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Forecasting structural change and fat-tailed events in Australian macroeconomic variables

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ABSTRACT

The 2007/08 Global Financial Crisis has re-stimulated interest in modeling structural changes and fat tail events. In this paper, we investigate whether incorporating time variation and fat-tails into a suit of popular univariate and multivariate Gaussian distributed models can improve the forecast performance of key Australian macroeconomic variables: real GDP growth, CPI inflation and a short-term interest rate. The forecast period is from 1992Q1 to 2014Q4, thus replicating the central banks forecasting responsibilities since adopting inflation targeting. We show that time varying parameters and stochastic volatility with Student's-t error distribution are important modeling features of the data. More specifically, a vector autoregression with the proposed features provides the best interest and inflation forecasts over the entire sample. Remarkably, the full sample results show that a simple rolling window autoregressive model with Student's-t errors provides the most accurate GDP forecasts.

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1. Introduction

Structural change refers to variation in the fundamental behavior of macroeconomic time series. Causes of structural change range from unanticipated events such as financial crisis (Hamilton and Lin, 1996; Hamilton, 2005) to man made changes in macroeconomic policy (Primiceri, 2005, Sims and Zha, 2006; Kudrna et al., 2015). Fig. 1 shows that key Australian macroeconomic variables: real GDP growth, CPI inflation and a short-term interest rate—the 90 day Bank Accepted Bills/Negotiable Certificates of Deposit—have undergone significant structural changes since the 1970s. Inflation was particularly high during the mid to late 1970s and 1980s and low in the last decade with interesting variations in and around the 2007/08 global financial crisis (GFC). Next, whilst actual real GDP doubled over the past decade, business cycle fluctuations have substantially moderated in the last 20 years. Finally, the adoption of inflation targeting by the Reserve Bank of Australia (RBA) in 1992/93 has seen a dramatic decline in short-term interest rate volatility over the sample period.

In addition to being subject to endogenous structural change, the modern market economy is also exposed to ubiquitous and diverse macroeconomic "shocks". Broadly speaking, these shocks can be categorized into two types: anticipated shocks and unanticipated shocks. Anticipated shocks, such as seasonal changes in tastes and preferences, do not significantly alter the pattern of macroeconomic activities and can be factored into policy decisions. Unanticipated shocks, such as unanticipated tax cuts, can have temporary or permanent effects on real economic activity (Mertens and Ravn, 2011). Although such shocks are a natural driver of the ebbs and flows of the business cycle, outlier or fat-tailed shocks have varying and often significant macroeconomic implications. For instance large unanticipated shocks, such as the oil price shocks of the 1970s, or the 2007/08 Global Financial Crisis (GFC), are difficult to forecast and may result in temporary or permanent structural changes within the economy making the policy responses difficult (see e.g. Hamilton (1983) for the former and Mian and Sufi (2010) for the latter).

In this paper, we investigate whether the incorporation of time variation and fat-tails into traditionally Gaussian, fixed coefficients

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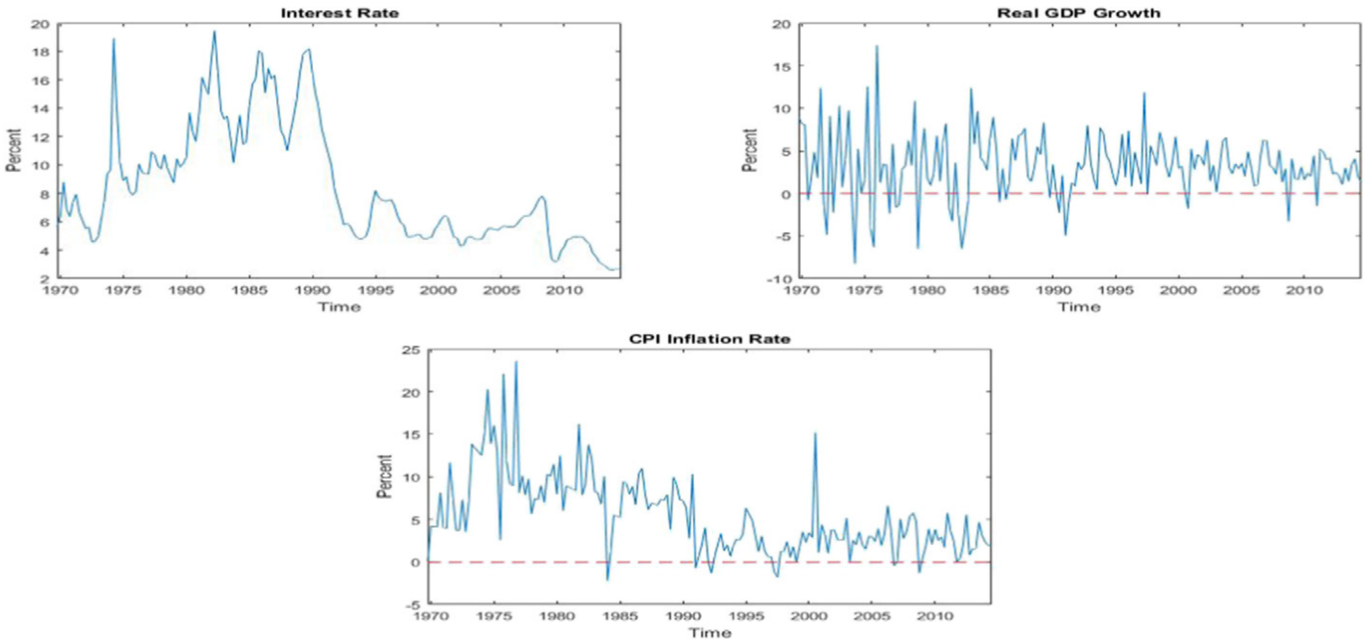

