December 1, 2016

Ramifications of Allowing the Unemployment Rate to Undershoot its Natural Rate[1]

In the September Summary of Economic Projections (SEP), a large majority of FOMC participants projected that the unemployment rate would fall to or modestly below their estimates of its longer-run normal level over the next two years. In the staff forecast, where the unemployment rate falls a bit further below its natural rate of unemployment (NRU), the undershoot is benign and slightly speeds the return of inflation to the Committee's target; the unemployment rate eventually drifts back up to its natural rate with an appropriate tightening of monetary policy. In this memo, we investigate whether the Fed has ever successfully engineered a soft landing of this type. We also examine other possible outcomes of an undershooting: whether a tight labor market tends to be associated with an undesirable increase in either inflation or financial imbalances; and whether an undershooting has ever resulted in lasting benefits to the labor market.

We take two approaches: First, we explore historical episodes—mostly domestic but also some foreign—during which the labor market appears to have exceeded full utilization. Second, we use simulations of the FRB/US model to explore possible risks to inflation posed by an undershooting under alternative assumptions about the inflation process. In the concluding section, we draw some specific connections to the current situation.

We find that a soft landing of the type described in the SEP—that is, a leveling off of the unemployment rate near full utilization without an unwanted increase in inflation or the start of a recession within the next couple of years—though not common, does have historical precedents and cannot be ruled out in the current economic situation. However, as highlighted in the discussion below, although the economic conditions prevailing at the start of each episode and the responses of policymakers were important determinants of the eventual outcomes, the outcomes were also strongly influenced by supply or demand shocks to the economy that were

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unanticipated by policymakers. Thus, to achieve the projected soft landing, policymakers will not only need to set policy appropriately, they will also need to be lucky in terms of the shocks that could arrive while they are slowing the economy.

More typically in the past, episodes of undershooting have ended with a recession, caused by adverse shocks, monetary policy, or both. Often, especially abroad or before the great moderation period, an undesirable increase in inflation has accompanied an unemployment rate undershoot. The domestic episodes occurred when the slope of the Phillips curve was steeper than it appears to be at present, inflation expectations were not well anchored, the degree of labor market tightness was underestimated, and monetary policymakers were arguably not very focused on increasing slack to keep inflation in check.

Our inquiries into whether an undershoot is likely to foster financial imbalances or yield benefits to the supply side of the economy suggest that both outcomes could be possible. However, given the nascent state of the related economics literature and that there are only a few episodes on which to base the analysis, we are unable to draw clear conclusions.

1. Key questions about the historical undershooting episodes

In this section, we examine historical undershooting episodes in the United States and abroad. To identify the domestic episodes, we used both our current-vintage estimate of the NRU and real-time estimates that we gleaned from a variety of sources.[2, 3] Because these two types of estimates often differ substantially and because the NRU is estimated imprecisely even in hindsight, the dates of the episodes that guided our investigation should be considered only rough and judgmental ranges. The seven undershoots we identified—1965:4–1969:3, 1972:2–1974:3, 1978:1–1980:2, 1987:1–1990:3, 1994:3–1996:1, 1996:2–2001:3, and 2005:1–2008:2—are shown by the yellow shaded areas in figure 1, along with current-vintage measures of the unemployment rate, the staff NRU, total and core PCE inflation, and the real federal funds rate. Note that because we used multiple vintages of the NRU in dating the episodes, the shading does

[2] We used Greenbooks, Bluebooks, minutes and transcripts from the FOMC meetings, testimonies, Monetary Policy Reports, and the academic literature.

[3] Throughout this memo, we draw no distinction between the NAIRU and the natural rate of unemployment (NRU), and we refer exclusively to the NRU when describing the level of the unemployment rate consistent with full utilization in the labor market. See Fallick and Rudd (2012) for detail on the differences between the two concepts.

not match up perfectly with the gap between the two lines in the upper panel. For instance, we consider the 1994-6 period to have been a small undershoot based on the real-time NRU, although the unemployment rate is *above* our current-vintage NRU. Table 1 provides a narrative summary of all the episodes for reference.

Has the Fed (or another central bank) ever successfully engineered a soft landing?

In an economy that has been growing fast enough to bring down the rate of unemployment, a soft landing can be thought of as convergence of the unemployment rate to a level near its real-time natural rate, with neither an unwanted increase in inflation nor a recession within a couple of years.[4] We identify three soft landings (one domestic and two foreign) and one "could have been" soft landing.[5] Two common characteristics of these episodes are: First, monetary policy was generally pre-emptive and began to tighten before the unemployment rate fell below real-time estimates of the NRU. Second, the shocks that hit the economy once it had slowed were either small or beneficial.

The domestic example of a soft landing was in **the mid-1990s**. In late 1993, the actual unemployment rate stood at 6.5 percent, about ½ percentage point above the staff's real-time estimate of the NRU (the dashed blue line on figure 2). With economic growth continuing to outpace potential output, the FOMC expressed concern that inflationary pressures were building, even as consumer prices were decelerating modestly. The FOMC began quickly removing accommodation in early 1994, eventually raising the real federal funds rate more than 300 basis points through February 1995. The cumulative tightening was sufficient to slow the economy by early 1995 and arrest the decline in the unemployment rate, which hovered around 5½ percent

[4] A soft landing can occur from above with the unemployment rate declining to and then flattening out at about the level of the NRU (which technically means there is no undershoot) or from below, with the unemployment rate moving back up to the NRU after it has undershot the level. The soft landings that we identify all occur from below. This finding does not contradict the conventional wisdom (discussed in the memo to the FOMC by Aaronson and others (2014)) that upturns in the unemployment rate always coincide with recessions because in the domestic episode (1995–96), the three-month moving average of the unemployment rate moved up by less than 0.4 percentage point.

[5] In addition to the soft landing in the mid-1990s and the interrupted soft landing in the late 1980s, we have identified three other periods where the domestic unemployment rate flattened out for a time: 1962–1963, 1965–1967, and 1984–1986. Ultimately, we rejected these as examples of soft landings because either inflation increased substantially (the mid-1960s) or the unemployment rate flattened out at a level well above what appears to be the Committee's real-time assessment of full employment (early 1960s and mid-1980s). We rejected the episodes of low unemployment in the late 1990s and the mid 2000s because the unemployment rate did not flatten out for as long and because each was followed by a recession within a couple years.

during the next year and a half, just a little below the real-time estimate of the NRU (the solid blue line on figure 2), which the staff had lowered to 5¾ percent when inflation failed to materialize.

Thus, the FOMC's policy actions contributed to a mild, temporary slowdown that was achieved without tipping the economy into recession. Some—or much—of the good inflation performance in 1995 and 1996 likely reflected the early effects of the sharp pickup in structural labor productivity in the second half of the decade, which served to keep unit labor costs in check, and to the effects of a higher dollar and slow increases in non-oil commodity prices.

Looking abroad, we highlight two examples of a soft landing. The **Canadian economy in the late 1990s and early 2000s** provides an insightful example. The unemployment rate, which had been declining sharply through the 1990s, fell below the presumed natural rate in 1996 and continued falling (top panels of figure 3). The Bank of Canada tightened policy over most of the period from 1997 through 2000, and the unemployment rate moved back up roughly 1 percentage point toward the natural rate. However, unlike the United States, Canada did not go into a recession in 2001: Real output only contracted slightly in the third quarter of 2001, and, even in real time, the unemployment rate increase was attributed mainly to higher labor force participation (whereas employment did not fall). Oil prices, which rose from just under $20 to over $30 per barrel from 1999 to 2000, may have provided some support to the Canadian economy during this period.

The experience of **the United Kingdom in the late 1990s** provides another interesting example of a soft landing. The U.K. unemployment rate moved down gradually from a peak of more than 10 percent in 1993 to just 5 percent by mid-2001 (middle panels of figure 3). By 1997—the start of the undershooting episode—the Bank of England was in the midst of a tightening cycle. The decline in the unemployment rate slowed, and unemployment rate hovered around 5 percent for several years amid relatively subdued inflation. Indeed, the U.K. economy would weather with remarkable resilience the high-tech crash in 2001.

In the **late 1980s** in the United States, the FOMC was explicitly trying to engineer a soft landing, and their efforts might have been successful absent the shock of the Iraqi invasion of Kuwait. As

they would do in 1994, the Committee began to tighten pre-emptively in 1987, at a time when the economy was expanding rapidly and the unemployment rate was declining but still above the Committee's real-time assessment of the NRU.[6] The economy subsequently slowed, and the unemployment rate flattened out at about 5¼ percent from mid-1988 to mid-1990, suggesting the possibility of achieving a soft landing from below. Economic activity decelerated further in late 1989, following additional tightening and the credit crunch stemming from the Savings and Loans crisis and the crash of the commercial real estate market, but with typical indicators of cyclical economic imbalances, such as inventories, in normal ranges, a recession was likely not yet in train.[7] And while inflation continued to run above the level the Committee considered consistent with its longer-run goal of price stability (McNees, 1992), policymakers did not feel pressure to bring inflation down particularly quickly.[8] In the event, the fallout from the Iraqi invasion of Kuwait contributed to the onset of the 1990-91 recession, thus ending the possibility of a soft landing.

Has a tight labor market typically resulted in an undesirable increase in inflation?

