A STUDY OF THE COMPARATIVE PERFORMANCE OF THE STATE SPACE MODEL-BASED AND THE ARIMA MODEL-BASED METHODS OF SEASONAL ADJUSTMENT

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ARIMA MODEL-BASED METHODS

1. CLEVELAND (1972): SIGNAL EXTRACTION METHOD
2. CLEVELAND & TIAO (1976): SIGNAL EXTRACTION METHOD
3. BOX, HILLMER & TIAO (1978): SIGNAL EXTRACTION METHOD
4. BURMAN (1980): SIGNAL EXTRACTION METHOD.
5. HILLMER AND TIAO (1982):CANONICAL DECOMPOSITION METHOD.

I HAVE USED BURMAN'S ARIMA MODEL BASED METHOD FOR COMPARISON IN THIS PAPER

BURMAN'S ARIMA MODEL-BASED METHOD

(i) FIND THE OPTIMAL (MINIMUM AIC) ARIMA MODEL FOR THE SERIES UNDER CONSIDERATION

(ii) ESTIMATE THE OPTIMAL ARIMA MODEL BY MAXIMUM LIKELIHOOD METHOD

(iii) THE PARAMETER ESTIMATES AND THE FORECASTS AND BACKCASTS OF THE CHOSEN MODEL ARE USED TO PARTITION THE MODEL SPECTRUM, GENERATE THE TREND AND SEASONAL FILTERS WHICH ARE THEN APPLIED TO THE SERIES TOGETHER WITH ITS FORECASTS AND BACKCASTS.

(iv) IF THERE ARE OUTLIERS(AO or LEVEL SHIFT) IN THE SERIES, THAT SERIES IS FIRST ADJUSTED FOR THOSE OUTLIERS BEFORE ARIMA MODEL IS ESTIMATED FOR THAT SERIES

STATE SPACE MODEL-BASED METHOD

(i) THIS METHOD USES STRUCTURAL UNOBSERVED COMPONENT MODELS IN STATE SPACE FORM

(ii) MODEL IS ESTIMATED BY THE ITERATIVE TECHNIQUES OF **KALMAN** FILTERING AND SMOOTHING.

(iii)HYPER-PARAMETERS (RELATIVE VARIANCES) OF THE MODEL ARE ESTIMATED BY **EM** ALGORITHM AND A **QUASI-NEWTON** METHOD SUCH AS DFP METHOD

(iv) INITIAL CONDITIONS: DIFFUSE PRIOR FOR THE FIRST ITERATION AND THEN ON THE SMOOTHED ESTIMATES OF THE STATE VECTOR AND ITS CORRESPONDING COVARIANCE MATRIX AT TIME t=0.

APPLICATION TO TWO BLS SERIES

(1) UNEMPLOYMENT OF MALE CIVILIAN WORKERS BETWEEN 16 & 19 (1/1983 - 12/1990) (UM1)

(2) CPI OF WOMEN'S DRESSES(1/1984 - 12/1991) (WDR)

OPTIMAL STRUCTURAL MODEL FOR UM1 (**OSM**)

$$y_t = \mu_t + \gamma_t + \varepsilon_t \tag{1.1}$$

$$\mu_t = 2\mu_{t-1} - \mu_{t-2} + \eta_t \tag{1.2}$$

$$\gamma_t = \gamma_{t-12} + \omega_{1t} \tag{1.3}$$

$$\gamma_t = -\sum_{j=1}^{11} \gamma_{t-j} + \omega_{2t} \tag{1.4}$$

see Kitagawa and Gersch [1984]. The errors $\varepsilon_t, \eta_t, \omega_{1t}$ and ω_{2t} are assumed to be serially and contemporaneously uncorrelated with means zeros and finite variances.

OPTIMAL ARIMA MODEL FOR UM1 (**BRM**)

(011)(011)12

OPTIMAL STRUCTURAL MODEL
WDR
(**OSM**)

$$y_t = \mu_t + \gamma_t + \sum_{j=1}^{3} \alpha_{jt} I_{jt} + \varepsilon_t \qquad (2.1)$$

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t + \theta_1 \eta_{t-1} + \theta_2 \eta_{t-2} \qquad (2.2)$$

TRIGNOMETRIC MODEL OF SEASONALITY (2.3)
(SEE HARVEY'S BOOK FSTSMKF)

$$\alpha_{jt} = \alpha_{jt-1} + \phi_t \qquad (2.4)$$

All the symbols have similar meaning as in the model for UM1.

OPTIMAL ARIMA MODEL
FOR WDR
(**BRM**)

(410)(011)12

INTERVENTIONS INCORPORATED IN THE OSM MODEL OF THE STATE SPACE MODEL-BASED METHOD FOR THE **WDR** SERIE

(I) $I_{1t} = 0 \quad t < 1987\text{-}03$

$\quad\;\; = 1 \quad t > 1987\text{-}02$

(2) $I_{2t} = 0 \quad t < 1988\text{-}04$

$\quad\;\; = 1 \quad t > 1988\text{-}03$

(3) $I_{3t} = 0 \quad t < 1990\text{-}03$

$\quad\;\; = 1 \quad t > 1990\text{-}02$

OUTLIERS AUTOMATICALLY DETECTED BY THE BURMAN'S COMPUTER PROGRAM FOR THE **WDR** SERIES

(1) 1988-07

(2) 1990-03

NOTE: FOR THE **UM1** SERIES NO INTERVENTION INCORPORATED IN THE OSM MODEL. AND BURMAN'S PROGRAM DID NOT DETECT ANY OUTLIER FOR THIS SERIES.

STATE SPACE REPRESENTATION OF THE STRUCTURAL MODEL

$$y_t = z_t \alpha_t + \xi_t$$

$$\alpha_t = T\alpha_{t-1} + R\eta_t$$

$E\xi_t = 0$; $E\eta_t = 0$.

σ^2 = SGMASQ IS TO BE ESTIMATED.

$Q = V(\eta_t)$ IS TO BE ESTIMATED

$\alpha_0, P_0 = V(\alpha_0)$ ARE ALSO ESTIMATED AFTER THE FIRST ITERATION

EVALUATION OF SSMB AND AMBM METHODS

TWO ASPECTS

1. EVALUATION OF THE STRUCTURAL & ARIMA MODELS

2. EVALUATION OF THE SEASONAL ADJUSTMENT BY THE TWO METHOD

<u>THE MODELS ARE EVALUATED FOR:</u>

1. ADEQUACY OF THE MODEL TO EXPLAIN THE SERIES

    (i) CUSUM GRAPHS

    (ii) LJUNG-BOX Q* STATISTICS

    (iii) BDS & MBDS STATISTICS

2. GOODNESS OF FIT OF THE MODEL

    (i) AIC

    (ii) RBARSQ, RBARSQ(DIF),RBARSQ(SEAS)

    (iii) SGMASQ

NOTE: AIC ARE ALSO USED FOR CHOOSING THE OPTIMAL MODEL

3. FORECASTING PERFORMANCE OF A MODEL

    (i) MPESS

    (ii) POST SAMPLE PREDICTION GRAPHS

QUALITY OF SEASONAL ADJUSTMENT IS EVALUATED FOR:

(i) SMOOTHNESS OF TREND

(ii) SMOOTHNESS OF SEASONALLY ADJUSTED SERIES

(iii)ORTHOGONALITY BETWEEN SEASONALLY ADJUSTED SERIES AND SEASONAL COMPONENT AND ALSO BETWEEN TREND AND SEASONAL COMPONENT

(iv) TEST FOR RESIDUAL SEASONALITY

(v) TESTS FOR STABLE & MOVING SEASONALITY

(vi) m7 STATISTICS

DRAWBACKS OF ARIMA-MODEL-BASED METHODS.

(i) DIFFICULT TO PICK THE OPTIMAL ARIMA MODEL FOR THE SERIES AS A WHOLE.

(ii) NO EXACT CRITERIA ARE AVAILABLE TO CHOOSE COMPONENT ARIMA MODELS FOR TREND, AND SEASONAL.

(iii)CANNOT ESTIMATE THE STANDARD ERRORS OF THE SEASONALLY ADJUSTED SERIES.

