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STAR

SMOOTH TRANSITION AUTO-REGRESSION MODEL.

All smoothing models are binded by probability

Consider y'_t (univariate case) to follow a (2 Regimes) STAR model such that

Degree of Smoothness

Threshold parameter

$$(1)\quad y_t = \phi_1 x_t \left[1 - \underbrace{G\left(S_t, c_t, \gamma\right)}_{\text{Transition parameter}}\right] + \phi_2' x_t \, G(s_t, c, \gamma) + e_t$$

where $x_t = \left[1, \hat{x}'_2\right)$ such that $\hat{x}_t = \left[y'_{t-1}, y_{t2}, \ldots, y_{t-n}\right]$

$$\phi_{ik} = \left[\phi_{i0}, \phi_{i1}, \phi_{i2}, \ldots \phi_{ip}\right]$$

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This model can be extended to include other exogenous variables.

STAR-X is given as

$Z_t = [Z_{1t}, Z_{2t}, \ldots, Z_{kt}]$

(11) $y_t = \phi_1' x_t [1 - G(S_t, c_t, \gamma)] + \phi_2 x_t [G(S_t, c_t, \gamma)] + Z_{1t} + Z_{2t} + \ldots \ldots + Z_{kt} + e_t$

$E(y_t / \Omega_{t-1}) = 0$, $E(e_t^2 / \Omega_{t-1}) = \sigma^2_e$.

Information set

$S_t = y_{t-d}$, $d > 0$ SETAR

$S_t = Z_{1t}$

$S_t = y_t$ $d = 0$

$S_t = t$

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STAR –
- two regimes if $G = 0 - 1$
- M Regimes if G assumes continues value between $0 - 1$

What Define G-Function (Regime) Behave

St defines the regime and value of transition function.

WE WILL SEE HOW WE DETERMINE THE CHOICE OF PROB. DISTRIBUTION

$$G(S_i, C_t, \gamma) = [1 + \exp - [-\gamma (S_t - C)]]^{-1} \quad \text{——— (III)}$$

if $\gamma > 0$, $c \approx 0$, $S_t = Y_{t-1}$

G is said to follow 1^{st} order logistic function. such that

LOGISTIC SMOOTHING TRANSITION......

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Equation 1 and 3 gives us

LSTAR-X

Equation 2 and 3 gives us

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$$G(S_t, C, \gamma) = \left[1 + \exp\left(-\gamma (S_t - c_1)(S_t - c_2)\right)\right] \quad \text{— (IV)}$$

It is just c and not c_t

$\gamma > 0$

If $c_1 \neq c_2$, $c = (c_1, c_2)$

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Combine (I) and (IV) | 2nd L —

(II) and (IV)

STAR-X

This can be generalised to a function such that

summation of the likelihood prob. distribution

likelihood function

$$G(S_t, c, \gamma) = \left[1 + \exp\left(-\gamma \prod_{i=1}^{\wedge} (S_t - c_i)\right)\right]^{-1}$$

The condition that Gamma $\gamma > 0$ is a must condition otherwise the model will collapse.

$c_1 \leq c_2 \leq c_3 \ldots \leq c_N$

$c = (c_1, c_2, \ldots c_n)$

ANOTHER FUNCTION

$$G(S_t, c, \gamma) = \left[1 - \exp\left[(-\gamma(S_t - c)^2\right]\right]$$

This is an exponential form.

I and V — E — STAR

II and V — E — STAR-X

(A) If $G = 1$ $S_t \to -\infty$ $+\infty$

$$\int_{-\infty}^{\infty} S_t$$

(B) $G = 0$ $S_t = c$

(C) If $\gamma = 0$, or $\gamma \to \infty$

the function collapse to constant and the model become linear

2 Regime STAR MODEL

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MULTIPLE REGIMES STAR

CASE

(1) if M regimes are charact-erised by one trancition variable S_t

(2) if M regimes are charac-terised by many transition variables i.e $(S_{1t}, S_{2t}, \dots, S_{mt})$