As was shown in figure 1, in periods of tight U.S. labor markets, an increase in inflation often followed closely.[9] This is also true in three-fourths of the undershooting episodes of advanced foreign economies (AFEs).[10]

[6] The Committee temporarily eased following the Black Friday stock market crash, but resumed tightening about six months later.
[7] Subsequent econometric analysis is inconclusive as to whether, in the absence of the subsequent shocks, the policy tightening would have led to a recession (Walsh, 1993).
[8] While the FOMC had no target inflation rate in the late 1980s, in transcripts and testimony FOMC members discussed inflation being above the rate they thought was consistent with longer-term objectives. See for example Greenspan's testimony before the U.S. Senate Committee on Banking, Housing, and Urban Affairs, February 24, 1988, in which he stated that "inflation rates…are still high in a long-term perspective".
[9] This is, of course, somewhat tautological because the staff's current-vintage estimates of the NRU are heavily informed by inflation outcomes.
[10] We have identified 29 undershooting episodes over the period 1973:1–2016:2 in a sample of 11 AFEs using the current estimate of the NAIRU by the OECD as a measure of the equilibrium unemployment rate (figures 3 and 4). The euro area replaces the euro-area-member countries in our sample following the introduction of the euro in 1999. We have supplemented these data with real-time information provided by OECD Economic Outlooks, IMF Article IV Consultations, and various foreign central banks reports and policy announcements. Of course, one caveat of this analysis is that drivers of business cycle fluctuations are often similar across economies either because of spillovers or common shocks.

The domestic undershooting periods associated with the largest subsequent inflation increases—the episodes in the 1960s and 1970s—shared some key features. First, the inflation dynamics of those periods involved a stronger relationship between resource utilization and inflation than appears to exist today, which means that a given undershoot is more inflationary.[11] The slope of the Phillips curve estimated using data through the mid-1980s was about three times larger, in absolute terms, than estimated for the current period, the black line in the top panel of figure 5.[12] In addition, Phillips curves estimated over those earlier periods find a larger role for lagged inflation (illustrated by the higher values for the persistence coefficient, the blue line), which implies a more persistent response of inflation to any given shock. As a result, inflation expectations appear to have been less well anchored and more responsive to shifts in actual inflation during those eras. In the model simulations in section 2, we explore the consequences of these parameters returning to their levels in earlier periods.

Second, during the 1960s and 1970s, the Committee typically underestimated labor market tightness. In the 1960s, the *Economic Reports of the President* regularly noted that an unemployment rate of about 4 percent was "a reasonable and prudent full employment target for stabilization policy," and the emphasis on policy coordination between the Administration and the Federal Reserve may have undermined the willingness of monetary policymakers to set a different benchmark.[13] Indeed, it was not until 1968 (when the unemployment rate fell below 3.8 percent) that policymakers concluded that resource utilization was unsustainably tight.[14] For the 1970s, Orphanides (2000) showed that estimates of the output gap based on real-time data generally indicated considerably more slack than those based on currently available data.[15]

[11] Of course, a steeper Phillips curve also implies that when inflation is too high, it can be reversed with a smaller increase in slack.
[12] Details about the precise specification are given later in section 2.
[13] See Meltzer (2009). Also, in Congressional testimony in 1966, Fed Chairman Martin noted, that at a rate of 4.2 percent, "we [are] approaching a state of full employment." U.S Congress (pp. 116-117). See also Orphanides and Williams (2011).
[14] As described in Romer and Romer (1989), the FOMC attempted to slow economic *growth* in 1966, but it evidently did not think there was too little slack until late 1968.
[15] Estimates of slack in the economy were also uncertain in early 2004 when both the Committee and the staff discussed the extent to which the improvement in productivity reflected a lasting increase in potential output. In contrast, in the mid-1990s, we now think there was more slack than the Committee seemed to think at the time.

Third, monetary policymakers did not always focus on restraining economic activity in order to avoid inflation. Between 1965 and 1968, the FOMC was heavily influenced by economists in the Johnson administration, who apparently believed that there was a permanent tradeoff between inflation and unemployment and that the social costs of high unemployment dictated tolerating a higher inflation rate.[16] And in the 1970s, some members of the FOMC were apparently not convinced that monetary policy was the right tool for addressing inflation, especially given the economic and political costs it would likely entail.[17]

In contrast to the experiences of the 1960s and 1970s, the periods of very high rates of resource utilization in the late 1990s and mid 2000s did not result in large increases in inflation, although in the latter period many FOMC participants deemed inflation to be "exceeding…their comfort zones—2 percent or a little less."[18] In addition to the flattening of the Phillips curve and the relative stability of longer-run inflation expectations, in the late 1990s and early 2000s, strong gains in productivity helped to hold down unit labor costs.

Has a tight labor market been associated with rising financial imbalances?

The possibility that an overheating economy could lead to financial imbalances that bring about subsequent dislocations in the real economy is another concern at present. Strong gains in income and accommodative financial conditions can spur borrowing and inflate asset prices, potentially to a level that proves destabilizing when interest rates rise or exuberance in asset markets wanes. Indeed, in the episodes described below we document the coincidence of tight labor markets, rapid credit growth, and overvaluations in asset markets. However, we should note that the research in this area has not yet been able to address the more difficult challenge of identifying the potential *causal* influence of tight labor markets on financial imbalances.[19] It could be the case that the causality goes the other way: Loose credit conditions and positive momentum in asset prices may lead to stronger economic activity. Alternatively, both may be

[16] Meltzer (2009) page 274 and FOMC minutes from October 1965 (page 69).
[17] Chairman Burns noted that "monetary policy could do very little to arrest an inflation that rested so heavily on wage-cost pressures. In his judgment, a much higher rate of unemployment produced by monetary policy would not moderate such pressures appreciably." (June 1971). See also Nelson (2004).
[18] Bernanke (2015) page 128.
[19] These dynamics are explored in research, but only to a limited degree. For example, Borio and others (2013) and Arseneau and Kiley (2014) find statistical evidence for links between financial imbalances, such as credit and house prices relative to trend, and the degree to which economic activity exceeds potential.

caused by a third factor. At this point, we don't have enough evidence to draw firm conclusions from the correlations described below.

Concerns about vulnerabilities in the financial system in the 1980s developed well before **the undershoot at the end of the decade**. Commercial banks suffered from deteriorating loan portfolios, lending by the thrift industry began to expand rapidly in 1984, and corporate debt rose on a wave of leveraged buy-outs. The credit-to-GDP gap turned positive in the mid-1980s and remained so until 1992 (the top panel of figure 6).[20] Indeed, if the staff's gap guide for the activation of the Countercyclical Capital Buffer had been in place at that time, it would have pointed to a need for higher capital. The Committee monitored the increase in debt along with the rising equity valuations, and reduced their ranges for credit growth. Toward the end of 1989, in the wake of a run of savings and loan failures and the deflation of the overheated commercial real estate market, the Committee noted signs of reduced credit availability, and by mid-1990, the growth of nonfinancial debt slowed noticeably, restraining real activity. [21]

In **the undershoot of the late 1990s**, the credit-to-GDP gap shown in figure 6 remained negative. But that measure is based on a two-sided trend that smooths the data using both earlier and later data, and so takes into account the explosive growth of credit in the subsequent decade. An alternative one-sided measure climbed above trend in the late 1990s, and the growth rate of credit reached a high level.[22] Moreover, a major equity market bubble developed, the unwinding of which likely contributed to the onset of the early 2000s recession.[23]

The association between the undershooting in **the 2005–2007 period** and the development of financial imbalances that resulted in the Great Recession remains controversial. The expansion of homebuilding and mortgage credit and rising house prices gathered steam in the first half of the 2000s, and the credit-to-GDP ratio reached unprecedented levels after the middle of that

[20] The credit-to-GDP gap has been found to be useful for predicting financial crises in cross-country studies, is emphasized in the Basel 3 capital standards, and is monitored in the staff's Quantitative Assessment of Financial Stability. For a general review of literature related to the credit-to-GDP gap, see Drehmann and Tsatsaronis (2014).
[21] In addition, a substantial break in the stock market occurred in 1987, but had only a limited spillover to the real economy.
[22] The one-sided measure is emphasized in Borio and Lowe (2002b). The growth of credit has been emphasized as an alternative measure of credit imbalances by Schularick and Taylor (2012).
[23] The exuberance for tech stocks in the late 1990s was accompanied by a burst of spending on high-tech equipment, which itself may have reflected some unrealistic expectations about future returns. See Doms and others (2001). The subsequent downturn in this category exacerbated the recession and the sluggish recovery.

decade. However, most of the debate does not focus on an overheated economy, but on low interest rates and elevated asset prices, high financial sector leverage, and inadequate supervision and regulation. Some critics, like Taylor (2008), argue that the Committee's decisions to maintain a relatively low funds rate after the 2001 recession and then to increase the funds rate at a "measured pace" exacerbated the rapid expansion of mortgage debt. Others, such as Bernanke (2010) and Dokko and others (2011), argue that the rise in house prices was inconsistent with the historical relationship between monetary policy and the macroeconomy and that a path of the funds rate consistent with a Taylor rule would have had a limited effect on house prices.

