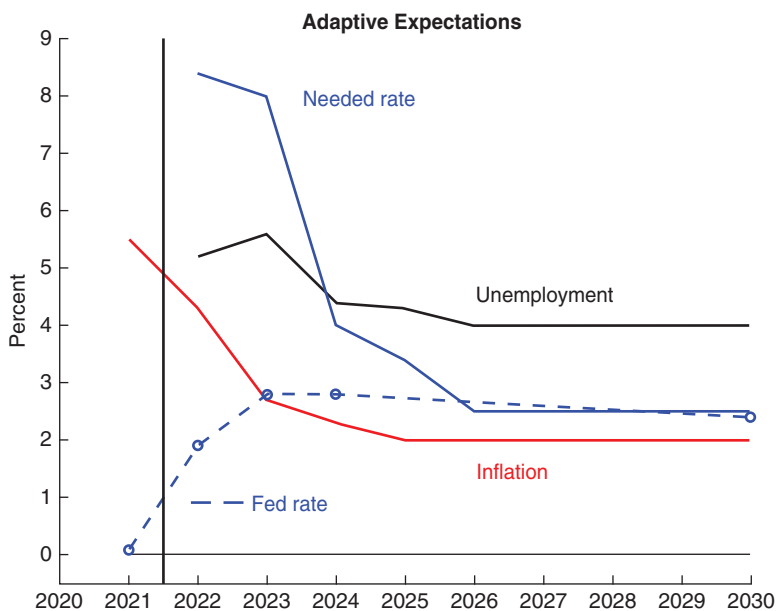


FIGURE 5.7. Interest Rate Path Needed to Attain the Fed's Inflation Target
 Source: Author's calculations.

Then I use the Fed's inflation forecast for π_t and π_t^e , the latter either one period ahead or one period behind.

The top panel of figure 5.7 shows that in the traditional adaptive expectations version of the model, we need sharply higher, Taylor-rule-style interest rates, 8.5%, not the Fed's projected 2%. Those higher nominal rates create higher real rates, which bring inflation down. They also cause a recession, with unemployment rising over the 4% natural rate. The recession is not so bad in my plot, because the simulation starts at last year's personal consumption expenditures (PCE) inflation, 5.5%, not, say, the March 2022 8.5% inflation, or the 10% or 12% inflation that figure 5.6 says will break out by 2023 if the Fed continues to move slowly. The recession is also mild because the model is incredibly simplified, and because I chose quite a low price-stickiness parameter (high κ) in order to fit the rather surprising speed of the Fed's projected return to normal in the rational expectations version of the model. Larger initial inflation, a larger price-stickiness parameter designed to fit the world with this model, and a more detailed model, can easily deliver a much worse recession.

By contrast, the New Keynesian model says that in order to hit the Fed's inflation forecast, interest rates can stay low, and indeed a bit lower than the Fed projects. And that path is perfectly consistent with unemployment slowly reverting to the natural rate, a soft landing.

All of these graphs are projections, forecasts, impulse-response functions. They assume that whatever "shock" started up inflation is over. They assume no additional "stimulus" will come from external events. Such events would be reflected in disturbances to the model's equations. The actual future course of inflation also depends on what future shocks hit us—continued fiscal stimulus, supply shocks due to war, government policy, and so forth.

Are the Fed's (Implicit) Beliefs Nutty?

No. There is a more serious debate to be had here than is often acknowledged. By writing a model that captures both traditional and Fed analysis, we can have a productive debate. We know the underlying assumption, and the key theoretical question we need to debate: *How forward looking are expectations?*

Do bond markets ($i_t = r_t + E_t \pi_{t+1}$) set rates based on forward-looking or backward-looking inflation expectations? Do price-setters and wage-setters ($\pi_t = E_t \pi_{t+1} + \kappa x_t$) do so? Does the Phillips curve shift based on past inflation or expected future inflation? Do people making consumption and investment decisions ($x_t = E_t x_{t+1} - \sigma r_t$) use forward-looking or backward-looking expectations to judge the rewards to saving and the cost of capital? If forward looking, what model of the world or forecast do they use?

Surely, permanent, exploitable, immutable, mechanically adaptive expectations in all these settings died in the mid-1970s. New Keynesian rational-expectations models have been around since the early 1990s. They are the standard workhorse of central banks and academic monetary policy analysis. Having a rational expectations view is, at least, not outlandish or incoherent.

On the other hand, it is hard to insist on perfectly forward-looking behavior, and especially rational expectations of the effects of novel shocks (\$5 trillion of helicopter money, a pandemic, lockdowns, and so forth). Empirical Phillips curves contain at least some backward-looking terms, which may also reflect wage indexation. Some new research tries to put less-than-rational expectations into New Keynesian models, in order to rescue something like traditional beliefs, though at the cost of substantial mathematical complexity. (García-Schmidt and Woodford 2019, Gabaix 2020; on the latter, see Cochrane 2016.)

As figure 5.6 emphasizes, the question, *How forward looking are expectations* is related to a deeper one: *Is the economy stable*

or unstable under an interest rate peg, or a target that moves less than one-for-one with inflation? Is the Taylor principle necessary for stability (nonexplosive dynamics), or does it just reduce volatility (variance)? The answers are not obvious.

If the answers to these questions seem obvious, consider the experience of the zero-bound era, plotted in figure 5.8. The same logic that predicts an inflation spiral today, starting from a period of inflation, predicts a deflation spiral starting from a deflationary shock. More generally, the same logic predicts that if the interest rate does not move in response to inflation, then inflation must spiral in one direction or another. Many commenters predicted such a spiral during the zero-bound era, loudly and correctly, with this model in mind. It never happened. Interest rates did not move, for years on end, and could not move in the downward direction, yet the deflation spiral never broke out. This model failed a test as clear as we get in macroeconomics. (See Cochrane 2018 for much on this point.)

Perhaps central banks have internalized the zero-bound experience. If the widely forecast *deflation* spiral never broke out at the zero bound, why should they worry about the analogous *inflation* spiral now? The spiral prediction cried wolf.

In sum, the Fed's forecasts and its slow response are not necessarily nutty, rosy scenarios, failures to act, politically convenient denial, and so forth. Before criticizing based on the standard adaptive expectations model, let us at least acknowledge that there *is* a model that makes sense of the Fed's forecasts, that model's equations have dominated academic macroeconomics for 30 years, and they make sense of the zero-bound experience. Now, we can debate if that model is right, or will be right in this instance. We can now debate its predictions by examining its assumptions and its ability to fit other episodes.

My opinion—or at least a compromise view consistent with theory and evidence—is that the economy is stable in the long run,

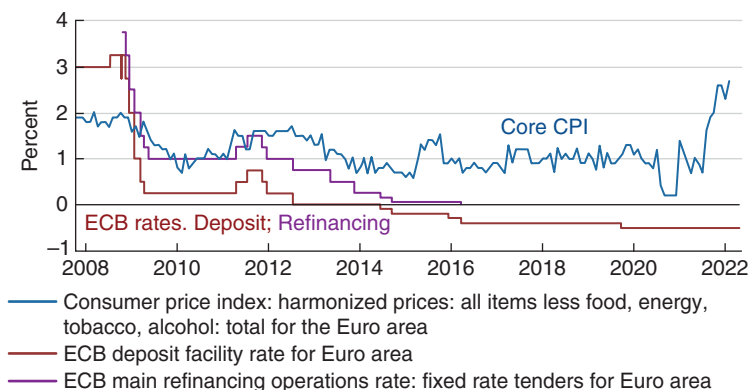
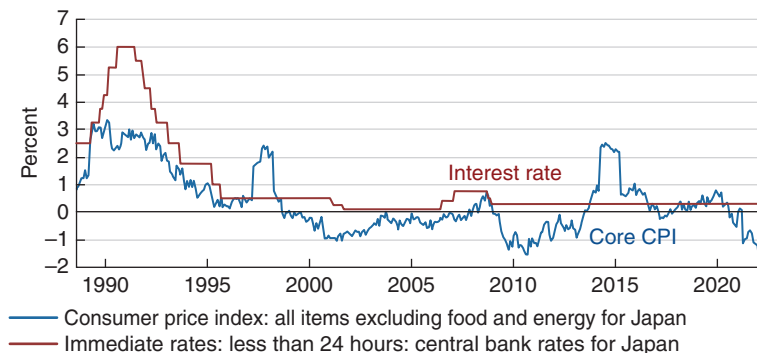
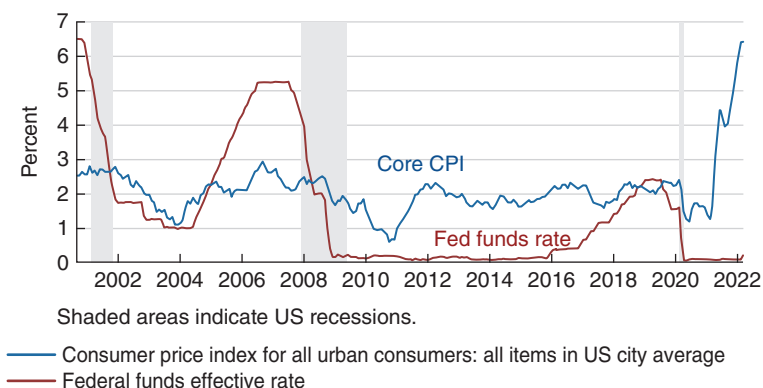


FIGURE 5.8. Core CPI and Federal Funds Rate in the Zero-Bound Era: US, Japan, and Europe

Source: BLS, Board of Governors, Organisation for Economic Co-operation and Development (OECD), European Central Bank (ECB) via FRED.

and the long-run predictions of the rational expectations model are right. Rational expectations are also right on average, which was always the central point: the Fed can fool people a few times, but once it gets in the habit of exploiting adaptive or other nonrational expectations as a matter of systematic policy, people catch on. Rational expectations are more likely in times of high and variable inflation when people pay more attention. Rational expectations are more likely as a description of policies that last a long time. A decade of high interest rates to fight volatile inflation is more likely to feature forward-looking expectations, while a few initial months of a onetime shock may leave people puzzling about what to expect. Expectations may not have moved fully this time, but don't expect that to be a robust, permanent, exploitable, and reliable feature of the economy.

