Journal of Macroeconomics 36 (2013) 51–62

Contents lists available at SciVerse ScienceDirect

Journal of Macroeconomics

journal homepage: www.elsevier.com/locate/jmacro

Reaction to technology shocks in Markov-switching structural VARs: Identification via heteroskedasticity

Aleksei Netsunajev *

Department of Economics, European University Institute, Via della Piazzuola 43, I-50133 Firenze, Italy

ARTICLE INFO

Article history:
Received 17 July 2012
Accepted 18 December 2012
Available online 11 January 2013

Keywords:
Technology shocks
Markov switching model
Heteroskedasticity

ABSTRACT

The paper reconsiders the conflicting results in the debate connected to the effects of technology shocks on hours worked. Given the major dissatisfaction with the just-identifying long-run restrictions, I analyze whether the restrictions used in the literature are consistent with the data. Modeling volatility of shocks using Markov switching structure allows to obtain additional identifying information and perform tests of the restrictions that were just-identifying in classical structural vector autoregressive analysis. Using six ways of identifying technology shocks, I find that not all of them are supported by the data. There is no clear-cut evidence in favor of a positive reaction of hours to technology shocks.

1. Introduction

A standard real business cycle model implies that hours worked per capita rise after a permanent shock to technology. This prediction is at the center of the literature that assesses whether it is consistent with the data. The general conclusion reached is that it is not. Not surprisingly, the result has attracted a lot of attention as technology shocks are a significant source of fluctuations in productivity and employment.

In the literature, one can find a variety of methods used to study reaction of hours worked to technology shocks, but the most common is based on structural vector autoregressive (SVAR) models. In a seminal paper, Gali (1999) identifies the technology shocks or, to put it differently, permanent productivity shocks, using long-run restrictions and he finds that hours worked fall after a positive technology shock. Several papers consider similar systems as in Gali (1999) and try to assess the validity of the identifying restrictions. A similar identification is used in Gali et al. (2003), Christiano et al. (2003), Francis and Ramey (2005), and Francis and Ramey (2009). The study by Francis and Ramey (2005) questions whether the shocks that are identified as in Gali (1999) can be classified as technology shocks. Using different identifying assumptions, they find that all but one specification produced the result similar to Gali (1999). In other words, Francis and Ramey (2005) show that permanent real wage and permanent productivity shocks, after controlling for capital tax rate, produce a negative reaction of hours worked.

Christiano et al. (2003) find that treating per capita hours worked as a difference stationary process yields the result that hours worked fall after the technology shock; if, on the contrary, hours worked are assumed to be a stationary process, the result is the opposite: hours worked rise after the technology shock. Fernald (2007) and Francis and Ramey (2009) argue that there are low frequency movements in hours per capita that may distort the results of the SVAR in Christiano et al. (2003). After either detrending the data (Fernald, 2007) or applying a filter to the data (Francis and Ramey, 2009), the response of hours worked to a neutral technology shock becomes negative.

* Tel.: +372 56905460.
E-mail address: aleksei.netsunajev@eui.eu

0164-0704/$ - see front matter
http://dx.doi.org/10.1016/j.jmacro.2012.12.005

Fisher (2002) proposes to disentangle investment-specific and neutral technology shocks. Similarly, Canova et al. (2010) consider the effects of neutral and investment-specific technology shocks on hours. Both studies show that hours worked fall in response to neutral shocks and increase in response to investment-specific shocks. Chang and Hong (2006) propose to identify the permanent total factor productivity (TFP) shocks in a way that is similar to Gali (1999). They show that the reaction of hours worked to a permanent TFP shock is positive.

It should be noted that the studies listed above may share some common shortcomings. Firstly, the underlying assumptions just-identify the macroeconomic shocks and leave no place for the data to speak out against restrictions. The problem of just-identified shocks is discussed, among others, by Lanne and Lütkepohl (2008), Lanne et al. (2010), and Herwartz and Lütkepohl (2011). Secondly, studies of technology shocks (for example, Gali (1999), Francis and Ramey (2005), Christiano et al. (2003), Canova et al. (2010), Chang and Hong (2006)) ignore relevant features of the data, namely heteroskedasticity. The presence of time-varying volatility is extensively discussed and documented by Kim and Nelson (1999), McConnell and Perez-Quiros (2000), Blanchard and Simon (2001), Stock and Watson (2003), so it should be taken into account.

