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Does trend inflation make a difference?☆

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ABSTRACT

Although the average inflation rate of developed countries in the postwar period has been greater than zero, much of the extensive literature on monetary policy has employed models that assume zero steady-state inflation. In comparing four estimated medium–scale NK DSGE models with real and nominal frictions, we seek to shed light on the quantitative implications of omitting trend inflation, that is, positive steady–state inflation. We compare certain population characteristics and the IRFs for the four models by applying two loss functions based on a point distance criterion and on a distribution distance criterion, respectively. Finally, we compare the RMSE forecasts and we consider also an indirect inference test. We repeat the analysis for three sub-periods: the Great Inflation, the Great Moderation and the union of the two periods. We do not find strong evidence that a model with trend inflation should always be preferred. During periods of high inflation or when a backward-looking component, indexed to past inflation, is not incorporated in the model, using a model that employs trend inflation can improve the analysis. Nevertheless, where there is uncertainty concerning the change of an inflation regime, such as the recent drop, we suggest adopting a traditional approach that does not use trend inflation.

1. Introduction

Looking at the macroeconomic data of developed countries, it is clear that the average inflation rate in the postwar period was greater than zero and that it varied by country. However, much of the extensive literature on monetary policy rules has employed models that assume zero steady-state inflation. Ascari and Ropele (2007) suggest that monetary policy literature has centred on this particular assumption, even though it is both empirically unrealistic and theoretically special, for two reasons: it is analytically convenient and price stability is the optimal prescription in a cashless economy.[1] By relaxing the zero steady–state inflation assumption, we gain new insights. First, Ascari and Ropele (2007–2009) show that even low trend inflation can affect optimal monetary policy and the dynamics of inflation, output and interest rates under a standard New Keynesian model. Moreover, trend inflation shrinks the determinacy region of a basic New Keynesian model when monetary policy is conducted by a contemporaneous interest rate rule.[2] Second, as shown by Cogley and Sbordone (2008), in small–scale models the inclusion of time–varying trend inflation seems to eliminate the need to include partial indexation schemes to produce a backward-looking dynamic.

Given the empirical practice and these theoretical caveats, the goal of this analysis is to shed light on the quantitative implications of omitting trend inflation in an estimated medium–scale DSGE model, whereas most of the literature on trend inflation involves calibrated models. We compare a NK DSGE model log–linearized around zero steady-state inflation and partially indexed to past inflation with an equivalent model using trend inflation.[3] Then, since trend inflation should, in theory, help to account for the backward-looking dynamic of inflation, we also compare these two models without indexing them to past inflation. The chosen NK DSGE model is based on two workhorse medium–scale DSGEs: Smets and Wouters (2007) and Schmitt-Grohe and Uribe (2004). These NK DSGE models add both real and nominal frictions to the standard textbook model. The real frictions are:

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[1] See Woodford (2003).

[2] Other papers study the effects of changes in trend inflation, such as Hornstein and Wolman (2005) and Kiley (2007), concluding that the Taylor Principle breaks down when the trend inflation rate rises and that a more aggressive policy in response to inflation is needed to insure determinacy.

[3] Ascari and Ropele (2007) show that with full indexation under the Calvo pricing scheme, log-linearization around zero trend inflation or positive trend inflation are identical. In this case the distortions due to positive trend inflation disappear when all the non–re–optimizing firms re–adjust their prices to past inflation and/or to the trend inflation.

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monopolistic competition in goods and labour markets, habit formation in consumption preferences, capital utilization and investment adjustment cost. The nominal frictions are based on the Calvo mechanism for nominal price and wage. We have chosen this model since it fits well with the observed data, replicating the main US macro features.

We analyse three different periods: the entire span of time between 1966 and 2004, the period before the Great Moderation (1966–1982) and the years of the Great Moderation (1983–2004). These periods have different average levels of inflation and therefore we are able to test the quantitative implications of trend inflation for different levels of inflation in the steady state.

We compare the cross-correlations and the IRFs for the four models by applying the evaluation method proposed by Schorfheide (2000). Specifically, we compare the models by using two types of loss functions. The first one is based on a point distance criterion, as in Schorfheide (2000). The second, proposed as a novelty in this study, is a distribution distance criterion based on the idea of entropy suggested by Ullah (1996). The benchmark against we compare the different models is a weighted average, computed from the marginal data density of the four different Bayesian VARs and the four DSGEs. The moments and dynamics computed in this way will be called 'population characteristics', since the approach takes into account the potential misspecifications of the candidate models. Moreover, since one of the advantages of the DSGE model is its use in forecasting, we compare the in-sample forecast RMSEs of the DSGE models.

We do not find clear evidence for preferring a model that uses trend inflation. In all our various comparisons, the presence of trend inflation does not produce results that differ significantly from those of the classical model. These results are consistent with those reported by Ascari et al. (2011). They studied the determinacy of the equilibrium in a calibrated medium–scale New Keynesian framework and concluded that trend inflation does not seem to offset the determinacy region when real frictions are included.

When we studied the two sub–periods, we found that the models are almost equivalent during the Great Moderation. However, the pre-1982 trend inflation is relevant since it results in better forecasting and a good fit between the IRFs.

A further comparison across models is considered by implementing a classical statistics based on Wald test as proposed by Le et al. (2016). This different perspective tends to confirm the previous findings, while the possible concerns on the power of likelihood ratio tests and the influence of the tightness priors are overcome.