However, there is also a substantial and temporarily negative effect of interest rates on inflation. Such an effect is not captured by my little model, but is captured by more elaborate models, even with fully rational expectations. An example follows.

Central banks can temporarily push down inflation by high interest rates, and do so. That short-run negative effect is more visible in historical episodes such as 1980 than the subtle long-run positive effect that we only see in rare occasions such as the zero-bound era when interest rates do not move for years on end. So it is possible that both sides are right; that failing to act promptly will not lead to an unlimited inflation spiral, though inflation may well get worse before it gets better, and that the Fed could lower inflation in the near term with interest rate increases.

For the rest of this paper, I adopt the New Keynesian rational-expectations version of the model. I adopt it as a working hypothesis, not immutable truth. Let us figure out what it says about how inflation will evolve, what the effects are of Fed policies, and how inflation might be ended if it gets out of control. I also adopt as a working hypothesis the view that fiscal constraints matter now as they

might not have mattered in the past, that the Fed cannot call on an unlimited amount of fiscal tightening to support its monetary policy efforts. The fact that this inflation was sparked by fiscal policy, and the fact of large debts and ongoing deficits means that we will have to pay more attention to fiscal-monetary policy coordination than in the past.

INFLATION PERSISTENCE AND UNPLEASANT ARITHMETIC

How long will inflation last? Even granting the Fed's rational expectations view, the dynamic response to sticky prices gives a certain momentum to inflation. It is *not* true that once you remove the stimulus, inflation stops on a dime.

A related question is: How does inflation respond dynamically to a fiscal shock? The standard New Keynesian model posits passive fiscal policy, implying there is no such thing as a fiscal shock. Here I adapt that model to include a fiscal shock, and study the persistence of that shock.

What happens in the Fed's (implicit) rational expectations New Keynesian model if the Fed does wish to tame inflation by substantially raising interest rates? This is a standard question, but I add a wrinkle: Suppose that the Fed cannot count on a "passive" fiscal response that produces abundant fiscal surpluses in response to Fed policy. We shall see a form of unpleasant arithmetic emerge.

Response to a Fiscal Shock

I use the most standard New Keynesian model, this time with a full dynamic IS curve:

$$x_t = E_t x_{t+1} - \sigma(i_t - E_t \pi_{t+1}) \quad (4)$$

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t \quad (5)$$

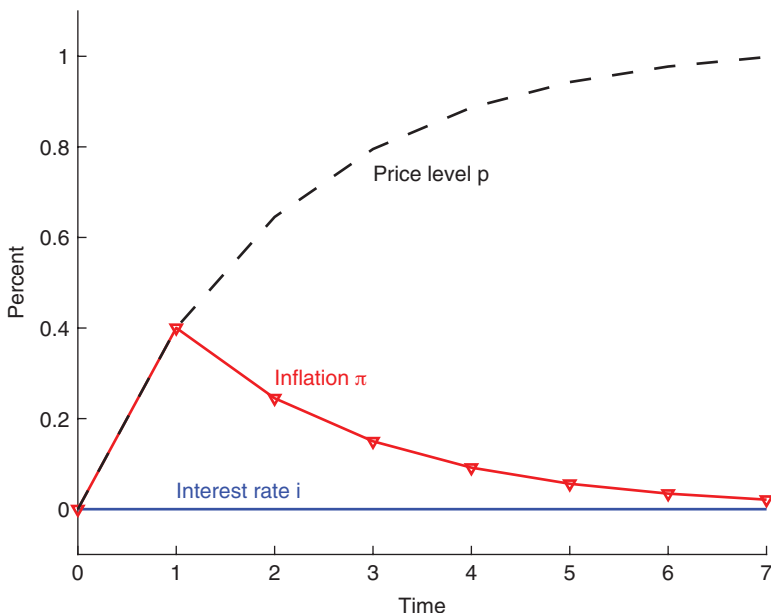


FIGURE 5.9. Response to a Deficit Shock Equal to 1% of Outstanding Debt: Sticky Prices with No Monetary Policy Response

Parameters $\sigma = 1$, $\kappa = 0.25$, $\beta = 0.99$, $\rho = 0.98$.

Source: Author's calculations.

Figure 5.9 presents the response of inflation to a shock that leads to an eventual 1% rise in the price level. That response is given analytically by

$$\pi_t = (1 - \rho\lambda_1^{-1})\lambda_1^{-(t-1)} \quad (6)$$

where

$$\lambda_1 = \left[(1 + \beta + \sigma\kappa) + \sqrt{(1 + \beta + \sigma\kappa)^2 - 4\beta} \right] / 2.$$

I interpret the shock below as a fiscal shock, as I believe we have experienced. But as before, this is the response to any shock, including a “supply shock” in the Phillips curve, that leads to 0.4% initial inflation and then goes away. It is the same calculation as above using the simpler model. It thus makes a few points immediately:

First, the essence of the simple model calculation does in fact hold with the standard dynamic IS curve (equation 4). Even if the Fed does nothing, inflation slowly goes away on its own. The standard New Keynesian model is *stable* under an interest rate peg.

Second, sticky prices lead to a drawn-out inflation, even though the shock ends in the first period. It is *not* true that once the “stimulus” ends, inflation goes away *quickly* on its own. Thus, we have a second quantitative question facing our evaluation of the Fed’s benign inflation projections: *How sticky are prices? How steep is the Phillips curve?*

To fit the Fed’s projections with the simple model in figure 5.6, I chose $\sigma = 1$, $\kappa = 0.5$. Using Okun’s law, and holding constant expected future inflation, those parameter values mean that a 2% output gap corresponds to 1 percentage point unemployment and 1 percentage point more inflation, a 45° slope to the Phillips curve. That’s pretty steep, or pretty price flexible. Figure 5.9 doubles price stickiness to $\kappa = 0.25$. That means 1 percentage point of unemployment means 0.5 percentage points of inflation, holding fixed future inflation, a flatter Phillips curve. Together with the full model dynamics, you see that figure 5.9 predicts much longer-lasting inflation than figure 5.6.

How steep is the Phillips curve? Well, in the 2010s, we observed very high unemployment, and then a slow, steady, and large decline in unemployment, with very little movement of inflation. Even unemployment equal to its current 3.6% in late 2019 did not spark any inflation. People wrote papers about how amazingly flat the Phillips curve was. Prices seemed very sticky. Now, we have just seen inflation rise from 2% to 8.5% with little movement in a very low rate of unemployment. It seems prices are very flexible, and the Phillips curve is steep. Which is it? Perhaps the Phillips curve is somehow state dependent. The Calvo fairy visits more often in Argentina. Perhaps the whole Phillips curve concept is garbage, a cloud of points not a curve of any slope. Perhaps inflation dynamics

don't have that much to do with output and employment. Perhaps we should move to a search-theoretic model of labor market (Hall and Kudlyak 2021), with more detailed, real-business-cycle-style modeling of aggregate supply.

Third, the calculation of figure 5.9 allows a concrete description of what I mean by a “fiscal shock,” and how it sets off inflation. Recognize the fiscal side of the model (equation 4)–(equation 5), the evolution of government debt,

$$\rho v_{t+1} = v_t + i_t - \pi_{t+1} - \tilde{s}_{t+1}. \quad (7)$$

Here, v is the real value of one-period nominal debt, \tilde{s} is the real primary surplus divided by the steady state value of debt, and ρ is a constant of approximation slightly less than one, which may be taken as $\rho = e^{-r}$ where r is the steady state real rate. Real government debt rises when the real rate of return $i_t - \pi_{t+1}$ is high, and declines when surpluses relative to debt \tilde{s}_{t+1} are high.

