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A self-organizing map analysis of survey-based agents' expectations before impending shocks for model selection: The case of the 2008 financial crisis



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ABSTRACT

This paper examines the role of clustering techniques to assist in the selection of the most indicated method to model survey-based expectations. First, relying on a Self-Organizing Map (SOM) analysis and using the financial crisis of 2008 as a benchmark, we distinguish between countries that show a progressive anticipation of the crisis, and countries where sudden changes in expectations occur. We then generate predictions of survey indicators, which are usually used as explanatory variables in econometric models. We compare the forecasting performance of a multi-layer perceptron (MLP) Artificial Neural Network (ANN) model to that of three different time series models. By combining both types of analysis, we find that ANN models outperform time series models in countries in which the evolution of expectations shows brisk changes before impending shocks. Conversely, in countries where expectations follow a smooth transition towards recession, autoregressive integrated moving-average (ARIMA) models outperform neural networks.

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1. Introduction

Economic expectations play a major role in modern macroeconomics and finance. Given the important role of agents' expectations in the decision-making process of firms and policy makers, a large amount of research has been dedicated to investigate the relationship between changes in expectations and economic growth (Mokinski et al., 2015; Salle, 2015; Leduc and Sill, 2013; Zanin, 2010; Claveria et al., 2007; Nolte and Pohlmeier, 2007; Mitchell et al., 2005), obtaining mixed results. Although it remains unclear how economic expectations are formed, anticipating agents' expectations is of utmost importance in order to assess the current state of the economy, as they are increasingly used as explanatory variables in quantitative forecasting models (Guizzardi and Stacchini, 2015).

Tendency surveys provide detailed information about agents' expectations. The fact that survey expectations are based on the knowledge of the respondents operating in the market and are rapidly available, makes them very valuable for forecasting purposes. Survey results are presented as weighted percentages of respondents expecting a variable to go up, down or to remain unchanged. The qualitative nature of survey results has often lead to quantify agents' responses making use of survey indicators, such as the balance statistic. See Lahiri and Zhao (2015), Nardo (2003), and Smith and McAleer (1995) for an appraisal of alternative measures of economic expectations.

The aim of this study is to analyze the role of clustering techniques to select the most indicated method to model agents' expectations according to their perceptions on the state of the economy before imminent shocks. With focus on the financial crisis of 2008, we track the evolution of economic experts' expectations during the transition period to the recession by means of a Self-Organizing Map (SOM) analysis. This technique allows us to cluster 14 countries of the European Union (EU) according to the pattern in the evolution of their agents' expectations: those in which the shock is gradually anticipated, vis-à-vis those where a brisk change in expectations occurs.

An SOM is a type of Artificial Neural Network (ANN) that is trained by means of unsupervised learning algorithms. SOMs make use of nonlinear regression techniques that organize data so as to disclose unknown patterns or structures. SOMs have been used in order to make visual predictions of different phenomena, but only recently in economic studies (Sarlin and Peltonen, 2013; Resta, 2012; Lu and Wang, 2010; Marghescu et al., 2010; Arcienagas-Rueda and Arcienagas, 2009; Eklund et al., 2008).

This is the first application of SOMs in analyzing survey expectations. We use SOM networks to generate visual representations of the different patterns in the evolution of economic experts' expectations on the state of the economy during the pre- and post-crisis quarters. These representations allow us to classify the fourteen European countries into two groups according to the degree to which their agents' anticipated the 2008 crisis.

Survey expectations are widely used in forecasting macroeconomic aggregates. Survey indicators have been used to predict business cycle turning points (Qi, 2001; Diebold and Rudebusch, 1989), to quantify business survey data (Lahiri and Zhao, 2015; Breitung and Schmeling, 2013; Claveria et al., 2006; Mitchell, 2002; Mitchell et al., 2002), to test economic hypothesis (Zárate et al., 2012; Jonsson and Österholm, 2011; Lemmens et al., 2005, 2008, Pesaran and Weale, 2006), and as explanatory variables in quantitative forecasts models (Martinsen et al., 2014; Ghonghadze and Lux, 2012; Lui et al., 2011; Klein and Özmucur, 2010; Graff, 2010; Claveria et al., 2007, Claveria and Datzira, 2010; Mitchell et al., 2005; Hansson et al., 2014; Mittnik and Zadrozny, 2005; Parigi and Schlitzer, 1995; Biart and Praet, 1987). Recently, Dees and Brinca (2013) empirically assessed the link between the consumer sentiment indicator and consumer expenditures in the United States and the Euro Area.

The relevance of survey-based expectations in macroeconomics has led us to generate predictions of business survey indicators that can be used as inputs in econometric models. We compare the forecasting performance of a Multi-layer Perceptron (MLP) ANN model to that of three different time series models: autoregressions (AR), autoregressive integrated moving average (ARIMA) models, and self-exciting threshold autoregressions (SETAR). Such an exercise allows to select the forecasting technique that shows the best predictive performance (Hendry and Clements, 2003; Stock and Watson, 2003). As far as we know, only two previous studies have conducted a forecast comparison for business survey indicators (Clar et al., 2007; Ghonghadze and Lux, 2012), but never before with computational intelligence techniques such as ANN models.

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