

ESSAYS IN HONOUR OF  
FABIO CANOVA

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ADVANCES IN ECONOMETRICS VOLUME 44A

# ESSAYS IN HONOUR OF FABIO CANOVA

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# INTRODUCTION

Juan J. Dolado<sup>a</sup>, Luca Gambetti<sup>b</sup> and  
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The collection of chapters in Volume 44 (A and B) of *Advances in Econometrics* pays tribute to Fabio Canova for his major contributions to Economics over the last four decades. Throughout his long and distinguished career, Fabio's research has achieved both a prolific publication record and stellar service to the profession. His colleagues, co-authors and PhD students wish to express their deep gratitude to Fabio for his intellectual leadership and guidance.

Fabio received a Laurea in Economics at the University of Modena, his hometown. As a Renaissance man, he then thought of becoming either an Orchestra Conductor or a Movie Director (his two passions, with diplomas in both arts) but a grant to complete a PhD at the University of Minnesota (under the supervision of Chris Sims) changed his career plans for the benefit of Economics (and all of us). Since graduation, he has held academic positions, *inter alia*, at Brown, UPF, EUI and (currently) BI Norwegian Business School, having supervised 27 doctoral dissertations so far. In addition, he has been a Regular Consultant and Instructor at many central banks and international policy institutions, a Founder of the International Association of Applied Econometrics (IAAE) and a Member of the Editorial Boards of many prestigious journals.

Fabio has made very relevant contributions in the areas of quantitative macroeconomics, monetary economics and time-series econometrics, with about 17,000 citations in Google Scholar. Hereafter we highlight a few. First, he has questioned the standard practice of assessing the performance of DSGE macromodels by their ability to match features of detrended data. In his classic [Canova \(1998a, 1998b\)](#) papers, Fabio highlighted the fragility of conclusions based on one detrending methodology alone. While this seems like a benign point today, it is

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useful to remember that generations of graduate students were brought up on the recipe of HP filtering the data without ever questioning that approach. Second, he has been one of the pioneers in pushing the estimation of dynamic equilibrium models by classical and Bayesian techniques. In parallel, he has laid bare many issues with standard practices in the estimation of these models. A prime example is the well-known [Canova and Sala \(2009\)](#) paper, where they clearly highlight that standard linearized equilibrium models around steady state suffer from substantial identification issues. Third, he has been one of the pioneers in the use of sign restrictions to identify structural shocks structural vector autoregressive (SVARs), having developed useful numerical tools to identify robust restrictions in this type of models (see e.g. [Canova & De Nicoló, 2002](#)). Fourth, his theoretical and empirical research on Time-varying Coefficients VAR models (see e.g. [Canova & Gambetti, 2010](#)) has been highly influential to assess the role of monetary policy in economies subject to structural changes. Overall, Fabio's research in the area of macroeconometrics is pathbreaking, having led to his highly deserved international reputation. For example, his textbook *Methods for Applied Macroeconomic Research*, Princeton University Press, has become compulsory reading for generations of students and scholars willing to do research on these topics.

Consistent with his contributions, this volume includes chapters on a variety of topics related to Fabio's research which we have grouped in four blocks. The first two blocks appear in Volume 44-A while the remaining blocks do so in Volume 44-B.

#### (I) Forecasting

In 'Real-time Real Economic Activity: Entering and Exiting the Pandemic Recession of 2020', Francis X. Diebold studies the high-frequency real-activity signals provided by a leading nowcast, the ADS Index of Business Conditions, during the pandemic. This nowcast performs well in forecasting recoveries both after Covid-19 and the corresponding signals during the Great Recession.

In 'State Correlation and Forecasting: A Bayesian Approach Using Unobserved Components Models', Luis Uzeda investigates the impact of different state correlation assumptions for out-of-sample performance of unobserved components models with stochastic volatility. An efficient estimation procedure of the parameters in these models and novel precision-based samplers are provided. When examining the behaviour of the trend and cyclical components of US inflation, it is found that assuming orthogonal components closely tracks survey-based measures of long-run inflation expectations, whereas correlated components behave similarly to survey-based nowcasts.

In 'On Identification Issues in Business Cycle Accounting Models', Pedro Brinca, Nikolay Iskrev and Francesca Loria investigate the effects of departures from both strong and weak identification assumptions on the estimation of a monetary variant of [Chari, Kehoe, and McGrattan's \(2007\)](#) Business Cycle Accounting models, where wedges resulting from departures from equilibrium outcomes are considered. Their basic finding is that neither of these identification issues are relevant for this kind of models

## (II) Shocks identification

In ‘The Effect of News Shocks and Monetary Policy’, Luca Gambetti, Christoph Görtz, Dimitris Korobilis, John D. Tsoukalas and Francesco Zanetti estimate a VAR model for the United States before and after 1980 to documents systematic differences in the response of short- and long-term interest rates, corporate bond spreads and durable spending to news total factor productivity shocks. Measuring expectations of future monetary policy rates conditional on a news shock suggests that the Federal Reserve adopted a restrictive stance before the 1980s to retain control over inflation and later switched to a more accommodative one.