We can unite equation 7 with the rest of the model and solve by the usual matrix method. Or, we can solve it forward separately. Iterating equation 7 forward, taking the innovation $\Delta E_{t+1} \equiv E_{t+1} - E_t$, and imposing the transversality condition $\lim_{T \rightarrow \infty} E_t \rho^T v_{t+T} = 0$, we have

$$\Delta E_{t+1} \pi_{t+1} = -\Delta E_{t+1} \sum_{j=0}^{\infty} \rho^j \tilde{s}_{t+1+j} + \sum_{j=1}^{\infty} \rho^j (i_{t+j} - \pi_{t+1+j}). \quad (8)$$

The innovation to inflation equals the innovation to the discounted present value of surpluses.

To produce figure 5.9, I assume that the surplus takes a onetime unexpected move, $\tilde{s}_1 = -1$. This is a one percentage point change in the ratio of surplus to value of debt, which at a 100% debt-to-GDP ratio is also a one percentage point change in the ratio of surplus to GDP. We get the same result whether the change is to current or expected future surpluses; it is a one percentage point change in

$$\sum_{j=0}^{\infty} \rho^j \tilde{s}_{1+j}.$$

The graph thus can model the response to the event we saw: a \$5 trillion, 25% of GDP, 30% of initial debt, onetime shock to deficits. In this way of thinking, however, the big unknown is, how much do people expect the initial deficit \tilde{s}_1 to be repaid by higher subsequent surpluses \tilde{s}_{1+j} ? If people expect all of the initial deficit to be repaid, there is no fiscal shock at all. If people expect none of it to be repaid, then the shock to the sum on the right-hand side of equation 8 is equal to the initial deficit. Reality lies in between.

However, again, we *observe* the initial inflation, 8.5%. That fact allows us to *infer* the size of the fiscal shock, and thus how much eventual inflation we will have.

If prices were not sticky at all, then the fiscal shock leads to a onetime price level jump equal to the fiscal shock. The 10% cumulative inflation from May 2021 to March 2022, of which about 8% is unexpected, means that people expect that, of the 30% increase in debt, roughly 22% would be repaid by subsequent surpluses, and 8% would not; inflation thus ate away 8% of the debt.

But prices are sticky. In figure 5.9, for a 1% shock to the sum of surpluses, the *total* rise in the price level is the same, 1.0%, but it is spread over time.

Now, again, we observe initial inflation, not the size of the fiscal shock. If this graph is right, we have a good deal of inflation left to go. The first year only produces about 40% of the total eventual price level rise. In this model, people do not expect the majority of the \$5 trillion deficit, 30% of debt, to be repaid. The total price level rise will be about 20% (8% divided by $0.4 = 20\%$).

With price stickiness, the fundamental story of a fiscal shock changes. In a flexible price model, we digest the plot simply: unexpected inflation and an unexpected onetime price level increase lowers the real value of outstanding debt, just as would a partial default. But this model still maintains one-period debt, so a slow expected inflation cannot devalue debt. Instead, with sticky prices there is a long period of negative real interest rates—as we are observing in

reality. This period of negative real interest rates slowly lowers the real value of government debt. With sticky prices, even short-term bondholders cannot escape inflation, even a slow predictable inflation.

In the accounting of equation 8, the second term is a discount rate term. Lower real interest rates are a lower discount factor for government surpluses and raise the value of debt, which is an anti-inflationary force. Equivalently, lower real interest rates give a lower interest cost of the debt, that acts just like lower deficits to reduce initial inflation.

That price stickiness draws out the inflationary response to a fiscal shock is perhaps not that surprising. Many stories feature such stickiness, and suggest substantial inflationary momentum. Price hikes take time to work through to wages, which then lead to additional price hikes. Housing prices take time to feed into rents. Input price rises take time to lead to output price rises. But such common stories reflect an idea of *backward-looking* price stickiness. The Phillips curve in equation 5 is entirely forward looking. Inflation is a jump variable. Indeed, in the standard New Keynesian solutions, inflation can rise instantly and permanently in response to a permanent monetary policy shock, with no dynamics at all. (Add $i_t = \phi\pi_t + u_t$, $u_t = 1.0u_{t-1} + \varepsilon_{i,t}$ and inflation, and interest rates move equally, instantly, and permanently in response to the shock.) Nonetheless, sticky prices draw out dynamics.

One might well add such backward-looking terms, e.g.,

$$\pi_t = \alpha\pi_{t-1} + \beta E_t \pi_{t+1} + \kappa x_t$$

and such terms are often used (Cogley and Sbordone 2008). These terms can add a hump-shaped response and spread the inflation response to the fiscal shock out even further.

In sum, even with a completely forward-looking rational-expectations model, as the Fed seems to believe, and even if the fiscal or other underlying shock is over, inflation is likely to continue for

some time. Even if we do not wish to disagree with the basic sign and stability of monetary policy and expectations, the parameters implicit in the Fed's view seem pretty optimistic, in this simplistic analysis.

This vision of fiscal policy is quite different from that in Summers's analysis, discussed above. Here fiscal policy acts as a stock, not a flow. Inflation results when there is more debt relative to people's expectations of its eventual repayment. In Summers's analysis, we take the flow current deficits, multiply by 1.5, and compare them to the GDP gap to determine inflationary pressure. Later, I'll come back to the central question going forward: Which view of fiscal stimulus is right?

MONETARY POLICY TO FIGHT INFLATION

The Fed will respond, however, and has already begun to do so. What happens when the Fed starts raising interest rates? How much can raising interest rates lower inflation? I continue to use the New Keynesian model, giving the Fed the benefit of the doubt on that question, and in the spirit of offering advice consistent with its recipient's worldview.

Unpleasant Interest-Rate Arithmetic

To model how raising interest rates lowers inflation, we need a model in which the Fed *can* lower inflation somewhat by raising interest rates, without relying on a contemporaneous contractionary fiscal shock, all while keeping rational expectations and the consequent implication that inflation will eventually settle down. The latter ingredients make the Fed's projections sensible. To that end, I add long-term debt to the model. The model is

$$x_t = E_t x_{t+1} - \sigma(i_t - E_t \pi_{t+1}) \quad (9)$$

$$\pi_t = \beta E_t \pi_{t+1} + \kappa x_t \quad (10)$$

$$i_t = \theta_{in} \pi_t + \theta_{ix} x_t + u_{i,t} \quad (11)$$

$$\rho v_{t+1} = v_t + r_{t+1}^n - \pi_{t+1} - \tilde{s}_{t+1} \quad (12)$$

$$E_t r_{t+1}^n = i_t \quad (13)$$

$$r_{t+1}^n = \omega q_{t+1} - q_t \quad (14)$$

$$u_{i,t} = \eta u_{i,t-1} + \varepsilon_{i,t}. \quad (15)$$

This is a simplified version of the model in *The Fiscal Theory of the Price Level* (Cochrane 2022b, section 5.5). The variable r_{t+1}^n is the nominal return on the portfolio of all government bonds. Equation 13 imposes the expectations hypothesis. Equation 14 relates the return of the government debt portfolio to the change in its price, where ω describes a geometric term structure of debt. The face value of maturity j debt declines at rate ω^j .

We can think of the Fed's response in two ways: It may follow a rule that responds to inflation, raising $\theta_{i,\pi}$, or it may raise the interest rate as a persistent discretionary response, a shock $\varepsilon_{i,t}$ that sets off a persistent disturbance $u_{i,t}$. Given the path of interest rates in equilibrium, we obtain the same output and inflation with either specification. It is conceptually easier to start with the latter.

So, to consider what the Fed can do about inflation, figure 5.10 plots the response of inflation to a persistent monetary policy shock $\varepsilon_{i,p}$ with no rule parameters ($\theta_{ix} = \theta_{i\pi} = 0$), and *holding fiscal surpluses or deficits constant*. Conventional New Keynesian responses to monetary policy shocks include strong “passive” fiscal policy responses. But that's not interesting here. We have had a fiscal policy shock, and as we look forward, fiscal constraints on monetary policy will loom. The first question for us and the Fed is: What can it do to address inflation *without* counting on a substantial fiscal policy response to its moves?

