



IMF Working Paper

Still Minding the Gap—Inflation
Dynamics during Episodes of Persistent
Large Output Gaps

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European Department

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Abstract

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This paper studies inflation dynamics during 25 historical episodes in advanced economies where output remained well below potential for an extended period. We find that such episodes generally brought about significant disinflation, underpinned by weak labor markets, slowing wage growth, and, in many cases, falling oil prices. Indeed, inflation declined by about the same fraction of the initial inflation rate across episodes. That said, disinflation has tended to taper off at very low positive inflation rates, arguably reflecting downward nominal rigidities and well-anchored inflation expectations. Temporary inflation increases during episodes were, in turn, systematically related to currency depreciation or higher oil prices. Overall, the historical patterns suggest little upside inflation risk in advanced economies facing the prospect of persistent large output gaps.

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I. INTRODUCTION

Most advanced economies are projected to recover only slowly from the global financial crisis, with output remaining below potential for several years to come. The IMF's April 2010 World Economic Outlook, for instance, projects negative output gaps through at least 2014 for all G-7 economies. Projections by other forecasters may differ in details, but paint broadly the same picture. It mirrors the common view that tight credit conditions, deleveraging in the private sector, and fiscal retrenchment will continue to restrain demand.

This outlook has prompted concerns that inflation might undershoot official targets for an extended period; see Krugman (2010) or Wolf (2010). The assumed link between spare capacity and disinflation is familiar from traditional Phillips curve arguments, but has support in modern microfounded models of the macroeconomy as well. Specifically, standard new Keynesian theory implies that negative demand shocks reduce the marginal cost of production, pushing both wage and price inflation lower.

Yet, the prediction of excessively low inflation, or even deflation, is not universally accepted. Indeed, many official forecasts show inflation stabilizing at target rates well before output returns to potential. Some other observers even view risks tilted to the upside, predicting an inflationary sequel to the financial crisis; see Meltzer (2010) or Halligan (2010).

Doubts about the downward pull from negative output gaps can be related to several factors. First, economists have argued that inflation expectations have become more firmly anchored as monetary policy has gained credibility in recent decades. This notion appears consistent with empirical evidence whereby Phillips curves have become flatter since the early 1990s. Accordingly, output gaps might have a more muted effect on inflation than in earlier periods.

Aside from better-anchored expectations, inflation might also resist the undertow of weak demand if there are large increases in non-labor input costs, perhaps as a result of higher commodity prices or a depreciating currency. Another argument, recently invoked by Dale (2009) and Dwyer et al. (2010), is that inflation might rise because of short-term 'speed limits'. In this view, even an underemployed economy could suffer inflationary pressure if it emerges very quickly from recession, as idle resources cannot be reemployed instantly. Lastly, some observers have argued that high fiscal deficits, coupled with unconventional monetary policies, will inevitably erode central bank credibility and drive up inflation.

Overall, the current situation entails significant uncertainty about inflation prospects, with debates raging on whether we should be worried about deflation, high inflation, or neither of both. Importantly, the disagreement relates not only, or even primarily, to the nature of the current cyclical outlook—most observers agree that there is sizeable slack—but to the moderating impact this slack will have on inflation, relative to other factors.

The significant uncertainty, along with inconclusive predictions from theory alone, puts a premium on empirical research into the link between inflation and output gaps. The standard approach is to estimate the slope of the Phillips curve, often in a single-equation approach using instrumental-variable methods. However, these efforts are fraught with many difficulties, notably the scarcity of time series data for inflation expectations, weak instrument problems, and the complications arising from nonlinearities, nontrivial lag structures, drift in mean inflation, and nuisance factors (like exchange rate or commodity price shocks) that do not feature in standard theory, but are potentially important in practice.

In this paper, we sidestep such estimation issues by focusing on a simpler empirical approach. Specifically, we trace inflation dynamics during past episodes in advanced economies where output remained well below potential for an extended period. In so doing, we limit attention to a segment of the Phillips curve that is of particular relevance today. The focus on drawn-out episodes allows us, furthermore, to look beyond the short-term dynamics typically captured in Phillips curve estimation. It is clear that stylized facts documented for the past can only be a rough guide to the present, but as our sample includes a total of 25 episodes in 14 countries from the last 40 years, it provides a broad perspective on inflation outcomes observed during episodes of persistent large output gaps (PLOG).

Our analysis pays special attention to the question of how much support there is for—or against—the downward pull of persistent large output gaps. Are there any historical episodes during which inflation failed to ease despite significant economic slack? If so, can these experiences be linked to any particular economic features or shocks? And have such episodes become more common in recent times, as steady-state inflation has eased and inflation expectations have become more entrenched?

At the outset it should be noted that our analysis takes the latest estimates of historical output gaps as given. This is not to downplay the considerable challenge of assessing spare capacity in real time, as evidenced by sometimes large ex-post revisions. However, this challenge can be, and has been, addressed as a separate research topic, while our focus is on studying key features of PLOG episodes conditional on a trusted set of output gap data.

The paper is structured as follows. Section II briefly lays out the theory of output-inflation dynamics and describes the difficulty of estimating Phillips curves. Section III then turns to the data used for our own analysis. Section IV documents the behavior of inflation during 25 historical PLOG episodes. Section V widens the perspective to consider the interaction of inflation with other important variables during such episodes. Section VI discusses the relevance of our findings for the current inflation outlook, and Section VII concludes.

II. RELATION TO THE LITERATURE

The New Keynesian Phillips Curve

Modern macroeconomic theory typically captures the relationship between output and inflation in a New Keynesian Phillips Curve (NKPC). The NKPC is derived from the pricing behavior of firms in a dynamic general equilibrium model with imperfect goods market competition and sticky prices. It postulates that current inflation is a function of past inflation, expected future inflation, and the contemporaneous marginal cost of production:

$$\pi_t = \phi^b \pi_{t-1} + \phi^f E_t[\pi_{t+1}] + \lambda mc_t, \quad (1)$$

where π_t denotes inflation between periods $t-1$ and t ; mc_t denotes the deviation of real marginal cost from its steady-state value; and ϕ^b , ϕ^f , and λ are parameters. Specifically, $\lambda > 0$ is a function of the frequency of price adjustments—the more often firms adjust prices, the higher is λ , and hence the more responsive is inflation to current marginal cost. For a full derivation, see Galí and Gertler (1999).

With competitive labor markets, real marginal cost has an approximately linear relationship to the output gap ($y_t - y_t^*$), implying a direct link between inflation and spare capacity:

$$\pi_t = \phi^b \pi_{t-1} + \phi^f E_t[\pi_{t+1}] + \theta(y_t - y_t^*). \quad (2)$$

The size of ϕ^b and ϕ^f , i.e., the relative role of forward- vs. backward-looking terms, has been the focus of much empirical research into the NKPC.¹ For our purposes, however, the main prediction relates to $\theta > 0$. In other words, a large negative output gap should lower inflation relative to its “normal” path.

Typical estimation strategies and findings

Estimation of the NKPC is frequently done in single-equation models, using the Generalized Method of Moments (GMM). The key challenge relates to $E_t[\pi_{t+1}]$, which is unobservable. Survey- or market-based inflation expectations might in principle serve as proxies, but are usually available for short time series only. Therefore, most studies use data on actual inflation outturns, π_{t+1} , exploiting the fact that forecasting errors are unpredictable under rational expectations. In particular, applying the law of iterated expectations to (2) yields

$$E[\phi^f \pi_{t+1} - \pi_t + \phi^b \pi_{t-1} + \theta(y_t - y_t^*) | Z_t] = 0, \quad (3)$$

¹ A high weight on the forward-looking term is reported, among others, by Galí and Gertler (1999), Sbordone (2002), Galí et al. (2005), and Kleibergen and Mavroeidis (2008), but not by Fuhrer and Moore (1995), Fuhrer (1997), and Rudd and Whelan (2005a).

where $E[\circ | Z_t]$ denotes an expectation based on information set Z_t . Equation (3) provides moment conditions that can be used for estimation via GMM. Specifically, the structural parameters of equation (3) can be identified by finding a set of instrumental variables $z_t \in Z_t$, at least one of which must be a good independent predictor of future inflation, π_{t+1} .

Empirical studies of the NKPC typically report that the output gap coefficient θ is very small and often statistically insignificant; see Nason and Smith (2008). Moreover, a few studies find the estimated slope coefficient to have declined over recent decades; see Kleibergen and Mavroeidis (2008) for a study on U.S. data and Bean (2007) for a general discussion.² This apparent “flattening” of the Phillips curve has been primarily attributed to the success of central banks in entrenching low inflation—see Laxton and N’Diaye (2002), Roberts (2006), and Mishkin (2007); and to globalization—see IMF (2006) and Borio and Filardo (2007).

Methodological pitfalls

Does the common finding of very low NKPC slope coefficients prove the irrelevance of output gaps for inflation dynamics? Before drawing that conclusion, it is important to recognize a few pitfalls in econometric work on the NKPC.

One central issue is the problem of *weak instruments*, first highlighted by Ma (2002) and Mavroeidis (2005). Identification of the parameters in (3) requires at least one instrumental variable that can be safely excluded from the Phillips curve—the instrument must be valid—but nonetheless has good predictive power for π_{t+1} —the instrument must be strong enough. Such variables are typically scarce. Yet without strong instruments, standard GMM becomes unreliable, yielding severely biased estimates. Studies using robust econometric methods, in turn, tend to report very imprecise results; see Kleibergen and Mavroeidis (2008).

A related problem arises from *omitted dynamics and possible nonlinearities* in the link between inflation and the output gap. Equation (2) posits a linear, contemporaneous relationship. In practice, however, output gaps could have a disproportionate effect on inflation when they are large in absolute terms; and their effect might be greater or smaller for negative than for positive output gaps. Moreover, the dynamics could be richer than captured in equation (2). It might be necessary, in particular, to include additional lags of inflation, or to allow for drift in the average inflation rate, as noted by Ascari (2004). Taken together, there is a case for exploring the inflation-output gap nexus in a way that imposes fewer constraints on functional form and allows for specific conditioning information.³

² The finding of a reduced slope coefficient is not uncontroversial, however. Nason and Smith (2008), for example, find no evidence for a parameter change in US inflation dynamics since 1955.

³ Laxton et al. (1995) and Turner (1995) are examples of such research, focusing on nonlinearities in the link between output gaps and inflation. The authors find that positive output gaps have a greater effect on inflation than negative ones, consistent with a convex Phillips curve.

Similarly, there are likely to be factors other than the output gap that independently affect inflation. Recall that the driving force in the original formulation of the NKPC in (1) is real marginal cost. In practice, firms' marginal cost is likely to reflect not only the extent of spare capacity, but also, say, changes in commodity input prices, exchange rates, or the cost of finance; see Batini et al (2005). This calls for the consideration of control variables in empirical work on the NKPC, lest parameter estimates suffer from omitted variable bias.

In sum, the link between output gaps and inflation might appear spuriously weak because standard models do not allow for sufficient complexity in the relationship. Yet this argument can be taken one step further: real-life complexity might also entail that the link between output gaps and real marginal cost is itself less strong than standard theory assumes. Labor market imperfections, for instance, may make real wages relatively unresponsive to spare capacity. Consistent with this view, several papers have documented larger and more significant NKPC slope coefficients when the output gap is replaced with other proxies for real marginal cost, notably the labor share in GNI; see Galí and Gertler (1999) or Woodford (2001). These findings pose a challenge to the view that output gaps are central for inflation behavior.⁴ As such, they provide additional motivation for this paper.