In ‘Statistical Identification of Economic Shocks by Signs in Structural Vector Autoregression’, Markku Lanne and Jani Luoto propose a new frequentist approach to sign restrictions in non-Gaussian SVAR models. Point identification is achieved by making efficient use of this feature of the data, facilitating the use of standard asymptotic inference and, hence, the assessment of both theoretically implied signs and the labelling of statistically identified structural shocks. An empirical application to the US labour market illustrates the advantages of this approach.

In ‘Skewed SVARs: Tracking the Structural Sources of Macroeconomic Tail Risks’, Carlos Montes-Galdón and Eva Ortega propose a Bayesian algorithm to estimate a SVAR model where structural shocks are identified by sign restrictions, and whose distribution is subject to time-varying skewness. The model allows tracking joint asymmetric risks to macroeconomic variables included in the SVAR, and provides a structural narrative to the evolution of those risks. Their main empirical finding is that, in comparison to the literature on growth- and inflation-at-risk, financial stress indicators are not enough to explain all the macroeconomic tail risks in the Euro Area.

## (III) Time-varying Coefficient VAR Models

In ‘Tests for Random Coefficient Variation in Vector Autoregressive Models’, Dante Amengual, Gabriele Fiorentini and Enrique Sentana propose to use Hal White’s information matrix test to assess the constancy of mean and variance parameters in VAR models. They additively decompose the test into several orthogonal components related to conditional heteroskedasticity and asymmetry of the innovations, and their unconditional skewness and kurtosis, respectively. In an empirical application this procedure detects variation in the autoregressive coefficients and residual covariance matrix of a bivariate VAR for the US GDP growth rate measured from the demand and supply sides.

In ‘Monetary Policy across Space and Time’, Laura Liu, Christian Matthes and Katerina Petrova examine the stability in the conduct of monetary policy across time and across major economies, and the international spillover effects of monetary policy decisions taken by major central banks. To address these questions, they build on recent semi-parametric advances in time-varying parameter models that allow to increase the VAR dimension and to jointly model the monetary stance in three advanced economies (USA, UK and the Euro Area).

In ‘Heterogeneous Switching in FAVAR Models’, Pierre Guerin and Danilo Leiva-León introduce a new Bayesian approach to estimate high-dimensional FAVAR models (FAVAR) where the factor loadings are subject to idiosyncratic regime-switching dynamics. This procedure alleviates computational challenges substantially and facilitates the estimation of these models. An empirical application to study the impact of credit market disruptions on a large set of macroeconomic variables highlights the importance of accounting for non-linearities in factor loadings when evaluating the propagation of these shocks.

#### (IV) International Business Cycles

In ‘Business Cycles in the EU: An Ultimate, Comprehensive Comparison across Methods’, Dimitrij Celov and Mariarosaria Comunale investigate the performance of different univariate trend-cycle decomposition methods to assess business-cycle patterns in European economies. For simulations, the structural model’s parameters are calibrated to match targets of euro area’s real GDP and unemployment rate. Their analysis confirms that, despite being synchronized with the aggregate euro area, some business cycle differences can be found in periphery and new member states, while the German business cycle is the least synchronized.

In ‘Understanding International Interest Rates Co-movement’, Michael Chiny, Ferre De Graeve, Thomai Filippeli and Konstantinos Theoridis use Bayesian calibration of an open-economy DSGE model for the UK to analyze whether its central bank is able to decouple long-term interest rates from the United States. Their main finding is that co-movement arises from nominal fluctuations, but not through real interest rates or term premia. Hence, small-open economies may experience stronger effects from changes in US inflation trends than the US itself.

Last, but not least, we would like to thank Evi Pappa and Amaranta Canova for organizing a very nice workshop in honour of Fabio last October at the beautiful Greek Island of Hydra where a selection of the above-mentioned papers were presented ([https://drive.google.com/file/d/1DoBsSa5CIHwwt-0LhUNPmj2uhw\\_mvKkB/view](https://drive.google.com/file/d/1DoBsSa5CIHwwt-0LhUNPmj2uhw_mvKkB/view)).

