



# Robust monetary policy under model uncertainty and inflation persistence

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## ABSTRACT

In this paper, we examine the inflation persistence puzzle by applying the robust control approach of Hansen and Sargent (2008). In line with the literature suggesting that inflation persistence may be affected by the monetary policy design and its institutional characteristics, we find that inflation persistence is positively related to the central bank's preference for model robustness. In effect, model uncertainty and robust decision making may be considered as a mechanism generating inflation persistence, for a given non-zero degree of autocorrelation in supply-side shocks. Further, the policy implication is that the central bank's monetary policy under model uncertainty renders, in terms of the sacrifice ratio, the output-cost of inflation stabilization more important.

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## 1. Introduction

Over the last decade, there has been a rapidly growing literature providing explanations for the relatively high degree of inflation persistence observed in the inflation data. Inflation persistence represents a key determinant for the monetary policy design. Hence, the question of how monetary policy should be set optimally when the structure of the economy exhibits a degree of inflation persistence is important for policymakers in stabilizing the economy.

In the light of this ongoing debate about the appropriate specification of the inflation persistence determination, several authors have proposed different mechanisms to build inflation persistence into the deep structure of the economy. Some interpretations consider inflation persistence as an intrinsic structural feature by focusing on microeconomic aspects, such as price and wage stickiness, indexation or staggered wages contracts, to incorporate inflation persistence in macroeconomic models (see Blanchard and Gali, 2007; Buiters and Jewitt, 1981; Calvo, 1983; Calvo et al., 2002; Christiano et al., 2005; Fuhrer and Moore, 1995; Taylor, 1980). Alternative interpretations are proposed to explain and remedy the high inflation persistence found in post-war U.S. data (see Cogley and Sargent, 2001; Taylor, 2000). More recently, economists in the frame of a research network of the European Central Bank (ECB) have been investigating the empirical evidence for the determinants of inflation persistence and its implications for monetary policy in the euro area (see Angeloni et al., 2003). In any case, there is little consensus in the empirical

literature about the degree of endogenous inflation persistence (Benati, 2008).

Another strand of literature suggests that the inflation persistence is not only due to an inherent structural characteristic of industrial economies, but may be also proper to changes in the monetary policy regime (Goodfriend and King, 2001; Sargent, 1999; Taylor, 2000; Westelius, 2005). Taylor (2000) suggests that the diminished degree of inflation persistence may be due to changes in the orientation of monetary policy. In this context, the way that economic agents perceive major changes in the monetary policy regime, such as central bank's independence or transparency, may have important implications for inflation persistence and thus for the transmission mechanism and the ability of monetary policy to stabilize the economy. For example, in an environment where central bank's independence prevails, inflation persistence may become restrained because a higher credibility of monetary authorities affects the inflation expectations of the price makers and wage setters. Therefore, the speed at which inflation reacts to changes in monetary policy may be faster and the economy may move more quickly to a new equilibrium with significant implications on the output cost of disinflation or sacrifice ratio (for a debate, see Diana and Sidiropoulos, 2004). In this context, inflation persistence may be affected by the optimal monetary policy design, as the result of the strategic game between the central bank and the private sector.

However, this literature is focused on how the central bank's characteristics may influence inflation persistence without taking into account the fact that the policymakers do not have a complete knowledge of the true structure of the economy. Therefore, in order to examine the persistence puzzle, we should investigate how the

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interaction between central bank's decisions and the wage setters' actions affects the inflation persistence, when the policymaker is faced with uncertainty about the structure of the economy. The raising question in this context is how the degree of inflation persistence is affected by the limited knowledge of central banks about the structure of the economy. Given the complexity of the economic system, policymakers may not have a complete knowledge of its true structure and thus be uncertain about the reliability of their macroeconomic models. Thus, without the possibility to have a complete description of reality, central banks make their decisions in the presence of considerable uncertainty about the structure of their economy. For instance, the ECB faces substantial model uncertainty, relating to the characteristics of the aggregate euro area inflation process and its monetary policy should ideally be designed to perform reasonably well under a range of alternative models of inflation determination which differ with respect to the degree of inflation persistence that they induce (Coenen and Wieland, 2005).

Model uncertainty refers to the discrepancy between the real state of the economy and the macroeconomic model supposed to represent it. As long as mathematically expressed models remain an incontrovertible tool for the policymaker, the problem of the mapping between an objective real data-generating process and a subjective artificial model will inevitably exist. In fact, macroeconomic models cannot be considered to be anything more than approximations to the reality of the economy. The models rest on a set of assumptions that may or may not be good approximations of true economies. Therefore, policy decision making based on such models suffers from uncertainty due to the lack of perfect precision in the process of modeling the real world. A policymaker is likely to prefer a policy based on principles that are also valid if some fundamental assumptions of the model differ from the reality.