It is useful to consider heteroskedasticity as it allows additional identifying information to be extracted from the data (Rigobon, 2003). In the present context this is important given the mixed evidence on the reaction of hours on technology shocks. Modeling heteroskedasticity can be used as a way of validating the restrictions that are just-identifying in a conventional SVAR analysis and for checking how different identification methods comply with the properties of the data.

Thus, the aim of the current paper is to reconsider the reaction of hours worked to technology shocks and to relax some of the assumptions common in this literature. For this purpose, I estimate a series of Markov-switching (MS) models that allow the changes in volatility and intercept to be captured, provide a framework to test for the validity of the identifying restrictions, and assess the labeling of identified shocks as technology shocks. The model used in the paper is a modified version of the model used by Lanne et al. (2010) and Herwartz and Lütkepohl (2011).

The rest of the paper is organized as follows. First, I provide additional motivations for the paper, while different identification schemes of technology shocks and the data are discussed in Section 2. In Section 3 the structural MS-VAR model deployed in the current analysis is described. Section 4 provides the empirical analysis. The last section concludes the analysis.

2. Identification of shocks

Consider a standard K-dimensional reduced form VAR with p lags:

$$Y_t = \nu + A_1 Y_{t-1} + \cdots + A_p Y_{t-p} + U_t, \tag{1}$$

where ν is a constant intercept term, the A_js $(j = 1, \ldots, p)$ are $(K \times K)$ coefficient matrices and U_t is a zero-mean error term.

In a conventional SVAR model, the structural shocks are usually obtained from the reduced form residuals by a linear transformation, $\varepsilon_t = B^{-1}U_t$ or $B\varepsilon_t = U_t$, where B is such that ε_t has identity covariance matrix, that is, $\varepsilon_t \sim (0, I_K)$, and the reduced form residual covariance matrix is decomposed as $E(U_t U_t\prime) = \Sigma_U = BB'$. To obtain unique structural shocks, one needs to place $K(K-1)/2$ restrictions. For this reason the B matrix is often assumed to be lower triangular. Thus the B is the matrix of instantaneous effects of the unique structural shocks.

In the related technology shock literature, a bivariate system is usually considered in the spirit of Gali (1999). Using long-run restrictions, one identifies two kinds of shocks: technology shocks and non-technology shocks. The shocks are identified in the following system, which is a moving average representation of a VAR:

$$\begin{bmatrix} \Delta x_t \\ \Delta n_t \end{bmatrix} = \begin{bmatrix} C_{11}(L) & C_{12}(L) \\ C_{21}(L) & C_{22}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_t^z \\ \varepsilon_t^m \end{bmatrix}, \tag{2}$$

where x_t denotes the log of labor productivity, n_t denotes the log of labor input, ε_t^z is the technology shock and ε_t^m is the non-technology shock, $C_{ij}(L)$ is a polynomial in the lag operator and Δ is the difference operator.

In the present paper I follow the strategy proposed by Blanchard and Quah (1989) and place the restrictions on the total impact matrix $\Xi_\infty = (I_K - A_1 - \cdots - A_p)^{-1}B$, which is identical to restricting the system in (2). It should be noted that the restrictions on Ξ_∞ can be transformed to the restrictions on B as shown in Lütkepohl (2005).

The most common identifying assumption restricts $C_{12}(1) = 0$, implying that only technology shocks have long-run effects on labor productivity (Gali, 1999). The non-technology shocks could thus be interpreted as demand shocks (Gali, 1999).

Another way of identifying technology shocks in the bivariate system is proposed by Francis and Ramey (2005). They argue that technology shocks should not have a long-run effect on hours or, in other words, they exclude permanent technology shocks. This restriction is implemented by constraining $C_{21}(1) = 0$ above. Francis and Ramey (2005) argue that the resulting residuals in the productivity equation may contain other shocks in addition to the productivity shock. For instance, these could be monetary shocks that have no long-run effect on hours. Therefore, this identification is different from the original one in Gali (1999) and may be problematic.

Francis and Ramey (2005) consider an alternative long-run restriction involving real wages using a theoretical result, i.e. that only a technology shock should have a permanent effect on real wages. Thus, an alternative way to identify the technology shock is to substitute real wages for productivity and to impose $C_{12}(1) = 0$.