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# CHAPTER 1

## REAL-TIME REAL ECONOMIC ACTIVITY: ENTERING AND EXITING THE PANDEMIC RECESSION OF 2020

Francis X. Diebold

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### ABSTRACT

*Entering and exiting the Pandemic Recession, the author study the high-frequency real-activity signals provided by a leading nowcast, the ADS Index of Business Conditions produced and released in real time by the Federal Reserve Bank of Philadelphia. The author tracks the evolution of real-time vintage beliefs and compares them to a later-vintage chronology. Real-time ADS plunges and then swings as its underlying economic indicators swing, but the ADS paths quickly converge to indicate a return to brisk positive growth by mid-May. The author shows, moreover, that the daily real-activity path was highly correlated with the daily COVID-19 cases. Finally, the author provides a comparative assessment of the real-time ADS signals provided when exiting the Great Recession.*

**Keywords:** Aruboba–Diebold–Scotti Index; ADS Index; nowcasting; business cycle; recession; expansion; coincident indicator; real economic activity; forecasting; Big Data

**JEL classifications:** E32; E66

## 1. INTRODUCTION

Accurate assessment of current real economic activity ('business conditions') is key for successful decision-making in business, finance, and policy. It is difficult, however, to track business conditions in real time, both because no single observed economic indicator *is* 'business conditions', and because different indicators are available at different observational frequencies, and with different release delays. Nevertheless there exists the tantalizing possibility of accurate real-time business conditions assessment ('nowcasting'), and recent decades have witnessed great interest in nowcasting methods and applications (e.g. [Banbura, Giannone, & Reichlin, 2011](#)).

The workhorse nowcasting approaches involve dynamic factor models, which relate a set of observed real-activity indicators to a single underlying latent real-activity factor. Both 'small-data' approaches (e.g. based on five indicators) and 'Big Data' approaches (e.g. based on 500 indicators) are available. Small-data approaches were developed first, and they typically involve maximum likelihood estimation (e.g. [Stock & Watson, 1989](#)). Subsequent Big Data approaches, in contrast, typically involve two-step estimation based on a first-step extraction of principal components (e.g. [McCracken & Ng, 2016](#); [Stock & Watson, 2002](#)).

Both introspection and experience reveal that Big Data nowcasting approaches are not necessarily better. First, they are more tedious to manage, and less transparent. Second, they may not deliver much improvement in factor extraction accuracy, which increases and stabilizes quickly as the number of indicators increases ([Doz, Giannone, & Reichlin, 2012](#)). Third, casual inclusion of many indicators can be problematic because a poorly balanced set of indicators can create distortions in the extracted factor ([Boivin & Ng, 2006](#)), whereas small-data approaches promote and facilitate hard thinking about a well-balanced set of indicators ([Bai & Ng, 2008](#)).

Against this background, in this chapter, I assess the performance of a leading small-data nowcast, the Aruoba–Diebold–Scotti (ADS) Index of Business Conditions ([Aruoba, Diebold, & Scotti, 2009](#)). ADS is designed to track real business conditions at high frequency, and it has been maintained and released in real time by the Federal Reserve Bank of Philadelphia continuously since 2008.<sup>1</sup> Its modelling style and underlying economic indicators build on classic early work in the tradition of [Burns and Mitchell \(1946\)](#), [Sargent and Sims \(1977\)](#), and [Stock and Watson \(1989\)](#). The underlying indicators span high- and low-frequency information on real economic flows: weekly initial jobless claims; monthly payroll employment growth, industrial production growth, personal income less transfer payments growth, and manufacturing and trade sales growth; and quarterly real GDP growth.

Crucially, I assess ADS using only information actually available in real time. This is required for truly credible real-time evaluation, and it can only be achieved by using nowcasts produced and permanently recorded in real time, which is very different from simply removing final-revised data and inserting vintage data into an otherwise *ex post* analysis. Unfortunately, such evaluations are rare, because there simply are not many instances of long series of nowcasts produced and

recorded in real time. ADS, however, has been produced and recorded in real time roughly twice weekly since late 2008, so I can provide real-time performance assessments both exiting the Great Recession and entering/exiting the Pandemic Recession.

Ultimately this chapter takes a two-pronged approach. The first is the above-sketched attempt at real-time ADS assessment, asking whether ADS sends reliable signals. The second conditions on reliability of the signals, and uses them to assess what actually happened in the Pandemic Recession of 2020 (and, for comparison, in the Great Recession of 2007–2009). The two prongs are ultimately inseparable and woven together in various ways throughout this chapter.

I proceed as follows. In Section 2, I provide background on aspects of ADS construction, updating, *ex post* characteristics and performance evaluation. In Section 3, I examine ADS entering/exiting the Pandemic Recession, and I relate the real-time ADS path to the real-time COVID-19 path. In Section 4, I provide a comparative examination of ADS exiting the Great Recession. I conclude in Section 5.

