ΣΥΓΚΛΙΣΗ ΕΠΙΤΟΚΙΩΝ ΚΑΙ ΣΥΝΑΛΛΑΓΜΑΤΙΚΑ ΔΙΑΘΕΣΙΜΑ ΣΕ ΜΙΑ ΑΝΑΔΥΟΜΕΝΗ ΟΙΚΟΝΟΜΙΑ:

Η σύγκλιση της Ελλάδας στην ΟΝΕ 1994 – 2000

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Πανεπιστήμιο Πειραιώς

10 Απριλίου 2008

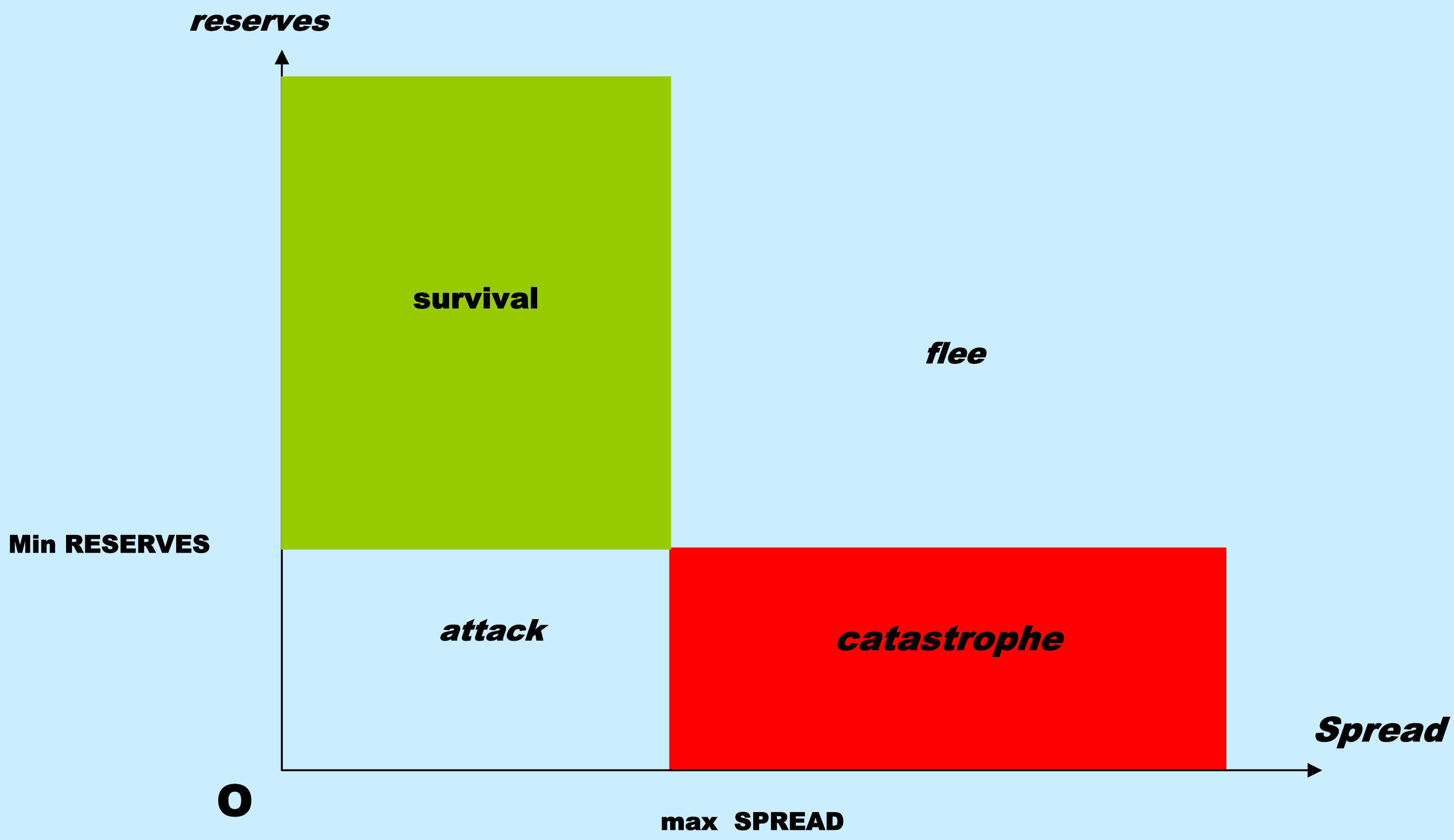
Risk-Premia and Optimal Reserves in a Transition Economy:

The case of Greece converging to EMU 1994-2000

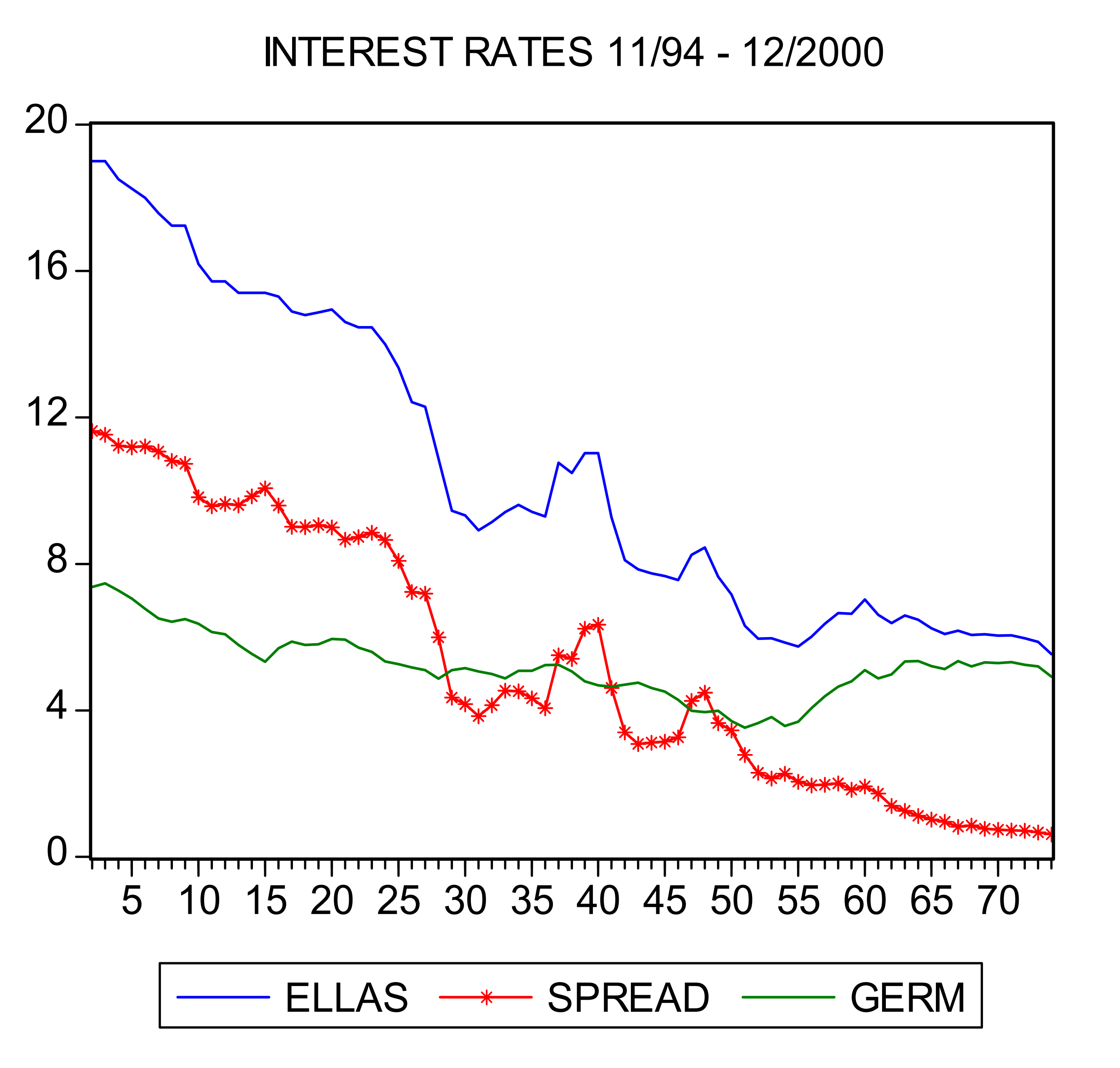
Nicos Christodoulakis

Athens University of Economics and Business

March 2008



reserves
survival
flee
Min RESERVES
attack
catastrophe
Spread
0
max SPREAD


INTEREST RATES 11/94 - 12/2000
20
16
12
8
4
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
ELLAS
SPREAD
GERM