The experiences of **several AFEs in the late 1980s and early 1990s**—Italy (1990–93), Japan (1988–93), Sweden (1985–92), and the United Kingdom (1988–91)—also involved undershoots that were associated with financial excesses and ultimately recessions. However, as in the United States, the association between labor markets, monetary policy and financial crises is controversial. Some observers point to overly accommodative monetary policy and an associated overheating economy as leading to overvaluations of asset prices, including stock markets, residential or commercial real estate, or the exchange rate, which impair the banking sector when they crash (see e.g., Bordo and Jeanne, 2002; Borio and Lowe, 2002a; Cecchetti and others, 2003). Notably, in Japan (the bottom panels of figure 3), as asset prices plunged at the start of 1990s, the economy underwent a massive financial crisis from which it never recovered. But the run-up in asset prices considerably pre-dated the start of the Japanese undershooting episode, suggesting that the crisis may have been caused by events that are unrelated to the degree of resource utilization.

Has unemployment undershooting sometimes resulted in lasting benefits to the supply side?

The evidence strongly suggests that a tight labor market has positive benefits, at least temporarily. A "high-pressure economy" can boost the share of full-time workers as well as the number of employed people overall, and as described by Okun (1973), it can lead to "the greater diffusion of opportunity and of upward mobility" to disadvantaged groups. Indeed we saw evidence of this in the late 1980s, when what had been a very uneven recovery finally spread to parts of the country previously hurt by the decline of manufacturing, and during the 1990s, when minorities and low-skilled workers experienced the strongest employment and wage growth in

decades. In addition, given the uncertainty that surrounds estimates of the NRU, allowing the unemployment rate to undershoot current estimates a bit allows the Committee to probe where the natural rate stands. Indeed during the 1980s and 1990s, estimates of the NRU were marked down as the unemployment rate fell without a significant rise in inflation.

A more difficult question is whether it might be possible to achieve highly persistent or even permanent positive supply-side effects by temporarily running a high-pressure economy, for instance, by permanently increasing labor force attachment and providing employers with an incentive to train workers, encouraging job-to-job transitions that improve the quality of job matches, and by spurring research and development, capital deepening, or entrepreneurship that permanently/persistently boosts productivity. A great deal of academic work has documented the adverse supply-side effects of prolonged *high* unemployment, or hysteresis, but surprisingly little research specifically addresses the phenomenon of "positive hysteresis."[24] Perhaps one reason for the paucity of a literature on this topic and its inconclusive results is that there are so few episodes and it is difficult to disentangle the effects from other coincident shocks.[25]

The evidence on whether a tight labor market permanently raises labor supply is mixed, which may partly reflect the difficulty in identifying such effects given the large structural changes over time in the labor market. For instance, Goldin (2006) argues that both strong aggregate demand and the effects of social and cultural change contributed to the large increase in female participation during the 1960s, which in turn led future cohorts of women to have higher

[24] Blanchard and Summers (1986) brought to the forefront the concept of hysteresis to explain the increase in unemployment across Europe over the 1970s and 1980s, spurring an extensive literature, (e.g. Bentolila and Bertola, 1990; Saint-Paul, 1995; Blanchard and Wolfers, 2000). A separate, though related, literature finds evidence that recessions can permanently lower potential output (Cerra and Saxena, 2008; Martin and others, 2015; Blanchard and others, 2015). This finding suggests hysteresis at work on an aggregate level. Moreover, it could be the case that strong expansions may be required simply to offset some of the damage done during downturns. Indeed, Blanchard and others (2015) suggest that monetary policy rules should put more weight on the unemployment gap relative to inflation. A corollary of this literature is that it may be difficult to empirically identify positive hysteresis because of the asymmetric nature of business cycle fluctuations.

[25] Holzer and others (2006) documented how employers became more willing to hire less-skilled workers, while Katz and Krueger (1999) explored the seemingly puzzling coexistence of low unemployment and low inflation. Nickell (2002) reviewed the behavior of unemployment across OECD economies but did not find a significant role for monetary policy even in those AFEs that experienced sustained decreases in the unemployment rate. More recently, Ball (2009, 2014) argued for positive hysteresis in the aftermath of the global financial crisis and proposed the idea of "super-hysteresis," i.e. that a recession may influence the growth rate rather than just the level of output.

expectations for their own participation and increased labor force attachment.[26] Similarly in the 1990s, the high-pressure labor market appears to have boosted participation for some demographic groups. But again, identifying the link is made difficult by the other structural changes that were taking place, such as welfare reform.[27] More generally, the literature examining the effects of the cyclical state of the economy on labor market entrants finds mixed evidence on the persistence of employment outcomes.[28]

There is also evidence to suggest that a strong economy improves the quality of the match between workers and jobs (Akerlof and others, 1988), although there is little evidence as to whether this produces lasting benefits. Better job quality might appear in the form of higher wages, and indeed the research cited earlier on the effects of the cyclical position of the economy on labor market entrants finds more consistent evidence that wages are persistently higher for those who enter in a tighter economy.

If a tight labor market leads to improved labor market outcomes, for instance by increasing labor force attachment, skills, or the quality of job matches, this might result in a lower average unemployment rate (through reduced turnover or shorter durations of unemployment). The bottom panel of figure 6 shows Beveridge curves for various decades. All else equal, the further to the left the Beveridge curve, the lower the natural rate of unemployment. The Beveridge curve for the 1960s is about in the middle of those shown, and the curve appears to have shifted in during the 1990s. But while this could be evidence of a sustained improvement in outcomes induced by the long periods of tight labor market conditions in those decades, it could also be attributable to factors unrelated to the cyclical state of the economy, including demographic changes, the increased use of temporary help services, and new technologies for job search.

Finally, it is possible that full employment economies generate an increase in activities such as research and development and business formation, which themselves boost the level of

[26] Relatedly, a number of studies have documented that the demand for women to participate in the war economy in the 1940s also had long lasting effects on both the participation of that generation and of future generations (Acemoglu and others, 2004; Fernandez and others, 2004).
[27] See Wilson (2015) and also Bradbury (2000) and Poole and Wall (2000). Note this is despite the greater cyclicality of unemployment among African Americans.
[28] See Beaudry and DiNardo (1991), Fleischman and Gallin (2001), Kahn (2010), and Kondo (2015).

productivity. Indeed, both these activities are highly pro-cyclical. However, it is unclear whether the more rapid pace of productivity enhancing activities during booms leads to a permanent increase in the level of trend productivity (Van Zandweghe, 2015).

2. Consequences of alternative Phillips curves during undershooting

In this section, we use the FRB/US model to explore the macroeconomic consequences of assuming that inflation will respond more strongly to the unemployment rate gap, and more persistently to past realizations of inflation, when the unemployment rate falls below the NRU than suggested by the staff's baseline Phillips curve. The staff's projection for inflation is informed by a current estimate of the Phillips curve, which has a fairly flat slope and a moderate degree of persistence to past inflation. Whether the slope will remain that flat and the persistence of inflation will remain moderate is an open question. A steeper Phillips curve or more inflation persistence could emerge, for instance, if there were a nonlinearity at high rates of resource utilization. [29]

Throughout our simulations, we employ an asymmetric specification of a version of one of the core inflation equations used by the staff to construct the Tealbook forecast:

$$\pi_t = \alpha^i \pi_{t-1} + (1-\alpha^i)\pi^e_{t-1} + \kappa^i (u_t - u^*_t) \;\; with\; i \in \{L,H\} \qquad (1)$$

where π_t is quarterly annualized core PCE price inflation, π^e_t is long-term inflation expectations (LTIE), u_t is the unemployment rate and u^*_t is the NRU.[30] The coefficient α^i captures the persistence of recent realizations of inflation. We assume this *persistence coefficient* is a nonlinear function of the unemployment gap taking the value α^L equal to the staff's baseline

[29] Although for the purposes of this memo we model inflation with a nonlinearity, we are agnostic as to what process might actually induce a more inflationary environment. Alternatively, there could be a regime switch, for instance because attitudes about inflation change once labor market tightness takes hold. For a discussion on nonlinearities in the Phillips curve and their implications for the staff forecast of inflation, see the Alternative View: "A Different Framework for Inflation" by Alan Detmeister in the January 21, 2015 Tealbook; on the likelihood of a regime switch see Nalewaik (2015).

[30] Throughout the simulations, we maintain the standard assumption of the FRB/US model that LTIE are well anchored, meaning that LTIE are not particularly sensitive to disturbances in past realized inflation. Specifically, we assume that LTIE follow the equation, $\pi^e_t = \pi^e_{t-1} + \gamma(\pi_{t-1} - \pi^e_{t-1})$, where $\gamma = 0.05$. In this equation, inflation expectations can be considered fully anchored when $\gamma = 0$, albeit not necessarily to the committee's long run target, and the opposite holds as γ approaches one. The March 4, 2016, memo to the FOMC titled "Longer-Term Inflation Expectations: Evidence and Policy Implications" explored in some detail the consequences of an unanchoring of LTIE using this equation.

estimate whenever unemployment is at or above the NRU and the value $\alpha^H > \alpha^L$ whenever it is below. Similarly, the *slope coefficient*, κ^i, captures how inflation may also be a nonlinear function of the unemployment gap.