Alternatively, the model is linear, so we can break it into its parts by asking: What is the effect of the fiscal shock that lowered \tilde{s}_1 (figure 5.9) and what are the effects of potential fiscal coordination that raises \tilde{s}_{t+j} (figure 5.9 upside down)? Then, separately, we ask: What are the effects of monetary policy and a raise in interest rates with no change in fiscal policy? To ask how inflation will evolve in

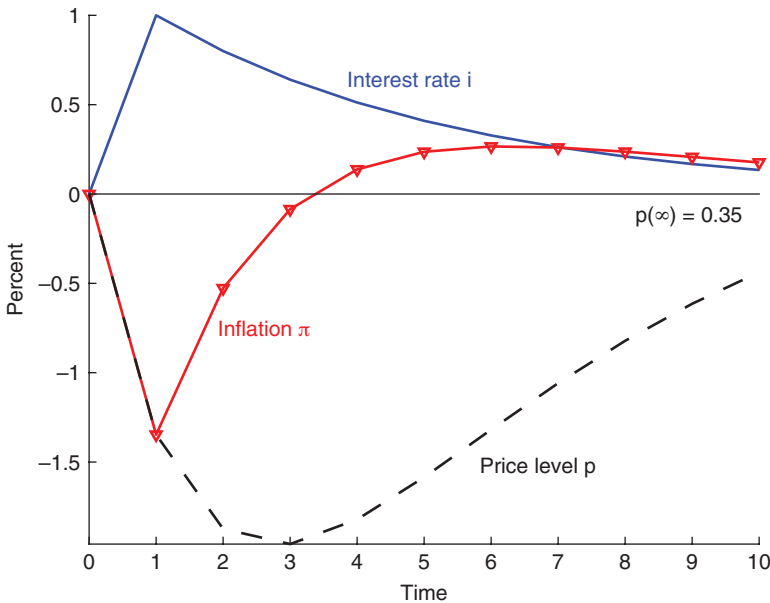


FIGURE 5.10. Unpleasant Arithmetic—A Response to a Monetary Policy Shock with No Change in Surplus or Deficit

Parameters $\sigma = 1$, $\kappa = 0.25$, $\beta = 0.99$, $\theta_x = 0$, $\theta_x = 0$, $\rho = 0.98$, $\omega = 0.8$, $\eta = 0.8$.

Source: Author's calculations.

the near term if the Fed tightens, we superimpose this response on the response of the economy to the fiscal shock with no change in monetary policy (figure 5.9), and likewise, ask how a joint fiscal-monetary tightening would look.

The higher interest rate in figure 5.10 lowers inflation. It also lowers output, as inflation is lower than future inflation. But inflation slowly creeps back up again, and inflation is higher in the long run. This long-run rise would be easy to miss in an estimated impulse-response function, and estimates have not tried to orthogonalize monetary and fiscal shocks.

This graph shows that, without modifying fiscal policy, the Fed can only move inflation around, buying lower inflation in the short run with higher inflation in the long run. Without changing fiscal policy, the Fed faces a form of “unpleasant arithmetic,” to use a

memorable phrase from Sargent and Wallace (1981). Sims (2011) called this pattern “stepping on a rake,” and offered it as a diagnosis of the 1970s. Interest rate hikes initially quell inflation, but without a coordinated fiscal tightening, they later raise inflation.

Iterating forward equation 12, using equations 13 and 14, and taking innovations, the identity in equation 16 generalizes in the case of long-term debt to

$$\begin{aligned} \sum_{j=0}^{\infty} \omega^j \Delta E_{t+1} \pi_{t+1+j} = & - \sum_{j=0}^{\infty} \rho^j \Delta E_{t+1} \tilde{s}_{t+1+j} \\ & + \sum_{j=1}^{\infty} (\rho^j - \omega^j) \Delta E_{t+1} r_{t+1+j} \end{aligned} \quad (16)$$

where $r_{t+1} \equiv r_{t+1}'' - \pi_{t+1}$ is the ex post real return on the portfolio of government bonds (Cochrane 2022b, section 3.5). Unexpected inflation, now summing current and expected future inflation, weighted by the maturity structure of government debt, devalues government bonds, and unexpected deflation raises their value. That inflation or deflation must correspond to a change in expected primary surpluses, or a change in the discount rate. Equivalently, higher interest costs on the debt in the last term act just as lower surpluses in the second term; higher interest costs on the debt must be paid by higher surpluses if they are not to cause inflation.

This identity clarifies the unpleasant interest rate arithmetic. Given that there has been a negative fiscal shock—deficits that people do not expect to be repaid by subsequent surpluses—the first term on the right-hand side is lower. Bondholders must lose via inflation or low returns (or default, though not in this equation, but easy to include).

Start by holding expected returns constant, which occurs with flexible prices. Then, bondholders must lose via inflation on the left-hand side. But with long-term debt $\omega > 0$, a change in expected future inflation can now devalue long-term bonds when they come due, in place of a one-period price level jump that devalues short-

term debt. By setting the interest rate target, the Fed can choose more inflation now or more inflation later; shifting the burden from short-term bondholders to long-term bondholders. But the Fed cannot alter the fact that there must be some inflation, now or later.

The first term on the left-hand side expresses the sort of budget constraint for inflation now vs. inflation later that Sargent and Wallace (1981) made famous. Moving inflation to the future might also give some breathing space for fiscal policy to reverse, for Congress and the administration to wake up and solve the long-run budget problem, or to hope for an opposite fiscal shock.

The future inflation rise is larger than the current inflation reduction. The “ $p(\infty) = 0.35\%$ ” notation in figure 5.10 shows that despite no change in surplus at all, this intervention *raises* the eventual price level. Future inflation enters the left-hand side weighted by the maturity structure of government debt, so it takes more future inflation to buy away some current inflation. Unpleasant interest rate arithmetic carries a greater than or equal to sign, not an equality.

With changing real interest rates and expected returns, bondholders can lose via the second term on the right-hand side as well, as I analyzed above for one-period debt. With sticky prices, inflation gives a period of low real returns to bondholders. This mechanism adds to the unpleasantness of interest rate arithmetic. With sticky prices, higher nominal interest rates are like higher real interest rates, raise debt service costs, and thus *raise* inflation.

How is this analysis different from Sargent and Wallace (1981)? There are four main channels of fiscal-monetary interaction: seigniorage, interest costs on the debt, revaluation of nominal debt due to unexpected inflation and deflation, and non-neutralities in the economy—including the tax code, non-indexed contracts, sticky government salaries, etc. Sargent and Wallace consider only the first channel in a model that includes money and only real debt. The model in my analysis has no money and, therefore, no seigniorage, but it includes interest costs on the debt and a revaluation of nominal debt.

Unpleasant interest rate arithmetic is thus fundamentally different from unpleasant monetarist arithmetic. A quantitative analysis of fiscal-monetary interactions should include the fourth component as well.

The models and exercises of the last two sections still embody long-run stability of inflation under an interest rate target. The inflation line eventually converges to the interest rate line. Once a burst of inflation has inflated away bonds, corresponding to a fiscal shock; once long-term bonds have matured; once prices move; once whatever other short-term effects get in the way, and (very important) if there is no *further* bad fiscal news—if new deficits are repaid by subsequent surpluses—the Fed is fully in control of the price level. At a long enough horizon, the one-period debt and flexible price version of the identity,

$$i_t = E_t \pi_{t+1}$$

$$\Delta E_{t+1} \pi_{t+1} = - \sum_{j=0}^{\infty} \rho^j \Delta E_{t+1} \tilde{s}_{t+1+j}$$

apply. The Fed can arrange a change in $\Delta E_{t+1} \pi_{t+2}$ by raising $E_t i_{t+1}$, and can set that future inflation to whatever it likes, with no change in surpluses.

Long-run stability has important implications. If the interest rate path eventually trends negative, then the Fed can, without fiscal help, bring the price level fully back to where it was below the fiscal shock.

Moreover, if the Fed does nothing at all, inflation will eventually settle down. Inflation will be stable under a k percent interest rate peg, as it was stable under a 0.25% interest rate peg. Fiscal shocks and other shocks will cause inflation, but that inflation will eventually pass. An interest rate peg is not necessarily optimal. If the Fed understands short-run dynamics, it can offset and smooth inflation; raising rates in the short run, and then lowering them in the long run. This proposition is a natural interest-rate-based counterpart to Milton Friedman's k percent money growth proposal. Friedman also acknowledged that if the Fed understands short-run dynamics, it

can artfully move money growth to stabilize inflation even more. But Friedman did not trust the Fed to understand those dynamics or to act on them wisely. An unreactive interest rate is a similar policy in these models.

A Policy Rule

We may ask the same question differently: What would happen if the Fed follows a Taylor-type rule, responding more quickly to observed inflation? Figure 5.11 gets at this question by calculating the response of the model (equations 9 through 15) to a 1% fiscal shock, but including a policy rule with $\theta_\pi = 0.9$, i.e., $i_t = 0.9\pi_t$. Compare the result to figure 5.9, which computes the response to the same fiscal shock but leaves interest rates alone.

The interest rate now rises to a point just below the inflation rate, since I specified θ_π slightly less than one. The effect of this monetary policy response is to reduce the initial inflation impact of the fiscal shock, from about 0.4% to 0.25%, but to further smooth inflation over time, raising inflation in the long run. Comparing figure 5.9 and figure 5.11, we see unpleasant arithmetic in action.

The Taylor rule in this model serves a very useful purpose. By spreading inflation forward over time, it reduces the volatility of immediate inflation in response to other (in this case, fiscal) shocks. In many models with sticky prices, like this one, small, smooth inflation is less disruptive than larger, sharper inflation. Reducing *volatility* is, in the larger picture, what the Taylor rule is all about, not remedying *instability* of old Keynesian models or *indeterminacy* of New Keynesian models with passive fiscal policy.