ASSUMPTIONS

1. **Small Open Economy**: Home and Exogenous World (F)

2. **Purchasing Power Parity**: $$P = P^F \Big/ E$$

3. **Fixed Exchange Rate Target**: $$E = \overline{E}$$

Fear of devaluation $$d \rangle 0$$

HOUSEHOLDS

Exogenous labour supply, Exogenous investment

Linear Production function: $Y = \bar{L}$

Resource constraint: $Y = C + G + N + \bar{I}$

Net exports: $N = N\left(E, Y, Y^F\right)$

4. Capital movements with transaction costs. Modified UIP

$$1 + r - E\left(d_{t+1} \mid t\right) - b = 1 + \rho$$

b : transaction costs, bureaucracy, domestic iquidity constraints, country premium, etc

The home-bias effect

5. Exogenous Output (Growth-detrended): $Y = \overline{Y}$

6. Disposable Income $Y^{D} = Y - T - \bar{I} + Y^{REC}$

THE FOREX MARKET

Prob Π : $\mathrm{E} = \overline{\mathrm{E}}$ *No devaluation*

Prob $1 - \Pi$: $\mathrm{E} = (1+d)\,\overline{\mathrm{E}},$ *Devaluation*

Returns on assets:

$$\Pi: \quad R_1 = xr + (1-x)\rho = r + s(1-x)$$

$$1-\Pi: \quad R_2 = x(r-d) + (1-x)\rho = \rho + (s-d)x$$

$$E(R) = r - \left(s - [1-\Pi]\cdot d\right)[1-x]$$

$$Var(R) = \Pi(1-\Pi)\,d^2\,[1-x]^2$$

DOMESTIC INCOME

$$\Pi \quad : \quad Y_1 = Y$$

$$1 - \Pi \quad : \quad Y_2 = Y\left(1 - q \cdot d\right)$$

q = the unindexed part of Income

$$E(Y) = Y - [1 - \Pi] \cdot d \cdot q$$

$$Var(Y) = \Pi(1 - \Pi) \cdot d^2 \cdot q^2$$

$$Var(q_0 Y + A) = \Pi(1 - \Pi) \cdot d^2 \cdot [q_0 q Y - (1 - x)A]^2$$

THE INFERENCE MECHANISM

Interaction between $s \longleftrightarrow \Pi$

$$\Pi = \Pi\left(s,\ Q,\ B,\ N,\quad etc_{,}\right)$$

$$s = \left(\Pi,\quad a,\quad a^{F},\quad d_{,},\quad etc\right)$$

Demand for domestic assets:

- For high Π: Increase with s
- For low Π: Reduce domestic holdings
- **Cut-off** threshold: If $s \rangle s_{MAX}$ no holdings

→ But there might be a **reversal** even before! Why?

Bayes´ Law: Adjusting Π

- Suppose up to t no devaluation

- Auction in the bond market results in spread S

- Prior odds: $$\Omega_0 = \frac{\Pr ob\left(Committment\right)}{\Pr ob\left(Devaluation\right)}$$

- Posterior odds: $$\Omega_t = \frac{\Pr ob\left(Committment / Auction\right)}{\Pr ob\left(Devaluation / Auction\right)} = \frac{\Pi}{1-\Pi}$$

- Revision of odds: $\Omega_t = \Lambda \Omega_0$

- Log-Likelihood Ratio

$$\log \Lambda = (\text{success score}) \log \frac{p}{1-p}$$

success score = (successes) - (failures) $\approx (s_{MAX} - s)$

p = distribution of commitment in Government's options

- Exogenous: $\lambda = \log \dfrac{p}{1 - p} = const. \rangle 0$

- Pessimist market: Low λ

- Optimist market: High λ

Combining, posterior **odds** are adjusted as:

$$\Omega_t \equiv \Omega(s) = \Omega_0 \exp\left[\lambda\left(s_{MAX} - s\right)\right]$$

Posterior probabilities:

$$\Pi = \frac{\Omega(s)}{1 + \Omega(s)} \qquad 1 - \Pi = \frac{1}{1 + \Omega(s)}$$

Private Sector Wealth: A

xA → Domestic Government Bonds (r)

$(1-x)A$ → Foreign **riskless** Bonds (ρ)

$$\dot{A} = E(R)A + Y^D - C$$

Choose: C_t and x

max $\int_0^\infty e^{-\delta j} u_{t+j} \, dj \, ,$

$$u_t = \frac{1}{1-a} C^{1-a} - \frac{\gamma}{1-a} \sigma^{1-a}$$

$$\Xi = u(c, \sigma) + \mu \left[E(R)A + E(Y^D) - C \right]$$

Euler conditions

$$\frac{\partial \Xi}{\partial C} = 0 \quad \Rightarrow \quad \mu = u_c = c^{-a}$$

$$\frac{\partial \Xi}{\partial x} = 0 \quad \Rightarrow \quad (1-x)A = q_0\, qY - \left(\frac{\gamma}{b}\right)^{\frac{1}{a}} \left[\frac{s}{m} \exp\left(1 - \frac{s}{m}\right)\right]^{\frac{1-a}{a}} \cdot C$$

$$\dot{\mu} - \delta\mu = -\frac{\partial \Xi}{\partial A} \quad \Rightarrow \quad \frac{\dot{C}}{C} = \frac{r-\delta}{a}$$

Set $h(s) = \frac{s}{m} \exp\left(1 - \frac{s}{m}\right)$, $m = \frac{2}{\lambda}$

Domestic demand for foreign bonds:

$$(1-x)A = q_0 qY - \left(\frac{\gamma}{b}\right)^{\frac{1}{\alpha}} C \cdot [h(s)]^{\frac{1-\alpha}{\alpha}}$$

Foreign demand for domestic bonds:

$$x^F A^F = \left(\frac{\gamma^F}{b}\right)^{\frac{1}{\alpha^F}} C^F [h(s)]^{\frac{1-\alpha^F}{\alpha^F}}$$

$$F(s) \approx \eta s(1 - \frac{s}{2s_M})$$

Here:

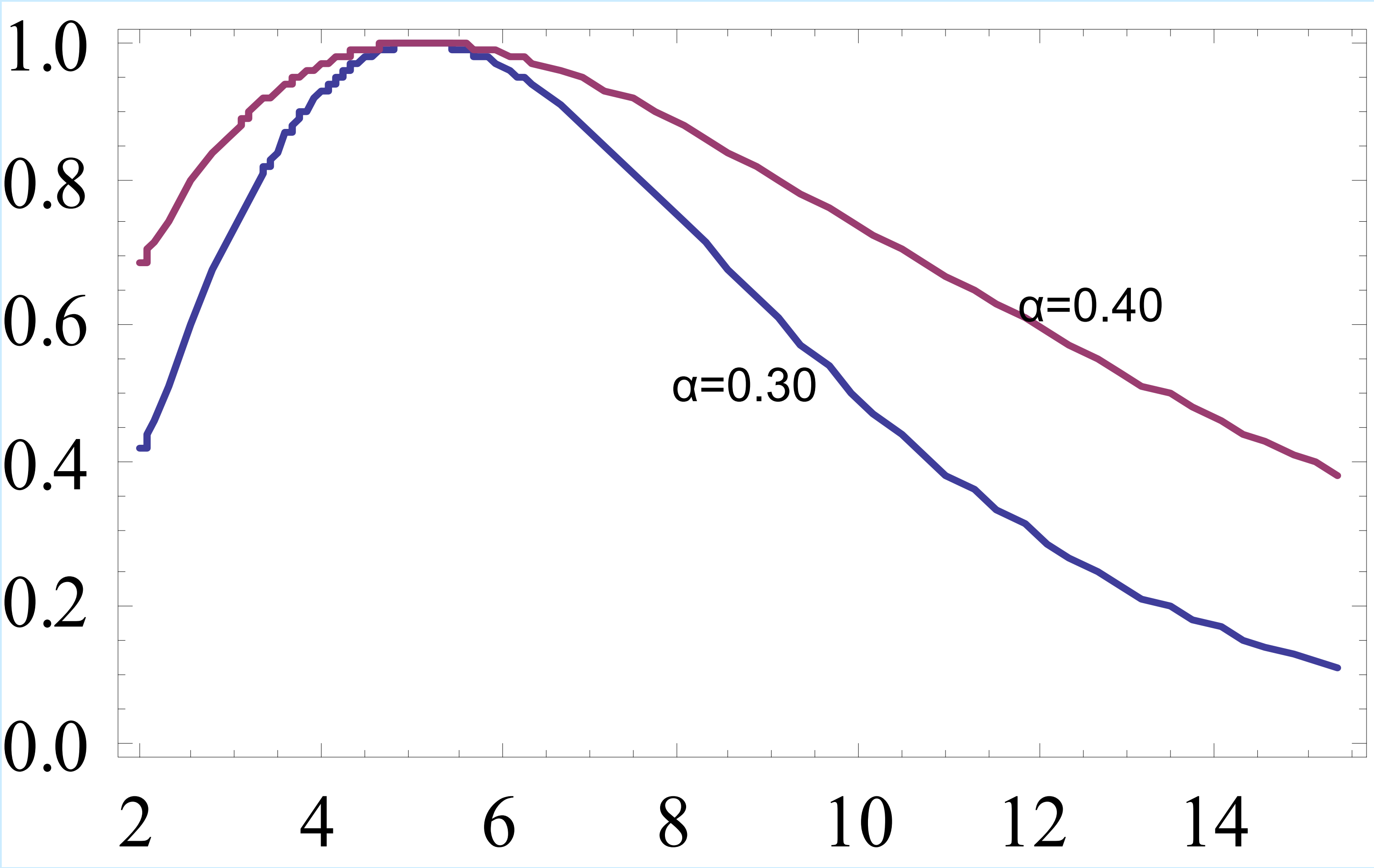
$$C = const. \quad and \quad C^F = const. \quad \Rightarrow$$