(iv) IF A SERIESIS AFFECTED BY OUTLIERS, THE SERIES HAS TO BE ADJUSTED FOR THAT, BEFORE SEASONAL ADJUSTMENT

Table 1. TESTS OF MIS-SPECIFICATION OF A MODEL

		ADEQUACY OF MODEL TESTS					OTHER DIAGNOSTIC TESTS				
		LJUNG-BOX CHI-SQUARE TESTS FOR DIFFERENT NUMBERS OF AUTO-CORRELATIONS IN RESIDUALS (degrees of freedom)			BDS	MBDS (Min/Max)	CHI-SQUARE TEST OF NON-LINEARITY IN RESIDUALS FOR DIFFERENT NUMBERS OF AUTOCORRELATIONS IN RESIDUALS (degrees of freedom)			F-TEST OF HETRO-SCHE-DASTI-CITY IN RESIDUALS (degrees of freedom)	CHI-SQUARE TEST OF NOR-MALITY OF RESIDUALS (degrees of freedom)
Series	Model	12	24	36			12	24	36		
UM1	OSM	9.61* (9)	17.63* (21)	25.64* (33)	0.40*	0.25/2.01*	11.08* (12)	23.74* (24)	28.46* (36)	0.85* (32,32)	1.23* (2)
	BRM	32.38 (10)	44.17 (22)	81.34 (34)	-0.53*	-1.49/-0.25*	10.19* (12)	21.98* (24)	34.06* (36)	0.83* (32,32)	1.05* (2)
WDR	OSM	12.18 (1)	40.86 (13)	56.42 (25)	2.59**	0.23/1.84*	12.95* (12)	23.30* (24)	32.73* (36)	0.39* (32,32)	0.28* (2)
	BRM	18.42** (7)	59.54 (19)	102.14 (31)	2.06*	-1.61/ 0.20*	0.78* (12)	34.99* (24)	36.04* (36)	0.19* (32,32)	1006.74 (2)

Note: One star (*) indicates that null hypthesis accepted at 5% level of significance;
Two stars (**) indicate that null hypothesis accepted at 1% level of significance

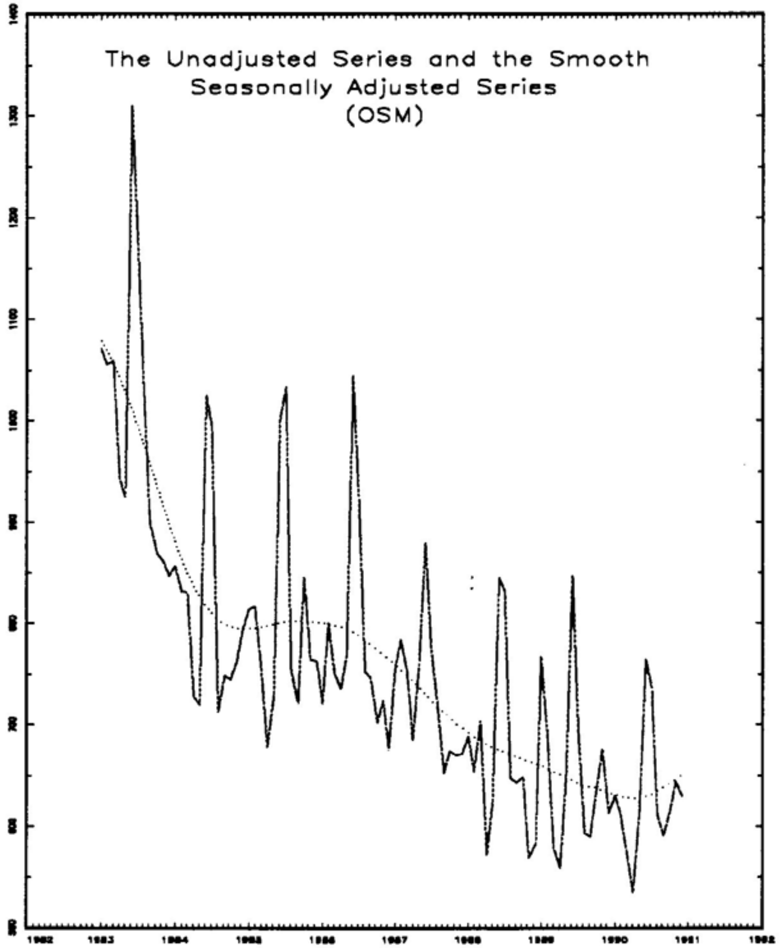
Table 2. GOODNESS OF FIT AND FORECASTING PERFORMANCE OF A MODEL

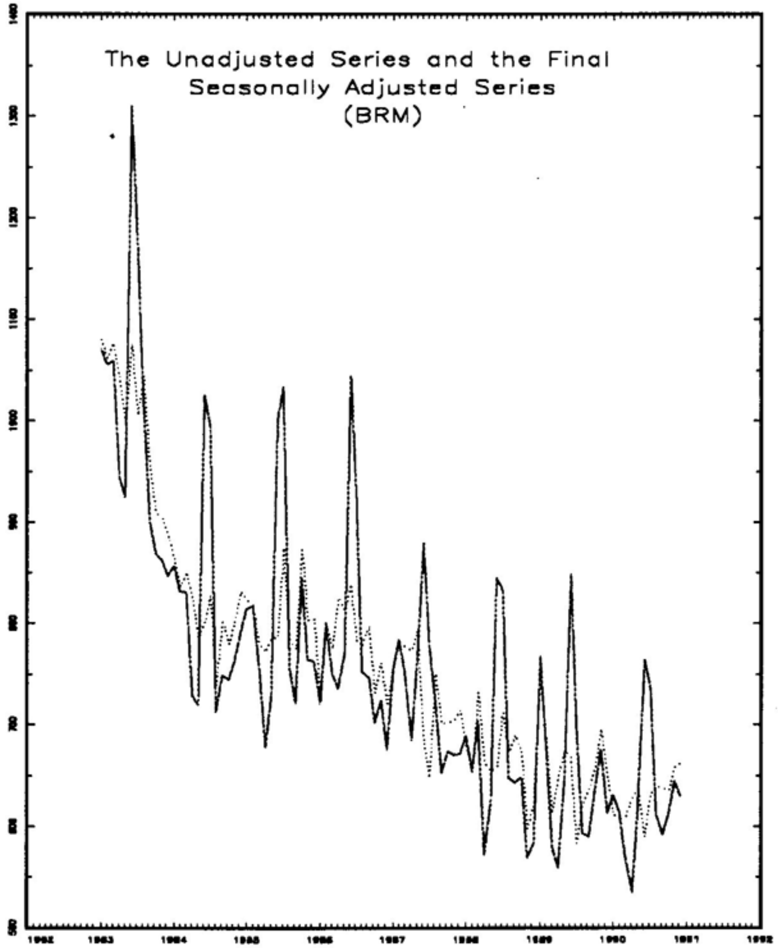
SERIES	MODEL	GOODNESS OF FIT					FORE-CASTING
		AIC	SGMASQ	RBARSQUARE			RMPESS
				Regular	Difference	Seasonal	
	OSM	851.41	1.00	0.88	0.78	0.24	62.11
UM1	BRM	785.47	824.94	0.96	0.93	0.75	131.62
	OSM	300.31	0.98	0.96	0.80	0.44	4.98
GAP	BRM	251.44	2.21	0.99	0.94	0.82	7.13