Empirical strategy of this paper

Although GMM estimation of the NKPC remains an important tool to uncover the structural relationship between inflation and output gaps, the previous subsection has outlined a number of methodological challenges. Consequently, there is merit in pursuing different empirical strategies to shed light on the issue. In this paper, we sidestep many of the above-mentioned challenges by focusing on an event study comprising 25 PLOG episodes. The idea is to provide direct evidence for the behavior of inflation during protracted downturns.

Compared to standard NKPC estimation, we limit attention to a specific segment of the Phillips curve that is of particular relevance today, i.e., situations of large negative output gaps. As argued above, dynamics in this segment might well differ from the *average* interaction of inflation and output gaps. The focus on drawn-out episodes allows us, furthermore, to look beyond the short-term dynamics typically captured in Phillips curve equations. Specifically, we consider broad trends during the relevant episodes in order to verify whether the evidence accords with theory at least “in the big picture”. By its nature, the approach of this paper is more descriptive and focused on statistical association, rather than clear-cut structural links. However, by considering a number of key variables over a sizeable set of historical episodes—some more distant, some more recent—our objective is to gain a wide perspective on the dynamics of inflation during PLOG episodes.

⁴ However, Rudd and Whelan (2005b) provide evidence suggesting that the labor share does not improve the empirical fit of the NKPC at all.

III. DATA SOURCES, DEFINITIONS, AND COMPOSITION OF THE SAMPLE

The goal of this paper is to trace inflation dynamics during episodes of ample spare capacity in advanced economies. Accordingly, we start from a sample of all 15 high-income OECD-DAC members for which quarterly output gap estimates are available from the OECD's *Economic Outlook* database. This set of countries includes, notably, all G-7 economies. The maximum time period we consider is 1970Q1–2007Q4, i.e., the last nearly forty years of data up to the eve of the global financial crisis. In several cases, however, the available time series commence a little later in the 1970s, or even as late as 1980Q1 in the case of New Zealand.

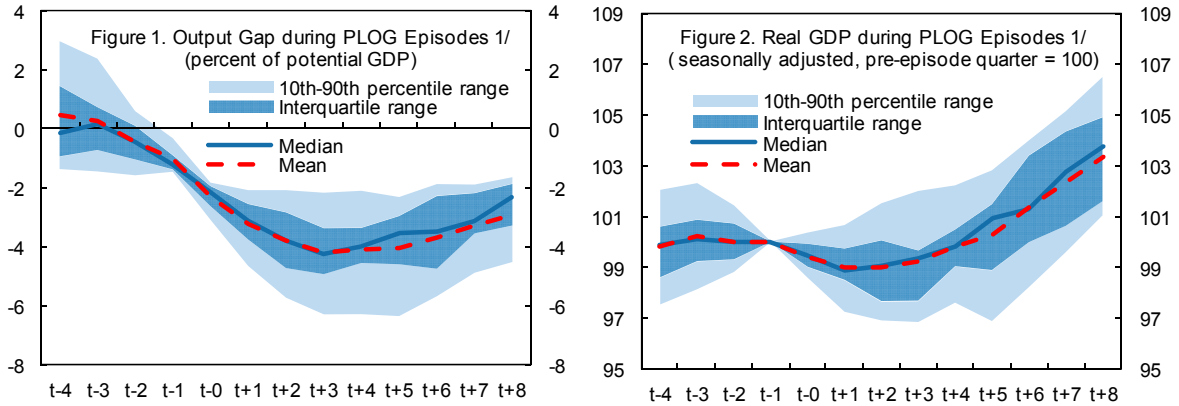
Output gap data are obtained from the OECD Economic Outlook No. 86, thus representing the latest, and presumably most accurate, time series of resource slack.⁵ The OECD estimates potential output—and thus output gaps—using a production function approach based on data for total factor productivity, capital services, and potential employment; see Beffy et al. (2006). All data sources used in this paper are detailed in Table 1.

We define an episode of interest as at least eight consecutive quarters of negative output gaps exceeding 1.5 percent in absolute terms. This definition captures two key elements of the constellation we are interested in: a *large* output gap, and one that *persists* for a significant period of time—both features of the current economic outlook according to key forecasters.

Among the 15 countries in our initial data set, all but Norway feature at least one such PLOG episode; several countries feature two episodes; and Canada three. The length of these episodes varies between 9 and 25 quarters. On average, a PLOG episode lasts a little more than three years, with an average output gap during the episode of 3.3 percent, indicating a severe demand shortfall. Further details are provided in Table 2.

Figure 1 displays the distribution of output gap paths in our sample of PLOG episodes. We focus on the first nine quarters of each episode, matching the minimum length observed in our sample. The fall in output relative to potential is sizeable across episodes. Still, the corresponding chart for GDP levels shows that the episodes were not periods of absolute decline (Figure 2). In fact, a recession is usually already underway when the PLOG episode begins; the fall in GDP tends to end around the second or third quarter of the episode, and is invariably followed by a rebound, as the economy gradually closes the output gap.

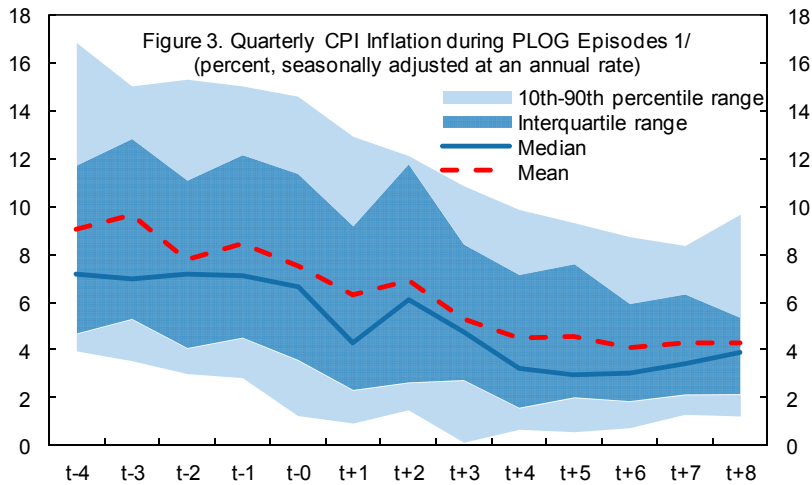
⁵ Data for the OECD's Economic Outlook No. 87 were released in June 2010, after most of the analysis in this paper had been completed. However, we still use the June 2010 dataset in Section VI below, which deals with the most recent, post-2007 period and hence is most prone to data revisions.



Source: See Table 1.
 1/ Episodes of persistent large output gaps as listed in Table 2. X-axis denotes quarters, with t-0 the first quarter of each episode.

IV. INFLATION DYNAMICS DURING PLOG EPISODES

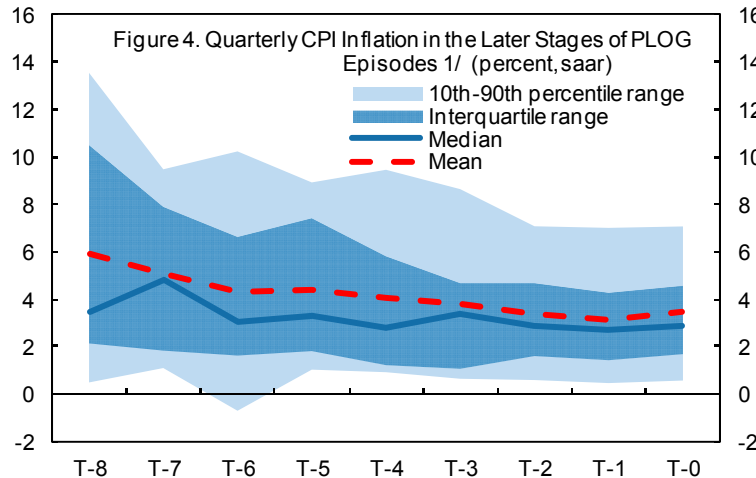
We now turn to the behavior of CPI inflation during the episodes identified in the previous section. Figure 3 visualizes key features of the distribution of outcomes. First and foremost, **there is a clear trend of disinflation during historical PLOG episodes**. Disinflation actually tends to start somewhat ahead of the episode. The strongest decline in inflation occurs, on average, during the first 4–5 quarters of the episode, followed by gradual further easing or bottoming-out at lower rates.



Source: See Table 1.
 1/ Episodes of persistent large output gaps as listed in Table 2. X-axis denotes quarters, with t-0 the first quarter of each episode.

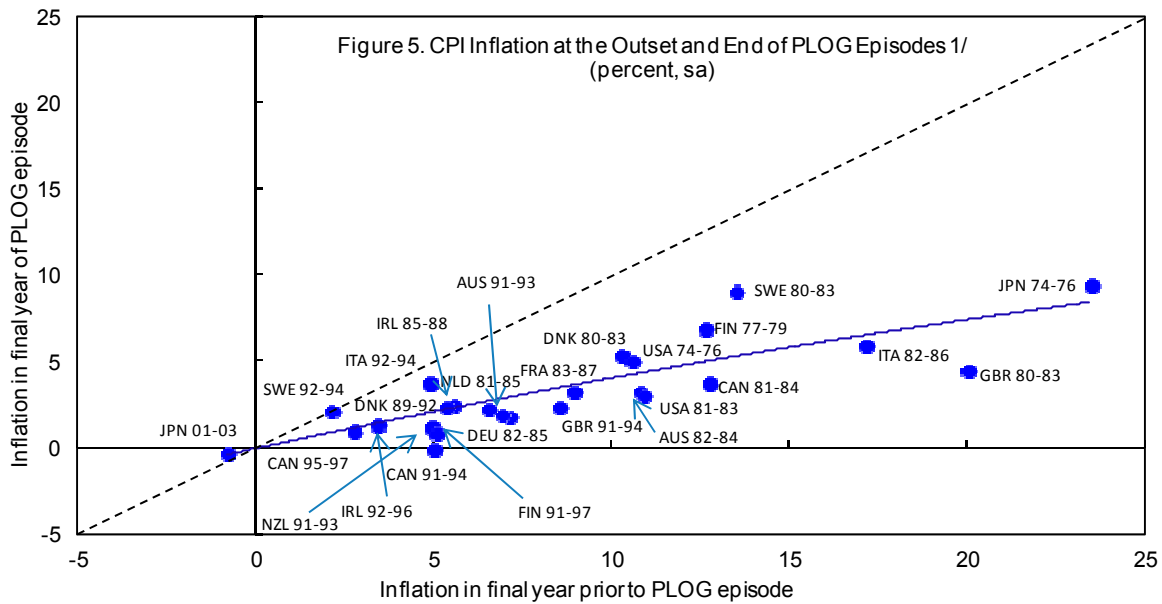
Looking at different segments of the distribution, it appears that disinflation continues through the later stages of the PLOG episode in cases where inflation is relatively high, while the bottoming-out starts earlier in low-inflation episodes.

The same dynamic is also apparent if we focus on a slightly different event window, covering the *final* nine quarters of all PLOG episodes (Figure 4). Relative to the previous chart, this figure also describes inflation dynamics toward the end of the longer PLOG episodes. It confirms a clear pattern of disinflation over the course of the event window, but with a flattening toward the very end.



Source: See Table 1.
 1/ Episodes of persistent large output gaps as listed in Table 2. X-axis denotes quarters, with T-0 the final quarter of each episode.