We consider four specifications of the persistence and slope coefficients. To calibrate the alternatives, we look at historical estimates of the persistence and slope coefficients from equation (1). The upper panel of figure 5, from earlier in the memo, shows the results of 10-year rolling window regressions, starting in 1970:1, the first quarter for which a measure of inflation expectations is available, assuming that the persistence and slope coefficients are not dependent on the unemployment gap. As noted earlier in this memo, both the (absolute value of the) slope and persistence coefficients have declined substantially over this period. This is stated with the important caveat, also illustrated in figure 5, that the parameters exhibit a good deal of variation over time and the associated (asymptotic) standard errors suggest a substantial degree of uncertainty regarding the underlying process driving inflation.[31]

To demonstrate the importance of the persistence and slope coefficients of the Phillips curve, we pick values for them based on episodes in history and use these estimates in the FRB/US model for the projected undershooting period in the current episode. For other periods, the coefficients of the inflation specification used to produce the staff long-term outlook apply. In all instances, the underlying scenario is the October Tealbook baseline, which projects that the unemployment rate will undershoot the NRU by ½ percentage point, on average, over the next five years. Throughout, we assume that policy is governed by the inertial version of the Taylor (1999) rule.

The coefficients that encompass the four variants of the Phillips curve are depicted in the top panel of figure 5 by the colored squares. Referenced by the ending date of the 10-year estimation window, these Phillips curves are:

- *Early 2000s*: A flat Phillips curve with a moderate degree of persistence consistent with estimates obtained from the rolling window ending in 2002:1, the orange squares.

[31] These results are broadly consistent with the findings of Blanchard and others (2015), who use a time-varying coefficients Phillips curve specification. In particular, their results show that during the 1970s, when inflation was increasing, the (absolute) slope and persistence coefficients of the Phillips curve were large, and when the disinflation started, the coefficients declined. Uncertainty about the estimates was also a feature of their results.

- *Early 1990s:* A mildly steeper Phillips curve with a moderate degree of persistence consistent with estimates obtained from estimation ending in 1992:4, the green squares.
- *Early 1980s:* A moderately steeper Phillips curve with higher persistence than the two previous cases consistent with estimates obtained from estimation ending in 1983:4, the purple squares.
- *Late 1970s:* A much steeper Phillips curve with persistence approaching one consistent with estimates obtained from estimation ending in 1980:1, the red squares.[32]

The results of the simulations, along with the October Tealbook baseline, appear in the bottom panel of figure 5, from which we draw the following conclusions. Using Phillips curve parameters calibrated from the 1990s or early 2000s, shown by the orange and green lines, inflation would have properties similar to those of the staff baseline. And if the tradeoff between inflation and unemployment were to return to that of the early 1980s (the purple lines), inflation would overshoot appreciably the 2 percent target. However, this overshooting is not as extreme as the one obtained if the Phillips curve were similar to that estimated to be in place during the late 1970s (the red lines). In that case, inflation would reach about 3½ percent at the end of 2020, although the unemployment rate would remain below the NRU through the end of the horizon.

Under an inertial Taylor rule, the unemployment rate undershooting does not lead to a recession in any of the scenarios considered, either over the period shown or beyond, although the early 1980s and late 1970s simulations eventually do have the unemployment rate rise back above the NRU.[33] The gradual policy response of the inertial Taylor rule permits inflation to rise substantially and persistently above the Committee's objective in the third and fourth simulations. This suggests that the inertial Taylor rule might not be appropriate for policymakers aiming to fulfil the dual mandate in the scenarios featuring a steeper-slope and higher-persistence

[32] The 1970s estimates effectively correspond to an "accelerationist" version of the Phillips curve with a slope set around the steepest values. An "accelerationist" version of the Phillips curve implies that it is possible to keep the unemployment rate below the NRU only at the cost of a constantly increasing inflation rate.
[33] We also considered simulations in which only the slope coefficient was subject to the nonlinearity, with the persistence coefficient remaining at the value consistent with the scenario regardless of the unemployment rate. Here too, the unemployment rate rises above the natural rate in the early 1980s and late 1970s scenarios and no recession arises; the principal difference is with respect to the persistence of inflation beyond 2020.

Phillips curve. A policy approach that is less inertial and more responsive to inflation, or is designed with the asymmetry studied here explicitly in mind, would be more effective at arresting incipient inflation pressures in the circumstances illustrated by the last two scenarios.[34]

3. Concluding Thoughts

Our review of domestic and foreign episodes suggests that a soft landing as represented by the median SEP paths is not unprecedented, but it is not as common as an unwanted increase in inflation. However, given the behavior of inflation in recent years, with a flatter Phillips curve slope and relatively stable inflation expectations, along with the currently below-objective level of inflation, a sizable undesirable inflationary episode seems less likely than a simple accounting of the historical episodes would lead us to expect.

Of course, many different types of shocks could derail a soft landing. An adverse demand shock, such as a significant weakening in foreign economic conditions or a slowdown in domestic demand resulting from a rise in economic uncertainty, could push the economy into recession even without any additional tightening of monetary policy. On the other hand, a commodity or energy price shock (or an unexpected drop in the exchange value of the dollar) that pushed up inflation and inflation expectations markedly could prompt the FOMC to tighten policy aggressively and perhaps cause a recession.

One risk addressed in this memo is that tight resource utilization might spur financial instability. According to current estimates, credit remains far below trend. But this sanguine assessment relies importantly on one's view of the trend. Growth in credit, which abstracts from the trend, has shown more signs of a pickup, but remains below a level that would raise concerns. On the other side of the ledger, there also may be additional supply-side benefits to letting the economy

[34] The poor outcomes in some of the scenarios suggests an approach in which policymakers commit to a policy that minimizes deviations from the dual mandate objectives, as in the optimal control simulations routinely presented in Tealbook B. Such a policy would lean more against emerging inflation pressures early in the simulation and eliminate the unemployment rate undershooting as inflation approaches 2 percent. Thus, the optimal control policy path would effectively engineer a soft landing even under an accelerationist Phillips curve as in the 1970s scenario. That said, the optimal control results depend heavily on the assumption that the policymaker accurately forecasts economic outcomes and can commit to a policy path despite inflation responses that would be unusual by recent standards. Note also that the consequences of a given forecast error are larger in an economy with a steeper Phillips curve and more persistence because of the magnification and propagation of shocks implied by those features.

run a little hot, but here, too, it is hard to draw firm conclusions. The evidence of highly persistent, beneficial effects on the supply side of the economy in past events is not strong.

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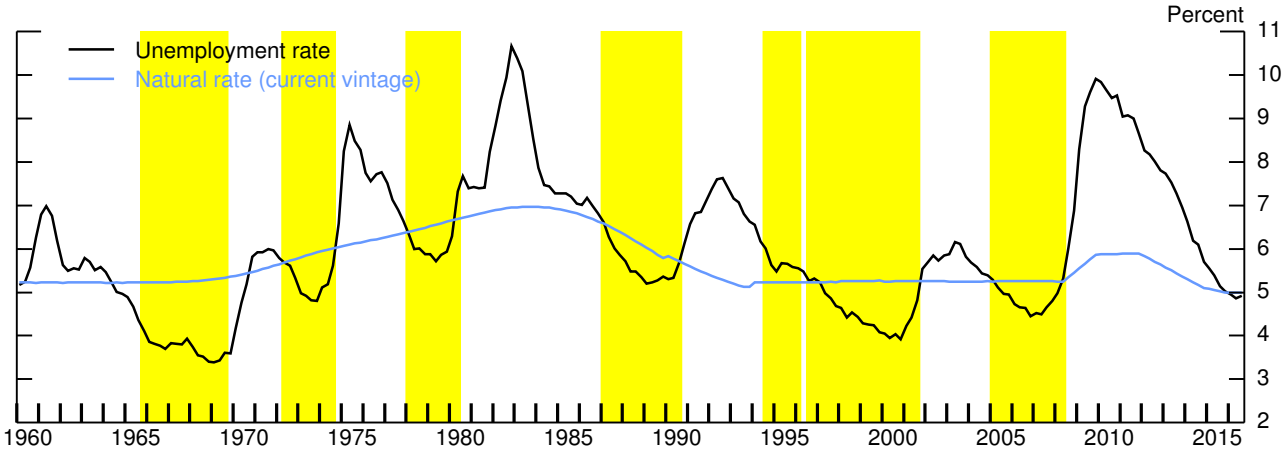
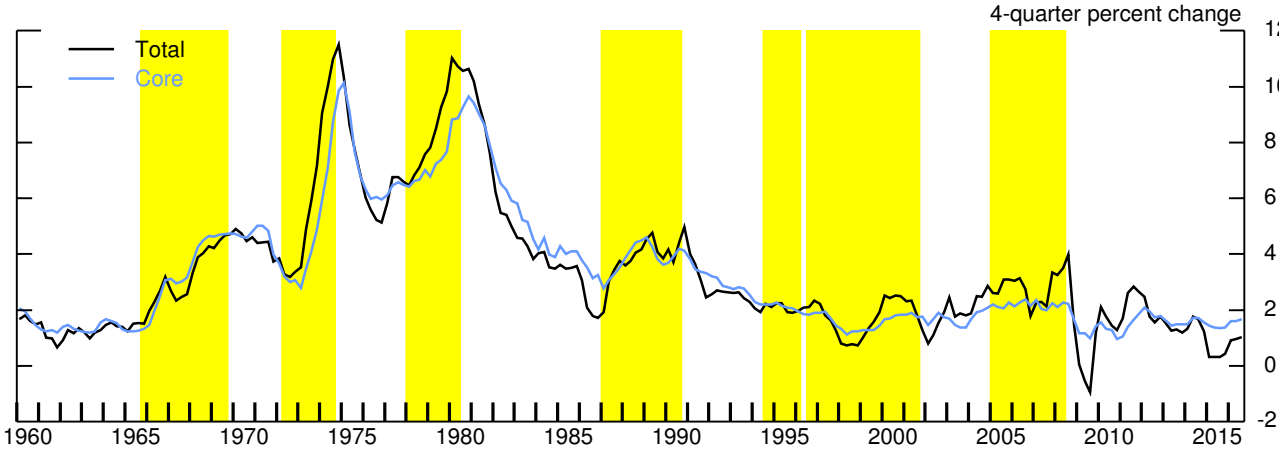
Unemployment Rate