Table 3. QUALITY OF SEASONAL ADJUSTMENT

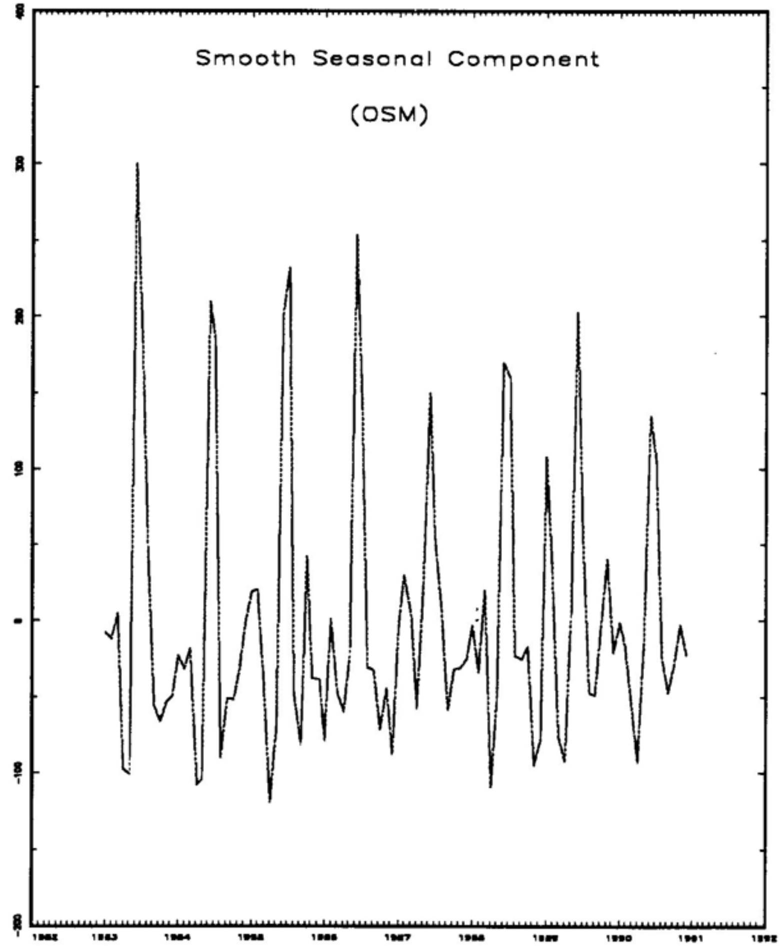
Series	Model	Presence of Seasonality			Identifiable Seasonality Measure	Orthogo-nality		Smoothness of Trend	Smoothness of Seasonally Adjusted Series
		Stable S. F(df)	Moving S. F(df)	Residual S. F(df)	m7	OG1	OG2	TRS	SAS
UM1	OSM	32.20 (11,77)	0.51* (7,77)	0.56* (11,84)	0.36	0.03	0.03	0.63	0.63
	BRM	25.78 (11,77)	2.69* (7,77)	0.00* (11,84)	0.54	0.03	0.01	0.78	4.71
WDR	OSM	16.06 (11,77)	96.51 (7,77)	0.16* (11,84)	3.04	0.07	0.04	0.04	1.48
	BRM	12.60 (11,77)	1.46* (7,77)	0.64* (11,84)	0.67	0.03	0.04	1.46	2.05

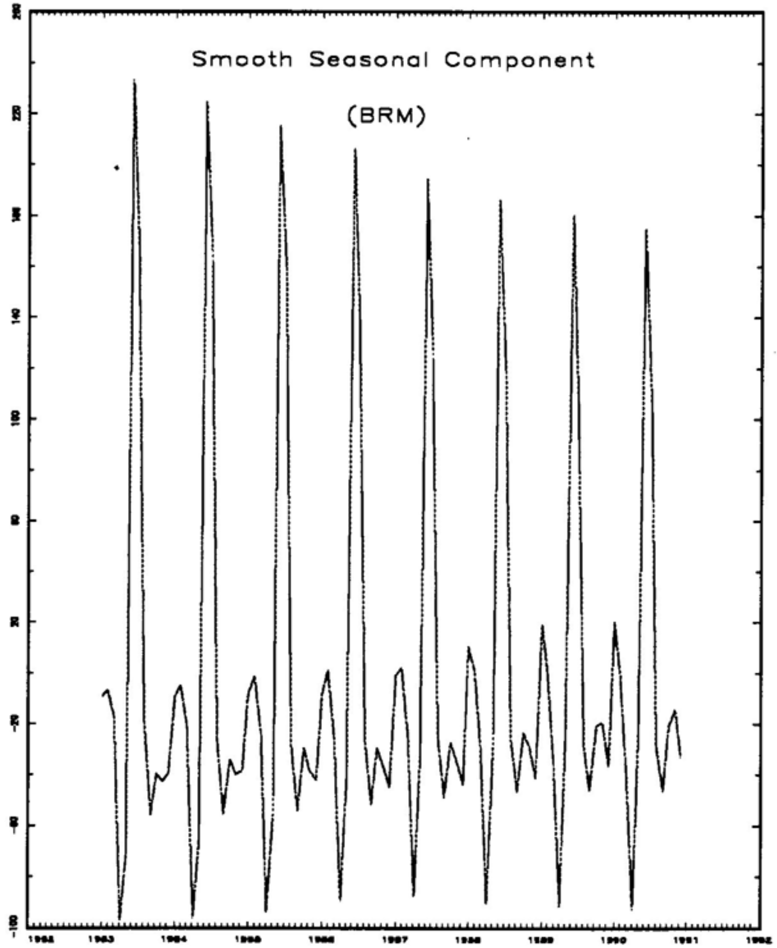
Note: One star (*) indicates that null hypthesis accepted at 5% level of significance;
Two stars (**) indicate that null hypothesis accepted at 1% level of significance





UNEMPLOYMENT LEVEL OF MALE CIVILIANS 16-19





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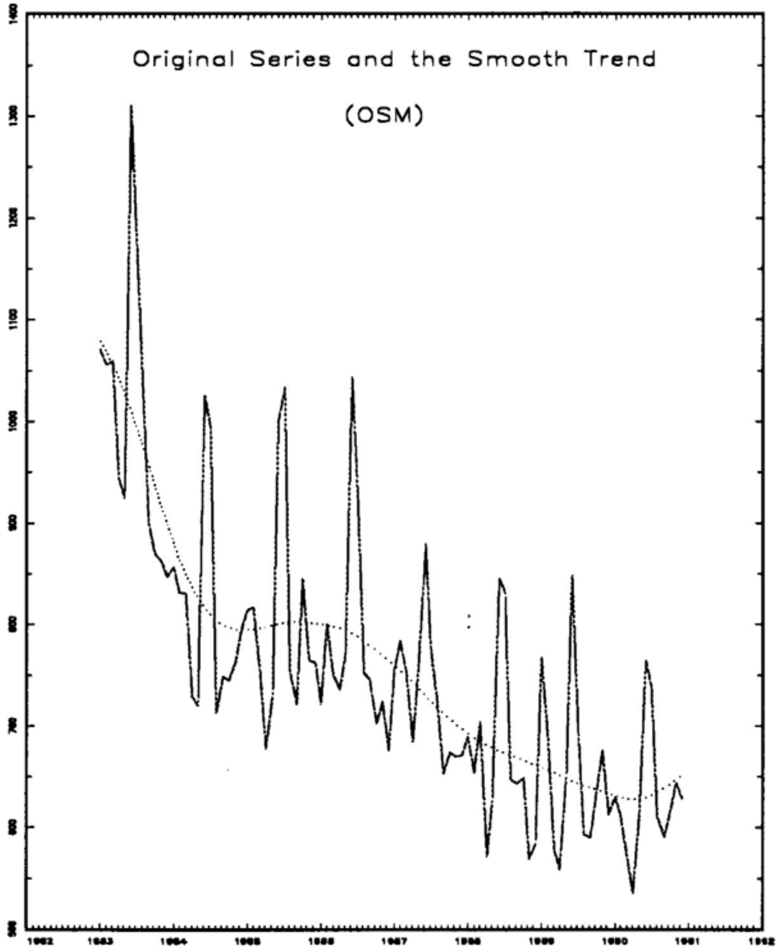

