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Effects of incorrect specification on the finite sample properties of full and limited information estimators in DSGE models☆

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ABSTRACT

In this paper we analyze the small sample properties of full information and limited information estimators in a potentially misspecified DSGE model. Therefore, we conduct a simulation study based on a standard New Keynesian model including price and wage rigidities. We then study the effects of omitted variable problems on the structural parameter estimates of the model. We find that FIML performs superior when the model is correctly specified. In cases where some of the model characteristics are omitted, the performance of FIML is highly unreliable, whereas GMM estimates remain approximately unbiased and significance tests are mostly reliable.

1. Introduction

New Keynesian DSGE models have become the workhorse monetary macroeconomic models in policy analysis and forecasting (e.g. Smets and Wouters, 2007; Schorfheide, 2013). This model class typically involves rational expectations as well as non-linearities in the structural model parameters. The econometric analysis of DSGE models has progressed in recent years and many estimation techniques – classical and Bayesian – have been proposed.

In particular, the availability of computational power strongly simplified the estimation of these models by full information (FI) methods and, thus, Bayesian estimation techniques became increasingly popular. There is now a growing interest in the econometric aspects of these models. One major concern has been potential identification difficulties

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(Canova and Sala, 2009; Kleibergen and Mavroeidis, 2009; Iskrev, 2010; Andrews and Mikusheva, 2015; Dufour et al., 2013; Guerron-Quintana et al., 2013). In this paper, we concentrate on another econometric aspect of New Keynesian DSGE models: the consequences of potential misspecification.

Although FI estimation of DSGE models are currently dominant (see e.g. Ireland, 2004; An and Schorfheide, 2007 for earlier examples), LI techniques remain popular to study selective parts of a DSGE model. Notably, the literature on the New-Keynesian Phillips curve made heavily use of GMM applied to a single equation (e.g. Galí and Gertler, 1999; Eichenbaum and Fisher, 2007; Kleibergen and Mavroeidis, 2009). An important advantage of limited information techniques is that it can be applied to study certain aspects of a model and leaving apart those of little interest. But generally, limited information procedures can also be applied to a complete DSGE model to estimate its structural parameters (see e.g. Beyer et al., 2008, for an application).

In this paper we investigate the relative performance of FI and LI techniques for New Keynesian macro models. To study the potential effects of misspecification, we use a standard (and potentially misspecified) DSGE model with nominal price and wage rigidities (as in Erceg et al., 2000). Several forms of misspecification are taken into account. First, we look at the consequences of estimating a model with price rigidities but omit nominal wage rigidities. Second, we omit price indexation in the Phillips curve. Finally, we investigate the case of misspecified shocks (missing autocorrelation) in the IS curve. In a simulation study we document the properties of the different estimation techniques for point estimates and standard significance tests.

In comparing full with limited information techniques we employ FIML on the likelihood of the state-space solution of the log-linearized model as our FI method. FI methods provide the complete range of statistical properties associated with the model under investigation. Normally, this is preferable in terms of efficiency, given a correctly specified model (see e.g. Cragg, 1967, for an early contribution). LI methods do not require a fully specified model, instead it is enough to set up certain moment conditions to estimate the parameters of interest. Thus, there is the classical trade-off between efficiency and the sensitivity to model misspecification known from simultaneous equation models (see Theil, 1971, Ch. 10 for a summary). For the LI methods we consider different variants of GMM estimators. We take into account system based as well as single equation techniques. It turned out that the continuous-updating GMM (CUGMM) as advocated by Hansen et al. (1996), produces much more promising results than the standard two-step GMM estimator (which is normally employed in this context).

This paper is closely related to the work of Ruge-Murcia (2007), who compares the properties of different estimators in a stylized RBC model. Instead, we look at a New Keynesian DSGE model which forms the basis of todays macroeconometric models. Moreover, we focus on different variants of GMM (which are related to the single equation techniques). Lindé (2005) as well as Jondeau and Le Bihan (2008) also take into account model misspecification. While Jondeau and Le Bihan (2008) look at misspecification within one equation of interest, we look at the consequences of misspecification in the whole system. Lindé (2005) only takes into account quite moderate degrees of misspecification (mainly the misspecification of shocks and lagged persistence). Both, Lindé (2005) and Jondeau and Le Bihan (2008) compare ML with GMM, but use the standard two-step GMM estimator in a single equation set-up. We apply GMM to a multi-equation framework, to estimate all relevant relationships jointly and consider the CUGMM estimator as an alternative.

Our results suggest that LI techniques can be seen as a useful complement to FI methods in analyzing DSGE models (as also suggested by Fukac and Pagan, 2010). If one is interested in the estimate of structural parameters, FI procedures should be used with caution. As expected, FIML is dominant when it comes to estimating the model under the null hypothesis (without misspecification). Parameter estimates are unbiased and quite precise. Moreover, confidence intervals are very reliable in this case, i.e. they provide at least the pre-specified coverage (even in smaller samples). GMM estimates (based on CUGMM) turn out to be less efficient in that case, but remain unbiased. Estimated standard errors are also reliable in most cases and under the proposed model.

In the case of model misspecification the performance of FIML worsens substantially. When nominal wage rigidities are ignored, all parameters are heavily biased and confidence intervals are totally unreliable. More milder forms of misspecifications result in slightly better estimates, but even in the case of misspecified shocks, FIML estimates turn out to be biased and some parameter estimates are far from their true value.

GMM estimates based on CUGMM remain roughly unbiased in all considered cases, although estimated standard errors get slightly less reliable. In general, our results suggest that if one has not very strong beliefs in the usefulness of all aspects of the model, one should stick to limited information methods. In particular, CUGMM applied to multi-equations does a good job in finite samples and is much less sensitive to model misspecification than FIML based on the Kalman filter. Therefore, the classical trade-off between efficiency and potential biases due to misspecification of the different estimation strategies remain valid for standard DSGE models.

The remainder of the paper is organized as follows. The subsequent section presents the model structure. Section 3 discusses the different estimation strategies. Section 4 outlines the simulation setup. Section 5 shows our results; followed by a short discussion in Section 6. Section 7 concludes.

2. The model economy

Our starting point is a stylized New Keynesian Dynamic Stochastic General Equilibrium (DSGE) model, the workhorse structural macroeconomic model for short-term analysis. Those models are well established in the academic literature (see