Hysteresis, Anchoring, and the Three-equation Model

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Abstract

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by Thomas R. Michl

Adding a hysteresis mechanism to the workhorse three-equation model that informs the teaching and practice of macroeconomics reveals some important findings. First, if central banks accept the accelerationist hypothesis and treat the observed inflation-neutral equilibrium as a purely supply-side constraint, they will lock in hysteresis unless inflation expectations are fully unanchored to their inflation target. Thus, anchoring, usually welcomed by policy makers, turns out to have a dark side. Second, the central bank can prevent permanent hysteresis effects by adopting an explicit invariant output target. In this case, anchoring gives it more room to run the high-pressure labor market needed to reverse the damage of negative demand shocks or unfavorable inflation shocks. This adds another argument to the list of reasons to overshoot the inflation target during the adjustment period after a demand shock.

In the aftermath of the Great Recession, hysteresis–the idea that large demand shocks can do permanent supply-side damage–has attracted increasing attention as evidence for it has accumulated.[1] In the U.S. economy, for example, ten years after the official end of the recession, the employment rate (the share of working age people in jobs) has yet to recover pre-recession levels. In a speech delivered when she still chaired the Federal Reserve Board, Janet Yellen (2016) placed research on hysteresis high on her wish list of pressing topics.

Over the last few decades, the three-equation model (or some version of it) has emerged as the core tool for teaching macroeconomics and for policy analysis. A natural question to ask is how hysteresis modifies the conclusions of this workhorse model. This note explains the results of two recent contributions (Michl, 2018; Michl and Oliver, Forthcoming 2019) that provide some answers.

1 Mechanisms

Mechanisms proposed to explain hysteresis include insider-outsider effects (Lindbeck and Snower, 1986), increases in unemployment duration resulting in skills obsolescence (Layard and Nickell, 1986), and losses in capital stock (Soskice and Carlin, 1989; Rowthorn, 1999). In Michl (2018), two alternative mechanisms are developed based on the work of post-Keynesian economic theorists (Stockhammer, 2011), one involving workers' wage aspirations and the other involving the price mark-up norms used by firms.

In the Carlin-Soskice text (and in much theoretical work), the lag between cost changes and price changes is assumed to be negligible so that workers wind up receiving the price-setting real wage all the time. But in real life and in light of the long-standing observation that real wages tend to be procyclical, it seems more likely that there are complex lags, both between prices and costs and between costs and prices. We assume that the wage that prevails will be a weighted average of the two target real wages.

A negative demand shock will typically reduce the efficiency wage required to incentivize effort by more than it reduces the real wage workers receive. This could cause the workers who remain employed to revise upward their wage aspirations and this will shift the wage-setting schedule upward.[2] Similarly, if real product wages are reduced by the demand shock, firms will typically find that their profit margins *ex post* exceed the *ex ante* margins

used to set prices, inducing them to revise upward their mark-up norm. This will shift the schedule of real wages consistent with price-setting downward. Both these mechanisms will lower the equilibrium levels of employment and output where the inflation process stabilizes. In other words, demand shocks have hysteresis effects. And it seems plausible that these effects work in both directions so that hysteresis can be reversed. These ideas are illustrated in Figure 1.
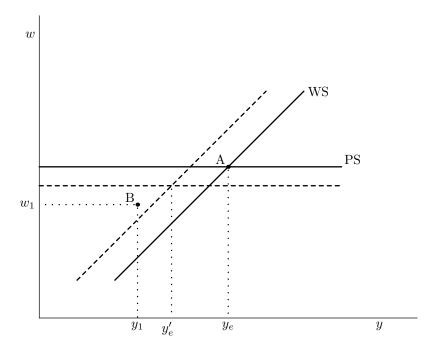

Figure 1: A prolonged slump will result in a downward shift in the price-setting schedule (PS) and an upward shift in the wage-setting schedule (WS) so that the equilibrium level of ouput, y_e, is permanently depressed.

Regardless of the specific mechanisms generating it, hysteresis can be incorporated into a standard three-equation model by including an equation of motion such as

$$y_{e+1} = \theta y + (1 - \theta)y_e$$

where y and y_e represent output and equilibrium output, θ is a fraction less than one, and the time subscripts have been left implicit except for the $+1$ indicating one period ahead. A negative demand shock will thus drag down

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the equilibrium level of output in the next period. The question then is whether monetary policy will undo all or only some of the damage.