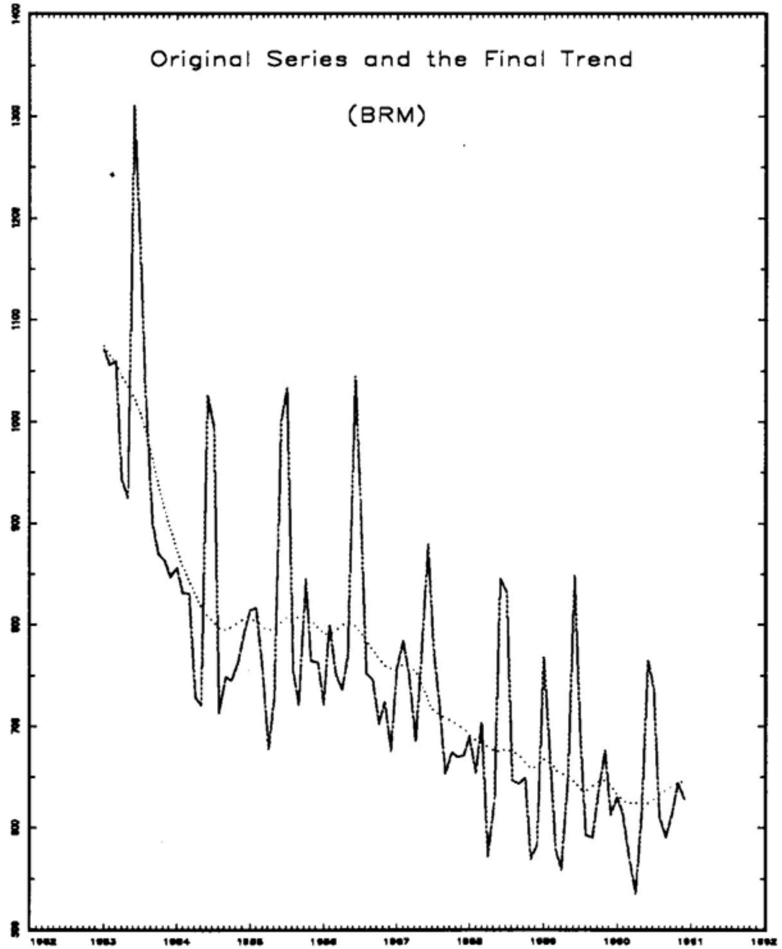

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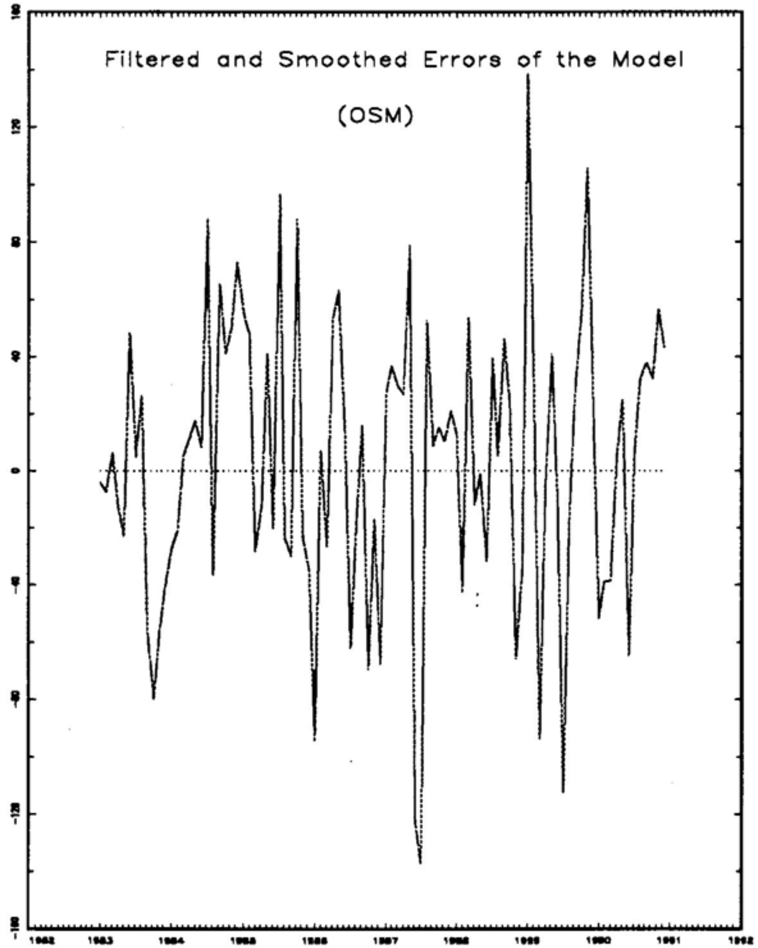

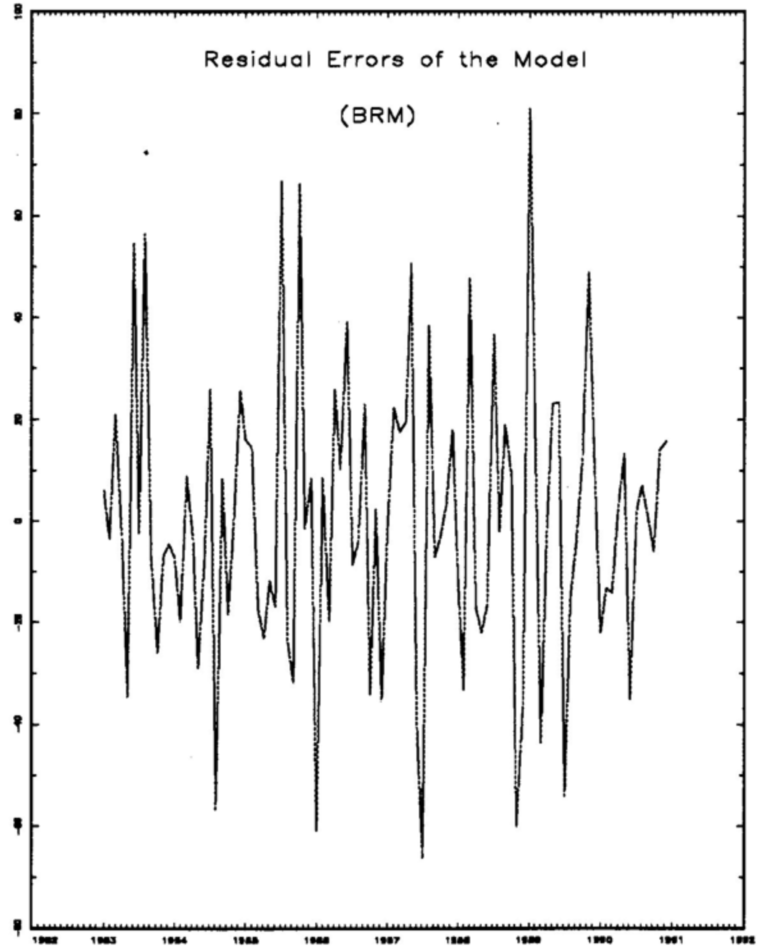

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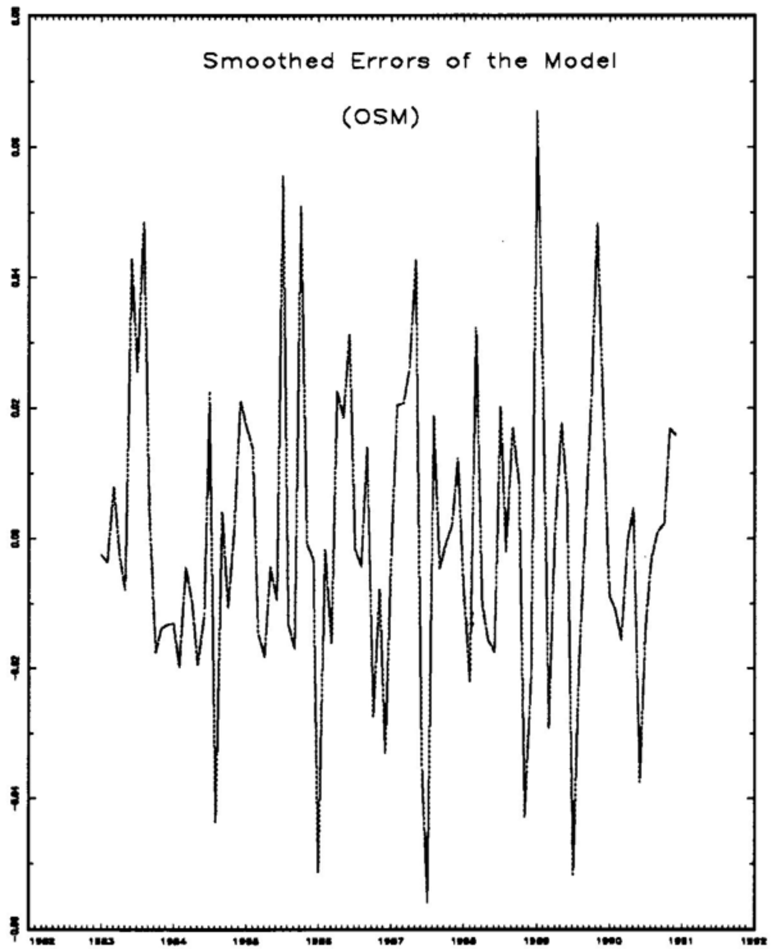