$$F(s) = \vartheta [h(s)]^{\frac{1-\alpha}{\alpha}} + \vartheta^F [h(s)]^{\frac{1-\alpha^F}{\alpha^F}} - q_0 qY$$

F(s) isotropic with h(s),   max at s=m

Second-order approximation:

$$F(s) \approx \eta_0 + \frac{\eta \cdot s}{m}\left(1 - \frac{s}{2m}\right)$$



SPREADS %

THE GOVERNMENT

Total Government Debt: B

Budget constraint

(new debt) = (interest payments) + (Primary deficit) – (Bank profits)

$$\dot{B} = rB + G - T + \dot{Q} - \rho Q$$

Domestic debt financing: $B = xA + x^F A^F$

Foreign purchases of domestic debt

$$F = x^F A^F - (1 - x) A = B - A$$

$$F = B - A$$

$$\dot{F} = \dot{B} - \dot{A}$$

$$= r(B - A) + G - T + \dot{Q} - \rho Q$$

$$J = N + Y^{REC}$$

The External Constraint:

$$\dot{F} = rF + \dot{Q} - \rho Q - J$$

THE BANK

Balance sheet: $\overline{M} = Q + D$

Foreign exchange reserves: Q

Domestic credit: D

Fixed Money Supply: $M = \overline{M}$

Sterilisation: $\dot{D} = -\dot{Q}$

Reserves accumulation: $Q \rangle Q_{\min}$

The policy problem

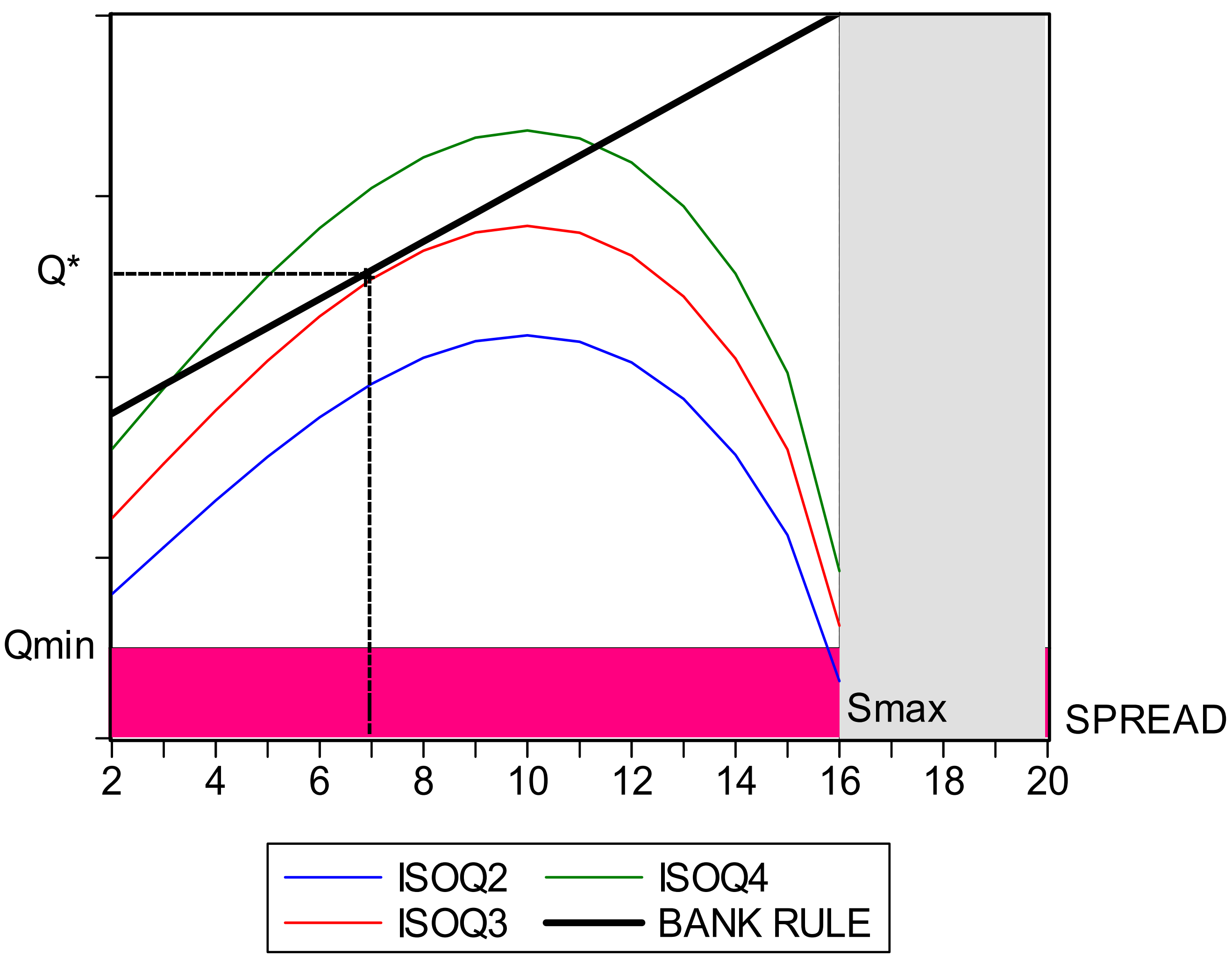
Choose change in reserves: $\dot{Q}_t$

$$\max \int_0^{\infty} e^{-\theta j} V_{t+j}(Q, s)\, dj$$

$$\frac{\partial V}{\partial Q} \rangle 0, \qquad \frac{\partial V}{\partial s} \langle 0$$

$$V = v(Q) - \beta \cdot v(F)$$

THE OPTIMAL RESERVES CHOICE



*

Hamiltonian

$$\Gamma = v(Q) - \beta v(F) + \omega \cdot (\dot{Q}) + \xi\left[rF + \dot{Q} - \rho Q - J\right]$$

Euler conditions

$$\frac{\partial \Gamma}{\partial (\dot{Q})} = 0 \qquad \Rightarrow \qquad \omega + \xi = 0$$

$$\dot{\omega} - \theta\omega = -\frac{\partial \Gamma}{\partial Q} = -V_Q + \rho\xi$$

$$\dot{\xi} - \theta\xi = -\frac{\partial \Gamma}{\partial F} = +\beta V_F - r\xi$$

The Rule

$$\left(\beta - \psi_2\right)\dot{Q} = const. + \frac{F(s)}{s}\left(\beta - \psi_1\right)\dot{s}$$

$$-\beta\left(r - \frac{\rho-\theta}{\psi}\right)F(s) - \left[\frac{\psi_2}{\psi}\left(r - \theta\right) - \beta\rho\right]Q + \beta J$$

$$\frac{F(s)}{s} \approx \frac{\eta}{m}\left(1 - \frac{s}{2m}\right)$$

$$v(Q) = \frac{1}{1-\psi}Q^{1-\psi} \qquad v(F) = \frac{1}{1-\psi}F^{1-\psi}$$

$$\psi_1 = v_Q / v_F = \psi_0 \psi_2 \qquad \psi_2 = v_{QQ} / v_{FF} \qquad \psi_0 = \overline{Q} / \overline{F}$$