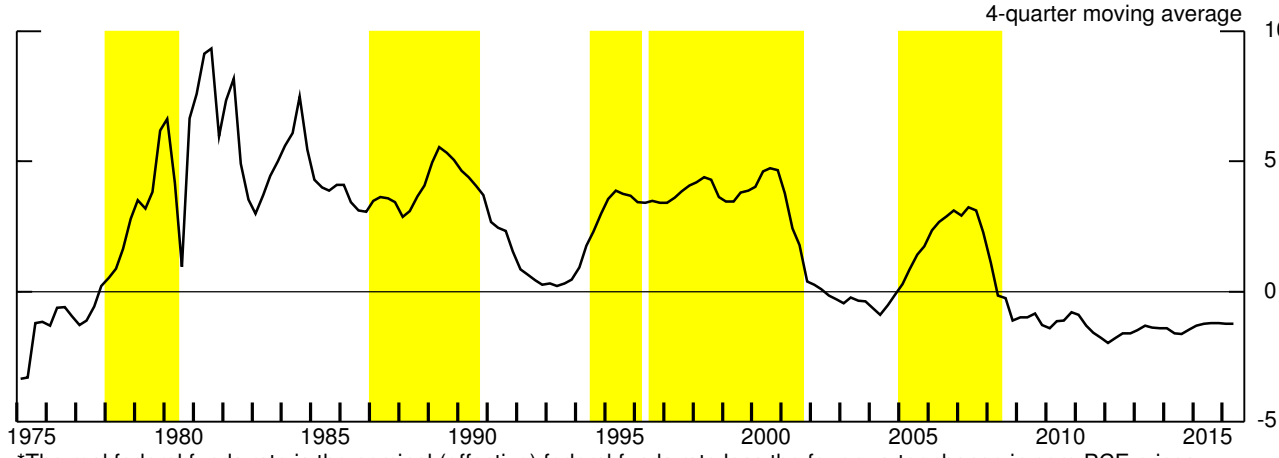


Yellow shading indicates periods of undershooting.

PCE Prices

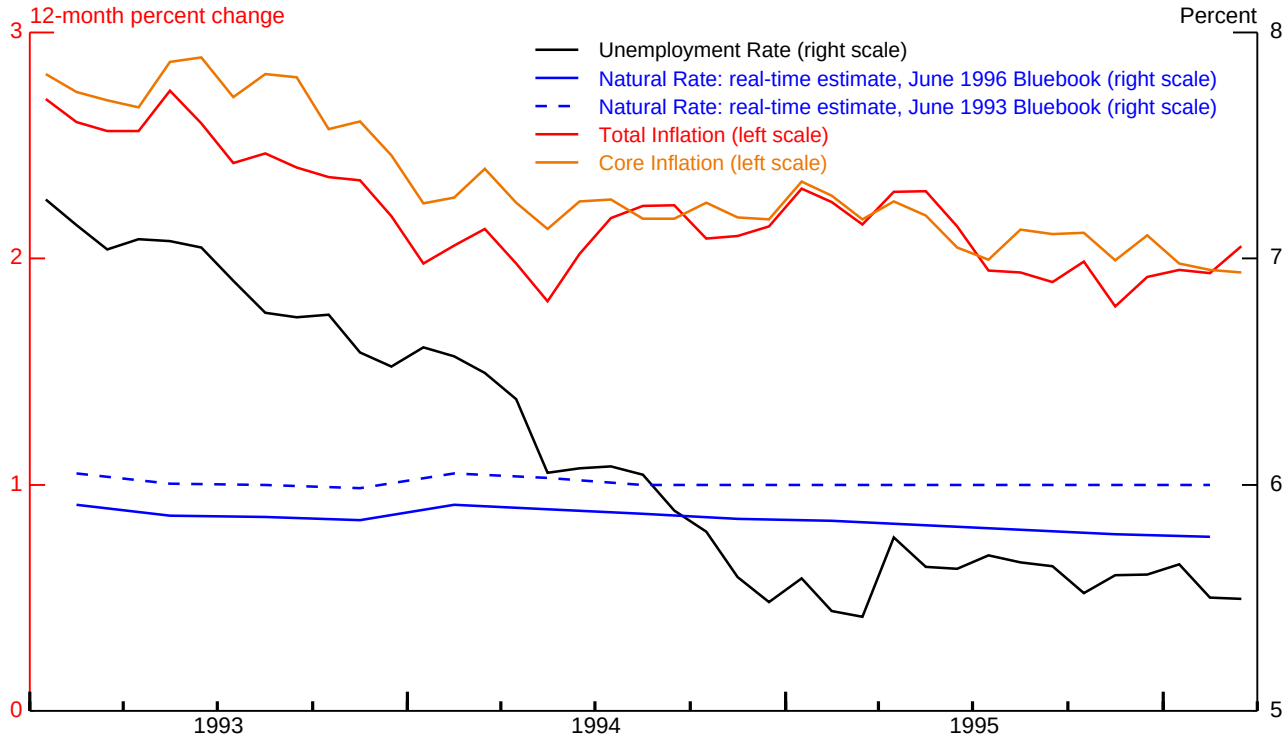


Real Federal Funds Rate*



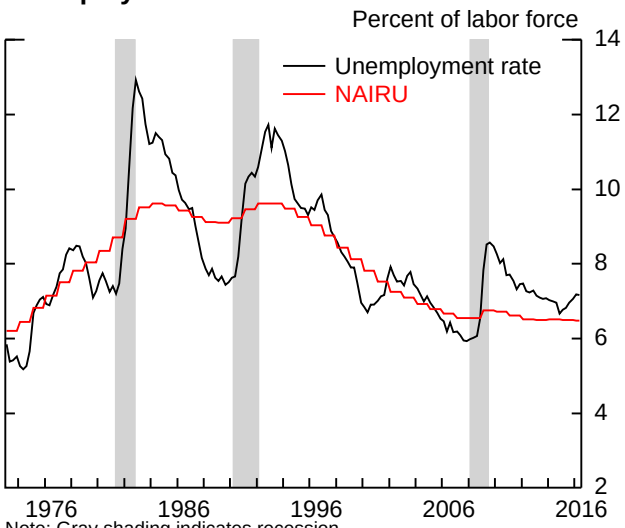
*The real federal funds rate is the nominal (effective) federal funds rate less the four-quarter change in core PCE prices.

Unemployment and Inflation: 1993q1 - 1996q1



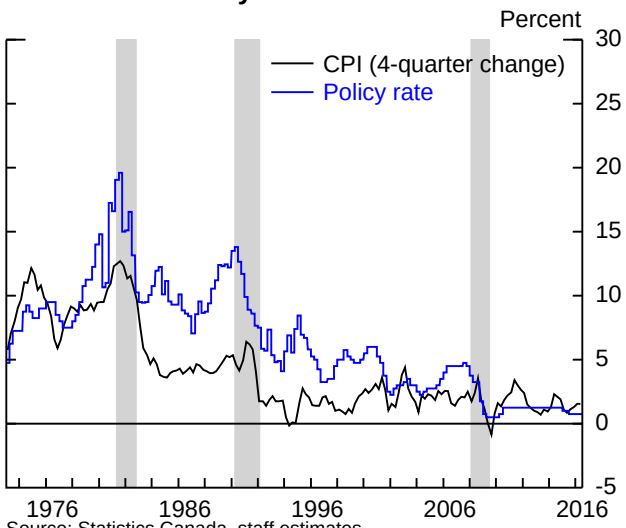
Canada

Unemployment



Note: Gray shading indicates recession.
Source: OECD, ECRI.

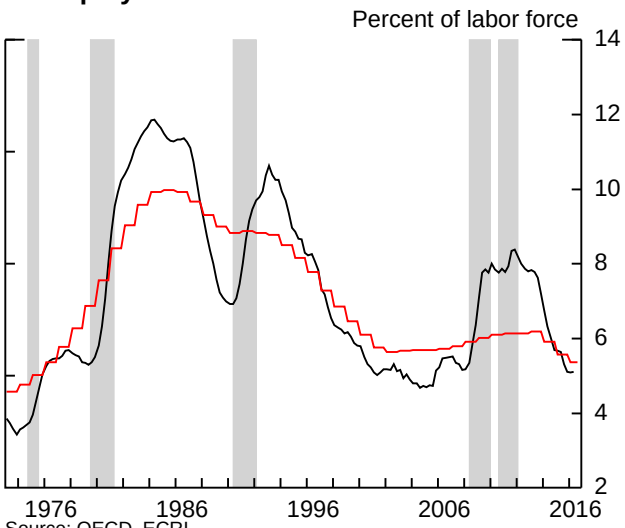
Inflation and Policy Rate



Source: Statistics Canada, staff estimates.