2   An accelerationist central bank

The standard model assumes that the equilibrium levels of employment and output are determined strictly by supply side factors and that demand shocks do not have significant effects on those factors. When combined with the expectations-augmented Phillips curve that constitutes one of the three eponymous equations, this leads to the conclusion that any elevation of output above equilibrium will inevitably lead to limitlessly increasing inflation, or "acceleration."[3] Modern treatments of the Phillips curve recognize that expectations have become anchored somewhat, perhaps as the result of the widespread adoption of inflation targeting by central banks over the last several decades. Anchoring will reduce the rate of increase of inflation but unless it is complete (which is unlikely if inflation persists significantly above or below target for long), it will not prevent acceleration. This *accelerationist hypothesis* has been the foundation for monetary policy formulation since the 1970s.

A central bank that accepts the accelerationist hypothesis will treat any change in the observed equilibrium rate of employment or output as the result of a supply shock that is beyond its control. In the presence of hysteresis, the central bank will generally lock in any supply-side damage from an aggregate demand shock, assuming as is standard that the central bank minimizes a quadratic loss function that includes the observed output gap.[4]

The exception occurs if there is no anchoring of inflation expectations because an inflation-targeting central bank will find itself obliged to replace cumulatively the amount of demand that was lost through the original shock. As a result, it will unwittingly reverse all the damage and in the long run the equilibrium level of output will return to the *status quo ante*. This is an example of the "divine coincidence" identified by Blanchard and Galì (2005).

But the presence of a hysteresis mechanism is far from innocuous in this case since it will prolong the adjustment to a new equilibrium. There will be fewer jobs available on the path of adjustment with hysteresis than there would have been without it.

If there is any anchoring at all the central bank will not have to apply as much stimulus to restore inflation to its target and as a result it will not
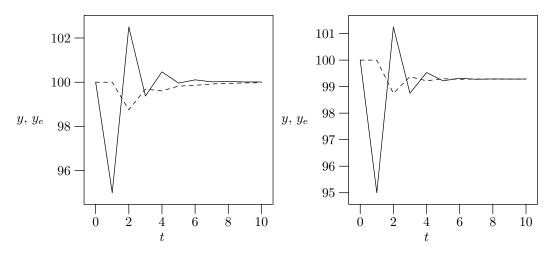
Figure 2: An accelerationist central bank after a demand shock. Left: With no anchoring, a shock will not have hysteresis effects on output (y, solid line) as the policy response undoes the damage and returns equilibrium output (y_e, dashed line) to its original level. Right: With partial anchoring, the central bank does not restore the lost demand sufficiently to fully undo the damage. Source: (Michl, 2018).

inject enough cumulative demand to reverse the damage. Hysteresis will permanently reduce the level of employment with obvious implications for social welfare. Anchoring is typically presented as a blessing since it makes it easier for central banks to stabilize inflation without creating excessive unemployment, but the blessing turns out to be a mixed one in the presence of hysteresis.

Figure 2 illustrates these points with the impulse response functions for output and equilibrium output from a three-equation model with and without anchoring.

A pure inflation shock (such as an exogenous increase in raw material prices) requires the central bank to create economic slack in order to reign in inflation. In the presence of hysteresis, this response inflicts permanent damage on employment as an unintended consequence of the policy. In fact, it was the aggressive use of contractionary monetary policy in European nations after the Great Inflation of the 1970s that led economists to theorize about hysteresis in the first place.

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3 Combating hysteresis

If the central bank becomes aware of the hysteresis mechanisms, what can it do to prevent shocks from inflicting permanent damage? One proposal (Michl and Oliver, Forthcoming 2019) is that it should adopt an explicit and invariant target for employment and output. Choosing the target raises difficult theoretical and practical questions but the same can be said of choosing an appropriate inflation target. We assume that this challenge has been overcome so that the economy starts at the target level of output and ask how the central bank should respond to shocks if it minimizes a loss function that includes the gap between actual and target output.

With an invariant output target, compared to its interest-rate setting rule (Taylor Rule) under the accelerationist hypothesis, the central bank's Taylor Rule will call for lower interest rates in response to any gap between target and actual inflation. This will allow the level of demand to remain above the equilibrium level of output long enough to run the hysteresis mechanism in reverse and undo the damage done by the initial demand shock. An important implication of this finding is that in order to achieve its objective of optimally stabilizing inflation and output, the central bank will be obliged to run a "high pressure labor market" with employment and output above whatever temporary equilibrium levels prevail along the adjustment path. This will require undershooting its invariant output target (since it is also concerned with the inflation gap) but overshooting its inflation target. Thus, hysteresis (or the possibility of reversing it) provides a reason to reflate aggressively after a large demand shock such as the Great Recession.[5]

Figure 3 illustrates the impulse response functions of a central bank with an invariant output target. Only in the special case of zero anchoring is the central bank absolved from overshooting its inflation target.