## 2. NOWCAST CONSTRUCTION, CHARACTERISTICS, AND ASSESSMENT

Here I provide background on the ADS index construction (Section 2.1), *ex post* historical characteristics (Section 2.2), and general issues of relevance to assessing *ex ante* nowcasting performance (Section 2.3).

### 2.1. Construction and Updating

ADS is a dynamic factor model with multiple mixed-frequency real-activity indicators driven by a single latent real-activity factor. The ADS index is an estimate of that latent real-activity factor. Importantly, the model is specified such that *the real-activity factor tracks the de-measured growth rate of real activity*. Progressively more negative or positive values indicate progressively worse- or better-than-average real growth, respectively. Because ADS tracks real-activity growth, not level, a positive value does not necessarily mean ‘good times’; rather, it means ‘good growth’, which may be from a level well below trend, as for example in the early stages of a recovery.

ADS is specified at daily frequency, allowing as necessary for missing data for the less-frequently observed variables.<sup>2</sup> Importantly, despite complications from missing data, time-varying system matrices, aggregation across frequencies, etc., the Kalman filter and associated Gaussian pseudo likelihood evaluation via prediction-error decomposition remain valid, subject to some well-known modifications.<sup>3</sup> Model estimation is therefore straightforward, after which the Kalman smoother produces an optimal extraction of the underlying real-activity factor, that is, the Kalman smoother produces the index: the extracted sequence at any time  $t^*$  is the vintage  $t^*$  ADS sequence,  $\{ADS_1, ADS_2, \dots, ADS_{t^*}\}$ .

The first ADS vintage was released 12/5/2008, covering 3/1/1960 through 11/30/2008. Since then, ADS has been continuously updated whenever new data are released. The Kalman smoother is re-run, generally within two hours of the release, and the newly extracted index from 3/1/1960 to ‘the present’ is re-written to the web. ADS has been updated approximately eight times per month on average since inception.

### 2.2. *Ex Post Characteristics*

In Fig. 1 I show the ADS index from 03/01/1960 through 12/31/2013, as assessed in the 6/26/2020 vintage. The sample range is well before the vintage pull date, so the chronology displayed is (intentionally) *ex post*. I do this because it is instructive to examine the *ex post* chronology before passing to real-time assessment, which can only be done after ADS went live in late 2008.<sup>4</sup>

Several features are noteworthy. For example, the ADS chronology coheres strongly with the NBER chronology, plunging during NBER recessions. In addition, several often-discussed features of the business cycle are evident in ADS, such as the pronounced moderation in volatility during the Greenspan era.

The ADS value added relative to the NBER chronology stems from the facts that (1) it is a cardinal measure, allowing one to assess not only recession durations, but also depths and patterns (see Table 1), and (2) its updates arrive in timely fashion, whereas the starting and ending dates NBER recessions are typically not announced until well after the fact (again see Table 1). Of course, if ADS is to be a useful guide for business and policy decisions, its frequently arriving updates must provide reliable signals in real time, not just *ex post* as in Fig. 1. I now turn to that issue.

### 2.3. *Performance Assessment*

Truly credible nowcasting performance assessment requires using *vintage information*, which emerges as the limit of a sequence of progressively more realistic and credible nowcast/forecast evaluation approaches<sup>5</sup>:

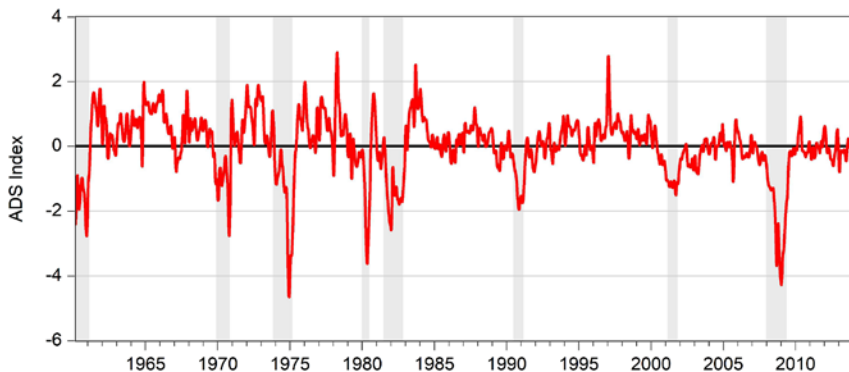


Fig. 1. ADS Index: *Ex Post* Path 03/01/1960–12/31/2013 (Vintage 6/26/2020).  
Notes: The shaded regions are NBER-designated recessions.