Steady - state

$$\dot{Q} = \dot{s} = 0$$

$$Q^{*} = -\left(\frac{k_2}{k_1}\right) s^{*} + \left(\frac{\beta}{k_1}\right) J^{*} + \left(\frac{k_2}{2s_M}\right)\left(s^{*} \right)^2$$

$$k_1 = \frac{\psi_2}{\psi}\left(r - \theta\right) - \beta\rho$$

$$k_2 = \eta\beta\left(\frac{r}{\psi} - \rho + \theta\right)$$

Cointegration equation

- Causality test

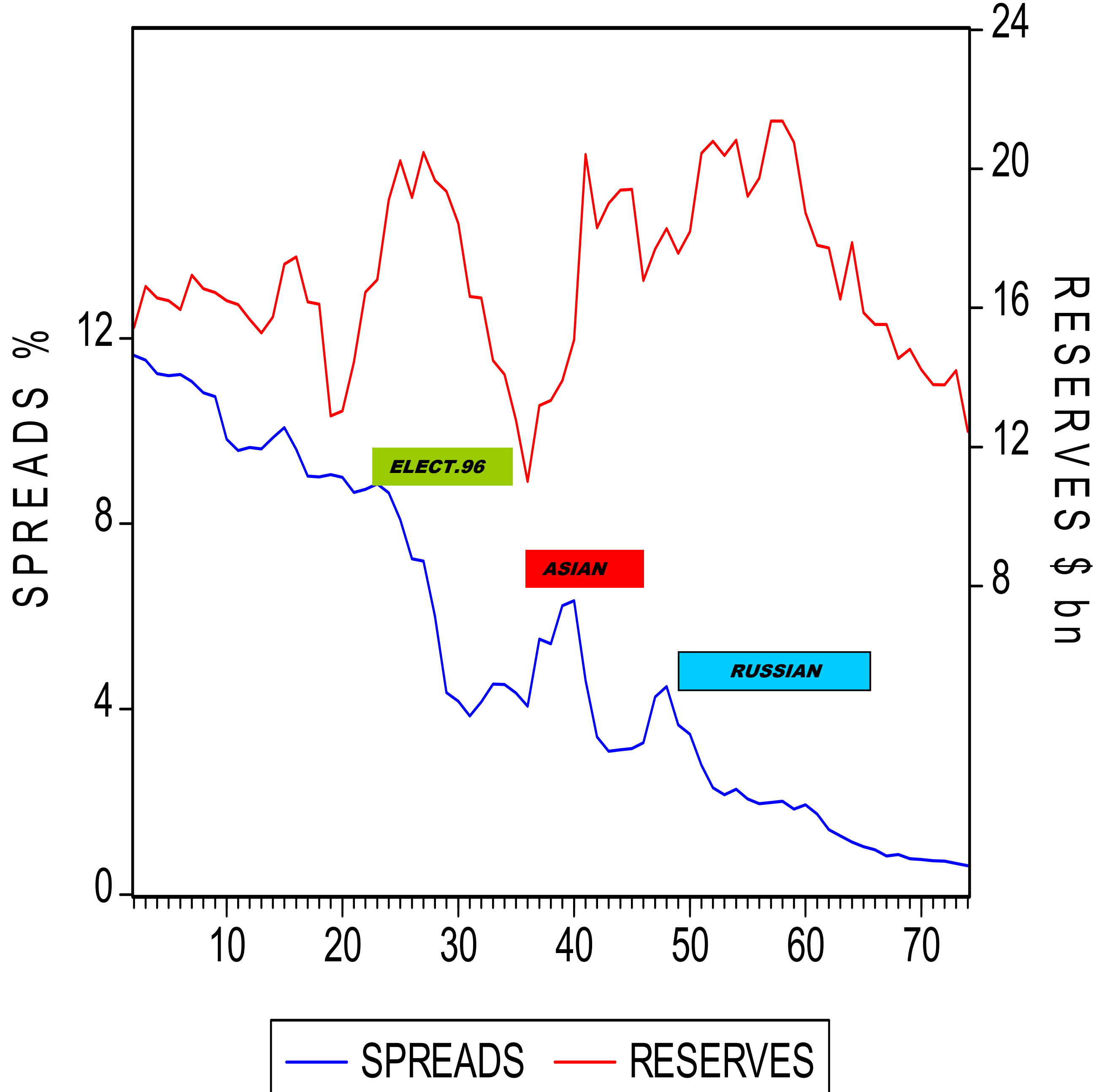
- Cointegration of degree 1

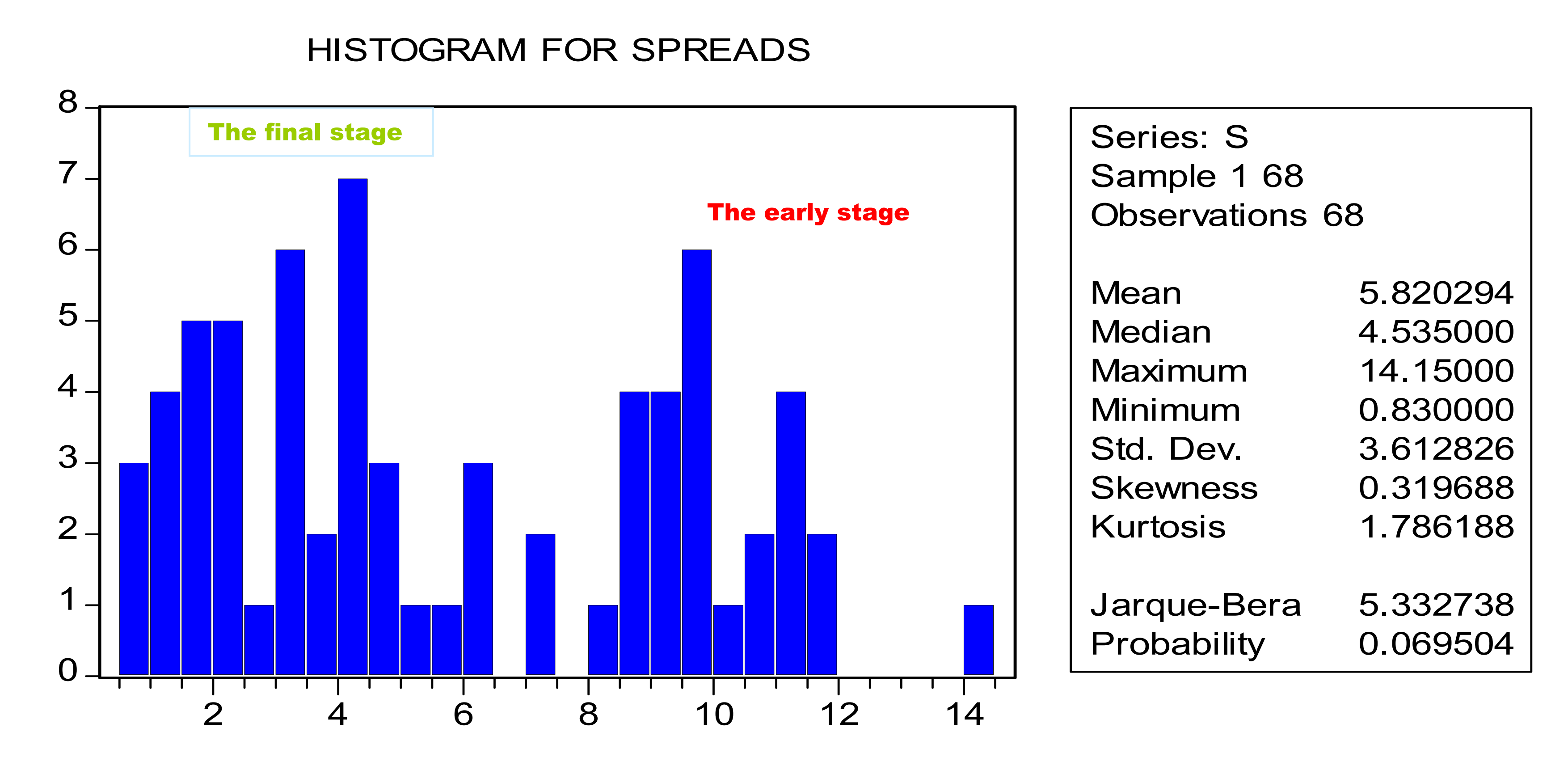
- Lags specification

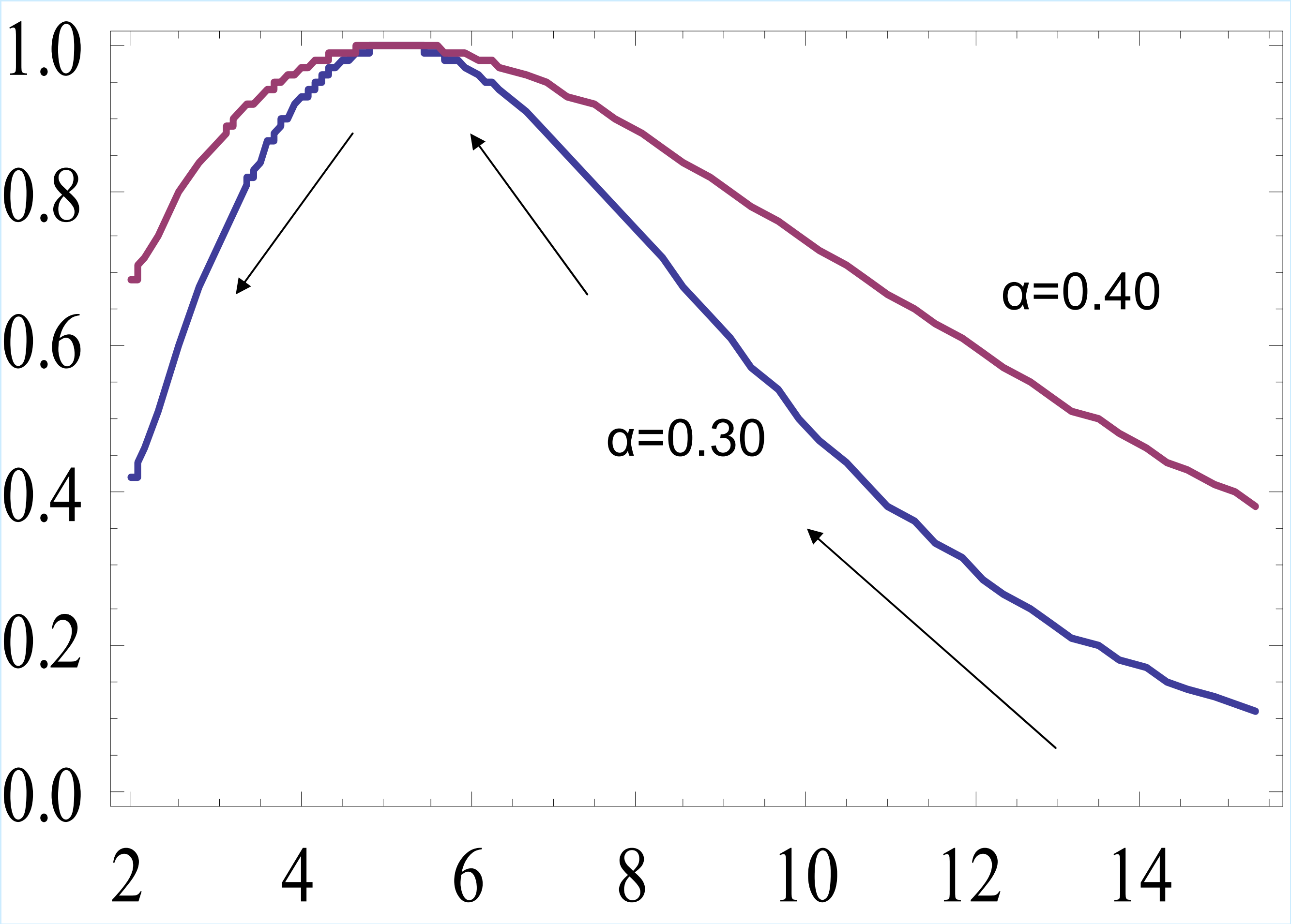
- Recover structural parameters

$(\ \beta, \quad \psi,. \quad \eta, \quad \psi_1, \quad \psi_2, \quad \psi_0)$

MONTHLY DATA Nov. 1994 - Dec. 2000




HISTOGRAM FOR SPREADS
The final stage
The early stage
8
7
6
5
4
3
2
1
0
2
4
6
8
10
12
14
Series: S
Sample 1 68
Observations 68
Mean 5.820294
Median 4.535000
Maximum 14.15000
Minimum 0.830000
Std. Dev. 3.612826
Skewness 0.319688
Kurtosis 1.786188
Jarque-Bera 5.332738
Probability 0.069504



SPREADS %

Hypothesis	Test	Critical Value 5%	Statistic	Prob.	Conclusion