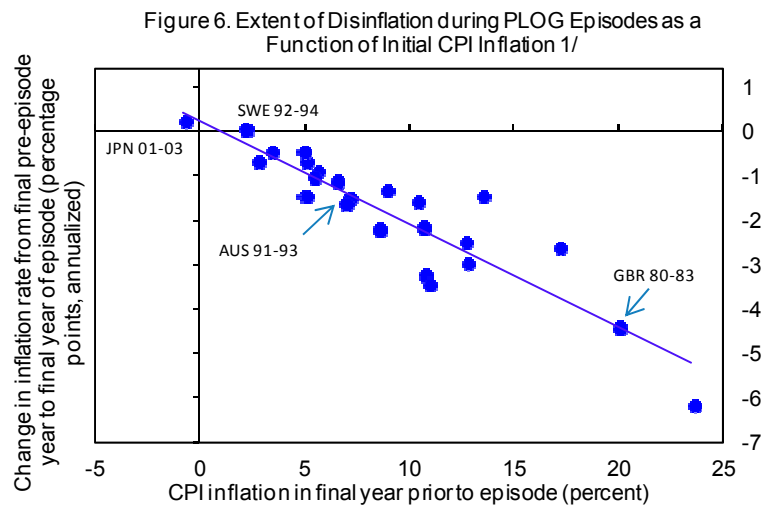
In a next step, we take a closer look at individual episodes, comparing inflation rates in the year prior to the PLOG episode to those in the final year of the episode. As Figure 5 shows,



Source: See Table 1.
 1/ Episodes of persistent large output gaps as listed in Table 2.

the evidence for disinflationary pressure during PLOG episodes is very clear.⁶ Specifically, all but two data points are below the 45 degree line, confirming that **inflation falls in the overwhelming majority of all episodes. Moreover, in the two atypical cases where inflation rose during the episode, the observed increase was negligible and occurred from very low (in one case, negative) initial rates of inflation.**

Furthermore, **the relationship between initial and final inflation rates seems roughly proportional**, suggesting that countries with high initial rates of inflation experience greater deceleration in absolute, but not relative terms. This result remains intact if we control for the different length of individual episodes, by considering annualized changes in inflation rates between the final pre-episode year and the final year of the episode (measured in percentage points). As the estimated regression line in Figure 6 shows, countries tend to see a very similar relative decline in inflation rates *per annum*.



Source: See Table 1.

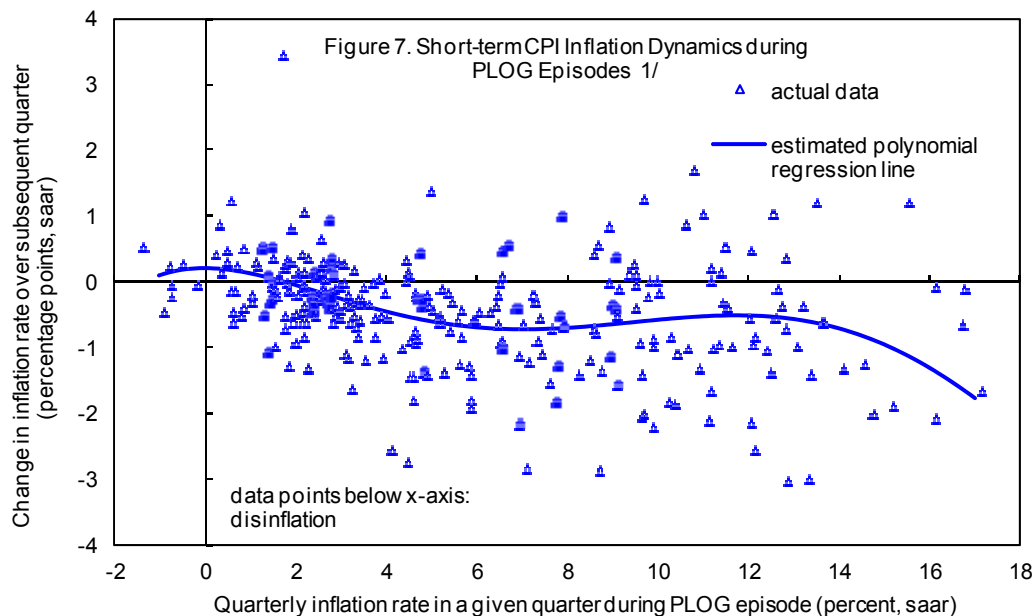
1/ Episodes of persistent large output gaps as listed in Table 2.

To illustrate, compare the experience of the U.K. during the early 1980s with that of Australia one decade later. In the former episode, inflation dropped from 20 percent to less than 5 percent over three-and-a-half years, implying average annual disinflation of 4.4 percentage points, or 22 percent of the initial inflation rate. The Australian episode, in turn, featured inflation falling from just below 7 percent to 2 percent over three years, implying average annual disinflation of 1.6 percent, or about 23 percent of the initial inflation rate—again close to the average speed of disinflation across episodes.

⁶ By contrast, the average quarterly change in inflation in the remainder of our sample is marginally positive.

With this pattern in mind, it is worth noting that the regression line in Figure 6 crosses the x-axis at a positive value. In other words, disinflation seems to taper off in our sample if initial inflation is already in the very low single digits. This finding corresponds with the presence of two episodes during which inflation actually *rose*, if only very slightly. In both cases (Sweden in the early 1990s and Japan in the 2000s), initial inflation was very low—indeed lower than in any other episode. Thus, the two outliers basically extend the general pattern whereby absolute declines in inflation become smaller, the lower the initial rate.

Further evidence on the same point is available from Figure 7, which provides a more granular image of inflation trajectories during PLOG episodes. Specifically, the figure relates inflation rates in any given quarter (shown on the x-axis) to the change in the inflation rate over the subsequent quarter (on the y-axis) within an episode. Any markers below the x-axis indicate disinflation. As the polynomial trend line shows, disinflation was indeed dominant throughout PLOG episodes, reaching its greatest relative speed at inflation rates between 4 and 6 percent. **However, inflation generally stopped declining and instead stabilized or increased somewhat when initial inflation rates were already very low.**



Source: See Table 1.

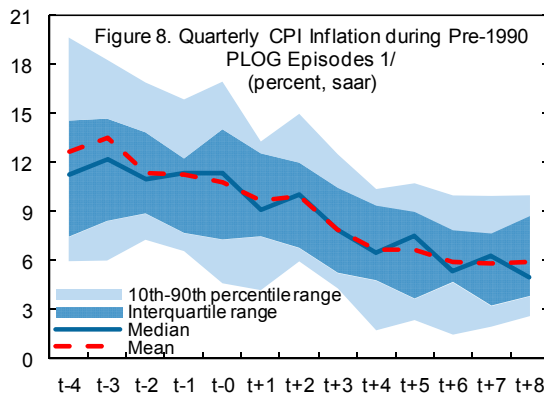
1/ Episodes of persistent large output gaps as listed in Table 2. Computation of the fifth-order polynomial regression line is based on all observations in the sample, although the chart focuses on the main cloud of data points, not showing three observations with initial inflation rates above 19 percent.

Why might disinflation peter out at very low rates of inflation?

The apparent relationship between initial inflation rates and their subsequent decline during PLOG episodes can be linked to the debate about a flattening of Phillips curves already mentioned in Section II. Lower “steady-state” inflation is a feature of the two last decades—a period for which some studies have also documented flatter Phillips curves, i.e., a weaker

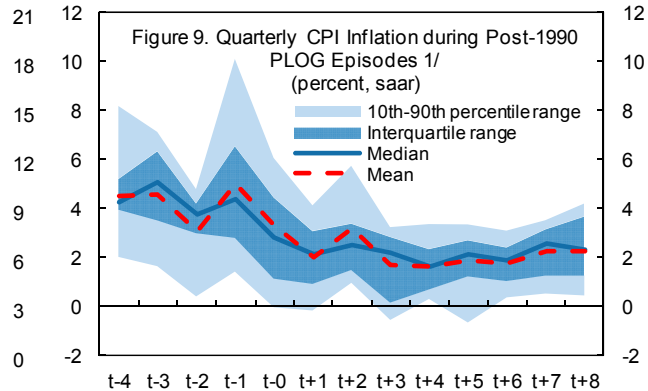
relationship between output gaps and inflation. The previous subsection, in turn, has shown that (i) inflation declines by less *in absolute terms* during PLOG episodes, the lower the initial inflation rate;⁷ and (ii) disinflation tends to stop altogether at very low inflation rates, which are relatively common in more recent episodes.

One way of illustrating the close link between time periods and inflation dynamics is to split our sample into pre-1990 and post-1990 subsamples. As Figures 8 and 9 confirm, the more recent sample features, on average, lower initial inflation rates and less disinflation in absolute, though not in relative terms.⁸ Moreover, the path of disinflation differs markedly. In the earlier period, inflation rates tend to decline in a relatively steady process throughout the first two years of the PLOG episode. By contrast, the recent period shows inflation falling sharply (in relative terms) in the first few quarters of the episode, but inflation then bottoms out at its new lower rate. This recalls the earlier finding from Figure 7 that disinflation is fastest at inflation rates around 4–6 percent, and slowest (or absent) at very low rates.



Source: See Table 1.

1/ Includes 14 pre-1990 episodes of persistent large output gaps as listed in Table 2. X-axis denotes quarters, with t-0 the first quarter of each episode.



Source: See Table 1.

1/ Includes 10 post-1990 episodes of persistent large output gaps as listed in Table 2. X-axis denotes quarters, with t-0 the first quarter of each episode.

Why could there be greater resistance to disinflation when inflation is already very low? In principle, three economic explanations come to mind.

⁷ It is not clear from the discussion in the literature whether this finding alone meets the definition of a flatter Phillips curve. Indeed, most of the theoretical work focuses on inflation dynamics around a zero-rate equilibrium, in which percent changes and percentage point changes coincide. In empirical applications, the interpretation depends on whether the Phillips curve is specified in terms of simple inflation rates or in log terms. In the latter case, the focus is on relative, rather than absolute changes in inflation, and our finding of broadly proportional disinflation during PLOG episodes would signal no flattening of the Phillips curve at all.

⁸ The pre-1990 subsample contains 14 observations, the post-1990 subsample 10. Denmark's 1989–92 PLOG episode is excluded from both.

First, the literature has emphasized the enhanced credibility of central banks in preserving price stability in recent years. Such credibility would be apparent not only in low average rates of inflation, but also in a strong anchoring of inflation expectations around the official (or implicit) target. If price-setters trust the central bank's commitment, they have less reason to respond to short-term variation in marginal cost, and a weaker relationship between output gaps and inflation will ensue. This point recalls the more general argument by Ball et al. (1988) that low and stable inflation induces price-setters to adjust prices less frequently.

Second, already-low inflation might inhibit further disinflation because of downward nominal rigidities, which have been widely documented for wages; see Akerlof et al. (1996) and the short literature survey in Benigno and Ricci (2010). Such rigidities become more binding as average inflation rates approach zero: if many wage- (and price)-setters in the cross section are averse to outright cuts, inflation is likely to hover at low positive rates, but not fall all the way to zero. This explanation would also account for the scarcity of outright deflation in post-war economic history. To the extent that zero inflation represents a particularly strong barrier, it may take an exceptional series of shocks (perhaps epitomized by Japan's experience during the last two decades) to create negative wage and price dynamics.⁹

A third potential explanation relates to the greater role of global price developments in recent years, as economic ties between countries have intensified. With more 'globalization', i.e., increased international competition in product and factor markets, inflation may have become less sensitive to domestic spare capacity. At the same time, the availability of cheaper imports from emerging markets may have contributed to the secular decline in inflation over the last two decades. In this account, low inflation and a flatter Phillips curve would be largely coincidental, rather than linked by a causal relationship.

