Economic Studies 163

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ECONOMICS AT UPPSALA UNIVERSITY

The Department of Economics at Uppsala University has a long history. The first chair in Economics in the Nordic countries was instituted at Uppsala University in 1741.

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Abstract

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Essay 1: Estimation of DSGE Models with Uninformative Priors

DSGE models are typically estimated using Bayesian methods, but because prior information may be lacking, a number of papers have developed methods for estimation with less informative priors (diffuse priors). This paper takes this development one step further and suggests a method that allows full information maximum likelihood (FIML) estimation of a medium-sized DSGE model. FIML estimation is equivalent to placing uninformative priors on all parameters. Inference is performed using stochastic simulation techniques. The results reveal that all parameters are identifiable and several parameter estimates differ from previous estimates that were based on more informative priors. These differences are analyzed.

Essay 2: A DSGE Model with Labor Hoarding Applied to the US Labor Market

In the US, some relatively stable patterns can be observed with respect to employment, production and productivity. An increase in production is followed by an increase in employment with lags of one or two quarters. Productivity leads both production and employment, especially employment. I show that it is possible to replicate this empirical pattern in a model with only one demand-side shock and labor hoarding. I assume that firms have organizational capital that depreciates if workers are utilized to a high degree in current production. When demand increases, firms can increase utilization, but over time, they have to hire more workers and reduce utilization to restore organizational capital. The risk shock turns out to be very dominant and explains virtually all of the dynamics.

Essay 3: Demand Shocks and Labor Hoarding: Matching Micro Data

In Swedish firm-level data, output is more volatile than employment, and in response to demand shocks, employment follows output with a one- to two-year lag. To explain these observations, we use a model with labor hoarding in which firms can change production by changing the utilization rate of their employees. Matching the impulse response functions, we find that labor hoarding in combination with increasing returns to scale in production and a very high price stickiness can explain the empirical pattern very well. Increasing returns to scale implies a larger percentage change in output than in employment. Price stickiness amplifies volatility in output because the price has a dampening effect on demand changes. Both of these explain the delayed reaction in employment in response to output changes.

Keywords: DSGE Models, Macroeconomics, Estimation, Uninformative Priors, Maximum Likelihood, Labor Hoarding, US Labor Market, Swedish Micro Data

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And because I love music, both to play and listen to, I am going to conclude the acknowledgments with a song. A song that pretty well represents the next chapter of my life and whose philosophy I've come to embrace. The Nickelback song "What Are You Waiting For?".

Uppsala, August 2016
Glenn Mickelsson

Contents

Introduction

This thesis consists of three essays. Essay 1 introduces a new method for estimating DSGE models using uninformative priors. This method is general and is used in Essay 2 and 3 as well. Essay 2 and 3 use labor hoarding mechanisms to explain the dynamics of output and employment, where Essay 2 uses US aggregate data and Essay 3 uses Swedish firm level data.

Estimation of DSGE Models

Since the critique in Lucas Jr (1976) it became clear that we need more theory in our models to get better understanding and to draw correct policy conclusions. Kydland and Prescott (1982) modified a standard equilibrium growth model in order to explain cyclical variances and covariances for US time series. Due to limitations in computer power and available methods, the models that followed did not increase much in size. This pattern continued up until the end of the 1990s where Christiano et al. (2001) estimated a dynamic model with nominal frictions and with a significant increase in the number of mechanisms and parameters. Even at this point, many parameters were calibrated and they ended up estimating only seven deep parameters. Furthermore, the model was subjected to only one stochastic shock, a monetary policy shock.

A few years later, Smets and Wouters (2003) introduced Bayesian estimation into the dynamic macro literature, estimating as many as 36 parameters and seven stochastic shocks. Bayesian estimation means putting prior distributions on the parameters. These prior distributions are then combined with the data using Bayes probability rule which results in a posterior distribution for each parameter. Prior information exists and should be used but Smets and Wouters did not have solid prior information for all of their 36 parameters. This puts the researcher in a tricky position of either postulating prior distributions on parameters, even where little or no prior information is available, or maybe not being able to estimate the model at all.

As a response to the dependence on prior distributions the "diffuse priors" literature started with Creal (2007), Chib and Ramamurthy (2010), Herbst and Schorfheide (2014) and Lanne and Luoto (2015) and others. The broad definition of diffuse priors is to postulate prior distributions with less curvature. As an example, a normal distribution with a mean of 2 and a standard deviation of 0.1 could be considered as diffuse if one increases the standard deviation five times to 0.5. This makes the distribution flatter (more diffuse). The concept of diffuse is a bit arbitrarily however and it is important to remember that even diffuse priors will add curvature to the posterior distribution.

