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# Fitting observed inflation expectations

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ABSTRACT

The paper provides evidence on the extent to which inflation expectations generated by a standard Christiano et al. (2005)/Smets and Wouters (2003)-type DSGE model are in line with what observed in the data. We consider three variants of this model that differ in terms of the behavior of, and the public's information on, the central banks' inflation target, allegedly a key determinant of inflation expectations. We find that (i) time-variation in the inflation target is needed to capture the evolution of expectations during the post-Volcker period; (ii) the variant where agents have Imperfect Information is strongly rejected by the data; (iii) inflation expectations appear to contain information that is not present in the other series used in estimation, and (iv) none of the models fully capture the dynamics of this variable.



## 1. Introduction

This paper uses inflation expectations as an observable in the estimation of a DSGE model, along with a standard set of macro-variables. We know very little on the extent to which DSGE models can accurately describe the behavior of observed inflation expectations.[1] The goal of the paper is therefore to provide evidence on the extent to which inflation expectations generated by standard DSGE models with nominal and real rigidities along the lines of Christiano et al. (2005) and Smets and Wouters (2003, 2007), which are currently used for policy analysis at several central banks, are in line with what observed in the data. We believe this to be an interesting question given that much of the effects of monetary policy in these models works through expectations.

We consider three variants of this prototypical DSGE model, all widely used in the literature, and we estimate them over the post-Volcker disinflation period (1984–2008). These variants differ in terms of the behavior of, and the agents' information on, the central banks' inflation target, allegedly a key determinant of inflation expectations. In the first variant the inflation target is fixed (as in, among others, Del Negro and Schorfheide, 2009) while in the second it is time-varying, but fully known to the public (as in Smets and Wouters, 2003).[2] We also consider a third variant where agents need to

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[1] Recent literature has used survey measures of inflation expectations in the limited information estimation of New Keynesian Phillips curves (e.g. Roberts, 1997; Adam and Padula, 2011; Nunes, 2010). None of this papers however studies the extent to which New Keynesian models can explain the dynamics of inflation expectations.

[2] Models where the inflation target is time-varying are ubiquitous in the estimated DSGE literature (e.g., Smets and Wouters, 2003; Cogley and Sbordone, 2008; Justiniano et al., 2010), and are also popular in macro-finance (e.g., Kozicki and Tinsley, 2001; Gurkaynak et al., 2005; Rudebusch and Swanson, 2008; Dewachter, 2008).

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infer the time-varying target from the behavior of interest rates, as in Erceg and Levin (2003). Including this model in the analysis is a natural step, both because it is a realistic alternative to the model where agents have full information about the target (over our sample Fed officials never announced an explicit inflation target) and because Erceg and Levin (2003) argue that this type of asymmetric information is a key feature for explaining the behavior of inflation expectations. We will refer to these three variants as the Fixed-$\pi^*$, Perfect and Imperfect Information models, respectively.

We find that a standard set of macro-variables over the post-Volcker disinflation period is unable to discriminate between the Perfect and Imperfect Information models. The data slightly disfavors the Fixed-$\pi^*$ version, but the evidence is not overwhelming. We also find that when we estimate the models on the dataset excluding inflation expectations and then generate a fictitious time series for expectations, for all three models the correlation between actual and model generated expectations is fairly small in levels (the median is around 0.25, with bands that generally include zero) and close to zero in first differences. Our baseline measure of observed inflation expectations consists of the four quarters ahead expectations for the GDP deflator obtained from the Survey of Professional Forecasters, which is the same measure used by Erceg and Levin (2003). We check for the robustness of the results using different sources of expectations and different inflation measures.

Including observed inflation expectations provides strong evidence as to which of the three models fits the data best: the Perfect Information one.[3] We show that the relative failure of the Imperfect Information model to fit observed inflation expectations is due to the fact that this model imposes much more stringent cross-equation restrictions than the Perfect Information model. Evidence based on the DSGE-VAR methodology (Del Negro and Schorfheide, 2004) confirms the above results: whenever inflation expectations are not included the degree of misspecification (as measured by the difference in marginal likelihoods between the DSGE model and the best-fitting DSGE-VAR) is about the same across models. When this variables is included, however, the degree of misspecification for the Imperfect Information model is substantially larger than for the Perfect Information one. The DSGE-VAR evidence also suggests that even the Perfect Information model may not properly capture the dynamics of observed inflation expectations: As we loosen the cross-equation restrictions the DSGE-VARs' ability to fit inflation expectations improves.

We compare the forecasting accuracy of the different models in a pseudo-out-of-sample forecasting exercise. We find that the out-of-sample exercise confirms the results of Bayesian model comparison: for the dataset without expectations the Perfect and Imperfect Information models have roughly the same one period ahead forecast accuracy, while for the dataset with expectations the Perfect Information model outperforms the Imperfect Information one at that horizon. Also consistently with the model comparison findings, we show that forecasts of observed inflation expectations themselves are more accurate for the Perfect than for the Imperfect Information model. In addition, we find that the four quarters ahead inflation forecasts from the Perfect Information model obtained without using observed expectations as an observable are comparable, if not marginally better, than those from the SPF. Nonetheless, adding inflation expectations to the set of observables improves the forecasting accuracy for several (but not all) variables, including inflation, real GDP growth, and interest rates, especially at longer horizons. Interestingly, this is true even for the Imperfect Information model, in spite of its documented inability to capture movements in inflation expectations.

We choose not to include the Great Disinflation period (1981–1985) in our baseline sample because of issues of structural instability: Since the early 1980s the policy rule, and possibly the US economy in general, has likely changed in dimensions other than just the inflation target. Nonetheless, for completeness but also for comparison with Erceg and Levin (2003) who focus on this period, we also discuss the results including the Great Disinflation. We find that the results for the entire sample (1980–2008) are in line with those obtained for the 1984–2008 sample. Results from the Great Disinflation period only provide some weak evidence in support of the Imperfect Information model, in partial agreement with Erceg and Levin (2003).

We draw a number of conclusions from our results. First, Christiano et al. (2005)/Smets and Wouters (2003)-type DSGE models need time-variation in the inflation target in order to capture the evolution of expectations during the post-Volcker period to a much greater extent than they need it to fit other variables, including inflation. Second, the model where agents have Imperfect Information on the value of the target produces a much worse fit of inflation expectations as the model where they are fully informed. This result is somewhat surprising, as this specification was conceived precisely to explain the dynamic of inflation expectations, but can be quite intuitively explained on the ground that it imposes more stringent cross-equation restriction than the variant where agents have Perfect Information. These cross-equation restrictions turn out to be at odds with the data. The finding are very robust across several different specification choices, and samples.

Third, from the perspective of the econometrician inflation expectations appear to contain information that is not present in the other series. Forecasters likely have a richer information set than the econometrician using a standard set of macro-variables, and including measured expectations among the observables is a way to exploit such information set.[4] This information can be exploited for both forecasting – as shown in the pseudo-out-of-sample exercise – and estimating latent variables. Indeed, the result that inflation expectations generated by all the models are quite different from the

[3] Observed expectations are rarely formally used in the existing literature, even when comparing models that differ in the way agents form expectations. For instance, Milani (2007) compares the fit of rational expectations and learning models.

[4] Following the FAVAR methodology (Bernanke et al., 2005) there are some attempts to combine factor and DSGE models with the goal of incorporating as much of the available data as possible (Boivin and Giannoni, 2006; Giannone et al., 2008). We take a different route and incorporate this information by adding agent's expectations to the list of observables.