But the Taylor rule does not eliminate inflation. There has been a fiscal shock, a deficit that will not be repaid. At some point some debt must be inflated away. Unpleasant arithmetic still applies. Monetary policy alone can shift inflation around over time, and it can smooth inflation. But monetary policy cannot eliminate a fiscal inflation entirely.

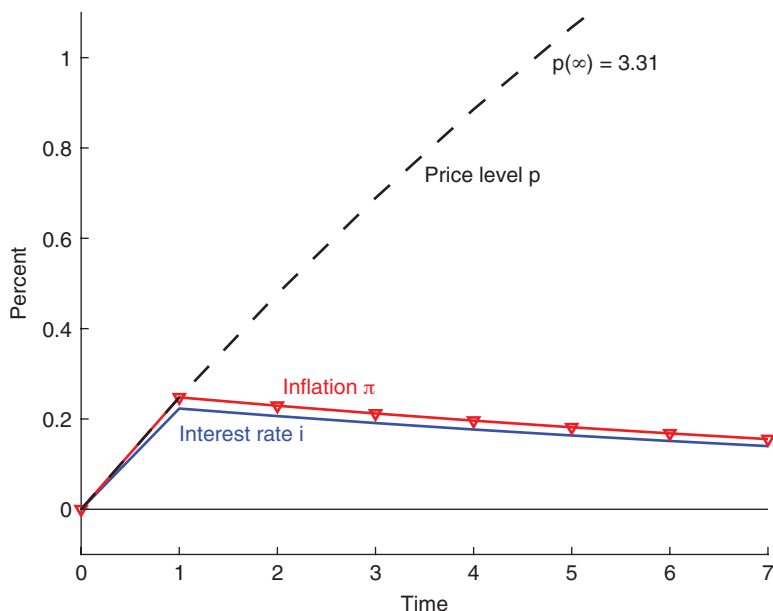


FIGURE 5.11. Response to a 1% Deficit Shock, with a Monetary Policy Rule
 Parameters $\sigma=1$, $\kappa=0.25$, $\beta=0.99$, $\theta_\pi=0.9$, $\theta_x=0$, $\rho=0.98$, $\omega=0.8$.

Source: Author's calculations.

Figure 5.11 builds on another main point of figure 5.9. With sticky prices, and now with sensible policy rules, a onetime fiscal shock leads to a very long and drawn out inflation, not to a onetime price level jump.

How much inflation will we experience? We could interpret this graph somewhat loosely as, what happens given that people expect the Fed eventually to start following such a rule. (We really want a rule with lagged response, $i_t = \phi i_{t-1} + \theta \pi_t$, as empirical Taylor rules uniformly find, and which would account for much of the Fed's slow response.) We *observe* the initial 8% inflation shock and infer the size of the fiscal shock. If this is the world we live in, we are only beginning to see the inflationary response to our onetime fiscal shock! The 3.31% total price level increase in response to a one percent

fiscal shock, and the 0.25% impact, means that our fiscal shock will lead to a $8/0.25 \times 3.31 = 106\%$ cumulative inflation in response to the 30% fiscal shock.

How can the cumulative inflation be even larger than the initial deficit? It is possible that an initial deficit \tilde{s}_1 leads to expectations of larger unfunded deficits to follow, as with an AR(1) process. But that is not the case here, as I specify completely the size of the fiscal shock.

In fact, the cumulative inflation in this model is 3.38%, three times *larger* than the 1% fiscal shock, and the 1% cumulative inflation of the last two models. The Fed, in this simulation, spreads inflation forward to fall more heavily on long-term bondholders, whose claims are devalued when they come due, and thereby lightens the load on short-term bondholders, who do not experience much inflation. But the rule spreads inflation forward even further than that, as the maturity structure of the debt with coefficient $\omega = 0.8$ is shorter than this inflation response. We enter the territory where higher interest rates lead to higher inflation all on their own. A more sophisticated rule could achieve the same reduction in current inflation by eventually lowering interest rates. For now, if this is our world, not only will we see the nearly 30% total price level rise suggested by the previous model, we will see a total price level rise nearly three times greater.

HOW WILL INFLATION END?

Unpleasant arithmetic and monetary-fiscal coordination also pose some severe constraints on how inflation might end. They also remind us, however, of some hopeful analysis and episodes of how inflation can end swiftly without the pain of 1980.

Let us imagine a few more years have gone by, and inflation has continued, to 10% or similar levels, as it did by the late 1970s. And imagine that inflation is fully reflected in wage growth and in high nominal interest rates and bond yields. How can inflation be put back in the bottle?

Some of the basic points:

- Every successful disinflation has featured coordinated monetary, fiscal, and microeconomic policy.
- That coordination will be crucial in a future US disinflation.
- Without fiscal coordination, a purely monetary approach to lowering inflation, based on higher interest rates, will fail.

Fiscal constraints will matter for a monetary disinflation. This inflation was, more clearly than the 1970s, sparked by a fiscal blowout. Fiscal policy remains stuck in persistent structural primary deficits, with unsustainable entitlement spending looming. Monetary policy will operate in the shadow of 100% of GDP debts that are growing exponentially, 5% of GDP primary deficits, and growing entitlement gaps. Figure 5.12 plots the CBO's projections to emphasize these points. In 1980, the debt-to-GDP ratio was 25%. The fiscal constraints on monetary policy will be at least four times larger this time.

The CBO projections are conservative. They assume nothing goes wrong. The debt surge of the Great Recession and the COVID-19 pandemic were not forecast in the pre-2008 CBO projections. But since 2008, we have become cemented in a bailout/stimulus regime. Any significant shock is met by new rivers of borrowed or printed money. There will be shocks—war, disease, private or sovereign debt, financial collapse. I graph suggestively what debt-to-GDP might actually look like after the next two shocks.

Moreover, the US is now stuck in a period of sclerotic long-run GDP growth; cut roughly in half starting in the year 2000, and as a consequence, slower growth in tax revenues. The boom of the late 1980s and 1990s, which dramatically raised surpluses, does not seem to be at hand.

How will fiscal policy constrain a monetary disinflation? There are four main channels. First, of course, the government loses seigniorage revenue. But seigniorage is close to irrelevant today.

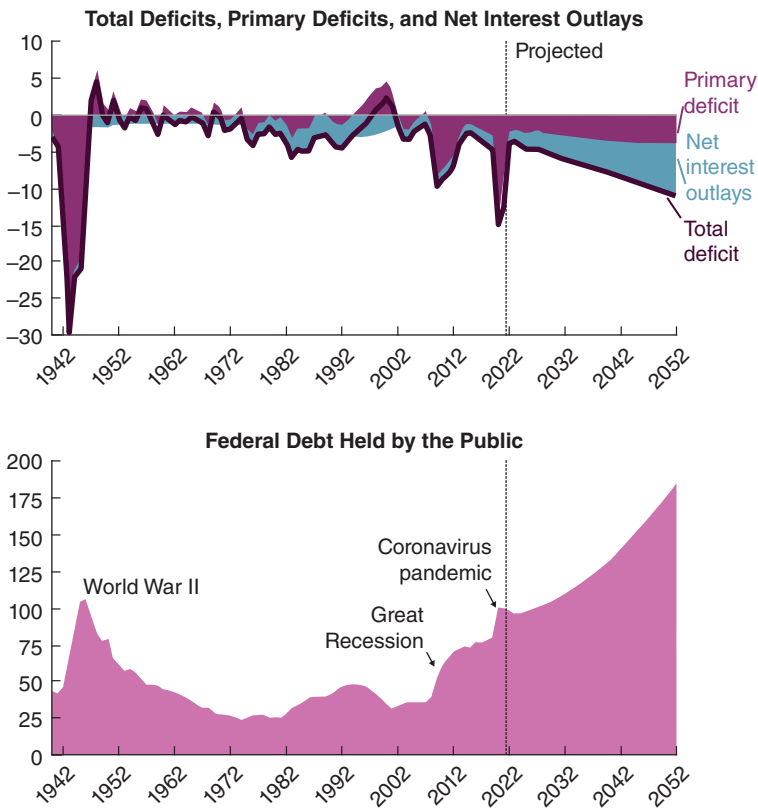


FIGURE 5.12. CBO Projection for Debt-to-GDP Ratio and Deficits. The debt forecast assumes nothing bad will happen and that's likely optimistic.

Source: Congressional Budget Office.

Second, higher interest rates raise interest costs on the debt. Suppose the Fed were to raise interest rates 5%. We have a 100% debt-to-GDP ratio, and rising. With interest rates at 5%, that means 5% of GDP interest cost, \$1 trillion per year, of extra deficit. If it is to lower inflation, then, the monetary contraction must come with \$1 trillion per year fiscal contraction as well. If it does not, then the fiscal forces behind inflation get worse. That our government has sadly chosen primarily to roll over short-term debt, and the

Fed has chosen to further shorten the maturity structure by buying trillions of long-term debt and turn it into overnight debt, means that interest costs flow much more quickly on the budget than they would otherwise, strengthening this channel.