United Kingdom

Unemployment



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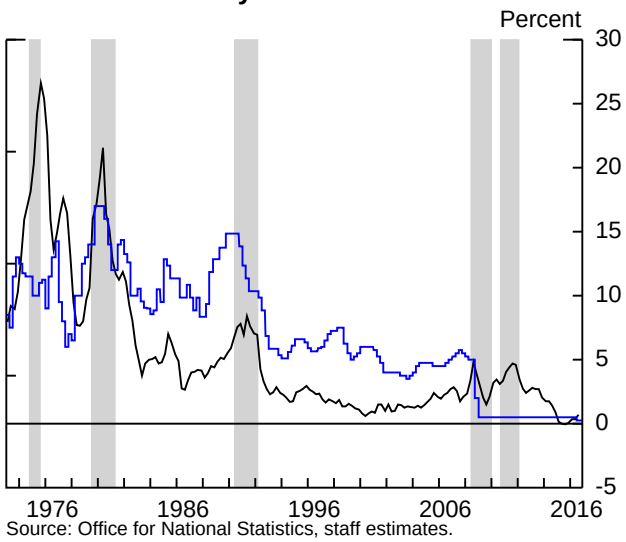
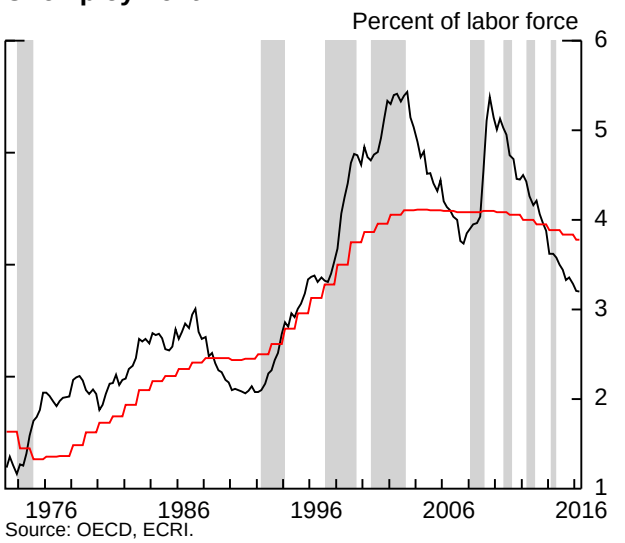
Inflation and Policy Rate



Source: Office for National Statistics, staff estimates.

Japan

Unemployment



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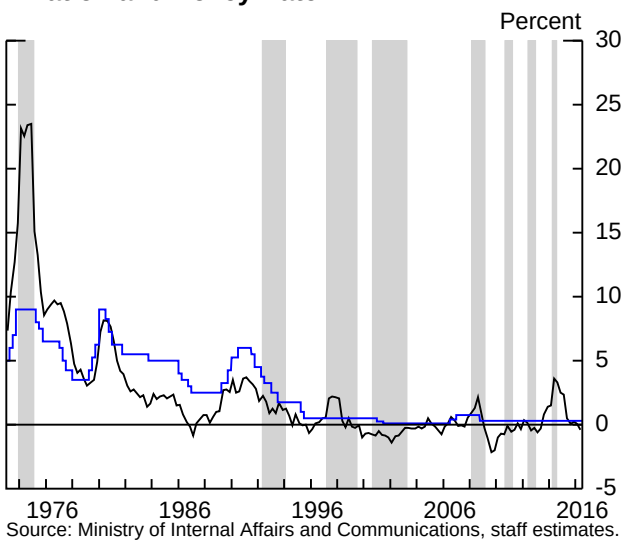
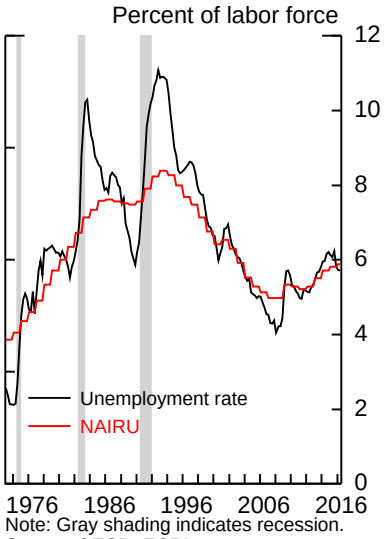
Inflation and Policy Rate



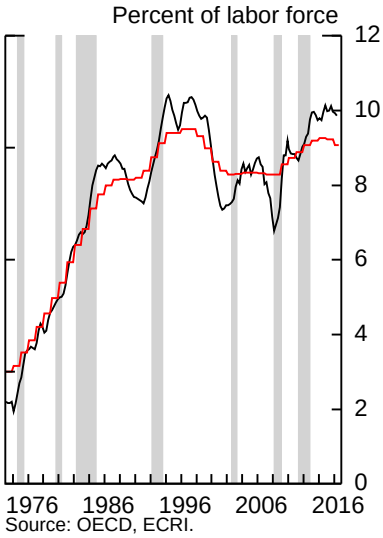
Source: Ministry of Internal Affairs and Communications, staff estimates.

Australia



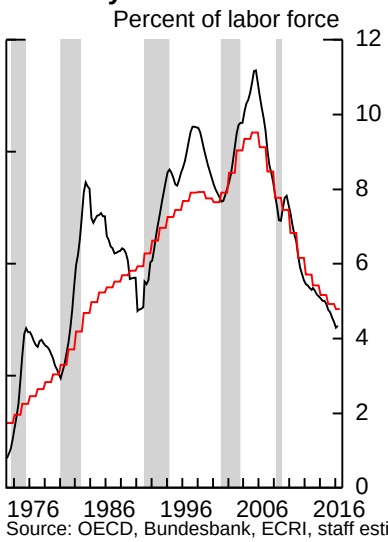
Note: Gray shading indicates recession.
Source: OECD, ECRI.

France



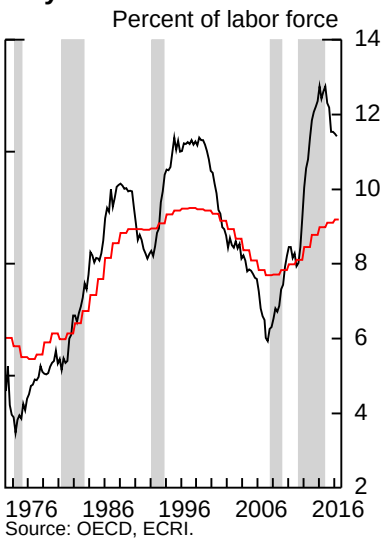
Source: OECD, ECRI.

Germany



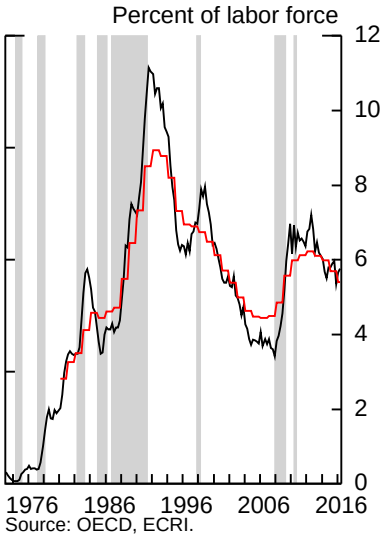
Source: OECD, Bundesbank, ECRI, staff estimates.

Italy



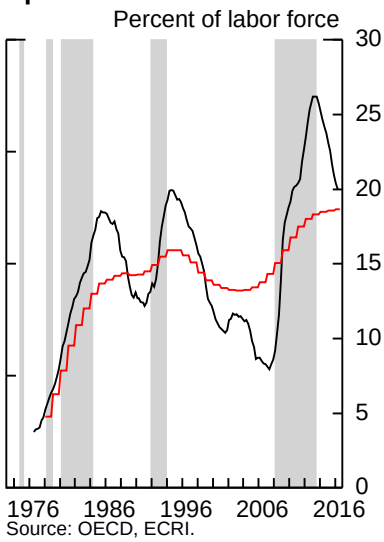
Source: OECD, ECRI.

New Zealand



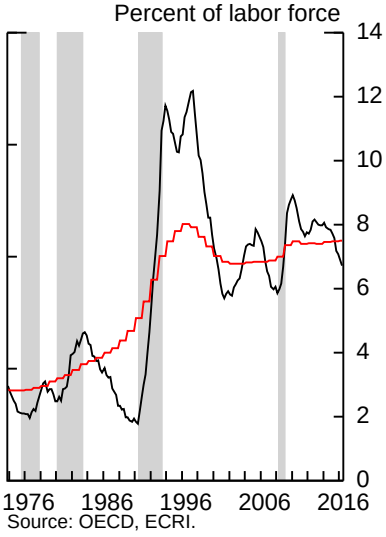
Source: OECD, ECRI.