Given the small number of episodes with very low inflation and their concentration in recent times, it is difficult—and beyond the scope of this paper—to settle the relative importance of the above hypotheses. Clearly, the build-up of monetary policy credibility over the last two decades may explain why most post-1990 disinflation episodes across advanced economies ended at inflation rates close to 2–3 percent, matching typical central bank targets; see Figures 5 and 7.¹⁰ However, downward nominal rigidities provide an equally plausible explanation, given the marked clustering of observations at inflation rates just above zero.¹¹

⁹ Even for Japan, de Veirman (2009) has emphasized the remarkable fact that deflation has proven very sticky at low rates, rather than accelerating over time.

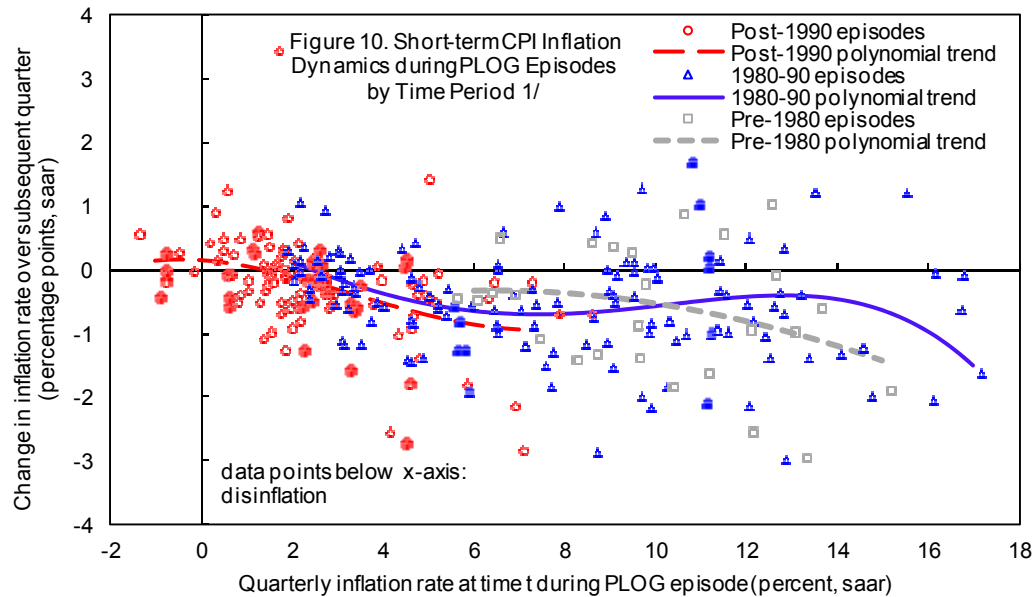
¹⁰ There are a few PLOG episodes from before the pervasive monetary policy reforms of the 1990s—i.e., a move to greater central bank independence and inflation targeting—where inflation nonetheless bottomed out at the same 2-3 percent. The list of countries (Germany and the Netherlands) suggests, however, that these were precisely cases in which central banks already enjoyed a high degree of credibility even in the 1980s.

¹¹ In principle, the two hypotheses could be distinguished by their implications for times of *positive* output gaps: the credibility hypothesis implies symmetric insensitivity of inflation, while downward rigidities do not.

The globalization hypothesis, in turn, seems somewhat less compelling for the evidence highlighted in this paper, as it cannot account for the apparent sensitivity of inflation to the domestic output gap even in post-1990 episodes. After all, the more recent episodes featured a very similar relative speed of disinflation as earlier episodes, unless initial inflation was already very low. That said it is possible that globalization-related effects are too recent to manifest themselves clearly in our sample.

Aside from the aforementioned *economic* explanations, there is also a *statistical* argument for why disinflation might seem to peter out at low inflation rates. In fact, those observations with the lowest/highest inflation rates in the sample are more likely to contain temporary shocks which lower/raise inflation below/above its “normal” rate. Consequently, there should be—irrespective of any pressures from the output gap—some upward movement in inflation among the lowest-inflation cases, and vice versa. This type of mean reversion could account for some of the negative correlation between initial inflation rates and subsequent inflation changes in our sample. It is, in particular, consistent with the pattern described by the trend line in Figure 7, which swings up at the left end of the distribution and down at the right end.

However, mean reversion arguably cannot explain the systematic pattern of inflation becoming stickier at low rates during post-1990 episodes, as apparent from Figure 9. To shed further light on this aspect, we revisit in Figure 10 the short-term inflation dynamics depicted in Figure 7, but now distinguishing observations by time period. As the estimated trend lines show, increases in inflation become relatively common at the lowest rates in the more recent time periods, whereas there is no such pattern for the earliest, pre-1980 subsample. Assuming



Source: See Table 1.

1/ Episodes of persistent large output gaps as listed in Table 2. Computation of the polynomial regression lines is based on all observations in the respective subsample, although the chart focuses on the main cloud of data points, not showing three observations with initial inflation rates above 19 percent.

a similar extent of temporary inflation shocks across subsamples, this suggests that mean reversion does not tell the whole story. Rather, **there are likely to be fundamental economic forces impeding further disinflation at already-low inflation rates—notably well-anchored expectations and downward nominal rigidities.**

Still, the argument about mean reversion recalls an important general point: whatever the specific interaction between initial inflation rates and subsequent disinflation, this is clearly not the only factor at work during PLOG episodes. Instead, it is crucial to consider a few key covariates in order to understand why inflation dynamics may differ across episodes. One candidate is the precise path of the output gap itself. However, the next section will take a broader perspective and consider other selected macroeconomic variables as well. Our goal is to examine how these covariates have developed *on average* during the episodes in our sample, and whether their behavior might account for any unusual (i.e., “no-disinflation”) behavior during PLOG episodes.

V. DYNAMICS OF KEY COVARIATES

As the short description of the NKPC in Section II has made clear, a key determinant of inflation ought to be developments in real marginal cost. While marginal cost should be related to the output gap, the relationship is likely to be confounded by a number of other factors. Most important, marginal cost will reflect specific labor market developments, but also trends in non-labor costs, such as the price of imported inputs. Accordingly, it appears worthwhile to study the dynamics of a few key variables, including commodity prices, exchange rates, and labor market indicators, in our sample of PLOG episodes.

What else happens during PLOG episodes?

Figure 11 depicts how key macroeconomic variables have evolved during the PLOG episodes in our sample. In keeping with the interest of this paper, we focus on variables that have a bearing on marginal cost or that may affect inflation dynamics in some other way. Specifically, we consider three indicators of labor market developments: the unemployment rate, nominal wage growth, and real unit labor cost; the US\$-denominated oil price as a proxy for commodity price developments; the nominal effective exchange rate; broad money growth, which is not obviously related to marginal cost, but might capture monetary driving forces of inflation; and the real policy interest rate, which serves as a proxy for the monetary stance and may pick up effects beyond standard aggregate demand and exchange rate channels, notably any direct impact on inflation expectations via central bank signaling.

As a general note, it bears emphasizing that none of these variables are thought to be fully exogenous to national output and inflation developments in our sample. Even in the case of the oil price, the interaction with national GDP developments will not be unidirectional,

especially in the case of large economies or synchronized global cycles. Consequently, our goal is not to pinpoint clear-cut causal links from such covariates to inflation outcomes, but to identify characteristic patterns for both typical PLOG episodes and the more unusual (no-disinflation) observations discussed in the previous section.

A few clear findings are apparent from Figure 11:

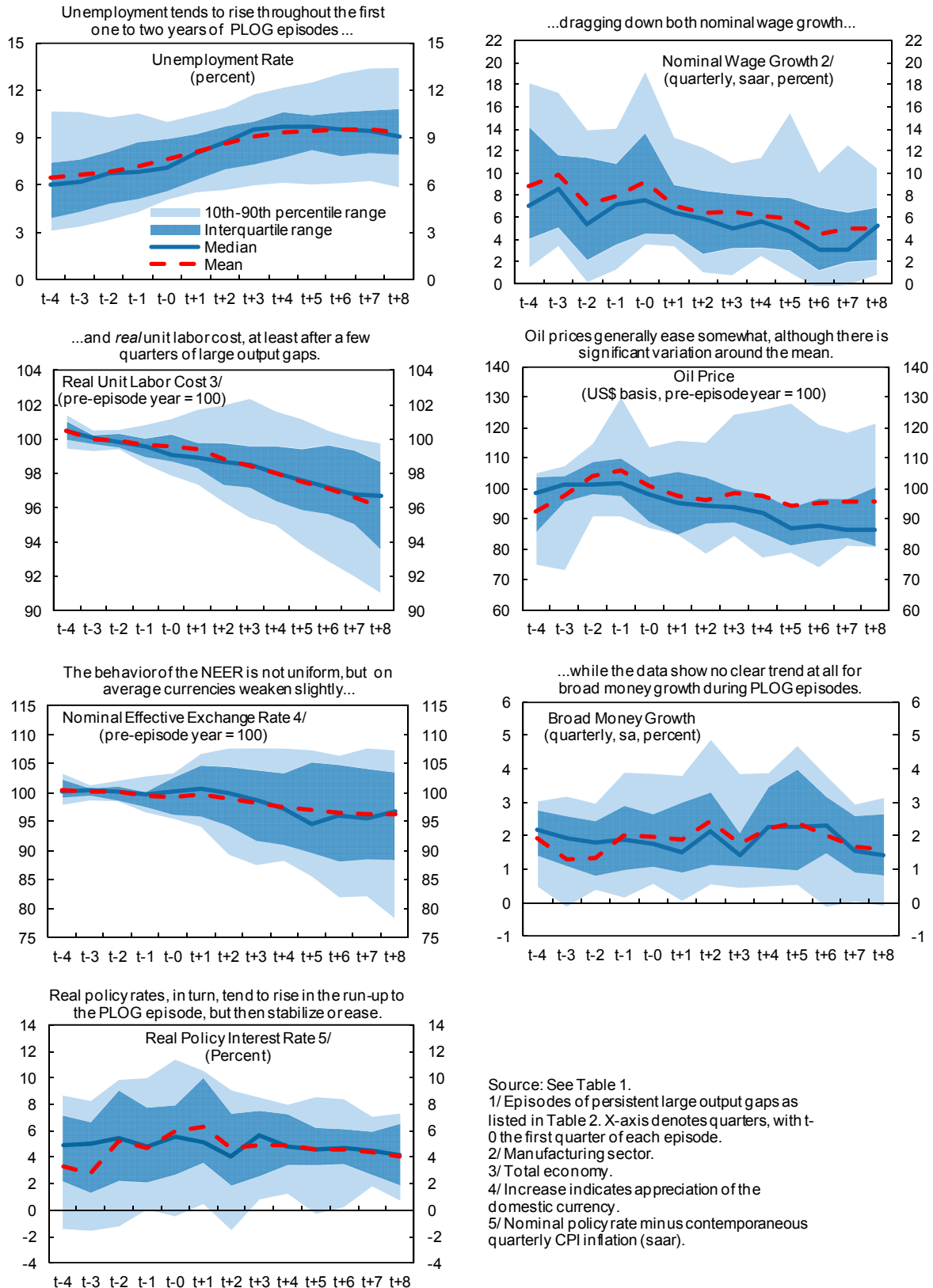
- Labor markets tend to be weak, even as positive GDP growth resumes (as seen in Figure 2). Unemployment rises during the first one to two years of the episodes and then stabilizes only slowly, while both nominal wage growth and real unit labor cost fall. This confirms the expected link between ample spare capacity and diminished cost pressures facing firms.
- The pattern for oil price developments is more diverse. On average, however, oil prices fall somewhat, offsetting a typical rise in the pre-episode year and thus supporting disinflation during PLOG episodes. This points to the fact that many economic downturns in our sample were synchronized internationally, implying weak global demand for commodities.
- Nominal exchange rates show no uniform trend, although the average PLOG episode features moderate currency depreciation. Thus, exchange rate movements are unlikely to be, on average, an important factor helping disinflation.
- The growth rate of broad money, perhaps surprisingly, shows no clear trend at all, remaining roughly stable on average throughout the episodes under consideration. The real policy rate, in turn, tends to ease or at least stabilize, suggesting no further tightening of the monetary stance after the onset of the episode.