Spread Unit Root Δ(Spread) Reserves Unit Root Δ(Reserves)	ADF	-2.902	-1.007 -7.891 -2.040 -8.510	0.75 0 0.26 0	NR R NR R
Causality ΔQ No G-C (ΔS) Δs No G-C (ΔQ)	Granger		 4.82 3.32	 0.002 0.015	 R R
<u>Q, s, J</u> Cointegrated (no trend) None None At most 1 At most 1	 Trace Max e-value Trace Max e-value	 29.80 21.13 15.49 14.26	 47.80 39.78 8.02 5.94	 $2x10^{-4}$ $1x10^{-4}$ 4.63 6.19	 R R NR NR

<u>Table 1</u>. Statistical tests for Spreads, Reserves and the Current Account (J). Monthly data, sample period Nov. 1994-Dec. 2000. (R: Reject the hypothesis at the 5% level, NR: Not Rejected at 5%, G-C: Granger-causes).

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Statistic	Trace 0.05 Critical Value	Prob.**
None *	0.488225	67.64977	47.85613	0.0003
At most 1	0.186213	24.10821	29.79707	0.1959

Normalized cointegrating coefficients (*standard *error in parentheses)

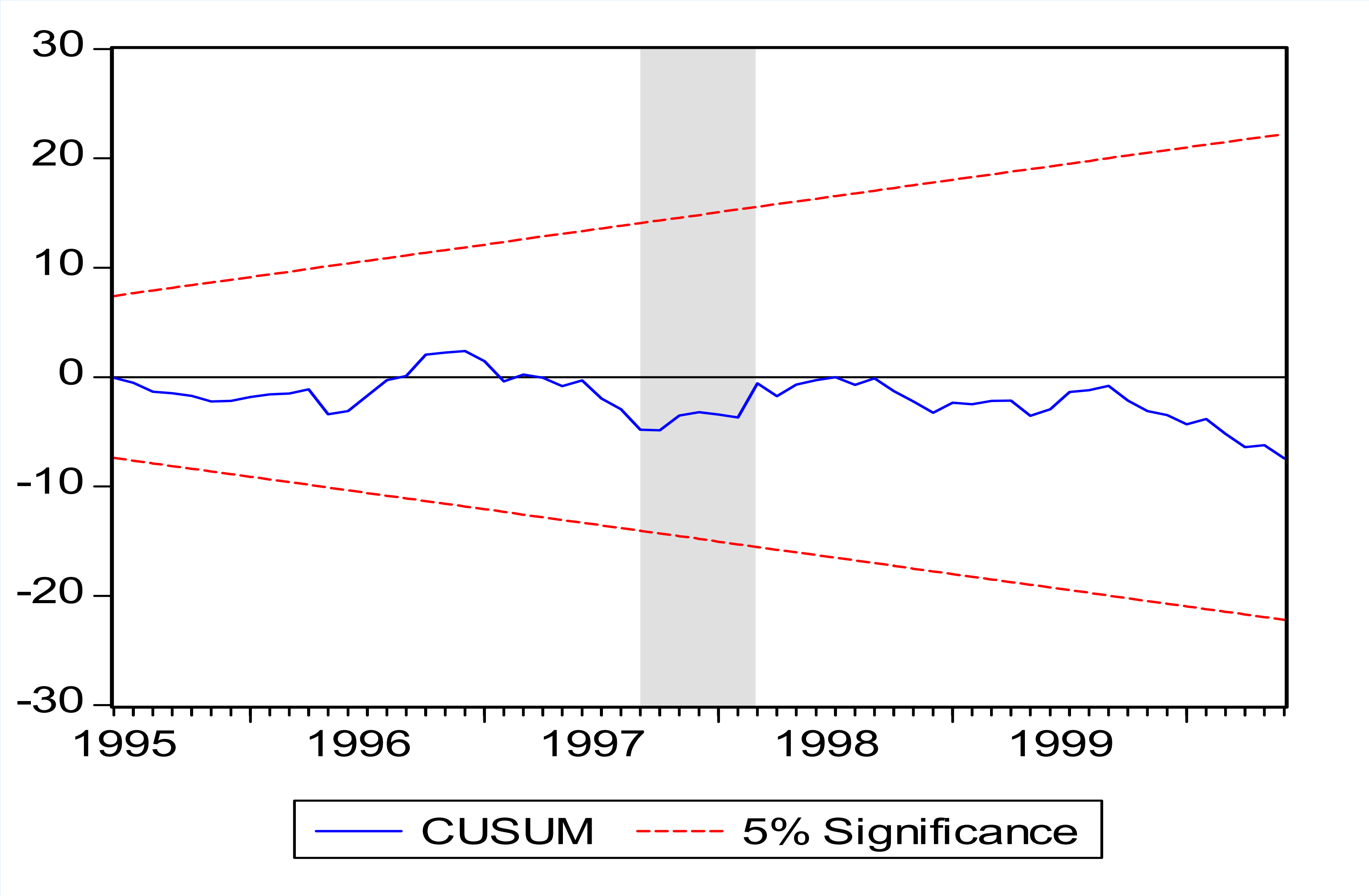
Q	S	S2	CACC
1.000000	2.045346	-0.146938	-16.09415
	(0.74104)	(0.05864)	(2.09965)

