

Resolving the missing deflation and inflation puzzles

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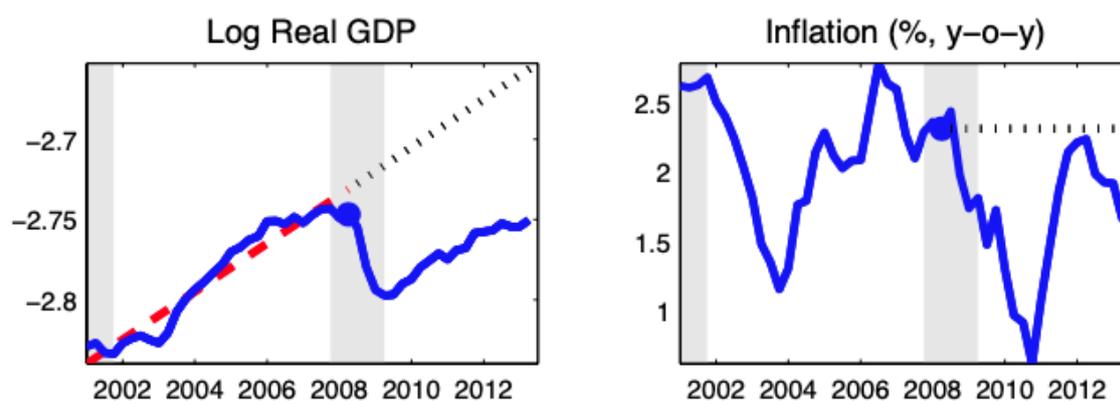
The alleged breakdown of the Phillips curve has left monetary policy researchers and central bankers wondering if we need to develop completely new models for price and wage determination. This column argues that a relatively small alteration of the standard New Keynesian model, combined with using the nonlinear instead of the linearised solution, is sufficient to resolve the two puzzles – the ‘missing deflation’ during the recession and the ‘missing inflation’ during the recovery – underlying the supposed breakdown.

The Great Recession has left macroeconomists with many puzzles. One such puzzle is the alleged breakdown of the relationship between inflation and the output gap – also known as the Phillips curve.

There are two main arguments underlying the hypothesis of a breakdown of the Phillips curve.

The first is the ‘missing deflation puzzle’. The Great Recession generated an extraordinary decline in US GDP of about 10% relative to its pre-crisis trend, while inflation dropped only by about 1.5% (see Figure 1).¹ The modest decline in inflation was surprising to many macroeconomists. For instance, New York Fed President John C. Williams (2010: 8) wrote: “The surprise [about inflation] is that it’s fallen so little, given the depth and duration of the recent downturn. Based on the experience of past severe recessions, I would have expected inflation to fall by twice as much as it has.”

Figure 1 Log US real GDP per capita and US core inflation



The second argument is the absence of upward pressure on price and wage inflation during the recovery from the Great Recession, sometimes referred to as the ‘missing inflation puzzle’. Standard price and wage Phillips curves imply that wage and price inflation should increase noticeably when the economy recovers from the recession.

The alleged breakdown of the Phillips curve – i.e. its inability to account for the missing deflation and inflation – has left monetary policy researchers and central bank economists wondering if we need to develop completely new models for price and wage determination. Leading policy institutions including the IMF and central banks have

devoted considerable resources to understanding the reasons underlying below-target core inflation rates, as well as to crafting appropriate policy responses.²

However, developing completely new models of price and wage determination does not seem to be necessary. In our ongoing research (Lindé and Trabandt 2019), we show that a relatively small alteration of the standard New Keynesian model combined with using the nonlinear solution instead of the linearised is sufficient to resolve both puzzles.

First, we argue that it is key to introduce real rigidities in price setting and wage setting. To do so, we use the Kimball (1995) aggregator instead of the standard Dixit-Stiglitz (1977) aggregator. The Kimball aggregator ‘bends’ the demand curve of firms and thereby introduces additional strategic complementarities in the price and wage setting. More strategic complementarity lowers the sensitivity of prices and wages to slack in goods and labour markets in a recession.