Third, disinflation is a windfall to bondholders. That windfall must also be paid, an additional expense requiring fiscal contraction. At 100% debt-to-GDP, a 10% disinflation requires 10% of GDP to be transferred from taxpayers to bondholders. For the moment, long-term bond yields have not risen to match inflation, so a golden opportunity still remains to disinflate without this fiscal cost.

Fourth, disinflation is by itself trouble for government finances, as inflation helps the government. I do not model these effects.

The second and third effects are captured by the identity in equation 16, which I repeat here for convenience:

$$\begin{aligned} \sum_{j=0}^{\infty} \omega^j \Delta E_{t+1} \pi_{t+1+j} = & - \sum_{j=0}^{\infty} \rho^j \Delta E_{t+1} \tilde{s}_{t+1+j} \\ & + \sum_{j=1}^{\infty} (\rho^j - \omega^j) \Delta E_{t+1} r_{t+1+j} \end{aligned}$$

To durably disinflate, and not just move inflation around over time; to produce a negative term on the left-hand side, we must have increased fiscal surpluses, the first term on the right-hand side. If that disinflation comes with higher expected returns on government debt, the third term on the right-hand side, the rise in surpluses, must be that much larger.

The disinflation of 1980 was not just monetary. It was a joint monetary, fiscal, and microeconomic reform. The monetary contraction of the early 1980s was quickly followed with two tax reforms, in 1982 and 1986, that dramatically slashed marginal rates, while broadening the base. The 1991 tax change raised marginal rates, but not back to earlier levels. Deregulation was at least aimed at increasing economic growth. Whether for these reasons or just good luck, economic growth rose, tax revenues rose, and so did surpluses.

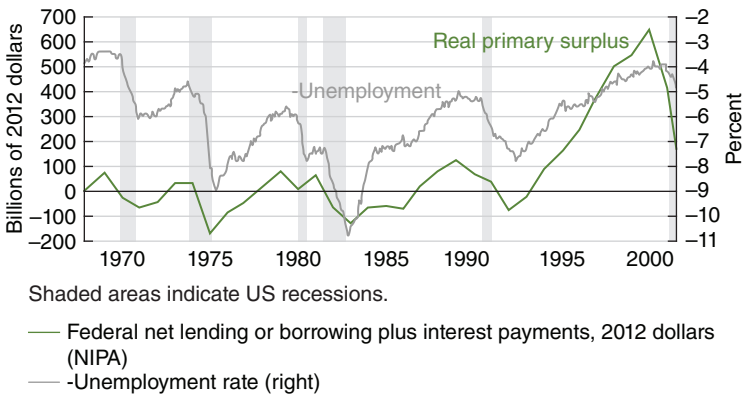


FIGURE 5.13. Real Primary Surplus and Negative Unemployment Rate 1980–2000

Source: US Bureau of Economic Analysis (BEA), BLS via FRED.

Note: Primary surplus is Federal net lending or borrowing plus federal interest payments, converted to 2012 dollars via GDP deflator.

Figure 5.13 presents the real primary surplus through the 1980s and 1990s. Despite the often-referenced “Reagan deficits,” *primary* deficits were not that large in the Reagan years. Most of the reported deficit was sharply higher interest costs due to the higher interest rates. I include the negative of the unemployment rate, to allow an ocular business cycle adjustment. Adjusted for the recession, the deficits of the early 1980s are at least no worse than those of 1975. (I plot the surplus itself, not the surplus-to-GDP ratio. It is actual surpluses that pay off debts.)

The main point: starting in 1982 and 1986, the US entered a period of strong primary surpluses that lasted until 2000. At least with ex post wisdom, the disinflation of 1982 corresponded to a strong fiscal contraction, a rise in the present value of surpluses. (Cochrane [2019] decomposes the value of government debt to make a calculation and an ex ante calculation using Vector Autoregression [VAR] methods.)

Interest costs on the debt rose in the 1980s, posing a fiscal headwind. The rise in surpluses was strong enough to overcome that rise in interest costs as well. In addition, investors who bought 10-year bonds

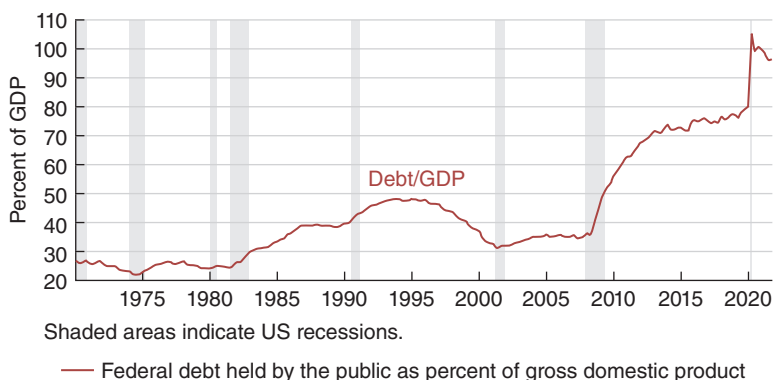


FIGURE 5.14. US Debt-to-GDP Ratio

Source: Office of Management and Budget (OMB) via FRED.

at 15% yields in 1980, expecting inflation, got repaid in an environment of 3% inflation. That windfall came courtesy of the US taxpayer.

Figure 5.14 plots the debt-to-GDP ratio. That ratio rises with deficits and also with higher interest payments on the debt. We see the continued rise in debt-to-GDP in the 1980s due to interest costs, but that the strong surpluses of the 1990s paid those interest costs as well.

Did people know this would happen? What gave them confidence that the US would in fact pay off its debt at the much larger value implied by disinflation? Something did, and that expectation was right. Ex post, at least, 1980 involved a joint monetary, fiscal, and microeconomic reform.

Contrary episodes abound in Latin American history (Kehoe and Nicolini 2021). Inflation surges, caused by intractable deficits. The central bank attempts a monetary stabilization, which slows inflation for a while. The underlying fiscal problem is not solved, however, and inflation comes back more strongly. In particular, higher interest costs on the debt with no corresponding fiscal reform can lead to higher inflation quickly. The US had a monetary reform that was followed by fiscal and microeconomic reform—the latter growing the tax base. There were a few years of high interest

rates in between. One might read the recession and period of high interest rates as a period of uncertainty whether the needed fiscal reforms and growth would indeed occur.

Onetime reversible “austerity” does not solve the fiscal problem. Equation 16 reminds us that a disinflationary reform needs to last decades; it must raise the *present value* of future *surpluses* (tax revenue less spending). And raising distortionary tax rates, which may take a decade or two to translate to lower growth, is at best climbing up a sand dune. Even on the left side of the Laffer curve, behavioral response yields less revenue and less growth for each rise in the tax rate.

Failed Stabilization

Without fiscal coordination, an interest rate rise will fail to control inflation. Equation 16 is an inescapable identity. To make this point concrete, figure 5.15 graphs the results of an interest rate rise in a perfectly standard New Keynesian model—no fiscal theory funny business here. (This figure, calculation, and discussion are adapted from Cochrane 2022b, chapter 17.)

The model is the standard New Keynesian model:

$$\begin{aligned}x_t &= E_t x_{t+1} - \sigma(i_t - E_t \pi_{t+1}) \\ \pi_t &= \beta E_t \pi_{t+1} + \kappa x_t \\ i_t &= \phi \pi_t + u_t\end{aligned}$$

Fiscal policy is passive, providing whatever surpluses are needed to validate inflation chosen by monetary policy. I use the unexpected inflation identity (equation 16), to solve for the needed passive fiscal policy of surpluses, and using $r_{t+1} = i_t - \pi_{t+1}$. The only innovation from standard New Keynesian analysis is to look at the required fiscal contraction that accompanies a monetary tightening. (This amounts to adding up the fiscal shock of figure 5.9 and the interest rate shock of figure 5.10, but for rhetorical purposes I want to combine them and present them in an utterly standard New Keynesian framework.)

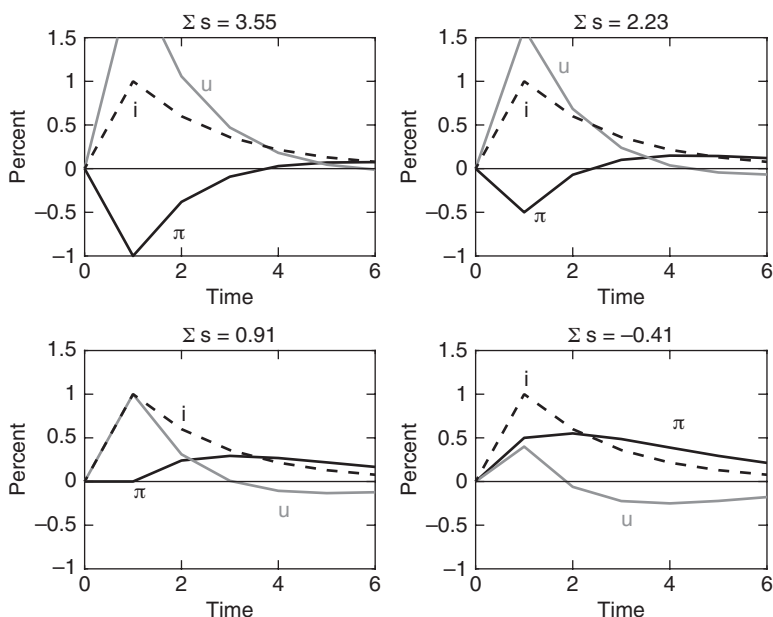


FIGURE 5.15. Inflation Response to an Interest Rate Rise

Source: Author's calculations.

