A flexible approach to parametric inference in nonlinear and time varying time series models

Gary Koop, Simon Potter (2010)

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Motivation

- Monetary policy rules have changed over time?
- Models that are nonlinear or exhibit structural breaks or time variation in parameters.
- The set of possible models is huge. Date mining issue.
- Can we develop a flexible parametric model which nests almost all of these specifications?

Literature Review

- Structural break or time varying parameter models:
  Cogley and Sargent (2001, 2005), Boivin and Giannoni (2006), Primiceri (2005)
- Regime-switching models:
  Sims and Zha (2006), Koop and Potter (2006)
- Flexible parametric modeling:
  Hamilton (2001, 2003), Lundbergh et al. (2003), Bec et al. (2008), Giordani et al. (2007)

Model

- TVP written in state space form:

$$y_t = \theta_t x_t + \sigma_\epsilon \epsilon_t \tag{1}$$
$$\theta_t = \theta_{t-1} + \sigma_\nu \nu_t \tag{2}$$

  ϵ_t and ν_t are $i.i.d.\ N(0,1)$ - assume homoskedasticity in this simple case, include volatility issues in the general model.

- Our model:

$$y_s = \theta_s x_s + \sigma_\epsilon \epsilon_s \tag{3}$$
$$\theta_s = \theta_{s-1} + \sigma_\nu d(z_s, z_{s-1}) \nu_s \tag{4}$$

  Add two simple concepts: hypothetical data reordering and distance function

Model

- The role of the distance function
- The rold of hypothetical data reordering

Model

Table 1
Links between our framework and popular nonlinear time series models.

Model	Distance function	Index variable
AR(p)	0	$z_t = t$
TVP	1	$z_t = t$
Structural Break 1 Break	$=1$ at time τ $=0$ otherwise	$z_t = t$
Structural Break K Breaks	$=1$ at $\tau_1, \ldots, \tau_K$ $=0$ otherwise	$z_t = t$
Structural Break Unknown # Breaks	$=1$ with prob p $=0$ otherwise	$z_t = t$
Chib (1998) Structural K Breaks Model	$=1$ with restricted Markov transition probs. $=0$ otherwise	$z_t = t$
Various nonparametric TVP models	Smooth function (e.g. kernel)	$z_t = t$
Standard TAR	$=1$ if $z_{s-1} < \tau$ and $z_s \geq \tau$ $=0$ otherwise	$z_t = y_{t-d}$
Other TARs	$=1$ if $z_{s-1} < \tau$ and $z_s \geq \tau$ $=0$ otherwise	z_t exogenous var. or functions of lags
Multiple Regime TARs	$=1$ if $z_{s-1} < \tau_1$ and $z_s \geq \tau_1$ $=1$ if $z_{s-1} < \tau_2$ and $z_s \geq \tau_2$ etc.	z_t exogenous var. or functions of lags
STAR[a]	Smooth function	$z_t = y_{t-d}$
Multiple Regime STAR	Smooth function with multiple modes	$z_t = y_{t-d}$
Markov switching model	$=1$ with restricted Markov transition probs. $=0$ otherwise	$z_t = t$
Various nonparametric time series models	Smooth function (e.g. kernel)	z_t exogenous var. or functions of lags

[a] This relationship is approximate and is illustrated in the artificial data section.

Empirical work

- Artificial data
- Empirical illustrations using real GDP growth
- The oil price and GDP growth

Discussion

- For researchers working with macroeconomic and financial data, there is great interest in investigating whether structural breaks and regime-switching behavior occurs in the conditional mean, $E(y_t|T_{t-1})$, and the conditional variance, $var(y_t|T_{t-1})$.
- This paper adds a new approach to flexible modeling to complement the existing literature, but embeds more flexibility.
- This model nests virtually every popular model in the regime-switching and structural break literatures, including everything from abrupt change models (e.g. threshold autoregressive models or structural break models such as Bai and Perron (1998)) to those which allow gradual evolution of parameters (e.g. smooth transition autoregressive models or TVP models such as Primiceri (2005)).
- This model adds two simple concepts, hypothetical reordering and distance, to a standard state space framework.
- Retain the state space framework, bayesian econometric methods are relatively straightforward drawing on the existing literature.