Is the extent of disinflation associated with other macroeconomic developments?

Needless to say, these general patterns could mask important divergence across episodes, including specific developments that might help understand why disinflation does not decline during certain periods. Section III already pointed out the apparent role of *lower initial inflation rates* for such atypical dynamics. We now take a closer look at other features that might set the relevant observations apart and, more broadly, account for the variation of disinflation trajectories in our sample.

Aside from the variables considered in Figure 11, we also revisit the role of the output gap path *per se* in explaining differences across episodes. Specifically, we relate inflation developments during PLOG episodes to the depth of the demand shortfall, and to the speed

Figure 11. Evolution of Key Macroeconomic Variables during Episodes of Persistent Large Output Gaps 1/



Source: See Table 1.
 1/ Episodes of persistent large output gaps as listed in Table 2. X-axis denotes quarters, with t-0 the first quarter of each episode.
 2/ Manufacturing sector.
 3/ Total economy.
 4/ Increase in indicates appreciation of the domestic currency.
 5/ Nominal policy rate minus contemporaneous quarterly CPI inflation (saar).

at which the output gap closes in the later part of the episode. The ‘depth’ aspect captures the standard Phillips curve view that a deeper downturn should generate stronger disinflation. The ‘speed’ aspect, in turn, refers to the argument that, for a given output gap, a faster economic recovery may cause stronger inflationary pressure because of short-term “speed limits”. Such speed limits could arise from frictions affecting the reallocation of factors: workers may need retraining to become productive in new occupations; and firms may have to adjust production structures to meet a changing demand. Because these adjustments take time, a relatively faster closing of the output gap might have the effect of limiting disinflation during a PLOG episode.¹²

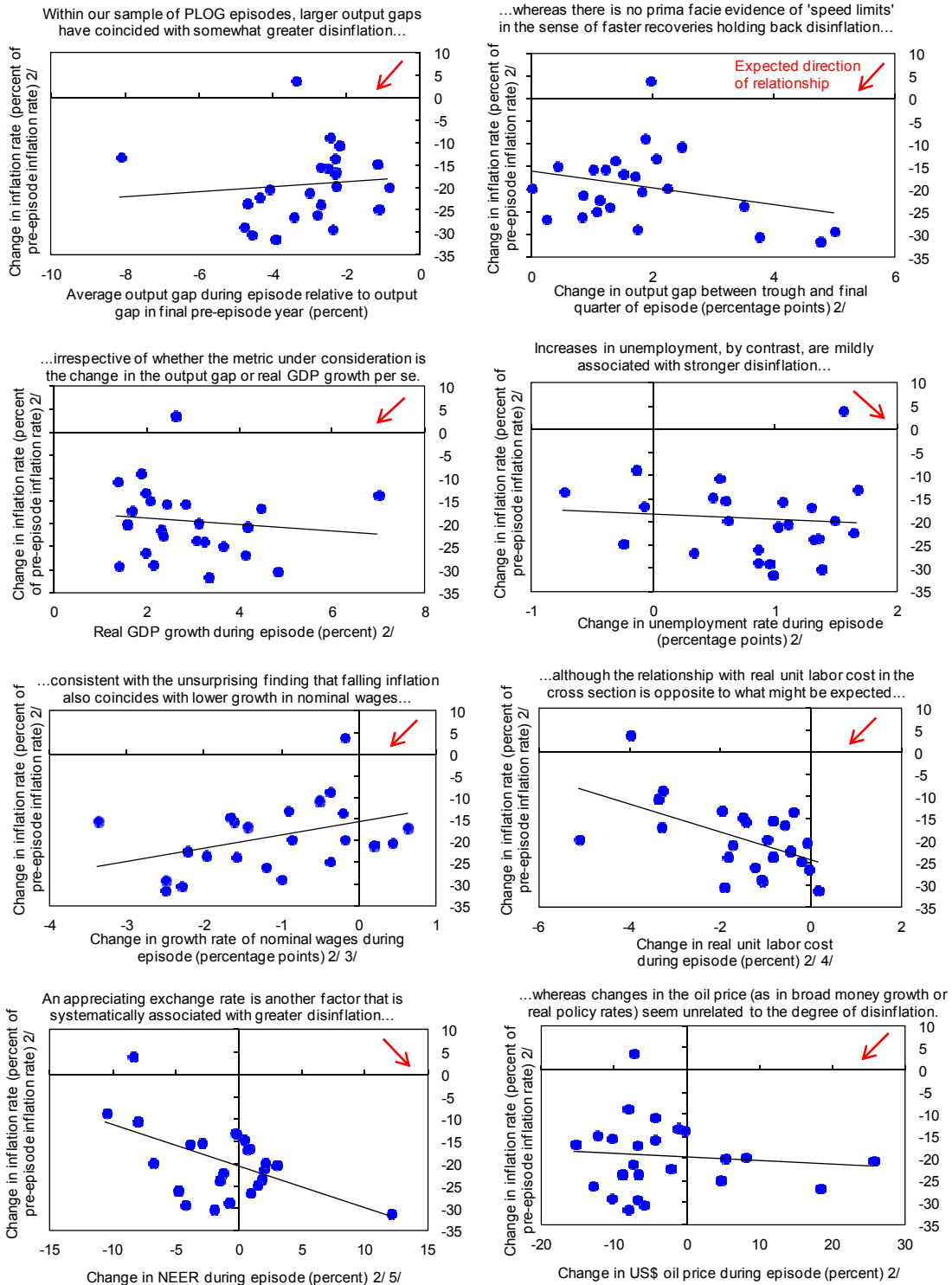
Figure 12 displays the bivariate relationships between movements in each of these variables and the extent of disinflation during PLOG episodes. The inflation variable is defined as the annualized decline in inflation during the episode, *relative to* the rate of inflation in the year preceding the episode. This definition allows us to control for the scale effect—apparent from Figure 6—whereby disinflation is systematically greater in absolute terms when initial inflation is high.¹³ As an alternative measure of disinflationary pressure, we consider, in Figure 13, the percentage of quarters during each episode in which four-quarter inflation declines. A few key findings emerge:

- There is mild evidence for a cross-sectional Phillips curve relationship in that a larger average output gap (in absolute terms) coincides with greater disinflation. By contrast, the scatter plots do not provide any *prima facie* support for speed limits, whether defined in terms of real GDP growth or changes in the output gap.
- Weaker labor markets are systematically associated with stronger disinflation. The relationship is apparent for *levels* of unemployment, but more strongly for *changes*, pointing to some heterogeneity in “steady-state” unemployment rates across episodes. Not surprisingly, falling inflation also coincides with slowing nominal wage growth.
- In contrast, the relationship between disinflation and changes in real unit labor cost (ULC) does not have the expected sign: although real ULC fall in virtually all episodes, the decline tends to be more moderate in episodes that feature greater disinflation. Mechanically, this suggests that the denominator effect—faster disinflation drives up real ULC growth—dominates movements in the numerator, i.e., changes in nominal ULC. Yet, the counterintuitive relationship with disinflation

¹² Another, purely statistical argument why the change in the output gap may be found to matter for inflation is highly persistent measurement error in output gap levels. See Orphanides et al. (2000) and Walsh (2003).

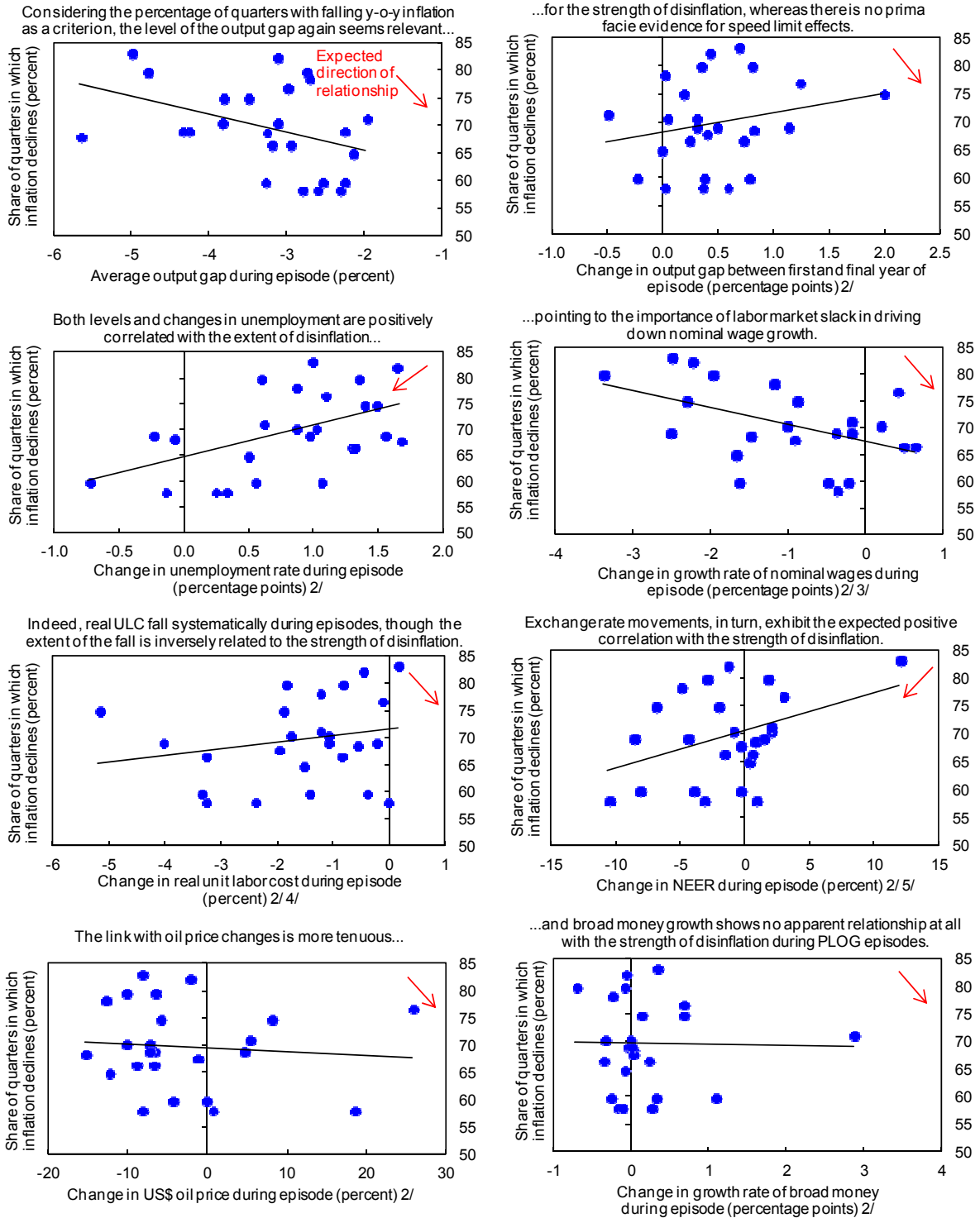
¹³ It also implies, however, that we have to exclude the Japanese episode of 2001–03 (which started from a negative inflation rate) to ensure a consistent interpretation. Figure 13, by contrast, includes all episodes.