Notes: Each panel presents a different choice of the disturbance u_t , which produces the same interest rate path. The title $\Sigma s = \dots$ gives the percent change in the sum of surpluses required by passive fiscal policy for each case. Parameters are $\eta = 0.6$, $\sigma = 1$, $\kappa = 0.25$, $\beta = 0.95$, $\varphi = 1.2$.

Suppose the Fed raises interest rates by a positive and serially correlated disturbance u_t . Figure 5.15 presents the result. The figure presents a surprise AR(1) rise in the interest rate, with serial correlation $\eta = 0.6$, a standard transitory monetary policy experiment.

However, there are multiple disturbance paths $\{u_t\}$ that produce the same interest rate path, but different inflation paths. In each case, I reverse engineer a $\{u_t\}$ disturbance to produce the same AR(1) interest rate path, and a chosen value of initial inflation π_1 .

Start in the top left panel. I choose the disturbance $\{u_t\}$ to produce the AR(1) interest rate and a -1% initial inflation. This panel gives the standard New Keynesian result: A higher interest rate

lowers inflation, here by exactly 1%. The disturbance u_t follows an AR(1)-like process. It moves more than the interest rate, since $\phi\pi$ and negative inflation drag the actual interest rate down below the disturbance u_t .

Fiscal policy is passive, but the fiscal response has to happen. In this case, as reported in the figure title, cumulative surpluses have to rise 3.55 percentage points of GDP. (I use $\rho=1$ and 100% debt-to-GDP ratio.) Surpluses have to rise one percentage point of GDP to pay the 1% deflationary windfall to bondholders. They have to rise an additional 2.55 percentage points of GDP because of the long period of high real interest rates, which you can see from a higher i_t line than π_t line, which represent a higher discount rate or higher real interest costs of the debt.

Multiplying by 5, a 5 percentage point interest rate rise and 5 percentage point disinflation require an 18% of GDP austerity program, \$4 trillion. Will the administration and Congress passively accede to this request? If they do not, the attempt must fail; the path is not an equilibrium.

What can the Fed do differently? It can follow a different disturbance $\{u_t\}$ that produces the same interest rate path, but requires less fiscal support. In the top right panel, I reverse engineer a disturbance u_t that produces the same interest rate path, but only -0.5% disinflation. The disturbance is smaller and has different dynamics. Since this disturbance produces less disinflation, it also requires less fiscal austerity, 2.23 percentage points of GDP rather than 3.55 percentage points. But for a 5% interest rate rise, this path still requires Congress and the administration to cut back by $5 \times 2.23 = 11.15\%$ of GDP, or \$2.2 trillion.

In the lower left-hand panel, I reverse engineer a disturbance u_t that produces the same interest rate path, but produces no disinflation at all. Though interest rates follow the same AR(1), inflation starts at zero and then slightly *rises*. But this path still requires passive fiscal policy to turn to austerity, by 0.91 percentage points of

GDP. Higher real interest rates still provoke a discount rate effect, or higher real interest costs, which surpluses must overcome.

In the bottom right panel, I reverse engineer a disturbance process u_t that produces +0.5% inflation, along with the same interest rate path. This time, passive fiscal policy includes a slight fiscal loosening. Congress and administration cheer, but we clearly have done nothing to fight inflation.

The lesson of this example is that in the stock New Keynesian model, thought of and solved in completely New Keynesian fashion, the same interest rate path may or may not cure inflation. For a higher interest rate to disinflate, it must be accompanied by fiscal contraction. If that contraction does not or cannot happen, the Fed cannot lower inflation by raising interest rates.

Future Fiscal Shocks

There is an even scarier scenario. I have assumed no further fiscal shocks; that from now on fiscal deficits ($s < 0$) will now be matched by expectations of later surpluses, at least up to the moment that monetary policy demands additional surpluses to pay for interest costs on the debt or a bondholder windfall. But the fiscal shock we just experienced is, in my reading, a case of a deficit that people did not expect to be repaid, a $s_t < 0$ not matched by $s_{t+j} > 0$, leading to inflation. Government debt exceeded people's estimate of what the government will repay, so they inflated debt away until the real value of debt declined to match that expectation. Will they now believe that the government can repay larger future deficits? Or, having crossed the Rubicon once and been inflated back to the water's edge, are we in the territory that any future fiscal expansion will be inflationary?

Moreover, while normal deficits might be tolerated, what about the next shock? In the next economic shock—war, pandemic, private or sovereign financial trouble—can the government really borrow or print an additional 30% of GDP, and this time people expect

that additional debt to be repaid? Or will we reach the fiscal limit even more quickly next time? We may have lost fiscal and monetary space to react to a shock. If the government wants to borrow or print another \$5 trillion, and nobody wants to hold the debt, either inflation or a debt crisis erupt immediately.

In stating this view I raise another central theoretical question, one dividing my fiscal analysis from that of Summers: Is the fiscal limit a flow or a stock constraint?

As I have posed it, inflation breaks out when the quantity of *debt* exceeds people's expectations of repayment. In Summers's analysis, inflation breaks out when the flow *deficit*, times a multiplier, exceeds the GDP gap. So long as that flow is not exceeded, additional deficits really do not matter. Debt sustainability is an issue for long-run analysis not pressing on today's inflation.

Related to this is another crucial empirical question: Are we quickly going to return to an era of low real interest rates on government debt? Or are we going to repeat the 1980s, with a decade or more of high real interest rates? The inexorable trend of declining real interest rates started in 1980, suggestively coincident with a big monetary change. The trend may not be written in stone as most people think.

The deficits of 2008 did not turn to inflation, and by the identity of equation 16 a large reason was the unexpectedly low real interest rates of the 2010s, which lowered debt service costs. Can we count on a quick return to low real interest rates, causing low debt service costs to continue? There certainly seems to be little room for a further decline in real interest rates of the magnitude experienced between 2007 and 2009!

Happier Scenarios

We take for granted that if inflation does become embedded, a disinflation must involve a 1980s style recession. Let us remember the much happier possibilities, considered then, and verified since. That

possibility is embedded in a Phillips curve driven by expectations of future inflation. At least in times of big reforms, the anchor point of the Phillips curve can move rapidly and favorably.

Inflation targets have been remarkably successful. Figures 5.16 and 5.17 show inflation around the introduction of inflation targets in New Zealand and Canada. On the announcement of the targets, inflation fell to the targets quickly, and stayed there, with no large recession, and no period of high interest rates or other monetary stringency, such as occurred during the painful US and UK stabilizations of the early 1980s. Sweden had a similar experience. Just how were these miracles achieved?

These episodes are the introductions of inflation targets. Now, inflation targets consist of more than just instructions to central banks to focus more on inflation. Central banks and politicians make announcements and promises all the time, which people take with skepticism well seasoned by experience.

Inflation targets are an agreement between central bank, treasury, and government. Yes, they instruct central banks to worry about inflation and thereby not to worry about other things. But inflation targets are also commitments by treasuries and governments, and specifically a commitment—implicit or explicit—to run fiscal policy so as to pay off nominal debt at the agreed-to inflation target, no more and no less, and to raise surpluses so as to pay any interest costs on the debt that may result from central bank monetary policy. Each of these inflation targets was implemented as a package of tax, spending, and microeconomic reforms. These *fiscal* and *microeconomic* commitments are as important to lowering inflation as is the central bank's *monetary* commitment.

The inflation target functions as a gold price or exchange rate target, which commit the legislature and treasury to pay off debt at a gold or foreign currency value, no more and no less. But the inflation target aims at the CPI directly, not the price of gold or exchange rate, eliminating that source of relative price variation.

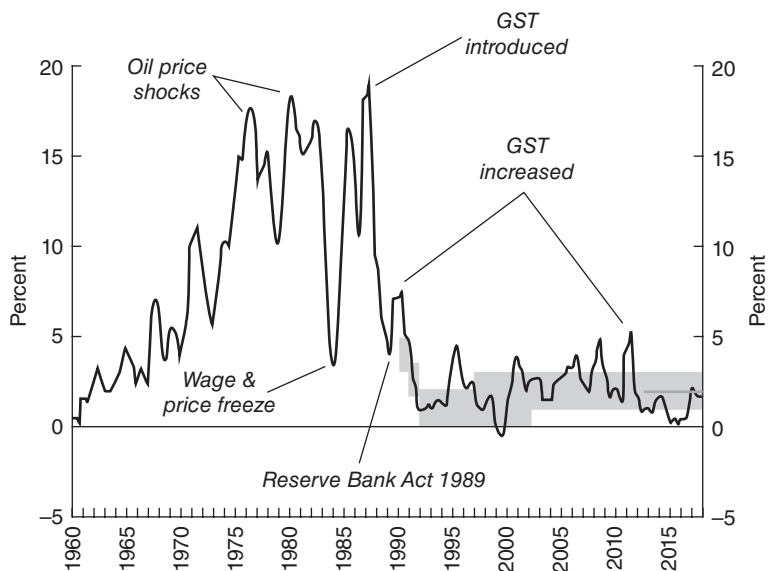


FIGURE 5.16. Inflation Surrounding the Introduction of a Target in New Zealand

Source: McDermott and Williams (2018).