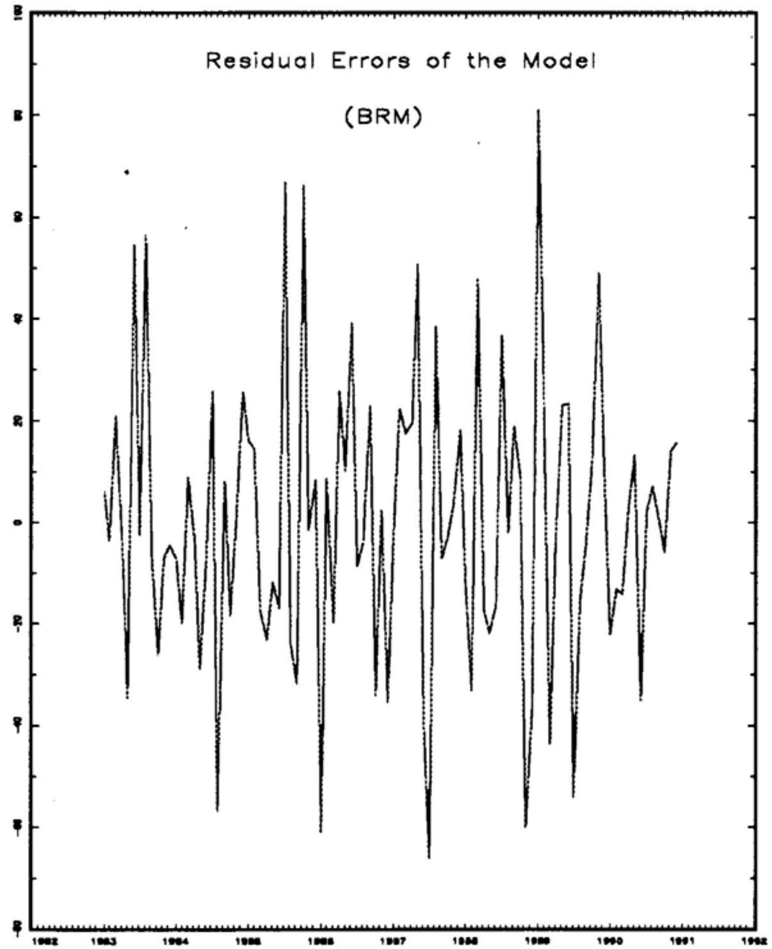

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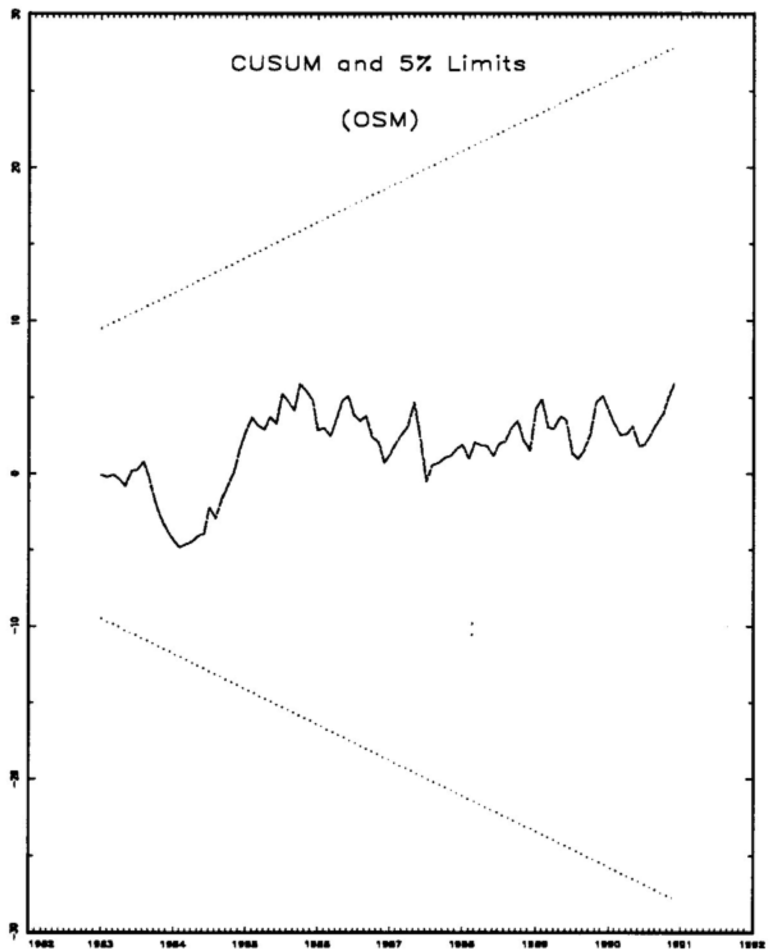

