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The zero lower bound on the interest rate and a Neoclassical Phillips curve

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ABSTRACT

I derive the exact analytical solution for optimal monetary policy given a Neoclassical Phillips curve and a zero lower bound on the nominal interest rate. There is a particular range of interest rate rule parameters that may close the output gap. One way of closing the output gap involves stable but high inflation (the divine coincidence). In the general case inflation is variable and potentially lower. Thus, one can achieve stable OR low inflation, but not both. When the productivity shock has an unbounded support, only the variable inflation version of optimal policy is implementable. Optimal policy then involves a lagged interest rate response to shocks and a random walk price level.

1. Introduction

This paper discusses monetary policy in a model with a Neoclassical Phillips curve and a productivity shock. In one version of the model, the productivity shock has a bounded support (and a uniform distribution). In another version, the shock has an unbounded support (and a lognormal distribution). One result is that the zero lower bound does not prevent the central bank from achieving the first best allocation. I describe a simple interest rate rule that implements this allocation. The intuition is that with a Neoclassical Phillips curve, expected inflation is not costly. In equilibrium, the nominal rate may be stable while a variable inflation rate delivers a real interest rate that tracks the natural real rate.

A second result is that the log of the price level follows a random walk (with drift) under optimal monetary policy. A lagged interest rate response to shocks is required in the general case. Since the first best allocation is attainable in the present model, there is no commitment problem associated with delivering a lagged interest rate response. Welfare is the same whether inflation is stabilized or not (given a bounded support for the shock), as long as any movements in inflation are known one period in advance - which is the case under the set of optimal policies considered here.

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A third result is that more volatile structural shocks require either a higher inflation rate or a more volatile inflation rate, if output is to be stabilized. The risky steady states for output and inflation[1] depend on the distribution of disturbances and monetary policy. With a bounded productivity shock, there is a range of interest rate rule parameters that deliver output stabilization. One way of closing the output gap in this case involves stable but high inflation (the divine coincidence). That same policy choice - with a high enough inflation target - would deliver output stabilization also given a New Keynesian Phillips curve, when productivity shocks have a bounded support. The straightforward reason for this is that a high enough inflation target gives room enough for maneuver, so that real shocks always can be absorbed by a variable nominal interest rate. But with a Neoclassical Phillips curve there are more options for output stabilization, and inflation may be variable and potentially lower under optimal policy. The latter point is a result highlighted in this paper.

The menu of possible policies that will deliver an optimal outcome narrows to only one possible choice in the context of an unbounded productivity shock; Output is fully stabilized if and only if inflation varies around its trend, and tracks the natural real interest rate. This policy choice would not deliver output stabilization under a New Keynesian Phillips curve, where fully expected but variable inflation is costly. If authorities deviate from optimal policy, and instead choose to stabilize inflation closer to its trend, there will be episodes of negative output gaps. The distribution of inflation and output gaps will then be skewed to the left. This policy is not time consistent. The frequency of hitting the zero lower bound will be increasing in the variance of productivity shocks, decreasing in the level of the inflation target, and increasing in the degree to which inflation is stabilized.

This paper is not about price level determinacy or the potential multiplicity of equilibria associated with the zero lower bound on interest rates[2]. Rather, it is concerned with situations where monetary policy may be prevented from being expansionary enough to stabilize output, as discussed in seminal work by Krugman (1998) and Eggertsson and Woodford (2003).

Much of the literature on the zero lower bound for the nominal interest rate relates to the case of a New Keynesian Phillips curve[3]. As discussed in among others Wolman (1998), Adam and Billi (2007) and Nakov (2008), the degree of intrinsic (endogenous) inflation stickiness determines the costs of the zero lower bound constraint. The value of being able to implement policy under commitment is higher when inflation is more sticky.

In this paper, some agents set prices flexibly, while some agents set prices one period in advance. Synchronized price setting creates a Neoclassical Phillips curve and enables me to derive an exact analytical solution, following Henderson and Kim (2001). The case of a Neoclassical Phillips curve may be of interest because it represents a limit case; Systematic monetary policy is useful[4], but anticipated policy beyond the next period does not have real effects even though agents are fully forward looking. The Neoclassical Phillips curve establishes an example where price level targeting is unhelpful in a low inflation environment. It may on the other hand be argued that the New Keynesian Phillips curve describes a case where anticipated policy too far into the future is powerful, and where the value of commitment might be overestimated.

As shown in Alstadheim (2013), the Neoclassical Phillips curve may be derived as the limit of the New Keynesian Phillips curve, when firms fully index their prices to *expected future* inflation. However, a model with the generalized Phillips curve cannot be solved without approximation. In this paper, I study an exact solution in order to integrate the treatment of level effects and stabilization effects of policy. I therefore focus on the limit case of a Neoclassical version only.

I abstract from distortions other than the one-sector price stickiness. This means that if policy removes the price stickiness distortion, any potential commitment problem also disappears in this paper. The results in Adam and Billi (2007) and Ngo (2014) highlight that level effects of policy under discretionary policy may have particular importance, given a potentially binding zero lower bound constraint, when optimal policy is not time-consistent. Those issues are not covered here.

The simple rule considered in this paper is optimal in the sense described in Woodford (2001). I use a public finance approach, where I solve for the optimal allocation in the economy, and then back out the set of parameters of the simple rule that deliver the first best outcome. The optimal rule responds directly to productivity shocks, and not only to endogenous variables.

The next section describes the model. In Section 3, I solve the flexible-price version of the model. In Section 4, I derive the sticky-price solution and present optimal monetary policy in the case of a uniform distribution of the productivity shock. I calibrate constant terms describing the risky steady states such that nominal levels increase when the volatility of shocks, and policy parameters, imply more interest rate volatility. In this way, the nominal interest rate never violates the zero lower bound constraint. It is thereby shown that a more stable inflation rate necessarily goes with a higher steady state inflation rate under optimal policy. I present a menu of different optimal monetary policies. In Section 5, I derive the solution for the model given a lognormal distribution of the shock, and I present optimal policy in that case. There, I also simulate the model, in order to illustrate the link between the degree of inflation stabilization and the frequency with which the zero lower bound is encountered. Section 6 provides concluding remarks.

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[1] I use the definition of the risky steady state established by Coeurdacier et al. (2011).

[2] See e.g. Benhabib et al. (2001) and also Chapter 2 in Woodford (2003). See also Alstadheim and Henderson (2006). For a more recent discussion, see Aruoba and Schorfheide (2013).

[3] But see Fuhrer and Madigan (1997) and Wolman (2005). Adam and Billi (2006) and Adam and Billi (2007) are important contributions to the literature on the zero lower bound in New Keynesian models. See also Braun and Korber (2011).

[4] In Sargent and Wallace (1975), a Neoclassical Phillips curve setup is applied, and there monetary policy is useless for stabilization purposes. In their setup, the expected real interest rate calculated with inflation expectation as of yesterday appears in the IS curve, $i_t - E_{t-1}\pi_{t+1}$. In this paper, the Euler equation includes the real interest rate calculated as of today, $i_t - E_t\pi_{t+1}$, and that makes monetary policy have real effects.

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