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Bridging DSGE models and the raw data

Fabio Canova [a,b,*]

[a] *Department of Economics, EUI, Via della Piazzuola 43, 50133 Firenze, Italy*
[b] *CEPR, United Kingdom*

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ABSTRACT

A method to estimate DSGE models using the raw data is proposed. The approach links the observables to the model counterparts via a flexible specification which does not require the model-based component to be located solely at business cycle frequencies, allows the non-model-based component to take various time series patterns, and permits certain types of model misspecification. Applying standard data transformations induces biases in structural estimates and distortions in the policy conclusions. The proposed approach recovers important model-based features in selected experimental designs. Two widely discussed issues are used to illustrate its practical use.

1. Introduction

There have been considerable developments in the specification of DSGE models in the last few years. Steps forward have also been made in the estimation of these models. Despite recent efforts, structural estimation of DSGE models is conceptually and practically difficult. For example, classical estimation is asymptotically justified only when the model is the generating process (DGP) of the actual data, up to a set of serially uncorrelated measurement errors, and standard validation exercises are meaningless without such an assumption. Identification problems (see e.g. Canova and Sala, 2009) and numerical difficulties are widespread. Finally, while the majority of the models investigators use are intended to explain only the cyclical portion of observable fluctuations, both permanent and transitory shocks may produce cyclical fluctuations, and macroeconomic data contain many types of fluctuations, some of which are hardly cyclical.

The generic mismatch between what models want to explain and what the data contain creates headaches for applied investigators. A number of approaches, reflecting different identification assumptions, have been used.

In the first approach a researcher fits a model driven by transitory shocks to the observables filtered with an arbitrary statistical device (see Smets and Wouters, 2003; Ireland, 2004a; Rubio and Rabanal, 2005, among others). Such an approach is problematic for at least three reasons. First, since the majority of statistical filters can be represented as a symmetric, two-sided moving average of the raw data, the timing of the information is altered and dynamic responses are hard to interpret. Second, while it is typical to filter each real variable separately and to demean nominal variables, there are consistency conditions that must hold – a resource constraint need not be satisfied if each variable is separately filtered – and situations when not all nominal fluctuations are relevant. Thus, specification errors can be important. Finally, contamination errors could be present. For example, a Band Pass (BP) filter only roughly captures the power of the spectrum at the frequencies corresponding to cycles with 8–32 quarters average periodicity in small samples and taking growth rates greatly amplifies

* Correspondence address: Department of Economics, EUI, Via della Piazzuola 43, 50133 Firenze, Italy. Tel.: +39 055 4685952.
E-mail address: fabio.canova@eui.eu

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the high frequency content of the data. Thus, rather than solving the problem, such an approach adds to the difficulties faced by applied researchers.

In the second approach a researcher fits a model driven by transitory shocks to transformations of the observables which, in theory, are void of non-cyclical fluctuations, e.g. consider real “great ratios” (as in Cogley, 2001; McGrattan, 2010) or nominal “great ratios” (as in Whelan, 2005). As Fig. 1 shows, such transformations may not solve the problem because many ratios still display low frequency movements. In addition, since the number and the nature of the shocks driving non-cyclical fluctuations need to be a priori known, specification errors may be produced.

In the third approach a researcher constructs a model driven by transitory and permanent shocks; scales the model by the assumed permanent shocks; fits the transformed model to the observables transformed in the same way (see e.g. Del Negro et al., 2006; Fernandez Villaverde and Rubio Ramirez, 2008; Justiniano et al., 2010, among others). Such an approach puts stronger faith in the model than previous ones, explicitly imposes a consistency condition between the theory and the observables, but it is not free of problems. For example, since the choice of which shock is permanent is often driven by computational rather than economic considerations, specification errors could be present. In addition, structural parameter estimates may depend on nuisance features, such as the shock which is assumed to be permanent and its time series characteristics. As Cogley (2001) and Gorodnichenko and Ng (2010) have shown, misspecification of these nuisance features may lead to biased estimates of the structural parameters.