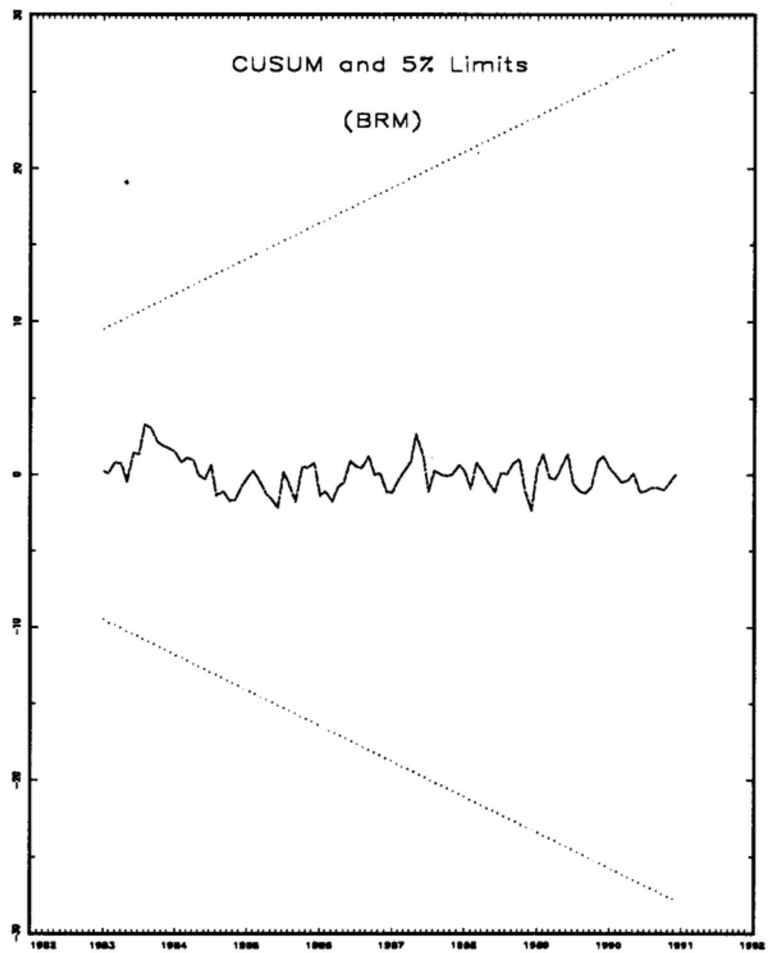

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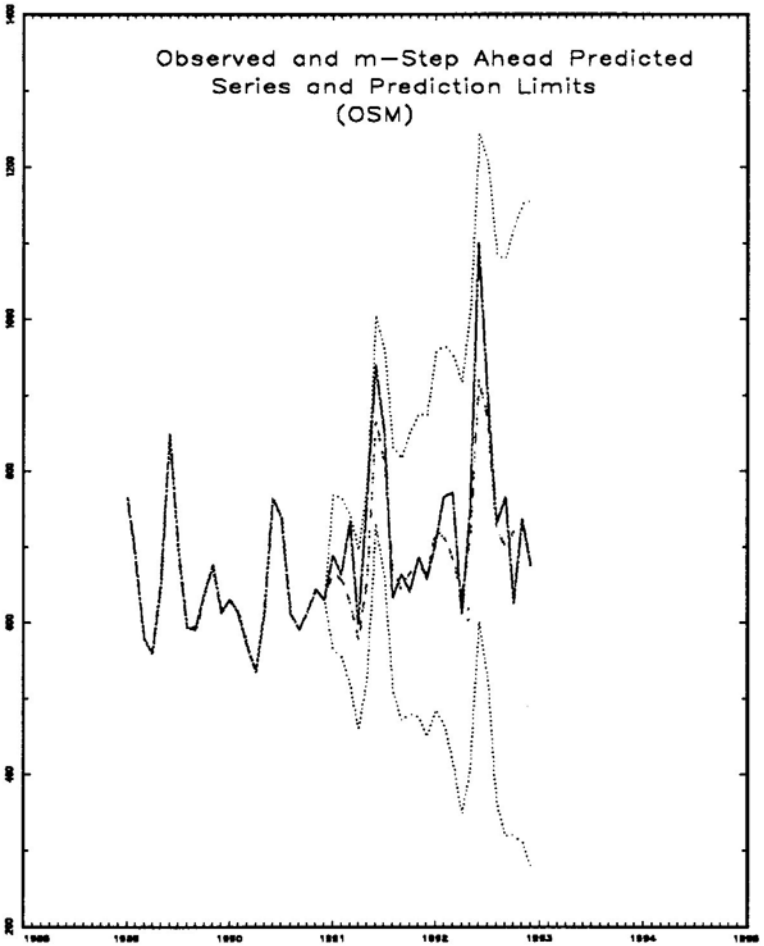

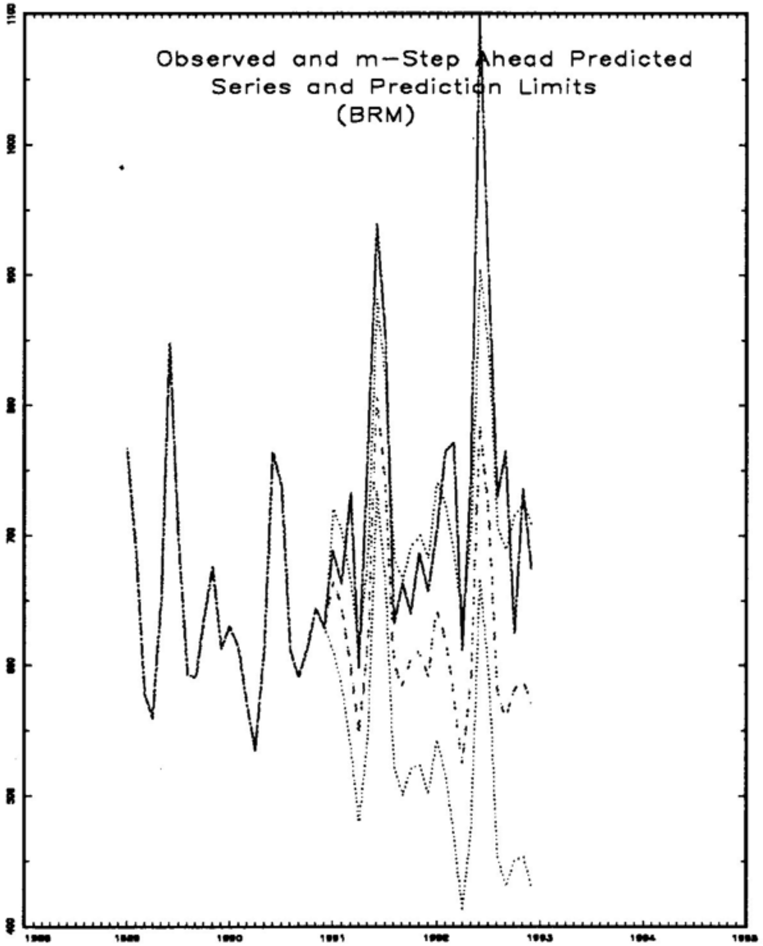

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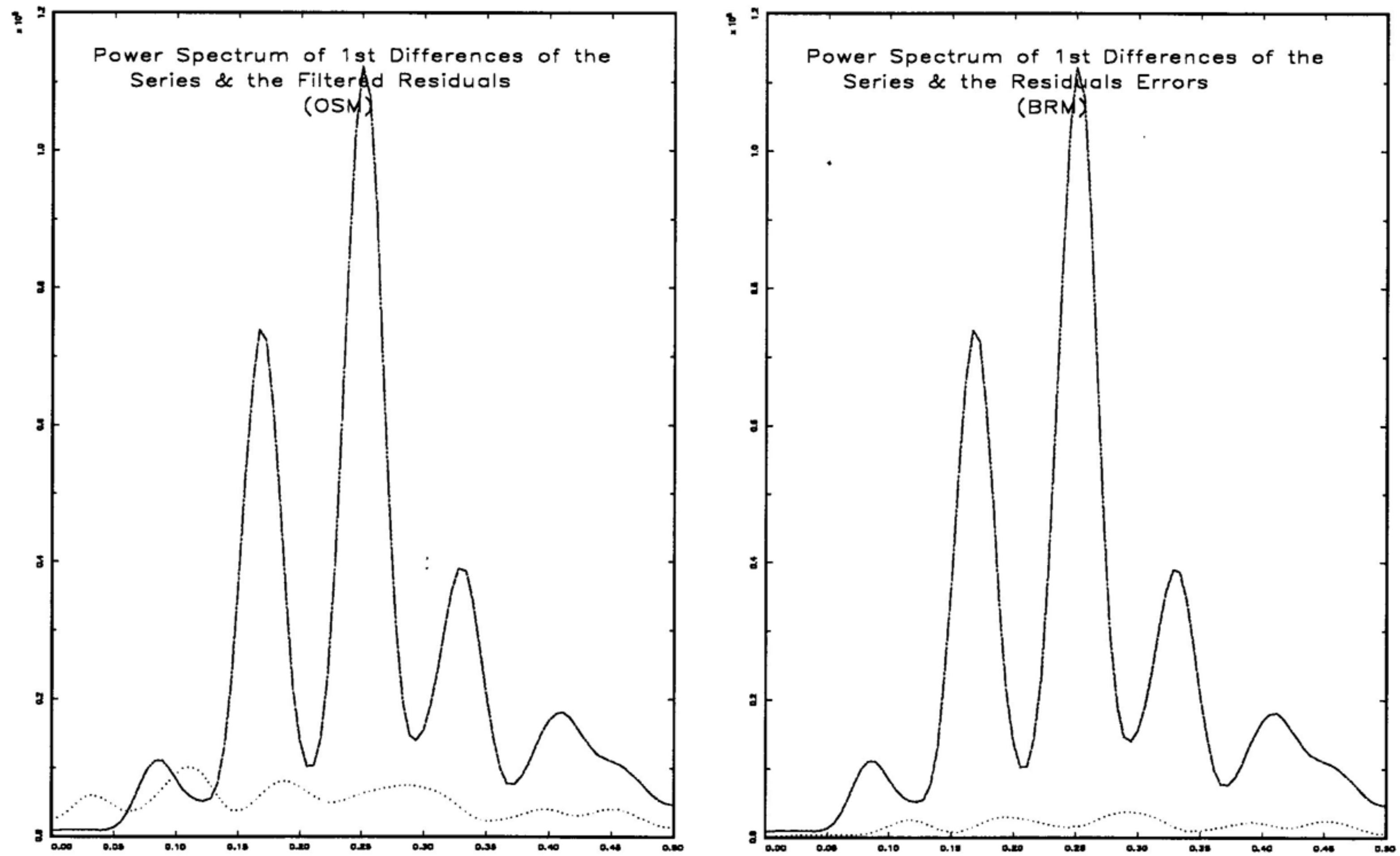