Essay 1 takes this development one step further by introducing a method that allows for estimation of a medium sized (36 parameters) DSGE model using full information maximum likelihood (FIML). FIML is equivalent to putting uniform (uninformative) priors on the parameters which adds no curvature a priori. The method is general and is used for Essay 2 and Essay 3 as well.

Essay 1: Estimation of DSGE Models with Uninformative Priors

Since Smets and Wouters (2003) many papers use Bayesian methods when estimating dynamic stochastic general equilibrium (DSGE) models, 70% of all studies between 2005-2010 according to Herbst (2011). Typically a search algorithm such as csminwel from Sims (1999) finds the posterior mode and then the random-walk Metropolis Hastings (RWMH) algorithm is used to find the distribution.

However, many search algorithms work poorly when the likelihood function has flat areas and suffers from multimodiality which quite often is the case for medium sized DSGE models. Poor identification causes problems for the RWMH algorithm as well.

These problems may force the researcher to add tighter priors than desired in order to be able to estimate the model which started the diffuse prior literature by Creal (2007), Chib and Ramamurthy (2010), Herbst and Schorfheide (2014) and Lanne and Luoto (2015) and others. Diffuse priors means prior distributions with significantly less information (less curvature). These authors developed methods that made it possible to sample a posterior distribution even though diffuse priors were implemented. But even though the prior is diffuse it contributes with information which might have undesirable effects on the posterior.

Essay 1 tackles this problem by introducing an algorithm that allows for a full information maximum likelihood (FIML) estimation of the model in Smets and Wouters (2007) which is equivalent to Bayesian estimation with uninformative (uniform) priors for all parameters. The algorithm outperforms other commonly used algorithms in a comparison. The algorithm comparison is made for both tricky mathematical functions and for estimation on artificial data.

Differences arise between FIML and Bayesian estimates. For instance, I find more wage stickiness than SW. Many of the shock persistences are close to unity, suggesting the presence of unit roots, indicating that the trend in the model is misspecified. Herbst and Schorfheide (2014) find evidence of this as well.

Labor Hoarding

In both US and Swedish data, output varies much more than employment and capital. During the 1980s, many believed that this pattern was caused by exogenous technology shocks to the production function (Prescott (1986)). If this view was correct, the Solow residual should have the same properties as the technology shock. Hall (1988) challenged this view and pointed out that the Solow residual is significantly correlated with military spending, indicating that firms can alter their production levels endogenously without having to fire/hire people. Burnside et al. (1993) extended the indivisible labor

model in Hansen (1985) and Rogerson (1988) and introduced utilization of labor. They called this feature "labor hoarding" since a decrease in utilization, instead of layoffs, could be seen as labor hoarding. They assume that employment is decided one period before production and the firm changes current production by changing the utilization of its employees.

Essay 2: A DSGE Model with Labor Hoarding Applied to the US Labor Market

In Essay 2, I consider a DSGE model with unemployment as in Gali et al. (2011) extended with utilization of labor. Different from Burnside et al. (1993) the cost of utilization does not take the form of disutility when the workers are being utilized. Instead I assume that "organizational captial" of the firm depreciates in proportion to the rate of utilization. This has two advantages. First, a utilization cost scheme that is based on the disutility requires that the shadow price of consumption is observed by the firm each period which is a strong assumption. Second, organizational capital allows for a more delayed effect of utilization on production which makes it easier to match the observed lead and lag patterns in employment and productivity.

The focus of this study is on the labor market and I therefore estimate the parameters by matching correlations and variances, primarily those in the labor market. These moments are matched using simulated method of moments (SMM).

The model can explain labor market dynamics very well. Most of the dynamics is explained by the risk shock which increases the interest rate margin that the banks charge. Thus, it is possible to explain the dynamics of production and employment in a model with a demand side risk shock, sluggish adjustment of labor input and variations in the utilization of labor.

Essay 3: Demand Shocks and Labor Hoarding: Matching Micro Data

Essay 3 uses the model of the firm from Essay 2 and estimates it using Swedish micro data. The econometric methodology is similar to Christiano et al. (2005) where a weighted sum of the squared differences between the impulse responses in the theoretical and empirical model is minimized.

To describe the dynamics in the data, a VAR system of linear equations for employment, capital, output and a demand shifter are estimated. We then estimate the deep parameters of the theoretical model by matching the impulse responses that result from these linear equations.

The model matches the empirical impulse response functions very well and labor hoarding is important to describe the dynamics of output and employment. Other key results are that the adjustment cost in hiring is more important than the delay between the hiring date and when the employees enter into production. Increasing returns to scale also helps to explain a high volatility in output compared to factor inputs. Price stickiness is also important since flexible prices would dampen the variation in output.

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