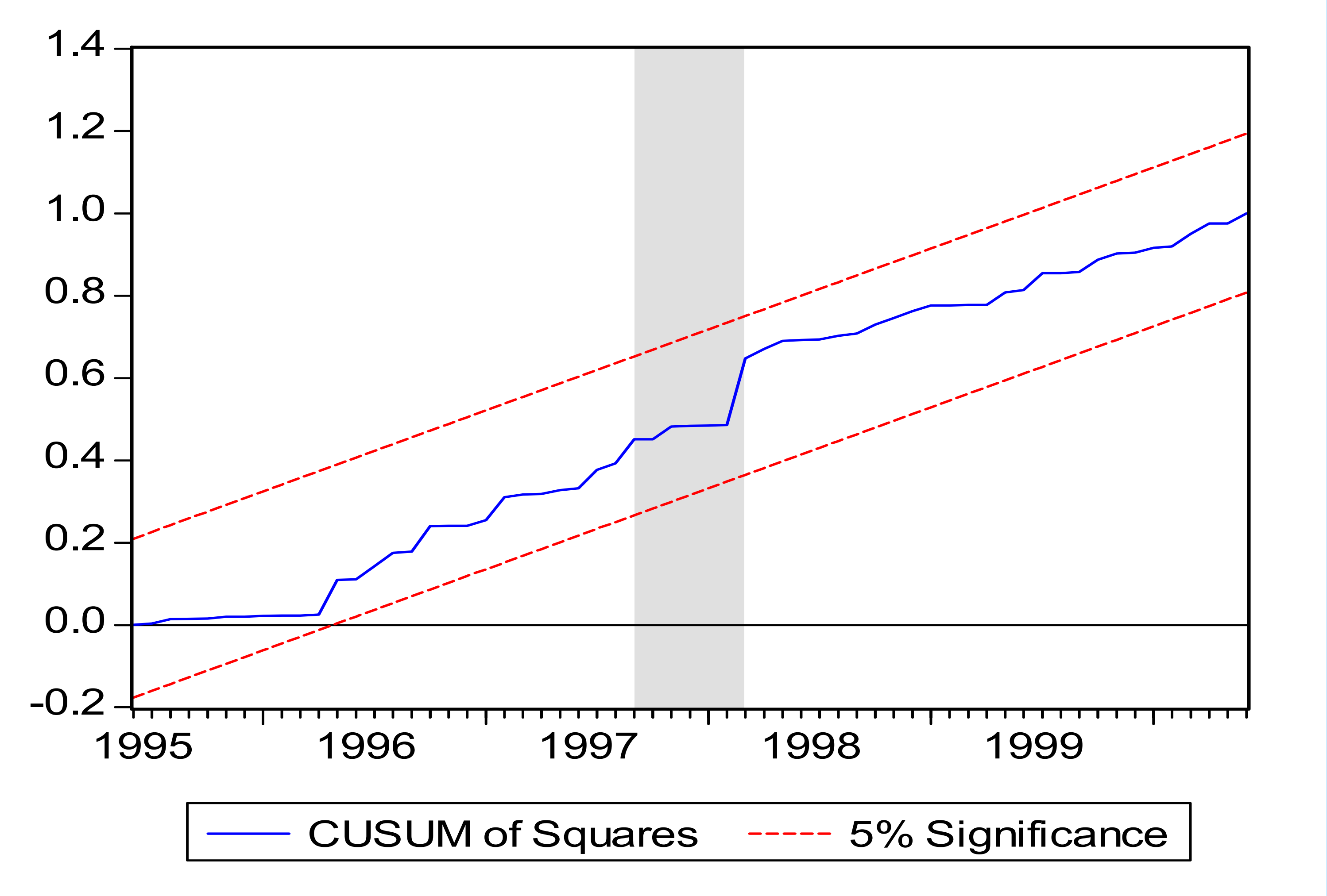
Dependent Variable: DQ
Method: Least Squares

Sample (adjusted): 1994M12 2000M06
Included observations: 67 after adjustments

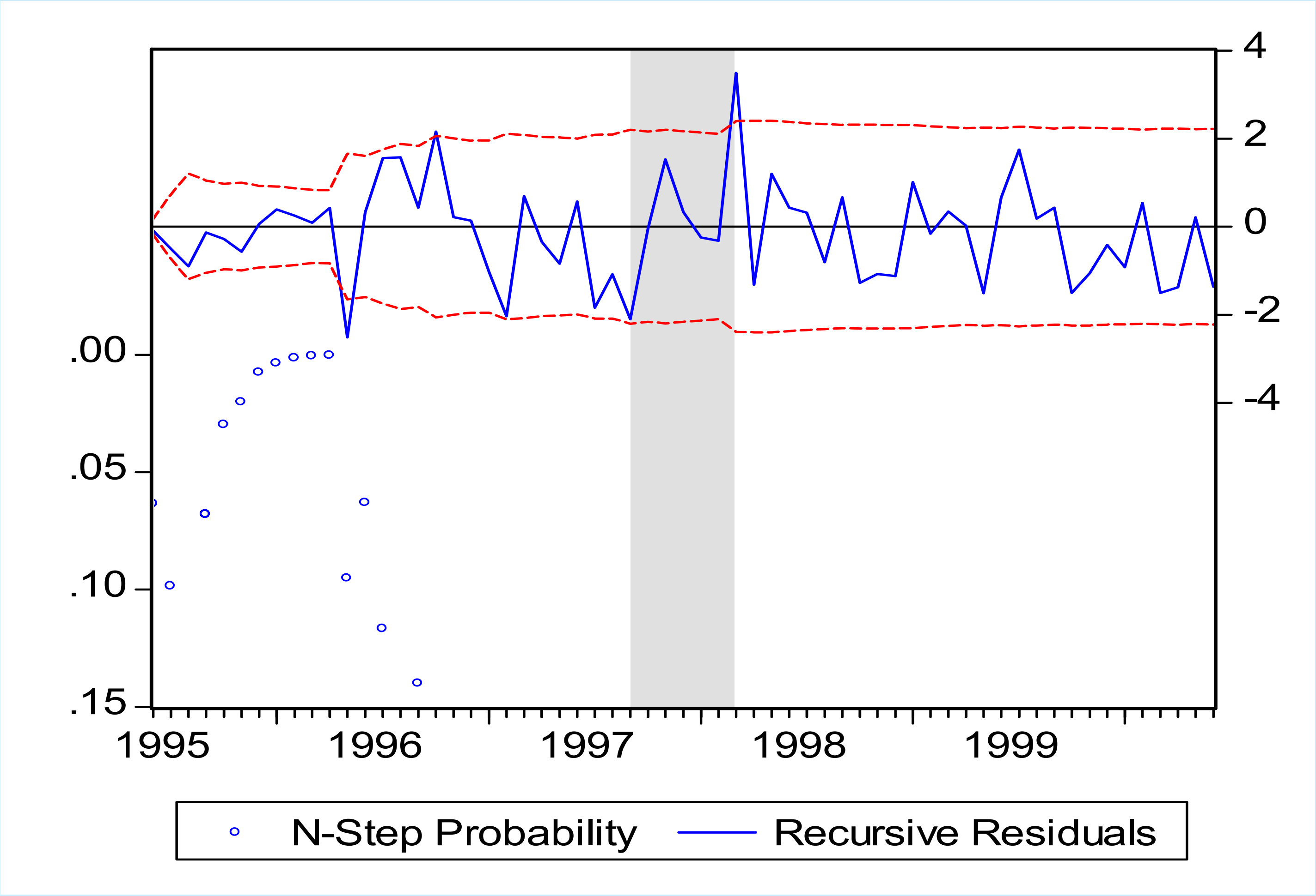
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.110643	2.352170	3.023014	0.0037
RGRM	-0.369355	0.225321	-1.639243	0.1063
Q(-1)	-0.261975	0.069669	-3.760294	0.0004
CURR ACC	1.052764	0.335577	3.137176	0.0026
S(1)*(1-0.0869*S)	-2.641697	0.551879	-4.786737	0.0000
S*(1-0.0869*S)	2.376547	0.583235	4.074765	0.0001