Figure 12. Relationship between Degree of Disinflation during PLOG Episodes and Key Covariates 1/



Source: See Table 1.
 1/ Episodes of persistent large output gaps as listed in Table 2. Scatterplots exclude the observation for Japan 2001-03, which started with a negative inflation rate, hampering the comparison with all other episodes.
 2/ Annualized.
 3/ Manufacturing sector.
 4/ Total economy.
 5/ Increase indicates appreciation of the domestic currency.

Figure 13. Relationship between Degree of Disinflation during PLOG Episodes and Key Covariates--Alternative Definition 1/



Source: See Table 1.
 1/ Episodes of persistent large output gaps as listed in Table 2. Degree of disinflation defined here as the share of quarters during PLOG episodes in which the 4-quarter inflation rate declines.
 2/ Annualized.
 3/ Manufacturing sector.
 4/ Total economy.
 5/ Increase indicates appreciation of the domestic currency.

prevails even if we consider nominal ULC (not shown). These findings are puzzling, given that real marginal ULC should be a key driving force for inflation. One possible explanation is that there may be systematic departures between marginal and average ULC during PLOG episodes.¹⁴ Significant labor hoarding, for instance, would drive up measured *average* labor cost, while giving rise to slack within firms that allows a scaling-up of production at a *marginal* labor cost of zero.

- Inflation declines more strongly in episodes that feature a strengthening currency, and vice versa. Given the weight of imported goods in national consumption baskets, this result is not surprising. Indeed, a sharp weakening of the exchange rate appears to be a key factor explaining why inflation failed to ease during one of the two unusual episodes identified above (Sweden 1992–94). That said significant nominal (and real) depreciation did not prevent disinflation in several other episodes, notably Sweden 1980–83 and Italy 1992–94.
- The link between disinflation and oil price dynamics is more tenuous, although it has the expected sign in Figure 13.¹⁵
- There is no correlation at all between the extent of disinflation and changes in the growth rate of broad money, matching our earlier finding from Figure 11.
- Finally, the real policy rate (not shown) is mildly positively correlated with one measure of disinflationary pressure, and mildly negatively with the other. This inconclusive result could be explained by two-way causation: *ceteris paribus*, more limited disinflation may prompt a relatively tighter monetary stance, while a relatively tighter stance may accelerate disinflation.

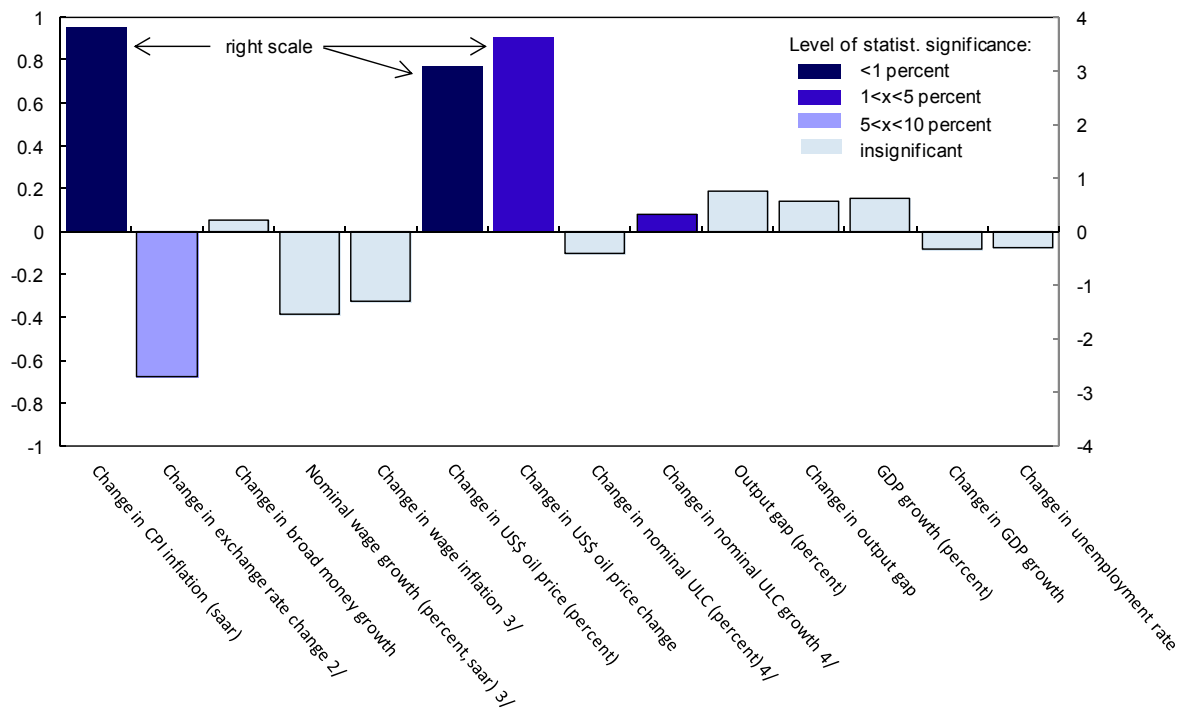
Are unusual observations special in any systematic way?

The analysis in the previous subsection has identified a few factors that are likely to have affected the overall extent of disinflation during historical PLOG episodes, above and beyond the impact of persistent large output gaps. These same factors, notably specific labor market developments, exchange rates, and oil prices, might also account for short-term inflation dynamics within PLOG episodes, as documented in Figures 7 and 10. In particular, they might help to explain why, despite the clear general trend of disinflation, there are

¹⁴ See the broader discussion in Rotemberg and Woodford (1999).

¹⁵ Although not shown here, we also obtain the expected relationship when we consider the change in oil price inflation (rather than the oil price level) between the final pre-episode year and the final year of the episode.

Figure 14. Behavior of Key Macroeconomic Variables during Unusual vs. Typical Quarters 1/
(percentage points, unless noted otherwise)



Source: See Table 1.

1/ Includes all quarterly observations from the PLOG episodes listed in Table 2. Unusual /typical quarter defined as featuring rise/fall in quarterly CPI inflation (sa). For each variable, the difference between unusual and typical quarters is first computed within episodes and then averaged across all 25 episodes.

2/ Increase indicates appreciation of the domestic currency.

3/ Manufacturing sector.

4/ Total economy.

nonetheless many observations showing a temporary rise in inflation rates during episodes. Are there any common features to these observations, aside from the fact—already documented above—that they are more pervasive at very low rates of inflation?

Figure 14 approaches this question by comparing the behavior of several key variables during unusual vs. typical quarters. A typical quarter is defined as one in which the quarterly inflation rate declines. In order to allow for heterogeneity across episodes, we do not calculate simple averages across all observations. Instead, we compute differences between unusual and typical quarters for each episode individually, and then report the average of these within-episode differences. The shading of the columns in Figure 14 indicates whether the differences are statistically significant—darker colors signal greater significance. A few clear results stand out:

- Unusual quarters—marked by rising inflation—systematically feature exchange rate depreciation and/or oil price increases. This matches our earlier finding that overall disinflation during a PLOG episode tends to be more limited when oil prices rise or currencies depreciate over the course of the episode.

- There is also a statistically significant link with the change in nominal ULC growth: in quarters of rising inflation, nominal labor cost growth appears to accelerate relative to quarters of falling inflation. However, the difference is small in economic terms, and does not carry over to the simple growth rate of nominal ULC.¹⁶
- All other variables show no statistically significant difference between unusual and typical quarters. In combination with our earlier findings, this suggests either that there is no apparent link at all with inflation developments during PLOG episodes (broad money growth) or that such a link becomes visible only at frequencies greater than a quarter (as is the case for wages and unemployment), because of comovement with a time lag. On the question of speed limits, the evidence remains tenuous, as the change in the output gap now exhibits the expected sign, but the correlation is statistically insignificant and could be fully accounted for by the apparent difference in output gap *levels* between unusual and typical quarters.

VI. IMPLICATIONS FOR THE CURRENT INFLATION OUTLOOK

The analysis of the previous sections suggests that output gaps matter, at least when they are persistent and large: during historical PLOG episodes, inflation generally fell, with the decline roughly proportional to the inflation rate at the outset of the episode. This conclusion is qualified only by the observation that disinflation has tended to taper off at very low inflation rates, arguably reflecting downward nominal rigidities and well-anchored inflation expectations. **For the current inflation outlook in most advanced economies, these findings would suggest little upside inflation risk, although further disinflation may also be limited in general. However, this inference comes with two important caveats:**

- **Current output gaps might not be what they seem.** Historical experience, especially from the 1970s, suggests that real-time assessments of spare capacity may be subject to very large ex-post revisions. Whether or not economists properly assess spare capacity today is impossible to tell. One may, however, derive some confidence from the fact that the profession is aware of the lessons from the 1970s. Moreover, most economists readily accept that the global financial crisis has not only depressed demand, but also curtailed supply capacity. Even so, the very sharp contractions in most advanced economies in 2008–09, coupled with a marked rise in unemployment and many survey-based indications of spare capacity, have generated a consensus that output is well below potential in most advanced economies right now and likely to

¹⁶ Considering real ULC instead, we find a marked *negative* difference between unusual and typical quarters, driven entirely by the fact that the real ULC variable includes the CPI in the denominator. With relatively limited movements in nominal ULC in a given quarter, the change in inflation dominates the dynamics of real ULC, generating a strong negative correlation with contemporaneous inflation.

remain there for some time. Whatever the truth, projections and policy plans must be made on the basis of the best available assessment. In this sense, the inflation outlook discussed above is conditional on the conventional view about output gaps today.¹⁷

- **The past may not be a good guide to the present.** The relationships documented in the previous sections may have held in the past, but this does not guarantee that they are relevant to today's circumstances. Strictly speaking, such concerns apply to all empirical work that deals not only with unalterably deep, structural relationships, which are exceedingly rare in macroeconomics. A pragmatic position may be to take the historical evidence as a starting point, but recognize its limitations by considering carefully in what ways current circumstances might be different.

Putting the current situation in a historical perspective

A natural approach is to compare recent developments in advanced economies to those studied in the previous sections. For this purpose, we identify all ongoing episodes that are forecast to feature persistent large output gaps based on the OECD's Economic Outlook No. 87. Applying the same definition as in Section III, we find that each of the countries in our sample is currently facing persistent large output gaps. Almost all of these latest episodes are estimated to have started with the intensification of the global financial crisis in late 2008, and most are forecast to last at least through the end of the OECD's forecast horizon in 2011. Table 3 provides a detailed overview.

