Journal of Macroeconomics 41 (2014) 16–20

Contents lists available at ScienceDirect

Journal of Macroeconomics

journal homepage: www.elsevier.com/locate/jmacro

Stabilising Taylor rules when the supply shock has a unit root

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ARTICLE INFO

Article history:
Received 19 September 2013
Accepted 4 April 2014
Available online 19 April 2014

JEL classification:
E30
E40
E50

Keywords:
Inflation persistence
Taylor rule
Unit root

ABSTRACT

This paper studies the implication of unit root supply shocks for the Taylor rule. I find that, when supply shocks have a unit root, if a central bank wishes to guarantee the stationarity of inflation, then their interest rate reaction function should not respond to the output gap. Once the stationarity of inflation is guaranteed by the output-gap-response parameter, the "Taylor principle" can be applied for warranting determinacy of the dynamics.

1. Introduction

Since the mid-1980's, the U.S. economy has witnessed a significant decline in the persistence of inflation (Cogley et al., 2010). However, the persistence of supply shocks that contribute to inflationary pressure does not appear to have declined materially (Fuhrer, 2009). Many macroeconomists believe that better monetary policy plays a central role in accounting for this change. In this paper I investigate how to specify a Taylor-type rule that will ensure the stationarity of inflation when supply shocks are a unit root process.

Supply shocks are an important driver of inflation. Ball and Mankiw (1995) and Gordon (1998) show that supply shocks measured by the changes in relative prices explain a large fraction of variability in the post-war U.S. rate of inflation. In addition, measures of supply shocks are found to be highly persistent. Empirical studies that explore the stochastic properties of crude oil prices – a conventional measure of supply shocks – typically find that they are well-described by a random walk process.[1] In the Bayesian estimation literature, Smets and Wouters (2007) also show that identified wage markup shocks are highly persistent with the posterior mode of the autocorrelation coefficient of 0.97. The persistence of these shocks is robust over two subsamples split around the early 1980's.

I conduct the analysis below in a stylized New Keynesian model with a simple Taylor rule. The New Keynesian Phillips curve (NKPC) is perturbed by a random walk supply shock, therefore inflation is inherently persistent. I show that, under these circumstances, the central bank can still control inflation by using a Taylor rule. The main theoretical findings are sum-

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[1] Recent evidence based on high frequency data are Barros and Gil-Alana (2011) and Maslyuk and Smyth (2008). Barros and Gil-Alana (2011) provides a detailed historical literature review on this topic.

http://dx.doi.org/10.1016/j.jmacro.2014.04.001
0164-0704/

marized as follows. Firstly, under the forward-looking NKPC, the central bank can make equilibrium inflation stationary by setting the Taylor rule response to the output gap to zero. Intuitively, under "strict inflation targeting", monetary policy isolates inflation from the non-stationary supply shocks by focusing solely on controlling aggregate demand. As a result, equilibrium inflation dynamics are completely decoupled from persistent supply shocks. Secondly, once the stationarity of inflation is guaranteed by the output-gap-response parameter, the "Taylor principle" can be applied to the inflation-response parameter for warranting determinacy of the dynamics. Furthermore, I also examine the robustness of this result under a more general setting, in which I allow for backward-looking behavior in the NKPC and the dynamic IS curve. Under this "hybrid" model, the zero-response to the output gap is still important in sterilizing the effect of supply shocks on inflation. In sum, my theoretical results illustrate that, when supply shocks are non-stationary, how the Taylor rule responds to the output gap is even more important than the response to inflation in forming equilibrium dynamics.