Note: Shading indicates the inflation target range.

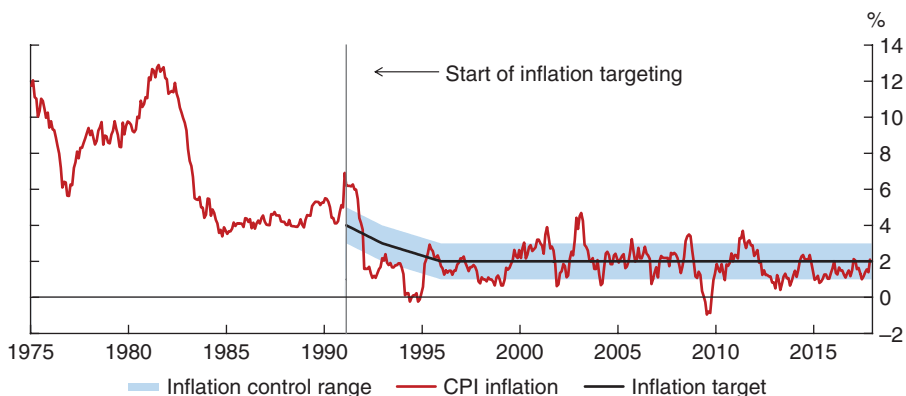


FIGURE 5.17. Inflation Surrounding Canada's Introduction of an Inflation Target

Source: Murray (2018).

Note: Consumer price index inflation, year-over-year, monthly data %.

Figure 5.16 provides evidence of this view, with the annotation “GST [goods and services tax] introduced” and “GST increased.” The inflation targets emerged as a part of a package of reforms including fiscal reforms, spending reforms, financial market liberalizations, and pro-growth regulatory reforms (McDermott and Williams 2018).

That fact accounts for their near-miraculous success. One would have thought, and most people did think, that the point of an inflation-targeting agreement is to insulate the bank from political pressure during a long period of monetary stringency. To fight inflation, the central bank would have to produce high real interest rates and a severe recession such as accompanied the US disinflation during the early 1980s. And the central bank would have to repeat such unwelcome medicine regularly.

Nothing of the sort occurred. Inflation simply fell like a stone on the announcement of the target, and the central banks were never tested in their resolve to raise interest rates, cause recessions, or otherwise squeeze out inflation. Well, “expectations shifted” when the target was announced, and became “anchored” by the target, but why? Not by ever more colorful speeches about “anchoring,” not by “forward guidance” speeches, and not by WIN buttons or the many other jawboning campaigns that public figures have used in attempts to manipulate expectations by hot air. Expectations shifted because the targets came with a new and durable *fiscal* and *micro-economic* regime, that cured the fiscal problems underlying inflation in the first place. They are a disinflationary fiscal shock, the mirror image of figure 5.9.

An inflation target failed instructively in Argentina in 2015–19. In the analysis of Cachanosky and Mazza (2021) and Sturzenegger (2019), the basic problem was that the necessary fiscal commitment was absent. Argentina’s failure reinforces my point that a successful inflation target is as much a commitment by the treasury as a commitment by and commandment to the central bank.

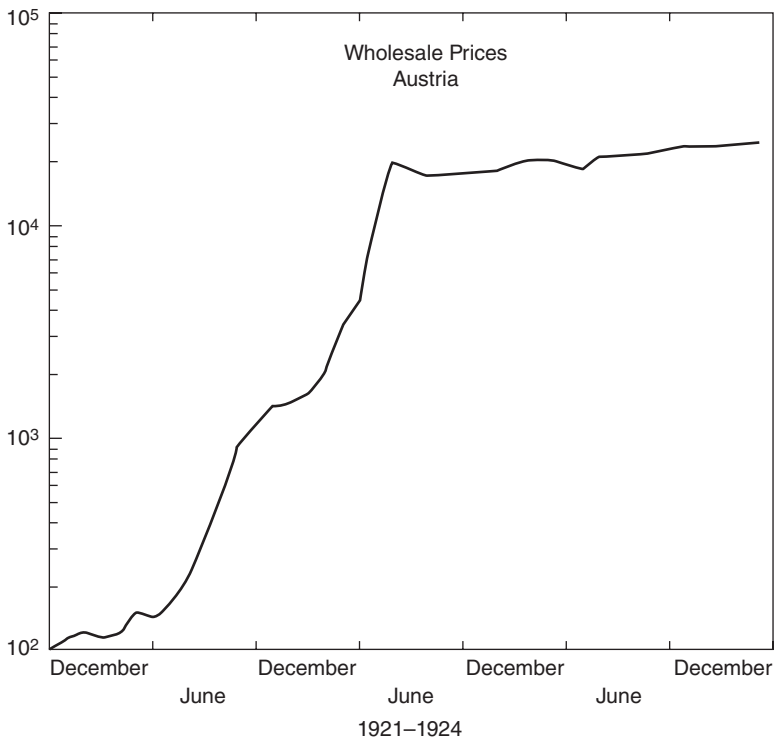


FIGURE 5.18. The End of Austria's Hyperinflation

Source: Sargent (1982).

This success of inflation targets is in this reading an application of the classic Sargent (1982) analysis of the ends of inflations. Figure 5.18 reproduces the end of the Austrian hyperinflation, as a visual reminder. When the long-run *fiscal* problem is credibly solved, inflation drops on its own, almost immediately. There is no period of monetary stringency, no high real interest rates moderating aggregate demand, no recession. Interest rates fall, money supply may rise, and deficits may rise temporarily as well, with the government newly able to pledge surpluses. As such, inflation targeting episodes are as revealing about lack of mechanical stickiness in expectations, specifically in the Phillips

curve, as they are about the fiscal foundations of those inflation expectations.

But as Sargent reminds us, expectations do not shift on promises or speeches. People need to see that the regime has changed durably.

The current discourse on inflation seems to have lost this history. Clearly, in much contemporary monetary policy, the conventional lessons of the 1970s and 1980s in the US have been somewhat forgotten. The Fed's average inflation targeting, with a focus on letting inflation rise to battle unemployment, seems to codify what most of us were taught to be the mistakes of the 1970s. But let us also not forget the wider lessons of history, and the durable lessons of the rational expectations revolution. *An economically painless disinflation is possible, if it combines fiscal, monetary, and microeconomic reforms that constitute a new and fiscally sound regime.* I qualify as economically painless because it certainly is not politically painless. The sort of tax reform, social program reform, and regulatory reform needed to straighten out US fiscal and monetary affairs are simple for us to design, but would be political suicide in today's environment. Perhaps, as in the late 1970s, or in the inflation targeting countries, enough inflation and stagnation will change that political consensus.

CONCLUSION

Where did inflation come from? The smoking gun suggests the \$5 trillion fiscal helicopter drop of 2020–21, which was made particularly potent by its quick monetization and by sending people checks.

Is the Fed behind the curve? That depends crucially on the question, *Are expectations forward looking or backward looking?* The Fed's projections are in fact consistent with a forward-looking New Keynesian model.

How long will inflation last? That depends a good deal on how sticky prices are. Even under the Fed's view that inflation will melt

away without a period of high interest rates, inflation can have substantially more momentum than the Fed's projections indicate.

How can the Fed ameliorate inflation? Without a change in fiscal policy, the Fed faces unpleasant interest rate arithmetic. It can lower inflation in the short run, but only by raising it in the long run. Creating a long drawn-out low inflation in response to a fiscal shock is, however, arguably better than allowing a large sudden price level jump. The Taylor rule also functions as a volatility-reducing rule.

When it is time to disinflate, it will require joint monetary, fiscal, and microeconomic (growth-enhancing) reforms. The fiscal constraints will be much tighter this time, with 100% or more debt-to-GDP and larger primary deficits than they were in the 1980s. Without fiscal coordination, to remove the fiscal source of inflation, to pay higher interest costs on the debt, and to pay bondholders in more valuable money, a purely monetary coordination can fail. With those reforms, a painless disinflation is possible.

Since fiscal expansion caused inflation once, will it do so again? In my stock and present value view, this is a clear danger, either in our regular fiscal policy, or the frightening possibility that a desired 30% of GDP or more deficit to fight the next shock will fail, and provoke essentially a sovereign debt crisis.

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