In the last approach a researcher constructs a model driven by transitory and/or permanent shocks; estimates the structural parameters by fitting the transformed model to the transformed data over a particular frequency band (see e.g. Diebold et al., 1998; Christiano and Vigfusson, 2003). This approach is also problematic since it inherits the misspecification problems of the previous approach and the filtering problems of the first approach.

The paper shows first that the approach one takes to match the model to the data matters for structural parameter estimation and for economic inference. Thus, unless one has a strong view about what the model is supposed to capture and with what type of shocks, it is difficult to credibly select among various structural estimates (see Canova, 1998). In general, all preliminary data transformations should be avoided if the observed data is assumed to be generated by rational agents maximizing under constraints in a stochastic environment. Statistical filtering does not take into account that cross equation restrictions can rarely be separated by frequency, that the data generated by a DSGE model has power at all frequencies and that, if permanent and transitory shocks are present, both the permanent and the transitory component of the data will appear at business cycle frequencies. Model based transformations impose tight restrictions on the long run properties of the data. Thus, any deviations from the imposed structure must be captured by the shocks driving the transformed model, potentially inducing parameter distortions.

As an alternative, one could estimate the structural parameters by creating a flexible non-structural link between the DSGE model and the raw data that allows model-based and non-model-based components to have power at all frequencies. Since the non-model-based component is intended to capture aspects of the data in which the investigator is not interested but which may affect inference, specification errors could be reduced. In addition, because the information present at all frequencies is used in the estimation, filtering distortions are eliminated and inefficiencies minimized. The methodology can be applied to models featuring transitory or transitory and permanent shocks and only requires that interesting features of the data are left out from the model – these could be low frequency movements of individual series, different long run

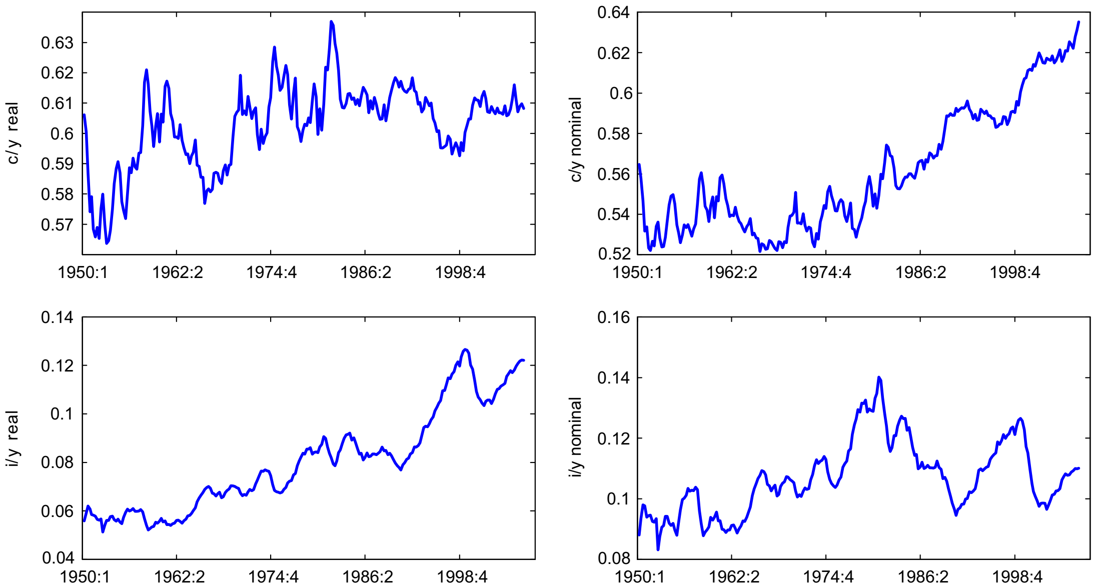

Fig. 1. US real and nominal great ratios.