My theoretical results are related to a vast body of the literature studying the effects of Taylor rules on macroeconomic dynamics. The majority of studies in this literature, however, focus solely on the Taylor rule's response to inflation.[2] The seminal paper by Taylor (1999) estimates monetary policy rules with two subsamples of the post WWII U.S. time series and finds that the Federal Reserve did not conform to the "Taylor principle" before 1979. He emphasizes this failure as the main cause of U.S. Great inflation during the 1960's and 1970's. By contrast, Orphanides (2004) estimates a forward-looking policy rule for the Fed with real-time data. His results suggest that there was no significant change in the Fed's response to inflation between the two subsamples. Instead, the U.S. great inflation resulted mainly from policy that was too activist in reacting to perceived output gaps. Boivin (2006) uses real-time data to estimate a forward-looking policy rule with drifting coefficients. He finds evidence suggesting gradual but substantial changes in the Fed's response to both inflation and real activity during the Volcker disinflation period. In contrast to the second half of the 1970's, monetary policy consistently responded strongly to inflation and weakly to real-activity from the mid-1980's onward. My theoretical results are consistent with these empirical findings in that, besides supporting the role of the Taylor principle in guaranteeing determinacy of the model, my analysis sheds new light on the important role played by the policy response to the output gap. Specifically, even when the Taylor principle is fulfilled, inflation persistence can, under certain circumstances, be worsened by an active policy response to real economic activity.

The remainder of the paper is organized as follows: in Section 2 I sketch the model; Section 3 shows the main analytical results; and Section 4 concludes.

2. The model

In its simplest form, the New Keynesian model can be expressed as three log-linearized equations around the non-stochastic steady state with zero inflation[3]:

$$\pi_t = (1-\gamma_1)E_t[\pi_{t+1}] + \gamma_1\pi_{t-1} + \lambda x_t + u_t, \tag{1}$$
$$x_t = (1-\gamma_2)E_t(x_{t+1}) + \gamma_2 x_{t-1} - [i_t - E_t(\pi_{t+1})] + r_t^n, \tag{2}$$
$$i_t = \phi_\pi \pi_t + \phi_y x_t. \tag{3}$$

Eq. (1) describes the Phillips curve relationship between the rate of inflation (π_t) and the output gap (x_t). In addition, I assume that there is a backward-looking term in the NKPC, which is motivated by rule-of-thumb or indexation price-setters (Gali and Gertler, 1999; Christiano et al., 2005). The supply shock (u_t) follows a random walk process $u_t = u_{t-1} + s_t$, where $s_t \sim iid\,(0, \sigma_s^2)$. λ is the slope of the NKPC. Eq. (2) is the dynamic IS curve describing the optimal savings problem of the household, in which i_t denotes the nominal interest rate and r_t^n is the natural rate of interest. It summarizes the combination of real structural shocks that affect the real interest rate. Parameter γ_1 and γ_2 are between zero and one, measuring the relative importance of the backward-looking term versus the forward-looking term.[4] Lastly, Eq. (3) is a simple Taylor rule.

3. Analysis

In this model, supply shocks have a unit root, so that inflation is inherently non-stationary. In the following analysis, I emphasize the role played by the Taylor rule response to the output gap in determining the inflation persistence. In particular, I first conduct my analysis in a simple case, where no backward-looking pricing behavior is considered. Then I extend the theoretical result in the full model.

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[2] For example: Orphanides and Williams (2003) study an economy where the public learns about the structure of the economy adaptively. In this environment, when monetary policy controls inflation tightly, long-run inflation expectations are well anchored and thereby inflation is less persistent. Carlstrom et al. (2009) emphasize the role of the monetary policy rule in determining the relative importance of shocks to inflation dynamics. They show that a more aggressive monetary policy rule can reduce the effects of demand shocks or offset the effects of technology shock.

[3] For a formal derivation see Gali (2009). Note that log-linearized models are only accurate when measuring economic dynamics close to the steady state. The fact that a permanent shock would cause the endogenous variables to drift away from the steady state without boundary casts doubt on business cycle statistics predicted by the model. However, given that quantitative prediction is not the objective of the paper, I view the log-linearized New Keynesian model as a reasonable and parsimonious analytical device for my research question.

[4] γ_2 can be motivated by the presence of habits in the consumer's utility function.