As such, the Kimball aggregator is commonly used in New Keynesian models (e.g. Smets and Wouters 2007) as it allows to simultaneously account for the macroeconomic evidence of a low Phillips curve slope and the microeconomic evidence of frequent price changes. However, although the introduction of real rigidities is necessary in this regard, it is not sufficient to explain the movements in aggregate quantities and prices observed during the Great Recession and the subsequent recovery.

We show that linearising all equilibrium equations of the underlying nonlinear model around the steady state, except for the lower bound constraint on the nominal interest rate, introduces large approximation errors when large adverse shocks hit the economy – as was the case during the Great Recession. Therefore, we argue that one ought to use the nonlinear solution to understand the output-inflation dynamics during the Great Recession. We show that the nonlinearity implied by the Kimball aggregator is a key model feature that accounts for the differences between the linearised and nonlinear model solutions: it is crucial to resolving the missing deflation and inflation puzzles.

In a nutshell, our model implies nonlinear price and wage Phillips curves – i.e. nonlinear relationships between price and wage inflation and the output gap (see Figures 2 and 3).³ The slopes of our price and wage Phillips curves are notably flatter in recessions than in booms. In other words, our Phillips curves have a ‘banana’ or ‘boomerang’ shape as in the seminal paper by Phillips (1958). Consequently, and consistent with the data, our nonlinear model implies that inflation falls relatively little in deep recessions. By contrast, the linearised model erroneously predicts a much larger fall in inflation by extrapolating local decision rules around the steady state to deep recessions far away from the steady state.

Figure 2 Price Phillips curves with nonlinear versus linearised model

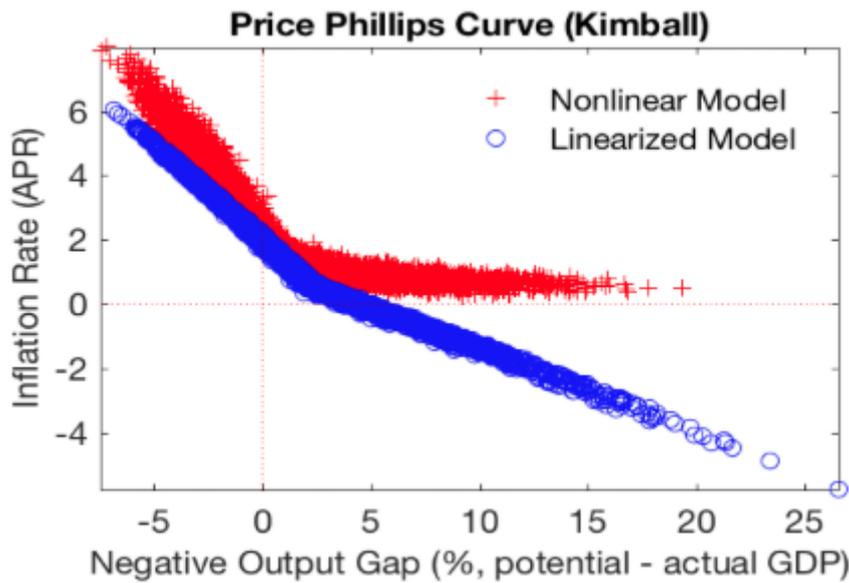
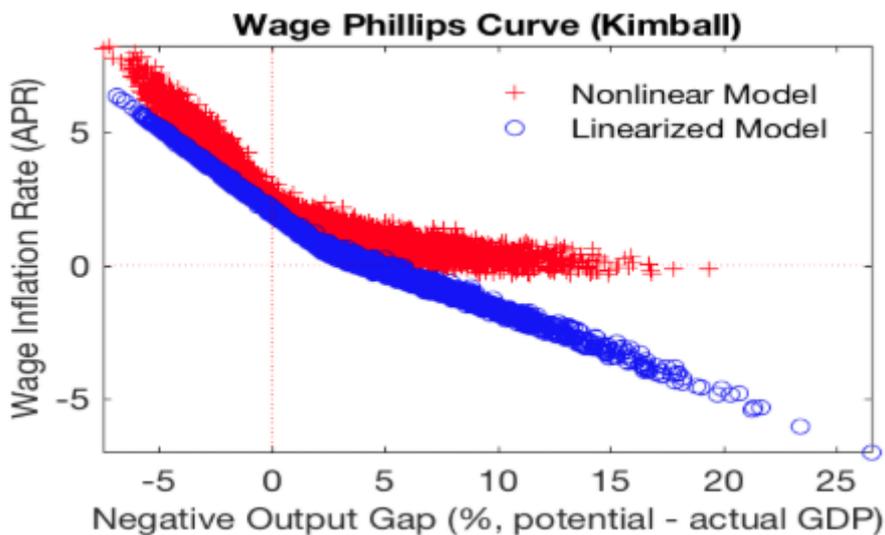