Fig. 1. Australian macroeconomic time series.

multivariate and univariate autoregressive models leads to enhanced forecast performance of key Australian macroeconomic variables: real GDP growth, CPI inflation and a short-term interest rate. As discussed in D'Agostino et al. (2013), the answer to this question is far from trivial. On the one hand, it seems obvious that if the economy is subject to structural change then any forecasting model that can account for such changes would be better suited, thus increasing forecast accuracy. On the other hand, a richer modeling structure implies a higher number of parameters, thus increasing the risk of estimation errors and possibly reducing forecast accuracy.

The class of univariate autoregressive (AR) and multivariate vector autoregressive (VAR) models includes the following specifications: constant parameter, constant parameter with stochastic volatility, time varying parameter and time varying parameter with stochastic volatility. Set in this manner, we allow for time variation through two sources: (1) in the model coefficients and (2) in the variance of the shocks. For the multivariate models we follow Primiceri (2005) and consider a third source of time variation via the covariance terms. In addition to accounting for time variation within the coefficients and volatilities, all models are estimated under both Gaussian and Student-t error distributions. A consequence of this modeling feature is that it leads to faster adaptation to large fluctuations, making it more appropriate model during times of economic uncertainty. For instance, when considering financial spillovers in macroeconomic linkages amongst developed countries throughout the GFC period, Ciccarelli et al. (2016) provide evidence that a panel VAR model with Student's-t distributed errors enhances the in-sample fit of a panel VAR with Gaussian errors. In addition to this class of models we also consider the forecast performance of non-linear regime switching as well as rolling-window ARs and VARs. The former class of models have been shown to generate a good description of the evolution of monetary policy and inflation dynamics in the US economy (Sims and Zha, 2006), whilst the latter class of models are simpler, implying that any forecast improvements would have significant practical implications.

Our paper is related to the growing literature on modeling structural instabilities as well as the reviving literature on the modeling of fat tailed events. In the first line of literature Cogley and Sargent (2002, 2005) and Primiceri (2005) pioneered the work on the time-varying parameter vector autoregression with stochastic volatility in the variance covariance matrix (TVP-VAR-SV). The TVP-VAR-SV model has since been a catalyst in the literature on the identification of structural instabilities within the monetary policy transmission mechanisms of various economies (see e.g. Benati (2008), Nakajima et al. (2011), Cross (2015) or Poon (2016)). Important for this study, Cross (2015) shows that stochastic volatility is an important modeling feature when examining the in-sample properties of Australian macroeconomic data. Despite this growing literature a major criticism of economic modeling has been the inability to predict the 2007–08 Global Financial Crisis (GFC) (see, for instance Ng and Wright (2013)). Since then, researchers have began investigating whether the class of aforementioned autoregressive models can enhance the forecastability of financial and macroeconomic variables (see, for instance: D'Agostino et al. (2013), Barnett et al. (2014), Bekiros (2014), Baxa et al. (2015) or Charfeddine (2016)). For instance D'Agostino et al. (2013) and Barnett et al. (2014) utilize the TVP-VAR-SV to respectively forecast US and UK macroeconomic indicators. Both studies conclude that the TVP-VAR-SV model produces superior forecasts as compared to a traditional fixed coefficients VAR model, however they lack a systematic comparison of the various nested VAR models listed above. The next line of research revives the earlier work of Geweke (1993, 1994) and Ni and Sun (2005), by incorporating Student's-t errors (Student, 1908) into macroeconomic models to allow for the possibility of fat-tailed events. For instance Chib and Ramamurthy (2014) show that incorporating fat-tails improves the in-sample fit of a traditional US calibrated DSGE model with Gaussian errors. In addition, Chiu et al. (2015) suggests that incorporating both fat-tails and stochastic volatility is fruitful in forecasting US macroeconomic and financial data.

Methodologically our paper is most similar to the recent study by Chiu et al. (2015) who investigate the importance of fat-tails and stochastic volatility in forecasting US data. We highlight that our study differs from Chiu et al. (2015) in three ways. First, rather than solely focusing on VARs we forecast with both multivariate and univariate autoregressive models. This is important for at least two reasons. First, a well known feature of macroeconomic forecasting

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