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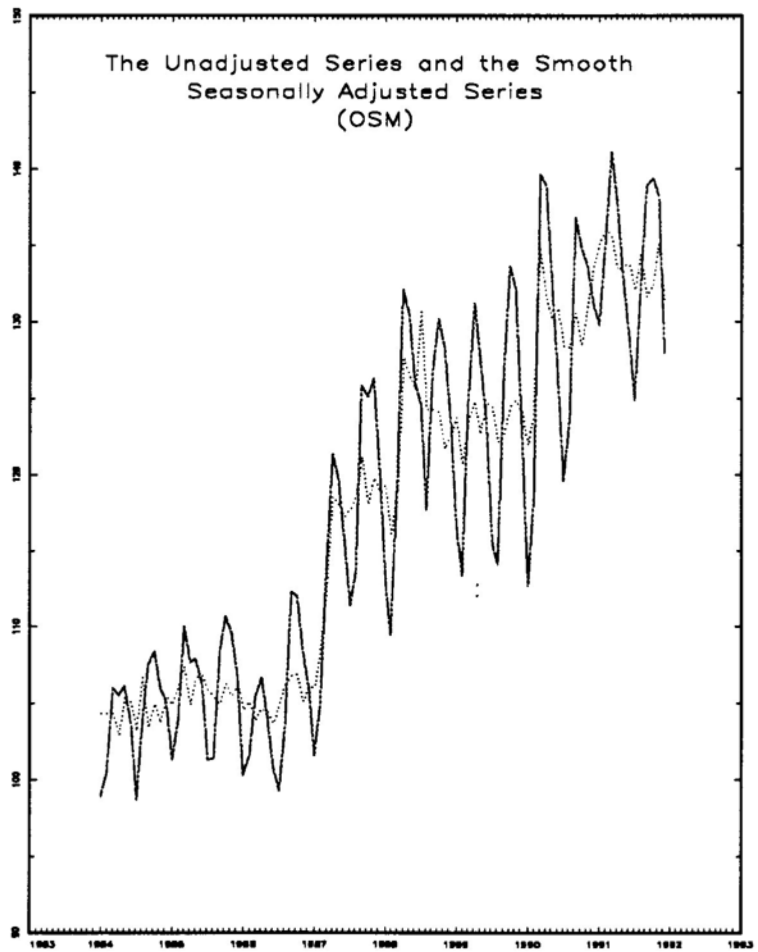
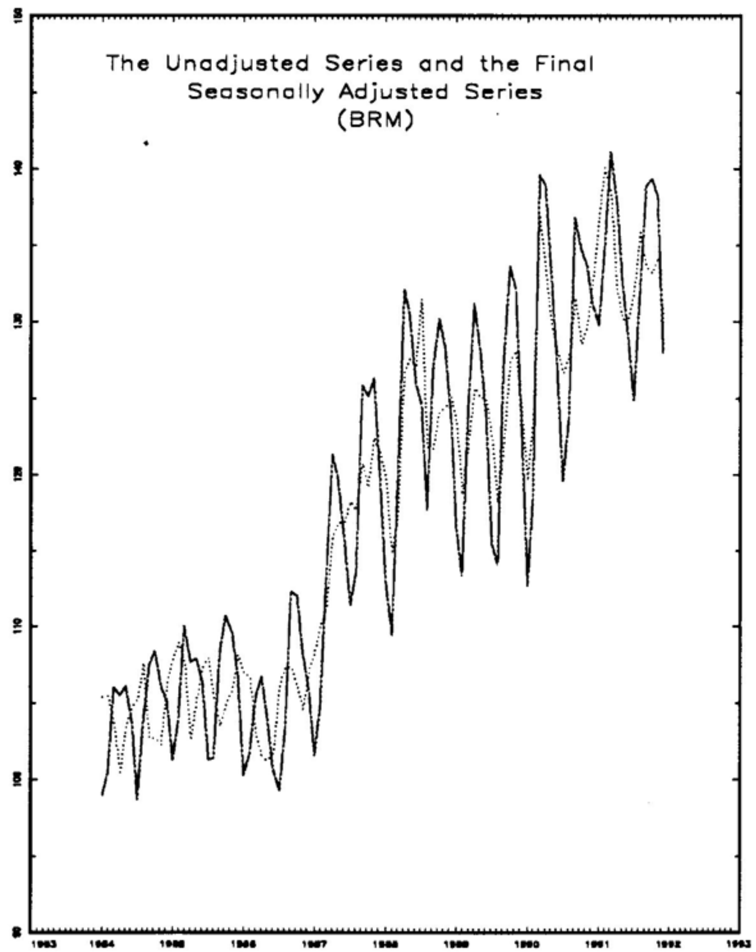
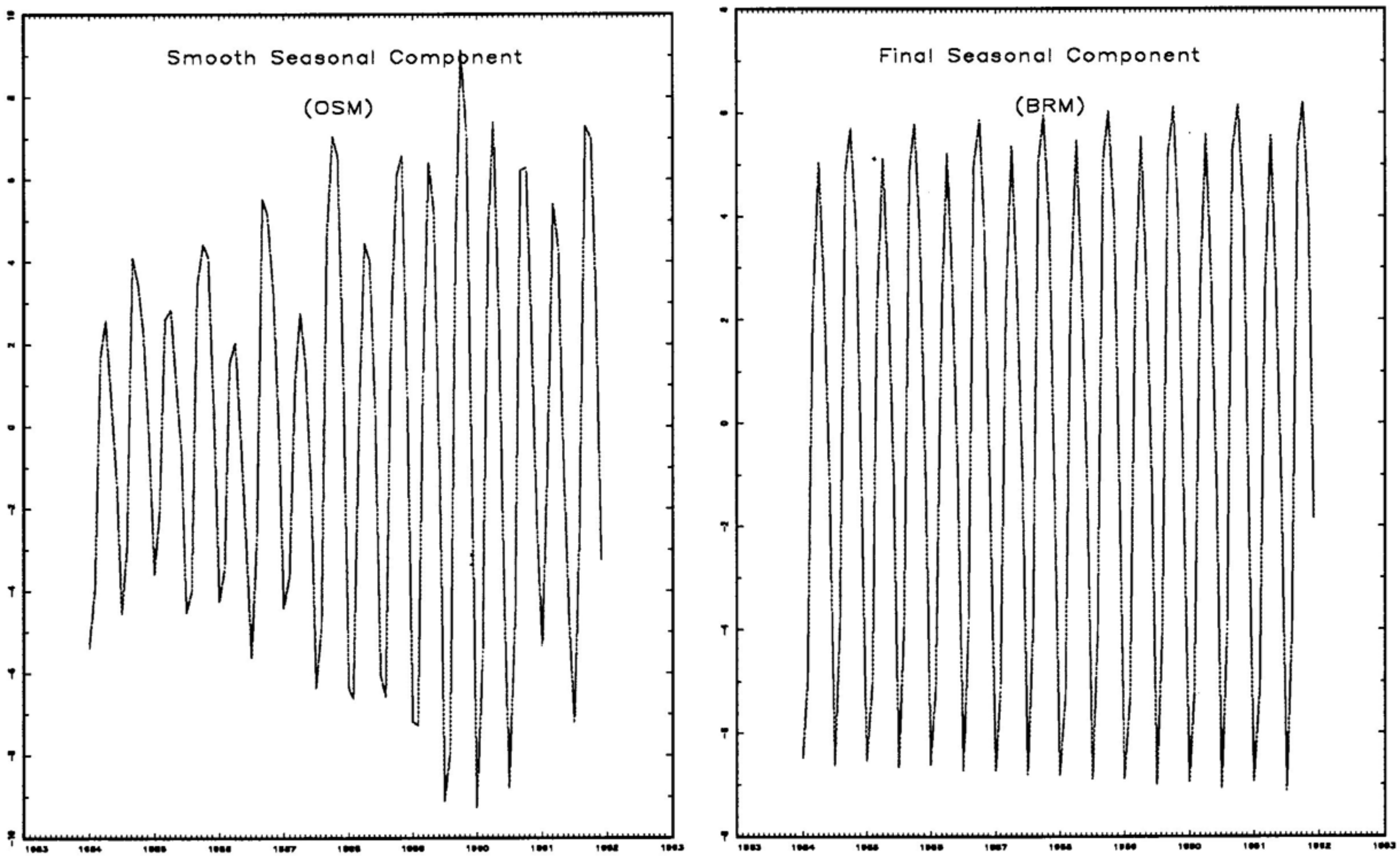