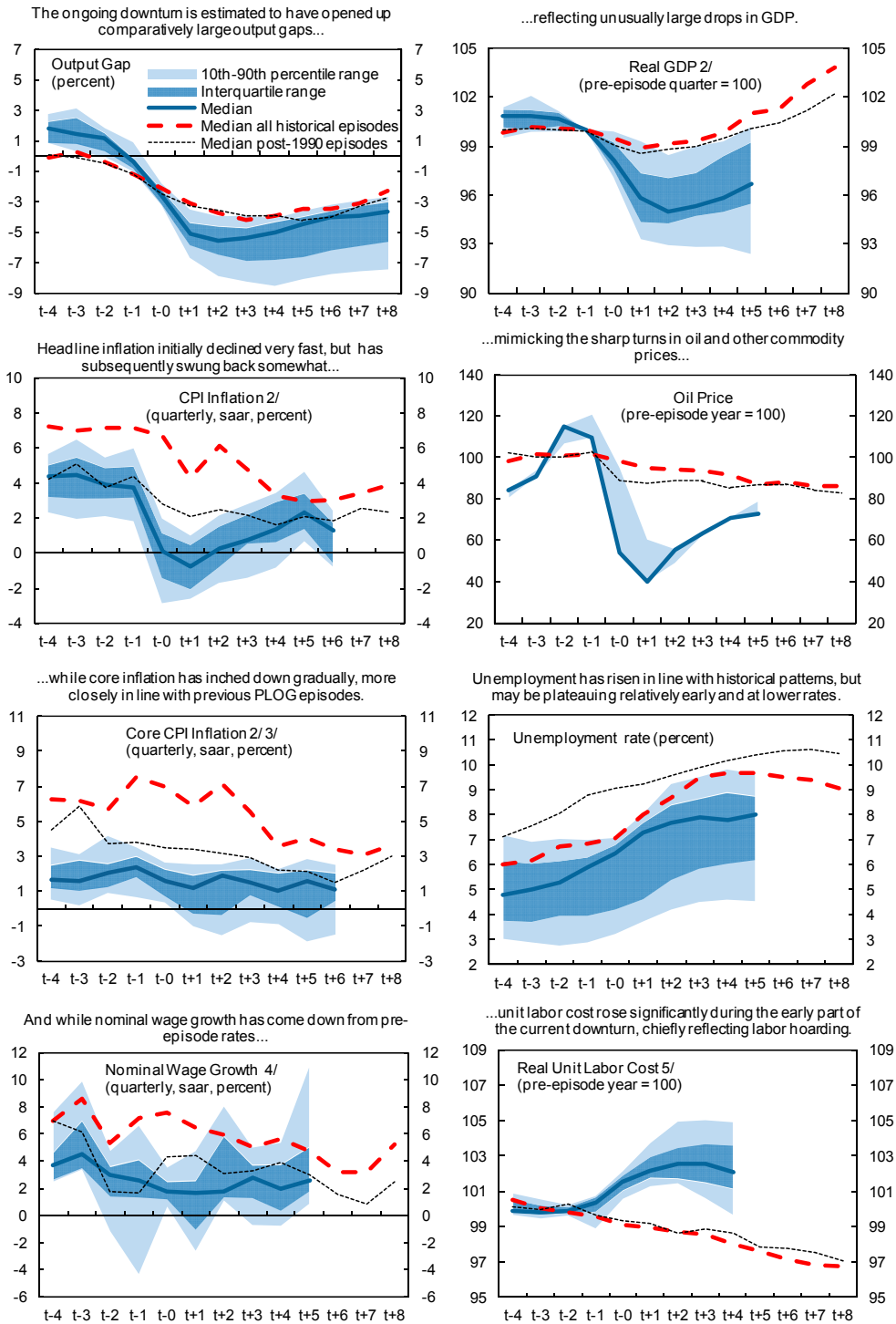
Figure 15 displays the path of key macroeconomic variables throughout the current PLOG episodes until now.¹⁸ To facilitate a comparison with historical precedents, we include two lines for the median behavior of the same variables during earlier PLOG episodes. The dashed red line indicates the median across all 25 historical episodes, corresponding to Figure 11 above; and the dotted black line depicts the median for the 10 post-1990 episodes. A few key findings are apparent:

- One striking feature is the depth of the latest economic downturn, which is thought to have opened up larger negative output gaps than most historical precedents. In and by itself, this should reinforce the disinflationary dynamics. The simultaneity of sharp downturns in essentially all advanced economies further strengthens this argument.

¹⁷ An interesting separate question is in what way policymakers should take the uncertainty around current assessments and forecasts into account when making policy plans.

¹⁸ While data for the output gap include forecasts through end-2011, we show only actual outturns for all other variables. Moreover, we impose a balanced sample requirement, so as to avoid trends being distorted by changes in sample composition. Thus the length of the series shown is constrained by the episode with the most limited data availability.

Figure 15. Behavior of Key Macroeconomic Variables During the Ongoing Downturn Relative to Historical PLOG Episodes 1/



Source: See Table 1.

1/ Blue lines and areas refer to current episodes of persistent large output gaps as estimated/forecast by the OECD Economic Outlook; for details see Table 3. Historical median lines refer to the episodes listed in Table 2. X-axis denotes quarters, with t-0 the first quarter of each episode. Variables are shown for as many quarters as actual data are available for all countries in the respective sample; top-left chart on output gap shows OECD forecasts as well.

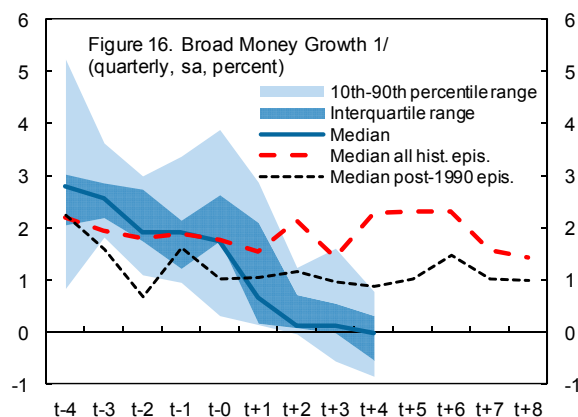
2/ Excludes observations for the Netherlands to increase sample length.

3/ CPI excluding food and energy. Chart excludes New Zealand, and Germany before 1991, as CPI concept defined differently.

4/ Manufacturing sector.

5/ Total economy.

- Indeed, inflation rates fell very sharply during the early quarters of the latest episodes, but like the partial rebound more recently, this appears to have been dominated by the remarkable swings in oil (and other commodity) prices. Consistent with this view, core inflation, defined as CPI inflation excluding food and energy, has generally fallen more gradually. For the median in the sample, core inflation eased from 2 percent in the final pre-episode year to 1¼ percent in the most recent four quarters, representing about the same relative pace of disinflation as during historical episodes, if at lower absolute levels. Nonetheless, it is noteworthy that even this measure of inflation turned negative in several countries during the early parts of the episode.
- Unemployment has risen to a similar extent as during historical episodes. Given the much greater fall in GDP, this actually points to relatively resilient labor markets during the current downturn. In fact, there are signs that unemployment rates may already be leveling off in several countries—earlier than in many historical episodes. Wage growth has also inched up most recently, but remains below the rates observed before the latest PLOG episodes. Meanwhile, average real unit labor costs have, unusually, risen so far, reflecting the sharp drop in CPI inflation along with pervasive labor hoarding. Yet while such labor hoarding drives up average ULC, it effectively creates slack within firms, adding to overall spare capacity.
- There is a wide variety of exchange rate developments across episodes (not shown here), with some currencies depreciating by more than 15 percent in nominal terms during the first year of the episode (New Zealand dollar, British pound) and others appreciating by nearly as much (Japanese yen). On average, however, NEERs have stayed roughly unchanged.
- Broad money growth, in turn, has declined sharply across the board (Figure 16). This departure from historical precedents reflects the extraordinary recent dislocations in many national banking systems.



Source: See Table 1.

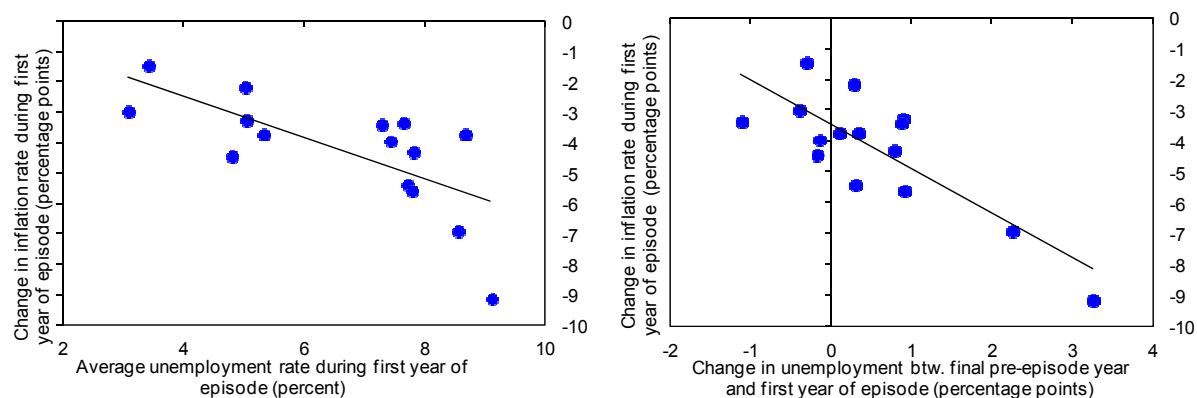
1/ For Eurozone countries, based on Eurozone monetary aggregates for current episodes. See also Figure 15.

Overall, Figure 15 shows many patterns familiar from historical PLOG episodes. There is, in particular, clear evidence that spare capacity has again exerted significant downward pressure on inflation. As a result, many countries are now facing historically low inflation rates, especially for core indices. This raises the important question whether disinflation will soon peter out, as has typically happened at very low inflation rates in historical episodes.

The depth of the latest downturn suggests that disinflationary pressures might well persist for somewhat longer, putting the historical barrier at very low inflation rates to a serious test. This concern indeed seems relevant in the economies most severely affected by the crisis, some of which have already seen price and wage inflation dip into negative terrain in recent quarters. Generally, however, downward nominal rigidities and the firm anchoring of inflation expectations—underpinned by strong policy action in response to the recession—should remain potent forces against a slide into outright deflation.

Judging from historical experience, prospects in individual countries are closely tied to trends in labor markets. Consistent with this notion, Figure 17 shows a relatively clear cross-sectional correlation between unemployment and disinflation over the first year of the latest episodes. Beyond labor costs, it is clear that exchange rate movements, commodity price shocks, and indirect tax changes can also have sizeable effects on inflation trajectories.

Figure 17. Relationship between Unemployment and Extent of Disinflation during Current PLOG Episodes 1/



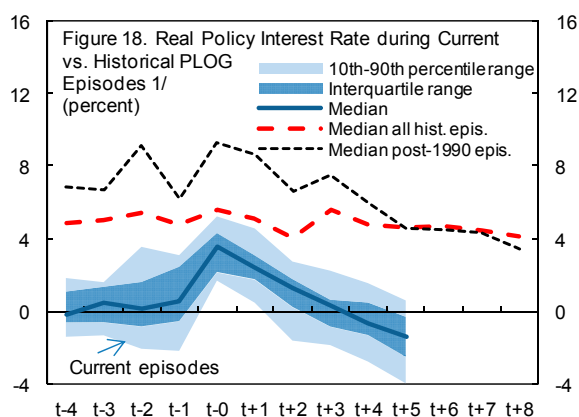
Source: See Table 1.

1/ For details on the episodes included in the chart, see Table 3.

Are we missing something? Central bank credibility and fiscal strains

The above considerations leave open how much longer disinflation might continue in the period ahead, but at least suggest limited *upside* inflation risk. Against this, one could argue that the current episodes feature some unique characteristics that might generate inflationary pressures beyond what has been observed in historical precedents. One often-cited argument relates to central bank credibility in times of unconventional monetary policies and strained public finances. Its proponents question the optimistic view of Dwyer et al. (2010), whereby monetary policy has reached a unique degree of credibility that will keep inflation closely aligned with official targets. Instead, they argue that central banks have *lost* credibility of late. The claim is closely linked to the large-scale asset purchase programs launched by several advanced country central banks over the last two years. Indeed, with disruptions in many financial markets and policy rates exceptionally low compared to most historical PLOG episodes (Figure 18)—and often constrained by the zero bound on nominal rates—unconventional monetary policies have become commonplace.