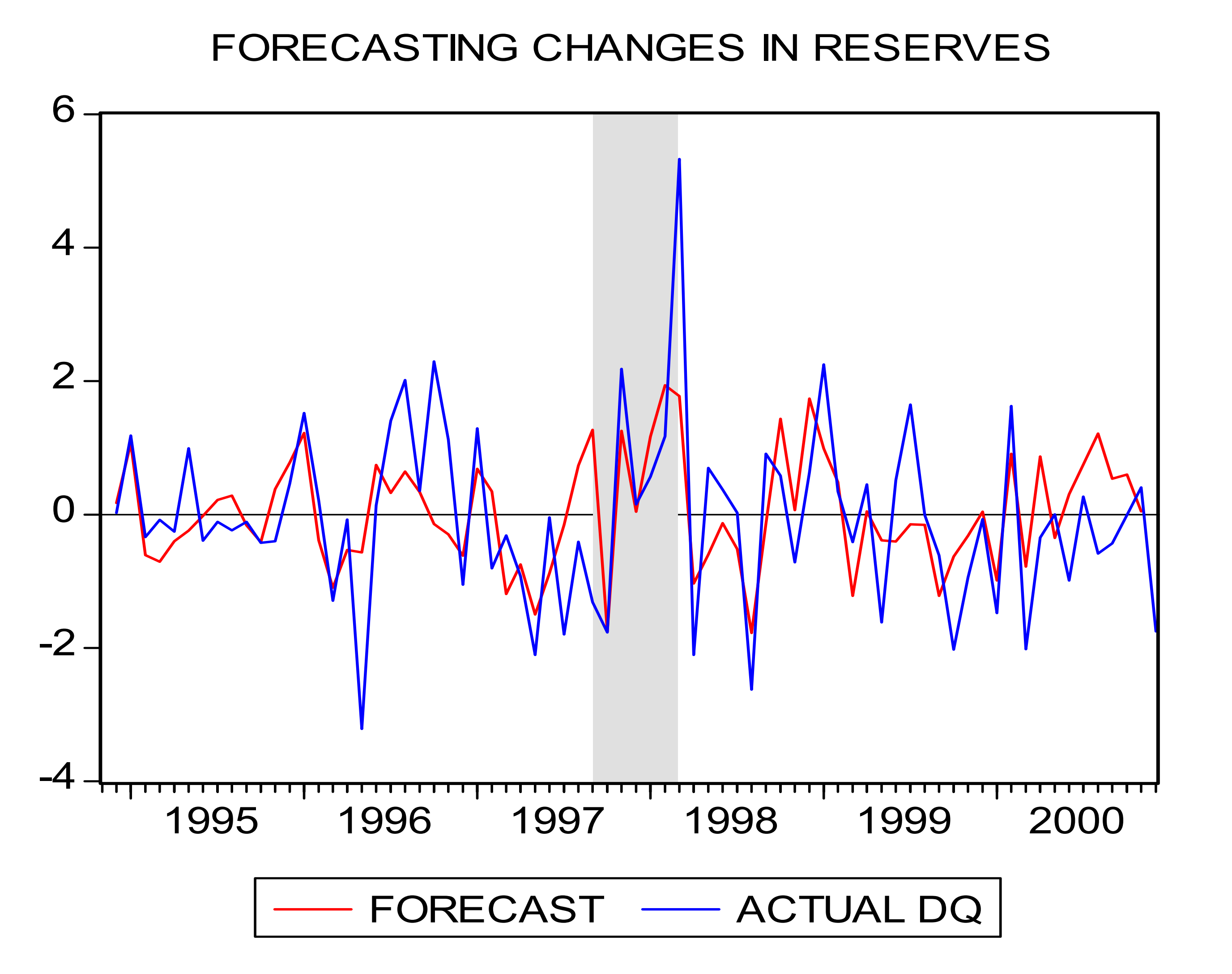
R-squared	0.387204	Mean dependent var	-0.012949
Adjusted R-squared	0.336975	S.D. dependent var	1.364062
S.E. of regression	1.110706	Akaike info criterion	3.133154
Sum squared resid	75.25373	Schwarz criterion	3.330590
Log likelihood	-98.96067	F-statistic	7.708746
Durbin-Watson stat	2.061814	Prob(F-statistic)	0.000011


30
20
10
0
-10
-20
-30
1995
1996
1997
1998
1999
CUSUM
5% Significance



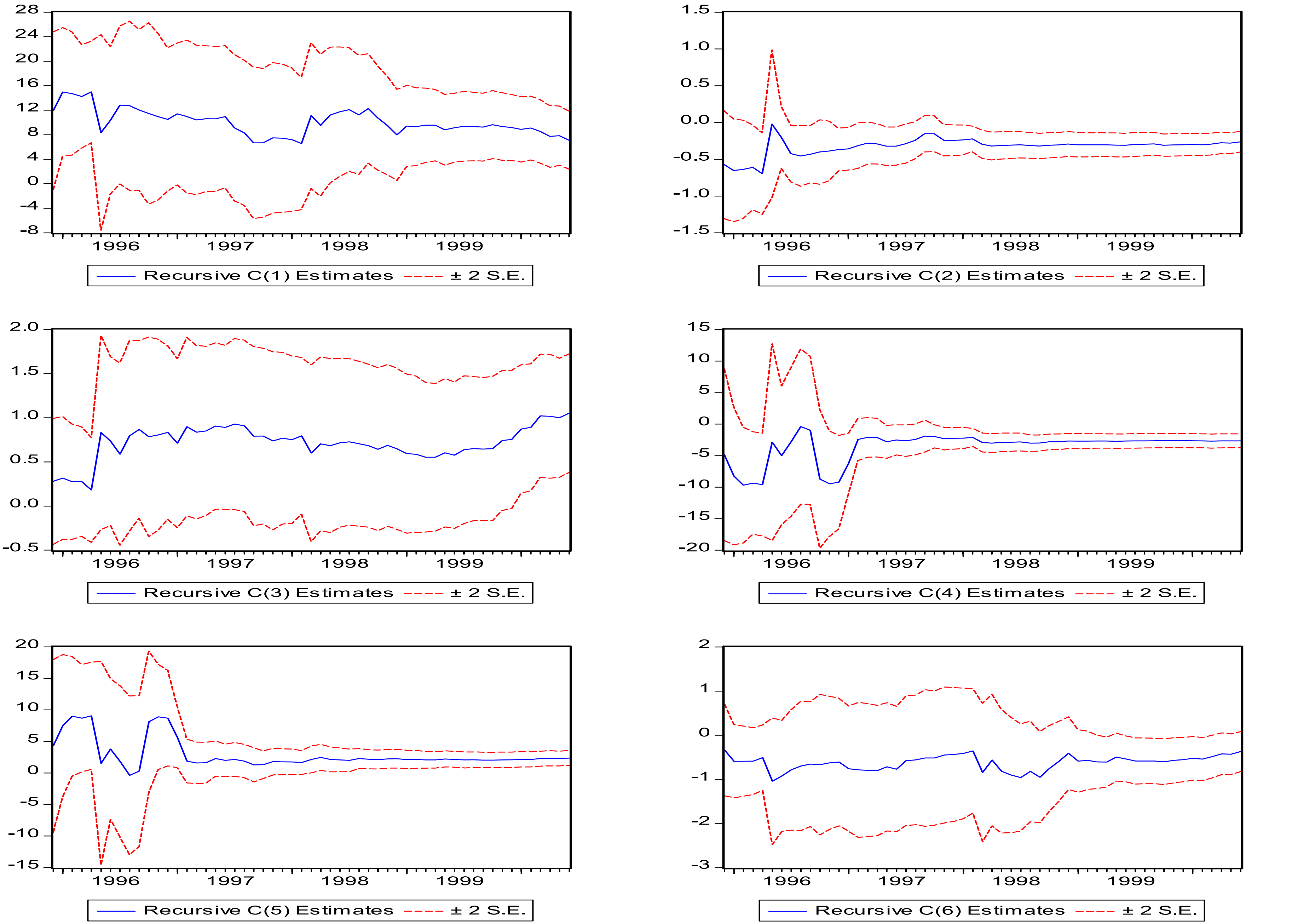
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
1995
1996
1997
1998
1999
CUSUM of Squares
5% Significance

