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Measuring nonfundamentalness for structural VARs

Stefano Soccorsi

ECARES, Université Libre de Bruxelles, Belgium

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ABSTRACT

As nonfundamental vector moving averages do not have causal VAR representations, standard structural VAR methods are deemed inappropriate for recovering the economic shocks of general equilibrium models with nonfundamental reduced forms. In the previous literature it has been pointed out that, despite nonfundamentalness, structural VARs may still be good approximating models. I characterize nonfundamentalness as bias depending on the zeros of moving average filters. However, measuring the nonfundamental bias is not trivial because of the simultaneous occurrence of lag truncation bias. I propose a method to disentangle the bias based on population spectral density and derive a measure for the nonfundamental bias in population. In the application, I find that the SVAR exercises of Sims (2012) are accurate because the nonfundamental bias is mild.

1. Introduction

Vector autoregressive (VAR) models are the dominant approach to date for the empirical validation of dynamic stochastic general equilibrium (DSGE) models. It is well known that when the structural model is nonfundamental, estimated VARs do not recover the economic shocks. Nonetheless, as shown by Sims (2012) and Beaudry et al. (2015) structural VAR (SVAR) methods may still perform well in some applications. In this paper, I show that this is the case when the VAR is affected by a mild *nonfundamental bias*. I provide a population measure of nonfundamentalness by disentangling the nonfundamental bias from the lag truncation bias.

Since their appearance, DSGE models have been extensively validated with SVAR methods. In the last decade of research, the econometric challenges of this approach have received much attention (see e.g. Giacomini, 2013). In this spirit, both the existence of an infinite order VAR representation – see Fernandez-Villaverde et al. (2007) and Franchi and Paruolo (2014) – and its approximation with a finite order VAR – see Chari et al. (2008), Christiano et al. (2007), Erceg et al. (2005) and Poskitt and Yao (2012) – have been addressed. Nevertheless, those have remained two separate literatures and to the best of my knowledge, no study has ever measured the nonfundamentalness in population.

However, given that the nonexistence of an infinite order autoregressive representation (nonfundamentalness) implies the nonexistence of a finite order approximation, nonfundamental models are generally affected by truncation bias.

E-mail address: stefano.soccorsi@ulb.ac.be

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Therefore, measuring nonfundamentalness requires disentangling between nonfundamentalness and lag truncation and it is misleading to evaluate the former without taking the latter into account.

If the set of observables used to estimate a VAR encloses all the relevant information necessary to retrieve the state of the economy, then the fundamentalness is granted, and the econometrician employing structural VAR methods is capable to estimate accurate impulse response functions to economic shocks. On the other hand, if the information available to the econometrician is insufficient, responses are contaminated by the error committed in the estimation of the state of the economy. Forni and Gambetti (2014) test for sufficient information in SVAR by comparing with a dynamic factor model whose estimated factors virtually include all information available acting as a proxy for the state of the economy.[1]

Nonetheless, the information used to estimate a VAR, albeit inferior, may be sufficiently close to that of the agents. Sims (2012), Beaudry and Portier (2013) and Beaudry et al. (2015) show that there are applications in which invertibility failures are mild and VARs remain a useful tool. Beaudry et al. (2015) derive a R^2 diagnosis based on the fact that under fundamentalness the innovations to the econometrician information set do not correlate with the past of the factors (and of the innovations to agents' information set). Yet neither does their approach provide a measure of nonfundamentalness in population.

In order to address this problem, I build on the fact that nonfundamentalness is a source of bias depending on the distance between the nonfundamental representation of the data providing the structural shocks and its unique fundamental representation. Population quantities are derived from the time series properties of the observables. Fernandez-Villaverde et al. (2007) provide a condition for nonfundamentalness. I contribute to this literature with a measure of the nonfundamental bias based on the frequency domain. Forni et al. (2016b) focus on single shocks rather than the nonfundamentalness of the whole VAR system as I do in this paper.

I first show that the error is a combination of the nonfundamental and lag truncation bias. The measure proposed here is then applied to the news shock model of Sims (2012). I find that the econometrician estimating the VAR of Sims (2012) is faced with little nonfundamental bias. This explains why in this application SVAR methods are found to perform well. I also find that when the DSGE is reduced to a real business cycle (RBC) model with news shocks the lag truncation bias is at least as large as the nonfundamental bias.

While avoiding stochastic singularity in the VAR representation of a DSGE model makes impossible to increase information by adding observables so mitigating nonfundamentalness, the lag truncation bias may in principle be ameliorated by estimating high-order VARs.[2] I find that this advice does not apply to the nonfundamental case.

The structure of the paper is as follows. Given a state-space representation of the DSGE model, the literature reviewed in Section 2 provides simple conditions in order to check for nonfundamentalness and the existence of a finite order VAR representation for the observables. In Section 3, I illustrate the nonfundamental bias and discuss how it relates to the truncation bias. Section 4 provides a measure of nonfundamentalness obtained by decomposing the bias of estimated VARs with a method based on the spectral density matrix of the data. Section 5 is a brief discussion of the economics of anticipated shocks and their link with nonfundamentalness in the general equilibrium literature. In Section 6, I apply the method proposed here to measure the nonfundamentalness in a news shocks model along the lines of Sims (2012). Last section concludes with practical suggestions and discusses future work.

2. Background: invertibility, nonfundamentalness and lag truncation

Typically the approximation to the solution of a DSGE model is cast into the state space form:

$$X_t = A(\theta)X_{t-1} + B(\theta)\varepsilon_t \tag{2.1}$$

$$Y_t = C(\theta)X_{t-1} + D(\theta)\varepsilon_t \tag{2.2}$$

where θ is a vector of deep parameters, Y_t is a $n_y \times 1$ vector of observed variables, X_t is a $n_x \times 1$ vector of endogenous and exogenous state variables, and $\varepsilon_t \sim iid\, N(0, \Sigma)$ a vector of n_ε structural shocks, (2.2) is the measurement equation and (2.1) the state equation.

DSGE models typically have unobserved latent states and the information enclosed in Y_t is limited because avoiding singularity requires the square case – i.e. $n_y = n_\varepsilon$. Assuming that D is nonsingular, from Eq. (2.2) we get $\varepsilon_t = D^{-1}(Y_t - CX_{t-1})$. Plugging this expression for the structural shocks into the state Eq. (2.1) and rearranging, the mapping between the states and the observables is

$$(I_{n_x} - FL)X_t = BD^{-1}Y_t \tag{2.3}$$

where $F := A - BD^{-1}C$.

[1] There is still an information loss due stationary transformations required for the estimation of the factor model (see Barigozzi et al., 2016).

[2] On a fundamental model De Graeve and Westermark (2013) show that extending the order of the estimated VAR above and beyond that suggested by information criteria helps in reducing the truncation bias. Using nonparametric approaches Christiano et al. (2007) and Mertens (2012) find mixed results.