Some critics of these policies argue that, by expanding their balance sheets and issuing large amounts of base money, central banks have sowed the seeds of future inflation; see Meltzer (2010). In and by itself, this contention is not very convincing, as there is no obvious, let alone automatic, link from higher base money to inflation, provided that central banks maintain control over policy rates.¹⁹ Consistent with this, empirical studies have found central bank asset purchases to have had a positive effect on asset prices, while broad money growth has remained very subdued (Figure 16) and medium-term inflation expectations have shown no signs of becoming unhinged; see Gagnon et al. (2010) and Meier (2009).



There is, however, one important caveat to this benign view. Even if unconventional policies *should* work only through rather standard channels, providing no magical short cut to either full employment or high inflation, there is a tail risk that the public might develop a different perception. As Borio and Disyatat (2009) put it, “market expectations and beliefs [are not necessarily] consistent with the underlying transmission mechanism.” Inflation expectations could rise sharply, in particular, if the public suddenly lost trust in the central bank’s capacity or commitment to maintain price stability, causing a self-reinforcing currency crisis.

Unconventional monetary policy alone is very unlikely to prompt such a reassessment, but it could heighten concerns about central banks’ operational independence in the current context of strained fiscal positions. To give a practical example, the public might start fearing higher inflation if the central banks’ monetary policy actions became compromised by the need to shore up government financing or cover large losses from earlier asset purchases.

To be sure, these conditions do not apply to any advanced country central bank right now and are not expected to emerge. Moreover, fiscal authorities in most advanced countries have already started tightening policies to bolster market confidence in fiscal sustainability. In the absence of the tail risk scenario outlined above, fiscal policy is therefore likely to reinforce, rather than counteract, disinflation over the coming period.²⁰

¹⁹ See the discussion in Borio and Disyatat (2009), Keister et al. (2009), and Meier (2009, pp. 15–16).

²⁰ Needless to say, certain fiscal measures, notably indirect tax hikes, could temporarily raise inflation, even if their macroeconomic effect is contractionary.

VII. CONCLUSION

This paper studies inflation dynamics during 25 historical episodes of persistent large output gaps (PLOG) in advanced economies. We find that such episodes generally brought about significant disinflation—exceptions are limited to two episodes in which inflation rose very slightly, and from especially low initial rates. In fact, the decline in inflation across episodes was roughly proportional to the initial rate of inflation, indicating a similar relative speed of disinflation. Underpinning these dynamics were weak labor markets, with rising and/or high unemployment and falling wage growth. Lower oil prices further supported disinflation in several cases. By contrast, there is little *prima facie* evidence in our sample to support ‘speed limits’ (in the sense of higher inflation when a negative output gap is closing fast) or a close link between inflation dynamics and developments in broad money.

Our principal finding is qualified only by the observation that disinflationary pressures within episodes have tended to taper off at very low inflation rates. Some of this phenomenon may reflect mean reversion related to earlier negative price level shocks. Indeed, short-term movements in inflation are systematically related to fluctuation in exchange rates and oil prices. However, our analysis points to additional, more fundamental forces halting disinflation at very low rates. The most likely causes are downward nominal rigidities and well-anchored inflation expectations.

Overall, our findings provide some assurance that output gaps matter, at least when they are large and persistent. The most recent experience in advanced economies further supports this view, as the deep global downturn has coincided with a marked decline in both headline and core inflation. Looking ahead, our findings would suggest little upside inflation risk in countries where ample spare capacity is expected to persist over the foreseeable future. At the same time, historical patterns caution against assuming significant further disinflation when inflation is already very low. It arguably takes a particularly harsh series of shocks to push economies into lasting deflation.

In this context, two important caveats are worth spelling out. First, our analysis deals with inflation dynamics conditional on an accurate assessment of spare capacity. This is not to downplay the challenge of assessing output gaps in real time, but to focus attention on the distinct question of inflation dynamics during PLOG episodes. Indeed, the view that output gaps continue to matter makes it worthwhile to develop more robust real-time estimates. Second, any inference from historical patterns implicitly assumes away sharp discontinuities. At the current juncture, this includes, in particular, the assumption that ongoing efforts to shore up fiscal sustainability will avert the tail risk of outright currency crises and unhinged inflation expectations in advanced economies.

Tables

Table 1. Data Sources and Definitions

Variable	Data sources	Details and definitions
Output gap	OECD Economic Outlook No. 86 (for historical episodes), and No. 87 (for post-2007 episodes).	Actual minus potential GDP in percent of potential GDP.
CPI Inflation	Haver, OECD Main Economic Indicators database, UK Office for National Statistics	Percent change in CPI, seasonally adjusted; series obtained from Haver for all countries, except Canada and France (raw series from Haver), Netherlands (raw series from OECD), and United Kingdom (raw series from Office for National Statistics); for the latter four cases, data seasonally adjusted using X12 by IMF staff.
Core CPI inflation	OECD Main Economic Indicators database	Percent change in CPI excluding food and energy; raw data obtained from OECD, seasonally adjusted using X12 by IMF staff. Data excluded for New Zealand, and for Germany before 1991, as series defined to include gasoline, unlike for other countries.
Real GDP	Haver, OECD Quarterly National Accounts database	Real GDP (seasonally adjusted) from Haver for all countries, except Denmark until 1997Q2 and Germany until 1990Q4 (seasonally adjusted data from OECD) as well as Ireland until 1998Q4, Japan until 1979Q4, and Sweden until 1996Q4 (raw series from OECD, seasonally adjusted using X12 by IMF staff); breaks in series are immaterial, as they lie outside of the time periods under study.
Unemployment rate	OECD Analytical database and Main Economic Indicators database	Unemployment rate, seasonally adjusted, from OECD-MEI for all countries, except for Denmark, Ireland and Netherlands (raw series from Analytical database, seasonally adjusted using X12 by IMF staff).
Nominal wage growth	OECD, Main Economic Indicators database	Earnings per hour in manufacturing (seasonally adjusted) for all countries, except Australia until 1985Q4 (hourly wage rate all activities, seasonally adjusted using X12 by IMF staff); data for Japan very erratic and hence excluded.
Unit labor cost	OECD Main Economic Indicators database	Nominal unit labor cost (total economy, trend-cycle series) from OECD; real ULC computed by deflating with seasonally adjusted CPI.
Nominal effective exchange rate	IMF INS database, OECD Analytical database	NEER from IMF for all countries, except Finland, Japan, and United States (from OECD).
Oil price	Haver	Spot oil price (US\$), WTI.
Broad money growth	Haver, IMF International Financial Statistics, OECD Economic Outlook No. 86 and Main Economic Indicators database	M3, seasonally adjusted, from OECD-MEI for all countries, except France and Germany (M3, sa, from IMF-IFS), Japan (M3 from IMF-IFS, seasonally adjusted using X12 by IMF staff), Netherlands (M2, sa, from IMF-IFS), Finland, Ireland, Italy and United Kingdom (Money supply, broad definition M2 or M3 from OECD-EO, seasonally adjusted using X12 by IMF staff), and the Euro area (M3, sa, from Haver).
Real policy rate	Haver, IMF International Financial Statistics	Nominal policy rate deflated by contemporaneous quarterly CPI inflation (saar); nominal policy rate from IMF-IFS (money market rate) for all countries except Norway and Sweden post-2004 (policy rate, Haver).

Table 2. Historical Episodes of Persistent Large Output Gaps 1/

Country	Period	Short reference	Length (quarters)	Average gap	Trough
Australia	1982:3-1984:3	AUS 82-84	9	-3.5	-6.5
Australia	1991:1-1993:4	AUS 91-93	12	-3.0	-4.1
Canada	1981:4-1984:3	CAN 81-84	12	-4.8	-8.3
Canada	1991:1-1994:2	CAN 91-94	14	-3.8	-4.7
Canada	1995:3-1997:4	CAN 95-97	10	-2.3	-3.1
Denmark	1980:4-1983:3	DNK 80-83	12	-2.5	-3.9
Denmark	1989:4-1992:2	DNK 89-92	11	-2.0	-3.3
Finland	1977:1-1979:1	FIN 77-79	9	-3.8	-4.8
Finland	1991:2-1997:2	FIN 91-97	25	-5.7	-9.8
France	1983:3-1987:3	FRA 83-87	17	-2.2	-2.8
Germany	1982:1-1985:2	DEU 82-85	14	-3.1	-4.4
Ireland	1985:4-1988:4	IRL 85-88	13	-3.3	-4.9
Ireland	1992:3-1996:3	IRL 92-96	17	-3.3	-5.1
Italy	1982:2-1986:2	ITA 82-86	17	-2.8	-4.5
Italy	1992:4-1994:4	ITA 92-94	9	-2.8	-3.9
Japan	1974:4-1976:4	JPN 74-76	9	-2.3	-3.3
Japan	2001:3-2003:3	JPN 01-03	9	-2.6	-3.1
Netherlands	1981:3-1985:1	NLD 81-85	15	-3.2	-6.1
New Zealand	1991:1-1993:2	NZL 91-93	10	-4.3	-5.7
Sweden	1980:4-1983:3	SWE 80-83	12	-2.3	-3.2
Sweden	1992:3-1994:4	SWE 92-94	10	-4.3	-5.8
United Kingdom	1980:3-1983:4	GBR 80-83	14	-3.1	-4.3
United Kingdom	1991:3-1994:1	GBR 91-94	11	-2.7	-3.4
United States	1974:3-1976:4	USA 74-76	10	-3.0	-5.0
United States	1981:4-1983:4	USA 81-83	9	-5.0	-7.1
Average			12.4	-3.3	-4.8

1/ The list contains all episodes during which actual output fell short of potential (thus creating a negative 'output gap') by at least 1.5 percent for at least eight consecutive quarters, based on data from the OECD's Economic Outlook 86, December 2009. The sample initially under consideration covers all high-income OECD-DAC member countries for which quarterly output gap data are available, with a maximum sample period from 1970:1 through 2007:4. Norway is the only country in the sample for which the available quarterly data include no episode at all. No quarterly data are available for Austria, Belgium, Greece, Luxembourg, Portugal, Spain, and Switzerland.

Table 3. Ongoing Episodes of Persistent Large Output Gaps 1/

Country	Period	Length (quarters)
Australia	2008:4-2011:4 (at least)	≥13
Canada	2008:4-2011:3	12
Denmark	2008:4-2011:4 (at least)	≥13
Finland	2008:4-2011:4 (at least)	≥13
France	2008:4-2011:4 (at least)	≥13
Germany	2008:4-2011:4 (at least)	≥13
Ireland	2008:3-2011:4 (at least)	≥14
Italy	2008:4-2011:4 (at least)	≥13
Japan	2008:4-2011:4 (at least)	≥13
Netherlands	2009:1-2011:4 (at least)	≥12
New Zealand	2008:3-2011:3	13
Norway	2008:4-2011:4 (at least)	≥13
Sweden	2008:4-2011:4 (at least)	≥13
United Kingdom	2008:4-2011:4 (at least)	≥13
United States	2008:4-2011:3	12

1/ The list contains all episodes beginning after December 31, 2007, during which actual output is estimated/forecast to fall short of potential (thus creating a negative output gap) by at least 1.5 percent for at least eight consecutive quarters, based on data from the OECD's Economic Outlook No. 87, June 2010. Needless to say, these OECD projections do not necessarily match IMF forecasts.

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