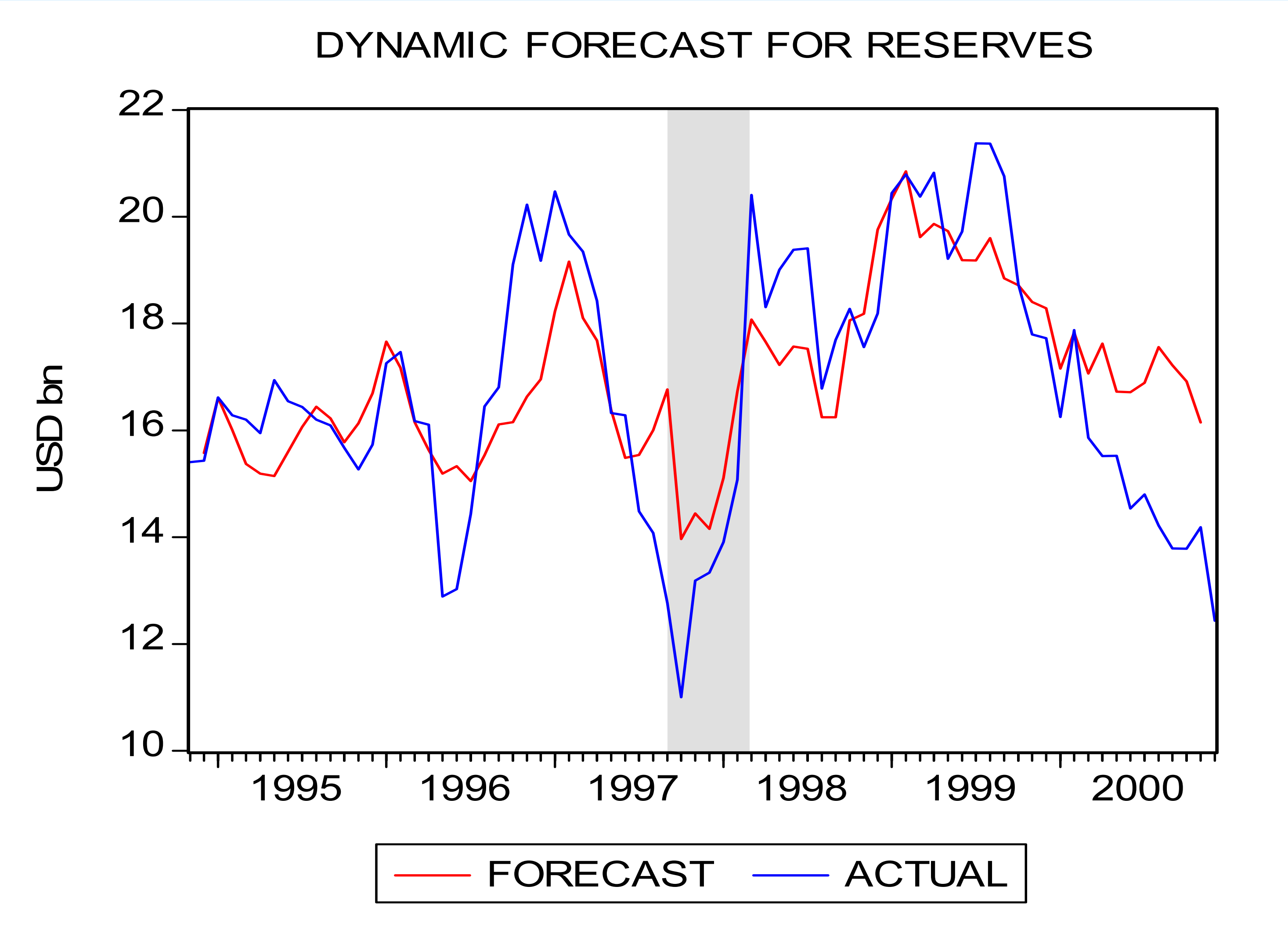

4
2
0
-2
-4
.00
.05
.10
.15
1995
1996
1997
1998
1999
N-Step Probability
Recursive Residuals



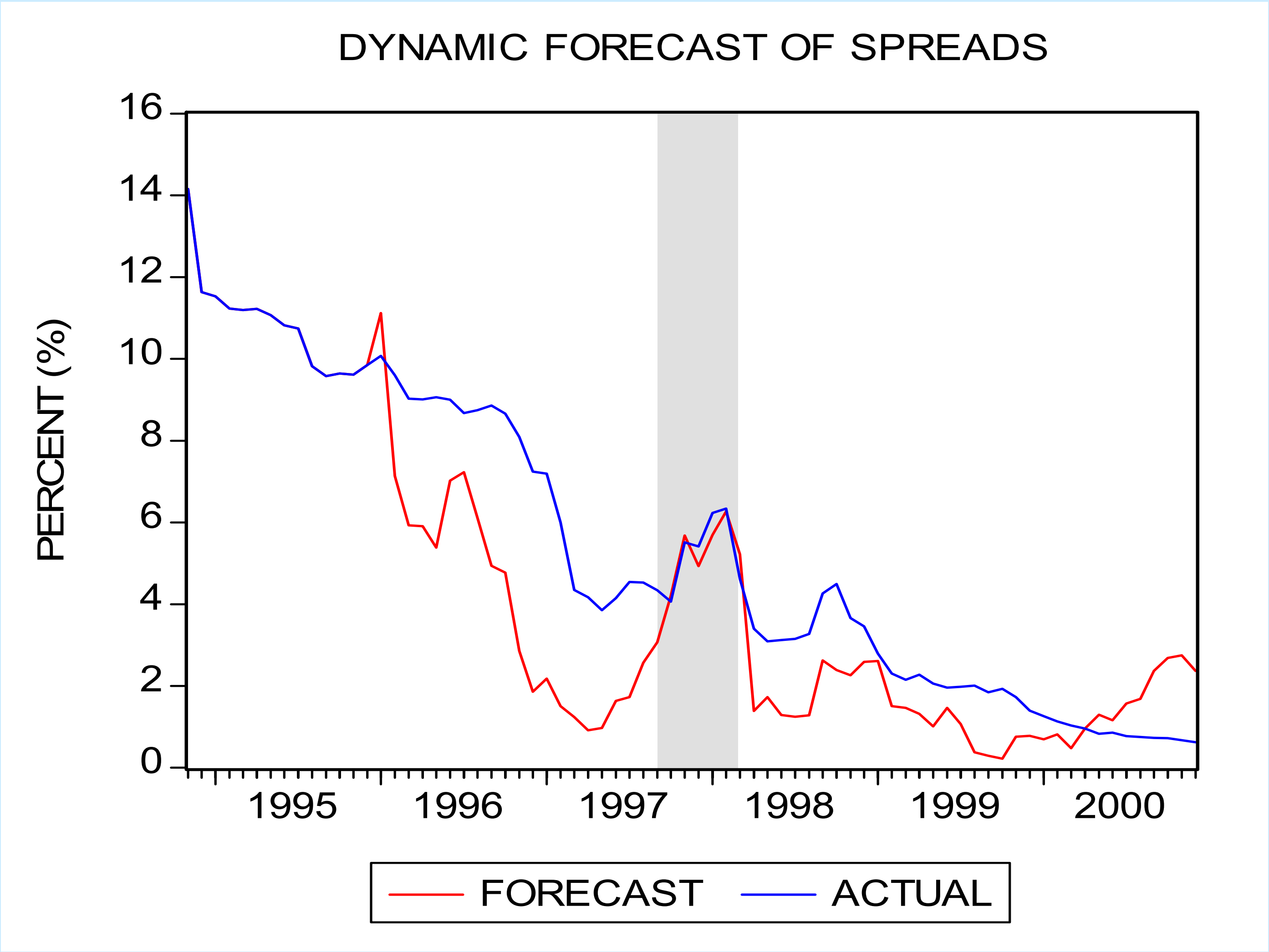
FORECASTING CHANGES IN RESERVES
6
4
2
0
-2
-4
1995
1996
1997
1998
1999
2000
FORECAST
ACTUAL DQ

RECURSIVE COEFFICIENTS





DYNAMIC FORECAST FOR RESERVES
USD bn
22
20
18
16
14
12
10
1995
1996
1997
1998
1999
2000
FORECAST
ACTUAL


DYNAMIC FORECAST OF SPREADS
PERCENT (%)
16
14
12
10
8
6
4
2
0
1995
1996
1997
1998
1999
2000
FORECAST
ACTUAL

Weighting β=0.90	Cautious Central Bank
Elasticity η=1.97	High
Risk aversion ψ=0.64	Medium
Discount rate θ= 2 %	Front- Loaded
ψ1=0.18, ψ2=0.046, ψ0=0.39	
Stock ratio F=40 $bn	Plausible (39% of stock)
Demand-max spread = 5.75%	In 1997-98, avg = 4.6%

THE END

ΣΑΣ ΕΥΧΑΡΙΣΤΩ ΠΟΛΥ !