We have contributed to the trend inflation literature studying the effects of different levels of inflation in an estimated NK model. Few articles have investigated trend inflation in a calibrated model while focusing on the determinacy issue. The first paper that examined the effects of trend inflation on the dynamics of the standard New Keynesian model was Ascari (2004). Subsequently Amano et al. (2007) studied how the business cycle characteristics of the model vary with trend inflation. Ascari and Ropele (2007) analysed how optimal short-run monetary policy changes with trend inflation, whereas, in Ascari and Ropele (2009), moderate levels of trend inflation offset the determinacy region, substantially altering the monetary policy rule. Kiley (2007) investigated how trend inflation influences the determinacy region and the unconditional variance of inflation in a model in which prices are staggered à la Taylor and monetary policy is described by à Taylor rule. Coibion and Gorodnichenko (2011) showed that determinacy in New Keynesian models under positive trend inflation depends not only on the central bank's response to inflation and output gap, as is the case under zero trend inflation, but also on many other components of endogenous monetary policy.

The paper is organized as follows. In Section 2 we introduce the general DSGE model and the nested models we will compare and we present the data, the Bayesian estimates for the parameters, the relative short-run dynamics and forecasts. In Section 3 we explain the procedure for comparing the models and the results for correlation and IRFs. In Section 4 we consider the indirect inference test proposed by Le et al. (2016). In Section 5 we state our conclusions.

2. Model and introductory comparisons

2.1. General model

We base our analysis on a medium–scale DSGE model, similar to the well–known model estimated by Smets and Wouters (2007). Households maximize a non–separable utility function with two arguments (final goods and labour effort) over an infinite life horizon. The presence of time–varying external habit formation means that the past also affects current consumption. Labour decisions are made by a union, which supplies labour monopolistically to a continuum of labour markets, sets nominal wages à la Calvo and distributes the markup applied over the marginal cost of labour to households. Households rent capital services to firms and decide how much capital to accumulate given capital adjustment costs. Capital utilization is variable and chosen by the households in accordance with a cost schedule.

There is a sector of intermediate goods where there is a continuum of firms that produce differentiated goods in a monopolistic market à la Dixit and Stiglitz, decide on labour and capital inputs, and set prices, again in accordance with the Calvo model. The consumption good is a composite of intermediate goods. The final good producers buy the intermediate goods on the market, package them into units of the composite good, and resell them to consumers in a perfectly competitive market.

We assume that the central bank systematically reacts to inflation ($\widetilde{\pi}_t$) and to output ($\widetilde{y}_t$) growth in accordance with the rule:

$$\widetilde{R}_t = \widetilde{R}_{t-1}^{\rho_R}\overline{R}_t^{\rho_R}\exp\{\epsilon_t^r\} \quad \overline{R}_t = \left(\frac{\widetilde{\pi}_t}{\pi_\star}\right)^{\psi_\pi}\left(\frac{\widetilde{y}_t}{\widetilde{y}_{t-1}}\right)^{\psi_y} \tag{1}$$

where ϵ_t^R is a monetary policy shock that captures transitory deviations from the interest rate feedback rule that are unanticipated by the public.[4]

Labour decisions are made by a union, which supplies labour monopolistically to a continuum of labour markets of measure 1, indexed by $l \in [0, 1]$, and sets wages in accordance with the Calvo model. Their optimization problem yields the following wage equation:

$$\frac{\theta^w - 1}{\theta^w}\widetilde{w}_t^o\widetilde{f}_t^{1,w} = \widetilde{f}_t^{2,w} \tag{2}$$

where $\widetilde{f}_t^{1,w}$ and $\widetilde{f}_t^{2,w}$ are defined as

$$\widetilde{f}_t^{1,w} = \left(\frac{\widetilde{w}_t}{\widetilde{w}_t^o}\right)^{\theta^w}\widetilde{L}_t^d + (\omega_w\beta\gamma^{1-\sigma_c})\left(\frac{\widetilde{\pi}_{t+1}}{\widetilde{\pi}_t^{\iota_w}}\right)^{\theta^w-1}\left(\frac{\widetilde{w}_{t+1}^o}{\widetilde{w}_t^o}\right)^{\theta^w}\widetilde{\xi}_{t+1|t}\widetilde{f}_{t+1}^{1,w} \tag{3}$$

and

$$\widetilde{f}_t^{2,w} = \widetilde{w}_t^h\left(\frac{\widetilde{w}_t}{\widetilde{w}_t^o}\right)^{\theta^w}\widetilde{L}_t^d + (\omega_w\beta\gamma^{1-\sigma_c})\left(\frac{\widetilde{\pi}_{t+1}}{\widetilde{\pi}_t^{\iota_w}}\right)^{\theta^w}\left(\frac{\widetilde{w}_{t+1}^o}{\widetilde{w}_t^o}\right)^{\theta^w}\widetilde{\xi}_{t+1|t}\widetilde{f}_{t+1}^{2,w} \tag{4}$$

and θ^w is the intratemporal elasticity of substitution in the labour market, $\widetilde{w}^o$ is the optimal wage, $\widetilde{L}_t^d$ is a measure of aggregate labour demand by firms at time t, β is the subjective discount factor, ω_w is the probability of not re–optimizing wages, ι_w is the indexation of wages to past consumer price inflation, γ represents the labour–augmenting

[4] The model used here is identical to the one estimated by Smets and Wouters, except for three departures. First, we assume that the final producers package their goods in accordance with the Dixit and Stiglitz aggregator instead of the Kimball aggregator. Second, in our model, the monetary authority adjusts the nominal interest rate in response to inflation and output growth, while Smets and Wouters use the output gap. Third, we log-linearize the model around a positive level of steady-state inflation. A detailed explanation is found in Appendix A.