Spain



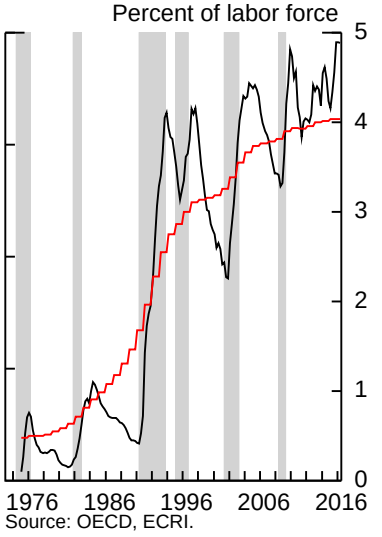
Source: OECD, ECRI.

Sweden



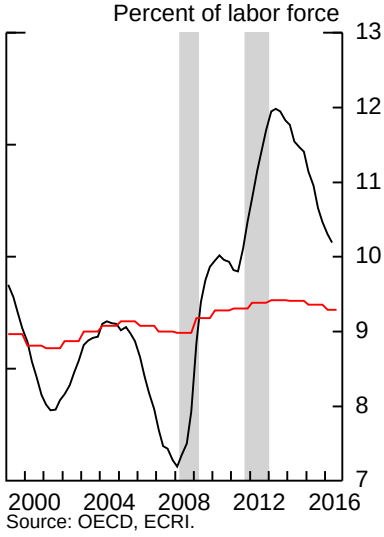
Source: OECD, ECRI.

Switzerland

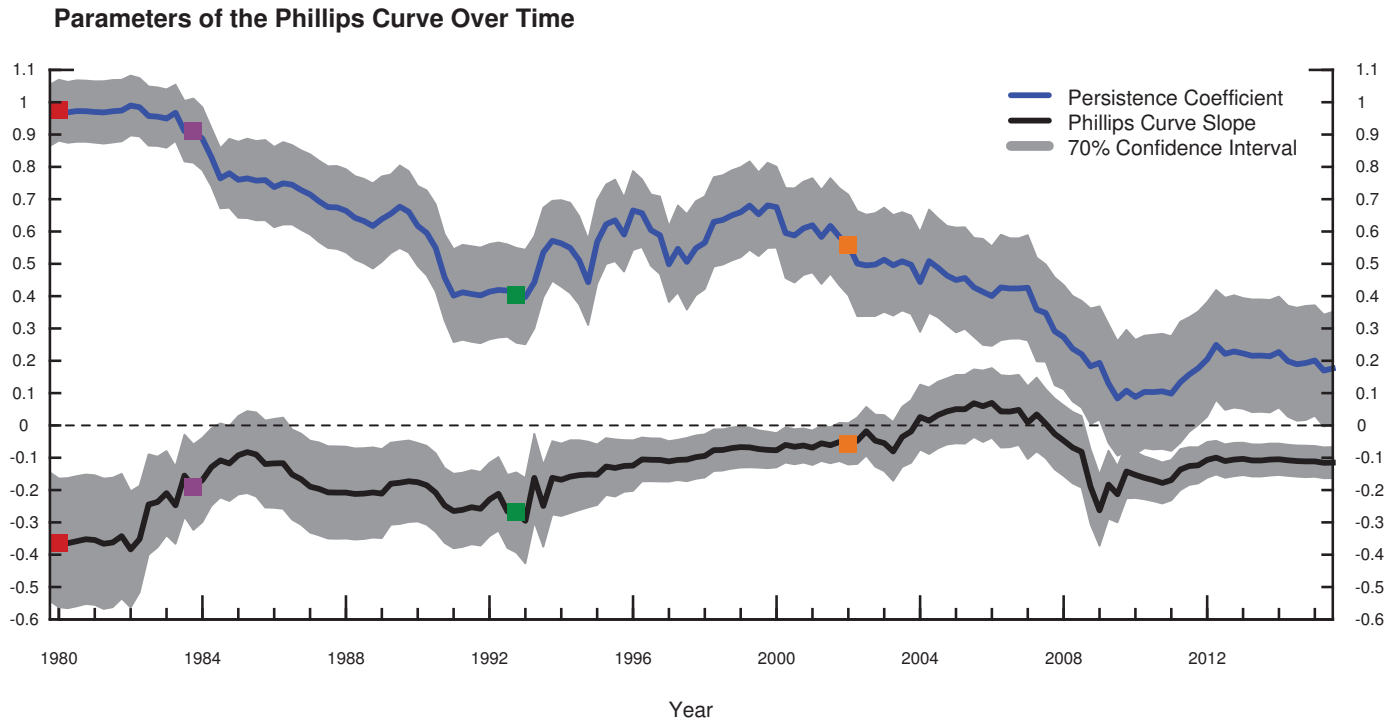


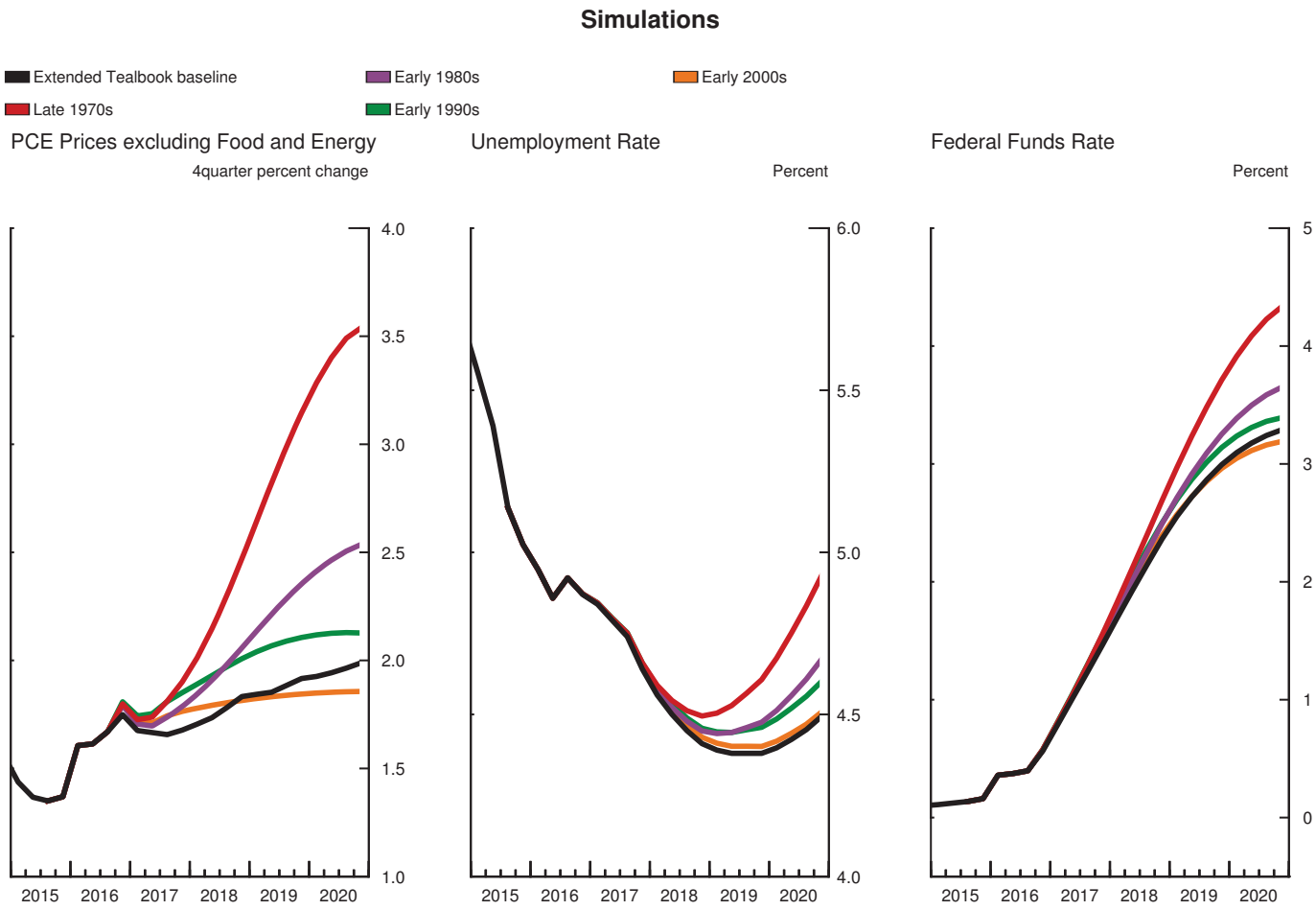
Source: OECD, ECRI.