In the literature accounting for model uncertainty issues, different approaches have been developed. For instance, Levin et al. (2003), Levin and Williams (2003) and Brock et al. (2007) use Bayesian decision-theoretic approach, while Hansen and Sargent (2008) apply robust control theory to deal with model misspecification. In this context, Coenen (2007) examines the performance of optimized interest-rate rules when there is uncertainty about a key determinant of the monetary transmission mechanism, namely the degree of inflation persistence. Using two variants of an estimated small-scale macroeconomic model featuring distinct types of staggered contracts specifications which induce quite different degrees of inflation persistence, he finds that, in terms of policy implications, inflation persistence is overestimated when designing robust policy rules making. Moreover, Tillmann (2009), focusing on optimal monetary policy design, discusses the rationale for delegating monetary policy to an inflation-averse central banker, when the economy faces structured uncertainty about the true degree of shock persistence. Using some model's parametrizations to assess the quantitative effects of monetary policy delegation, he shows that the stabilization bias increases if uncertainty becomes larger. The social planner should overestimate the degree of shock persistence. Thus, the optimal degree of conservatism under uncertainty is higher than under certainty.<sup>1</sup> However, the above studies are different with respect to our approach to modeling uncertainty and robust policy-making, which is more indicated for a deeper investigation of the inflation persistence issue, since it is not specific to the process governing the persistence dynamics.

In this study, we will focus on the approach of Hansen and Sargent (2008) applying robust control theory to deal with model misspecification, on which a series of studies has been based (see for example, Dai and Spyromitros, 2010, 2012; Dennis et al., 2009; Diana

and Sidiropoulos, 2007; Giordani and Söderlind, 2004; Leitimo and Söderström, 2008a, 2008b; Qin et al., 2010; Sanchez, 2011; Sorge, 2012; Tillmann, 2009; Walsh, 2004). The robust control approach is one efficient approach for policymakers confronting uncertainty, especially when the latter is characterized by possible specification errors over which they are unable to specify a probability distribution. This approach not only provides a set of tools to assist decision makers in dealing with uncertainty, but it also allows private agents to express concerns about model misspecifications when forming expectations. Under the assumption that the central bank acknowledges that its reference model is subject to specification errors, it regards henceforth a range of models located in the neighborhood of the reference one as potentially true. The objective of robust control is to seek a robust policy delivering the most acceptable result across the whole set of candidate models. Thus, the more candidate models are considered, the more robust the resulting policy is. In particular, in order to guard against undesirable outcomes of uncertainty, the central bank should consider worst case scenarios. In other words, policy prescriptions should be robust to reasonable deviations from the reference model.<sup>2</sup>

This paper adds to the literature by contributing to our understanding of the persistence puzzle, by addressing the case of robust monetary policy, when the policymaker is faced with uncertainty about its model, in the presence of a degree of persistence characterizing the inflation process. Using a simple model structure, we are able to find closed-form solutions for the robust control analysis. In such context, the policymaker has a preference for model robustness which affects the conduct of monetary policy. Inflationary expectations of wage setters are affected by the model uncertainty and the central bank's preference for robustness. For instance, if the policymakers have incomplete knowledge of the economy (i.e., labor market distortions), they respond more aggressively to supply or cost shocks, altering in this respect the inflationary expectations and thus inflation persistence. In this context, we analytically show how the inflationary expectations and the process of inflation persistence are affected by the preference for model robustness and find that inflation becomes more persistent due to a stronger fear of model uncertainty, inducing significant policy implications on the output cost of disinflation (or sacrifice ratio).

The paper is structured as follows. Section 2 presents the basic model. Section 3 takes into account model misspecification and solves for the equilibrium of the worst case model. Section 4 analyzes the relationship between inflation persistence and preference for robustness, and the implied policy implications with regard to the output cost of disinflation. Section 5 concludes.

## 2. The model

We consider a simple monetary policy game model extended to allow for persistent stochastic supply-side shocks and nominal wage contracts. Output is given by a Cobb–Douglas production function that combines the sole variable input, homogeneous labor with other fixed factors of production. The relationship between output and employment at the aggregate level is described by the following log-linear production function:

$$y_t = \alpha l_t + u_t, \quad 0 < \alpha < 1, \quad (1)$$

where  $y_t$  is the log of output,  $l_t$  is the log of employment and  $u_t$  represents a random supply-side shock. In the case where  $u_t$  is positive, it represents a production technology or productivity shock and if  $u_t$  is negative, it refers to a cost-push shock. In the following, we

<sup>1</sup> Recently, Sorge (2012) introduces in the monetary policy delegation framework uncertainty about monetary policy preferences and reverses the Rogoff's principle, meaning that it is optimal for society to appoint a weight-liberal central banker under reasonable model parametrizations.

<sup>2</sup> Crucially, our paper deals with unstructured model uncertainty (i.e. uncertainty incorporated in specification errors which may make the actual model deviate from the reference one).

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