CASE 1

Consider 2 regimes STAR

second regime

$$y_t = \phi' x_t + (\phi_2' - \phi_1') x_t \, G_t(S_t, c_1, \gamma) + e_t$$

If you have to go for 3 regime STAR

Threshold point

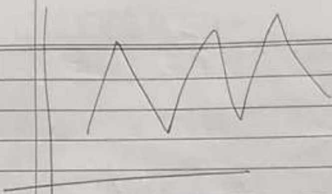
$$y_t = \underbrace{\phi_1' x_t}_{\text{linear}} + (\phi_2' - \phi_1')' x_t G_1 (S_t, c_1', \gamma) + (\phi_3' - \phi_2')' x_t G_2(S_t, c_1, \gamma) + e_t$$

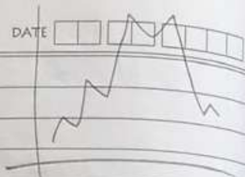
If G_1 is exponential then G_2 must also be exponential.

It can be extended to multiple regimes. (Generalised Case)

$$y_t = \phi' x_t + (\phi_2' - \phi_1')' x_t G_1 (S_t, c_1, \gamma) + (\phi_3 - \phi_2)' x_t G_2 (S_t, c_2, \gamma)$$

$$+ \dots + (\phi_m - \phi_{m-1})' x_t G_{m-1} (S_t, c_{m-1}, \gamma_j) + e_t$$





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CASE 2

TWO REGIMES

With in the 2 regimes there are 2 transitions.

$$y_t = \left[\phi_1' x_t \left(1 - G_1(S_{1t}, \gamma_1, c_1)\right) + \phi_2' x_t G_1(S_{1t}, \gamma_1, c_1) \right]$$

either the process is driven by first transition or 2nd transition

$$+ \left[1 - G_2(S_{2t}, \gamma_2, c_2) \right]$$

Beyond this bar is the second regime

$$+ \left[\phi_3' x_t \left(1 - G_1(S_{1t}, \gamma_1, c_1)\right) + \phi_4' x_t G_1(S_{1t}', \gamma_1, c_1) \right]$$

$$+ G_2(S_{2t}, \gamma_2, c_2) + e_t$$

Smoothing transition VAR

OR

Vector STAR

OR

Multivariate STAR

Next week.

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VECTOR STAR

OR

SMOOTHING TRANSITION VAR MODEL.

Consider y_t to be K-dimensional vector of stationary variables such that

$y_t = (y_{1t}, y_{2t}, \ldots, y_{kt})'$ two-regime ST-VAR

$$y_t = \left(\underset{K\times 1}{\phi_{1,0}} + \underset{K\times K}{\phi_{1,1}} y_{t-1} + \cdots + \phi_{1,p} y_{t-p}\right)\left(1 - G(S_t, \gamma, c)\right)$$

Slope of first lag of first regime

$$+ \left(\phi_{2,0} + \phi_{2,1} y_{t-1} + \cdots + \phi_{2,p} y_{t-p}\right)\left(G(S_t, \gamma, c)\right) + e_t$$

$\phi_{i,0}$ $i = 1, 2$ $k \times 1$ vector

ϕ_{ij} $i = 1, 2$ and $j = 1, 2$ $K \times K$ matrix

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$e_t = (e_{1t}, e_{2t}, \ldots e_{kt})$ $K \times 1$

The error is white noise with 0 mean and positive definite covariance matrix Σ

idiosyncratic error term

TRANSITION FUNCTION

$G_1(S_{1t}, \gamma_1, c_1) \ldots \ldots$

$\ldots G_k(S_{kt}, \gamma_k, c_k).$

Each equation will be guided by a specific transition function.

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Alternatively you can give each equation a specific transition function

This CAN BE EXTENDED TO MULTIPLE REGIMES

$$Y_t = (\phi_{1,0} + \phi_{1,1} Y_{t-1} + \ldots \phi_{1,p}) (G_1(S_t) + (\phi_{2,0} + \phi_{2,1} Y_{t-1}$$

$$+ \ldots + \phi_{2,p}) \, G_2(S_t) + \ldots$$

$$\ldots + (\phi_{m,0} + \phi_{m,1} Y_{t-1}).$$

$$+ \ldots + \phi_{m,p} Y_{t-p}) \, G_m(S_t) + e_t$$

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where

$$G_j(s_t) = (\zeta_{jt}, c_j, \gamma_j), \quad J = 1, \ldots\ldots m.$$