Euro Area

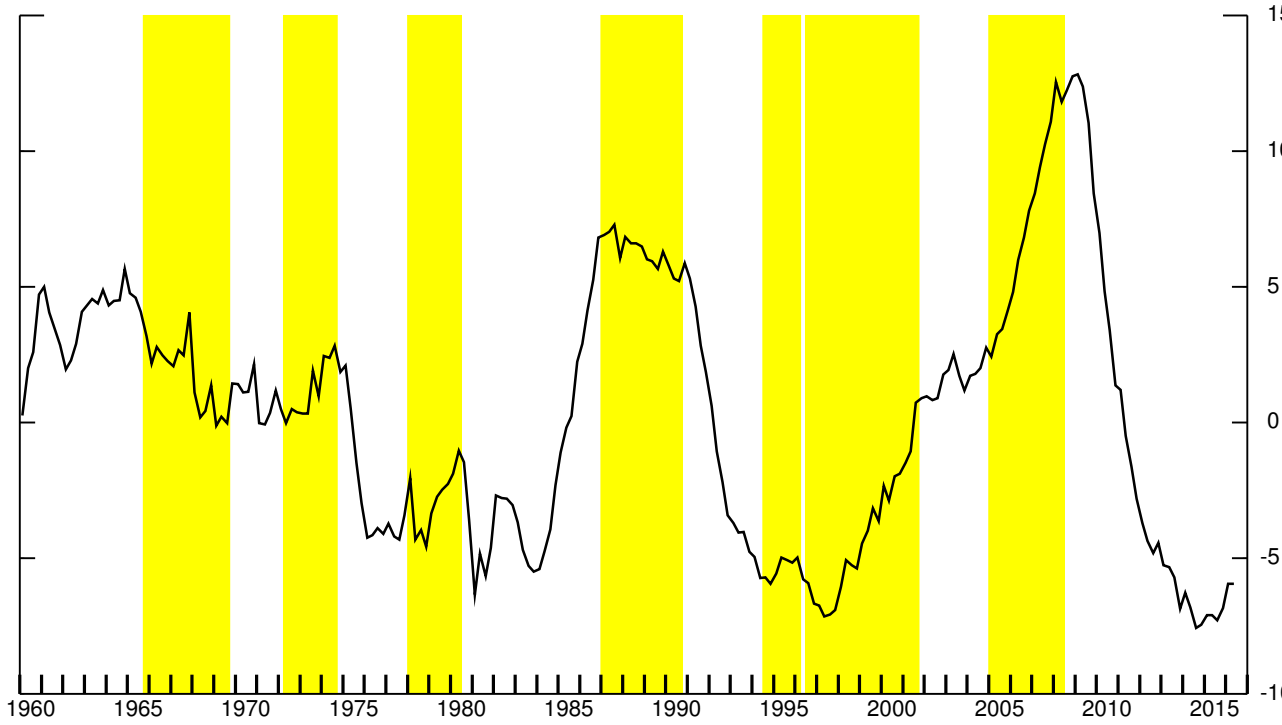


Source: OECD, ECRI.



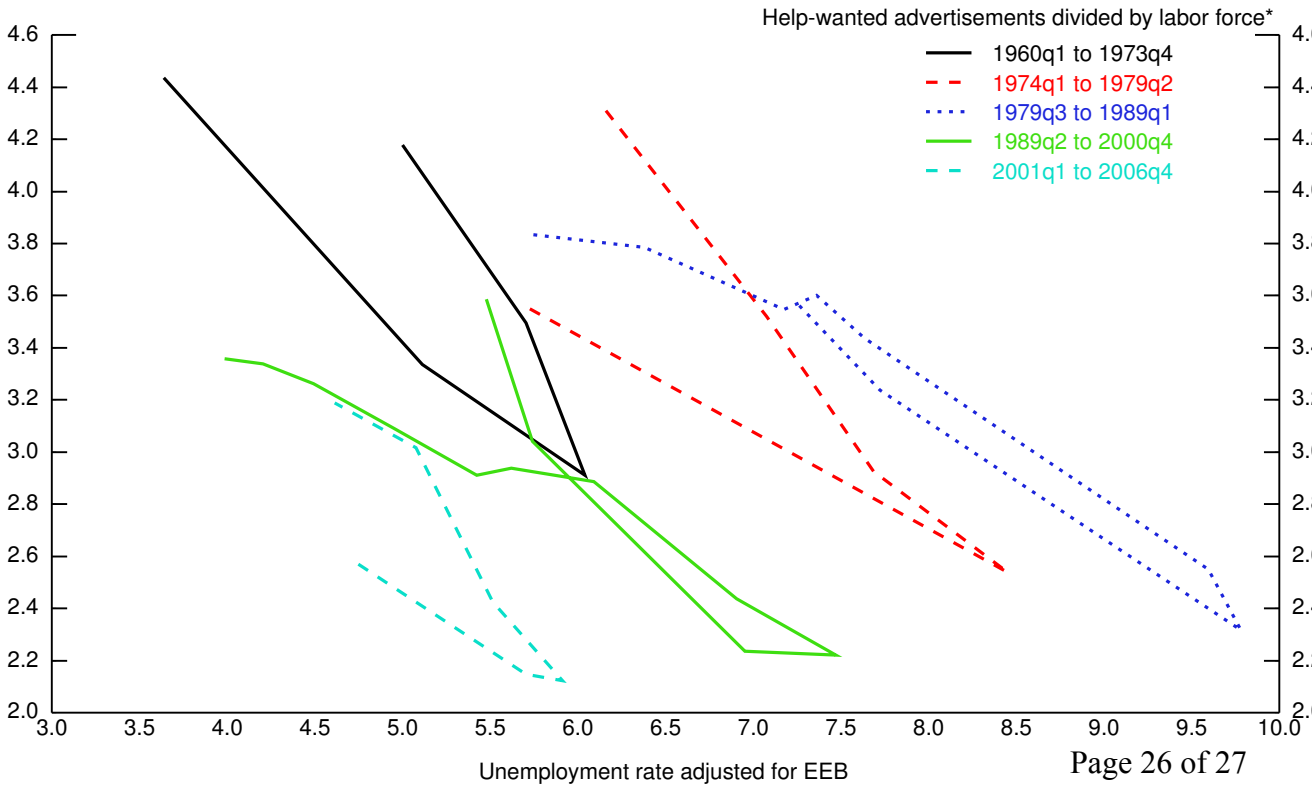


Private Nonfinancial Credit-to-GDP Ratio Gap (actual relative to trend)



Note: The trend is calculated using a two-sided HP filter with lambda=400,000. Yellow bars indicate periods of undershooting.

Beveridge Curves by Business Cycle Peak



Note: Beveridge curves are calculated within business cycle peaks. Annual average of monthly data, except mid-year peaks.
*Job vacancies are from the Cajner-Ratner adjusted help-wanted index.

Brief Narratives of Undershooting Episodes

Episode	Unemployment rate and gap	MP stance	Inflation	Shocks (+/-)
65-69	The unemployment rate flattened around 3¾% in 1966-1967, which most participants saw as near full employment. Then fell to 3½%.	Participants considered themselves tightening in 1968-1969, not looking for a recession.	Inflation rose steadily over this period from less than 2% to nearly 5%.	+positive fiscal shocks -slowdown in productivity
72-74	The unemployment rate briefly fell below 5 percent. Some participants were discussing tight utilization with the unemployment rate around 5¼%.	Tightening in 1972-1973. Expecting slowing but hoping to avoid recession.	Inflation rose from 3% to over 11%.	-Oct. 1973 energy crisis -removal of wage/price controls -weak dollar after breakup of Bretton-Woods
78-80	The unemployment rate fell below 6% and hovered there for two years. Participants discussed "full employment" near the end of 1978, with unemployment rate around 6%.	Tightening in 1978 and early 1979. Aimed to tighten without causing recession. However, Volcker announced targeting of nonborrowed reserves in late 1979 to "get firmer control." FF jumped.	Inflation rose from 6½% to 11%.	-oil price shock -sharp drop in the dollar in the middle of 1979 was considered a crisis by participants
87-90	Participants viewed economy as near full employment with unemployment rate at 6% in 1987 but lowered estimates of the NRU and viewed utilization as high, but not overly so, as unemployment rate reached 5½%.	Began tightening in 1987; RFF rose nearly 300 bp, although they paused following Black Monday.	Inflation reasonably stable in the neighborhood of 4½%, but above long-term goal. Participants sought to reduce it at a measured pace.	-1987 stock market crash -oil price shock associated with invasion of Kuwait - confidence shock at start of war -credit crunch from S&L crisis and bursting of CRE bubble
93-95	The unemployment rate fell to 5½% and hovered there for 18 months. The staff NRU, at 6% at start of episode, was lowered to 5¾%.	Tightening from February 1994 to early 1995, with RFF up 300 bp. Tightening began with the unemployment rate above the real-time NRU.	Actual price and wage inflation lower than expected in 1994, but FOMC still concerned about building inflationary pressures.	+pickup in productivity reduces inflationary pressures despite tightening labor market
96-00	The unemployment rate fell steadily to around 4%. The staff lowered the NRU over this period and it stood at 4¾% in 2000.	Modest (passive) tightening of 125 bp through mid-1998, as core inflation slowed. Eased RFF in response to Asian crisis (100bp). Actively tightened (125 bp on RFF) beginning summer 1999.	Inflation was low and falling until early 1999 and then began to rise, at least partly due to a positive energy shock; core inflation remained below 2%.	+pickup in productivity put downward pressure on inflation and boosted potential output growth -Asian and EME financial crisis -tech bubble and bust
05-07	The unemployment rate reached 4½% before edging up in the second half of 2007. The staff NRU was around 4¾%.	Began tightening in June 2004 and continued until August 2006, eventually increasing RFF about 400 bp.	Inflation was fairly steady, with PCE inflation running between 2½% and 3%, and core inflation closer to 2¼%, but this was above the comfort zone of some participants.	-oil prices rose sharply, and dollar declined noticeably, on net, over 2005-2007 -housing bubble burst, leading initially to contraction in homebuilding and eventually to Global Financial Crisis