Figure 3 Wage Phillips curves with nonlinear versus linearised model



Our research is also useful for understanding the absence of upward pressure of price and wage inflation during the recovery from the Great Recession – i.e. the ‘missing inflation puzzle’. The banana-shaped Phillips curves imply that price and wage inflation remain subdued until the level of economic activity has recovered sufficiently relative to its potential. Put differently, even though economic growth may resume after a deep recession, price and wage inflation will only increase modestly until economic slack has subsided sufficiently.

Therefore, our model not only resolves the missing deflation puzzle, it also offers an explanation for the missing inflation puzzle. According to our model, subdued price and wage inflationary pressures as observed during the recovery from the Great Recession are indicative of substantial economic slack, consistent with Figure 1 which shows that post-crisis GDP has not nearly caught up with the level implied by its pre-crisis trend.⁴

All told, our nonlinear model allows us to simultaneously explain the quantitative inflation performance prior to the Great Recession, the missing deflation during the Great Recession, as well as the missing inflation in recent years. Our results caution against the

common practice of using linearised models to study inflation and output dynamics when the economy is exposed to large shocks.

Authors' note: The views expressed herein are those of the author and should not be attributed to the IMF, its Executive Board, or its management.

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Endnotes

[1] The 'missing deflation puzzle' refers to the small drop in core inflation in the face of a large GDP contraction during the financial crisis and has attracted considerable interest among academics and policymakers. Hall (2011) argues that popular DSGE models based on the simple New Keynesian Phillips curve "cannot explain the stabilization of inflation at positive rates in the presence of long-lasting slack". Similarly, Ball and Mazumder (2011) argue that Phillips curves estimated for the post-war pre-crisis period in the United States cannot explain the modest fall in inflation during the years of the financial crisis from 2008 through 2010. A further challenge to the New Keynesian Phillips curve is raised by King and Watson (2012), who find a large discrepancy between actual inflation and inflation predicted by the workhorse Smets and Wouters (2007) model. They use all use linearized variants of the New Keynesian Phillips curve in their analysis.

[2] For instance, the IMF devoted one chapter in its autumn World Economic Outlook publication (IMF (2016)) to discussing price inflation determination in and after the crisis. One year later, the World Economic Outlook discussed wage inflation determination following the crisis (IMF 2017).

[3] We establish our main results in a variant of the Erceg et al. (2000) benchmark model. We also examine the robustness of our results in an estimated medium-sized New Keynesian model based on Christiano et al. (2005) and Smets and Wouters (2007).

[4] Central banks in many advanced economies argue that resource utilization has been close, or even above normal in recent years. However, most estimates of potential economic activity is based on how well the actual economy is doing, i.e. they are two-sided. So, if actual economic growth is low, then potential is eventually measured to be low as well, implying modest or no economic slack. If one instead compares post-crisis GDP with its pre-crisis trend economic slack is still more elevated than standard two-sided measures suggest.