Under invariant output targeting, any anchoring of inflation expectations makes the central bank's job easier. This becomes significant in the case of inflation shocks. After an exogenous increase in inflation, the central bank will need to dampen demand in order the disinflate and in doing so generate some temporary unavoidable hysteresis effects. In order to prevent these effects from becoming permanent, the central bank needs to operate a high-pressure labor market with output above its (temporary) equilibrium levels during the adjustment process. Anchoring gives the central bank this capability.

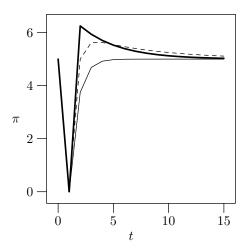In the absence of anchoring, the central bank will be unable to operate

Figure 3: After a demand shock with an invariant output target the central bank will overshoot its inflation target (here $\pi = 5$ percent) with full anchoring (bold solid line) or intermediate anchoring (dashed line). Only with no anchoring (thin solid line) will inflation converge on the target from below. Source: (Michl and Oliver, Forthcoming 2019).

a high-pressure labor market and inflation shocks (including a reduction in the inflation target) will leave behind permanent scars.[6] Anchoring emerges as an unmixed blessing for a central bank that adopts an invariant output target in its policy framework.

4   Conclusion

We have included a hysteresis mechanism in an otherwise conventional three-equation model and shown that if the central bank operates within the standard accelerationist framework, large demand shocks will typically have permanent negative effects on employment and output. The only exception occurs when there is no anchoring of inflation expectations, in which case the central bank will be obliged to reflate so aggressively that it undoes the damage done by the demand shock. Anchoring relieves the central bank of this obligation, and as a result explains why hysteresis effects are permanent under the accelerationist framework. This negative implication of expectations anchoring has perhaps not been fully appreciated.

If the central bank wants to combat hysteresis, it can do so by adopting an invariant output target so that after a shock it endeavors to return to

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the original level of employment even though there may be some reduction in equilibrium (inflation-neutral) output along the adjustment path. In this case, after a demand shock the central bank will generally have to operate a high-pressure labor market and overshoot its inflation target for at least some interval during the adjustment period. Anchoring has the desirable implication that it makes this response easier, and makes it possible to stabilize both demand and inflation shocks.

The room for research that responds to Janet Yellen's wish remains large. Are hysteresis effects truly permanent and can they be reversed as this note has argued? How does hysteresis interact with the effective lower boundary on interest rates? These and other questions remain to be fully addressed.

Notes

[1]See Mason (2017), Yagan (2017), or Ball (2014) for some of that evidence.

[2]For a standard textbook model of the labor market that focusses on the wage-setting curve and the price-setting curve, see Carlin and Soskice (2015). This text also develops the three-equation model in careful detail.

[3]An alternative (and perhaps more convincing) interpretation of the inclusion of past and target inflation in a Phillips curve is that they define the reference rate where negotiations over wages start. Carlin and Soskice (2018) observe that "[t]he desire of wage-setters to avoid the negotiating costs involved in a rational expectations-based Phillips curve explains the widespread use of compensation for previous inflation in wage-setting. . . ". For expositional simplicity, this note sticks to the more familiar expectations interpretation.

[4]Formally, this is because the three-equation model with a hysteresis mechanism has a unit root, meaning that its dominant eigenvalue or characteristic root equals one exactly. This implies that there is no unique equilibrium point. Rather, there are multiple equilibria, in this case lying along the line $\pi = \pi^T$ where π and π^T are inflation and target inflation. Which equilibrium prevails depends on the initial conditions of the model (i.e. the shock), an example of path dependence.

[5]Other arguments for overshooting include the idea that price *level* targeting is superior to inflation targeting (Hatcher and Minford, 2014) and the optimal control approach to policy which optimizes dynamically (Brayton et al., 2014) over the whole adjustment path rather than statically (as we assume in this note) on a period-by-period basis. Some (Kiley and Roberts, 2017; Bernanke, 2017) have suggested that overshooting the inflation target helps stabilize output near the zero or effective lower bound on interest rates.

[6]This is another case in which there is a unit root in the three-equation model so that there are multiple equilibria. In this case, they lie along the schedule (in ouput-inflation space) associated with the central bank's reaction function or Taylor Rule.

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