CPI OF WOMEN'S DRESSES 1984-01 TO 1991-12



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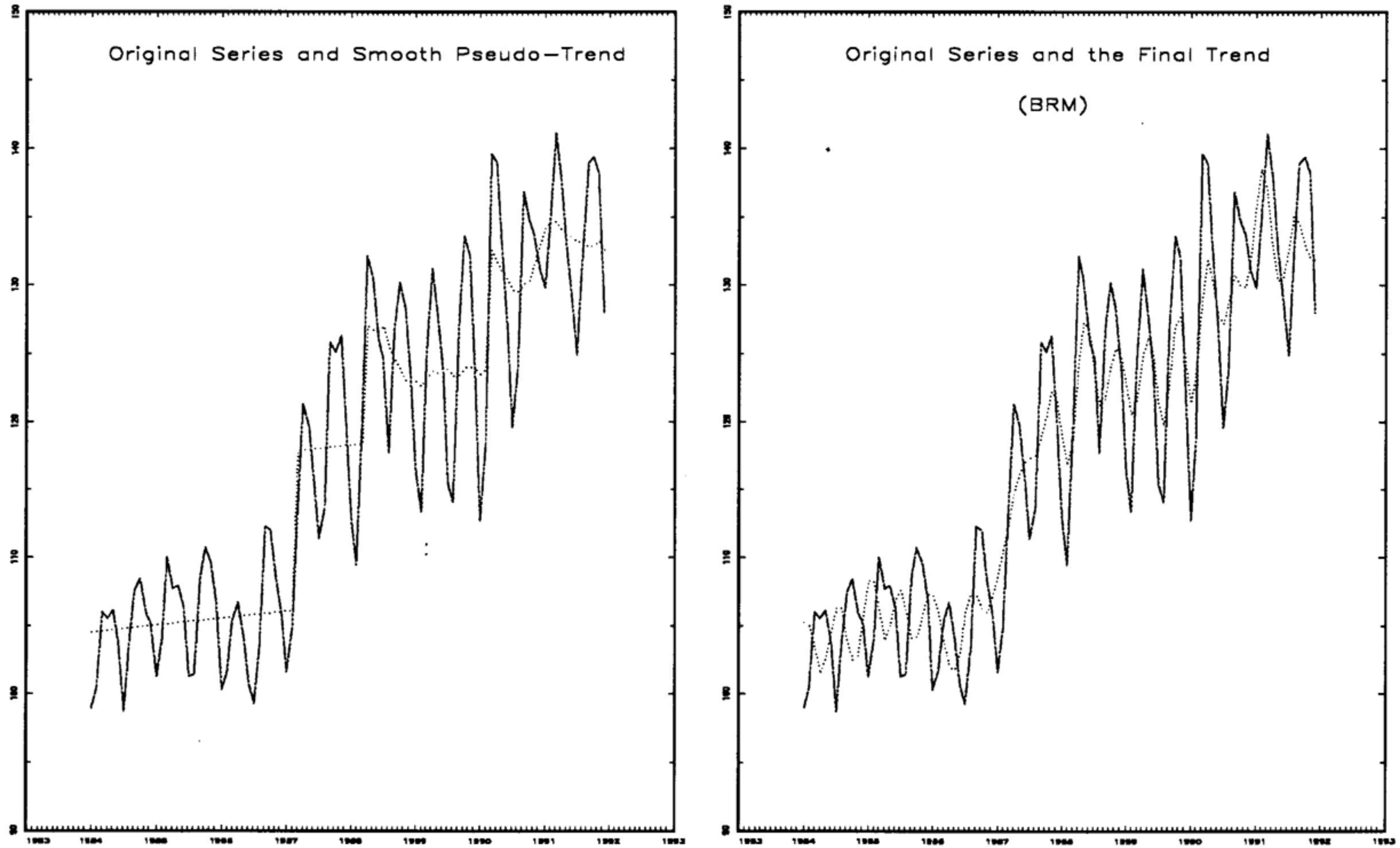

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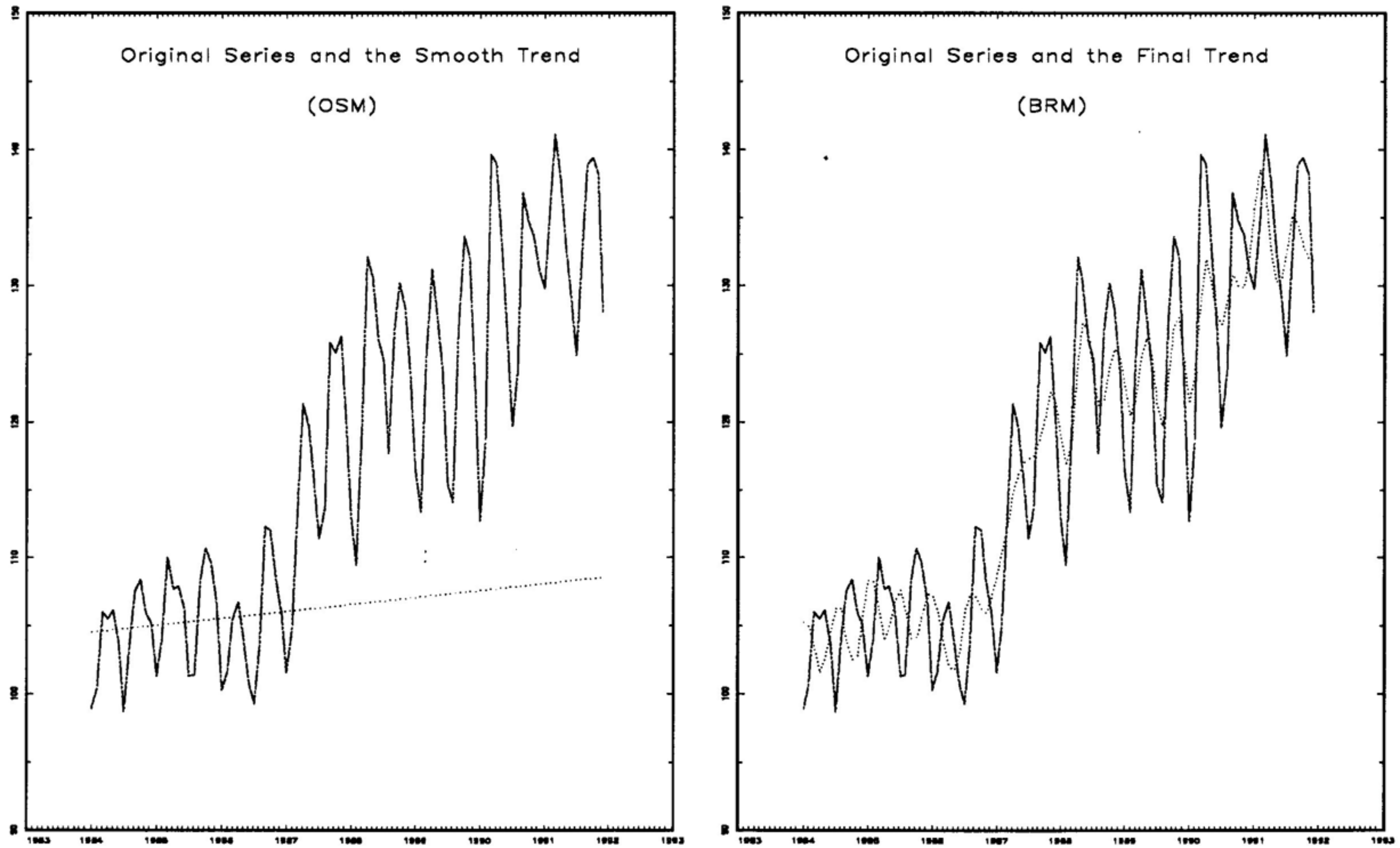

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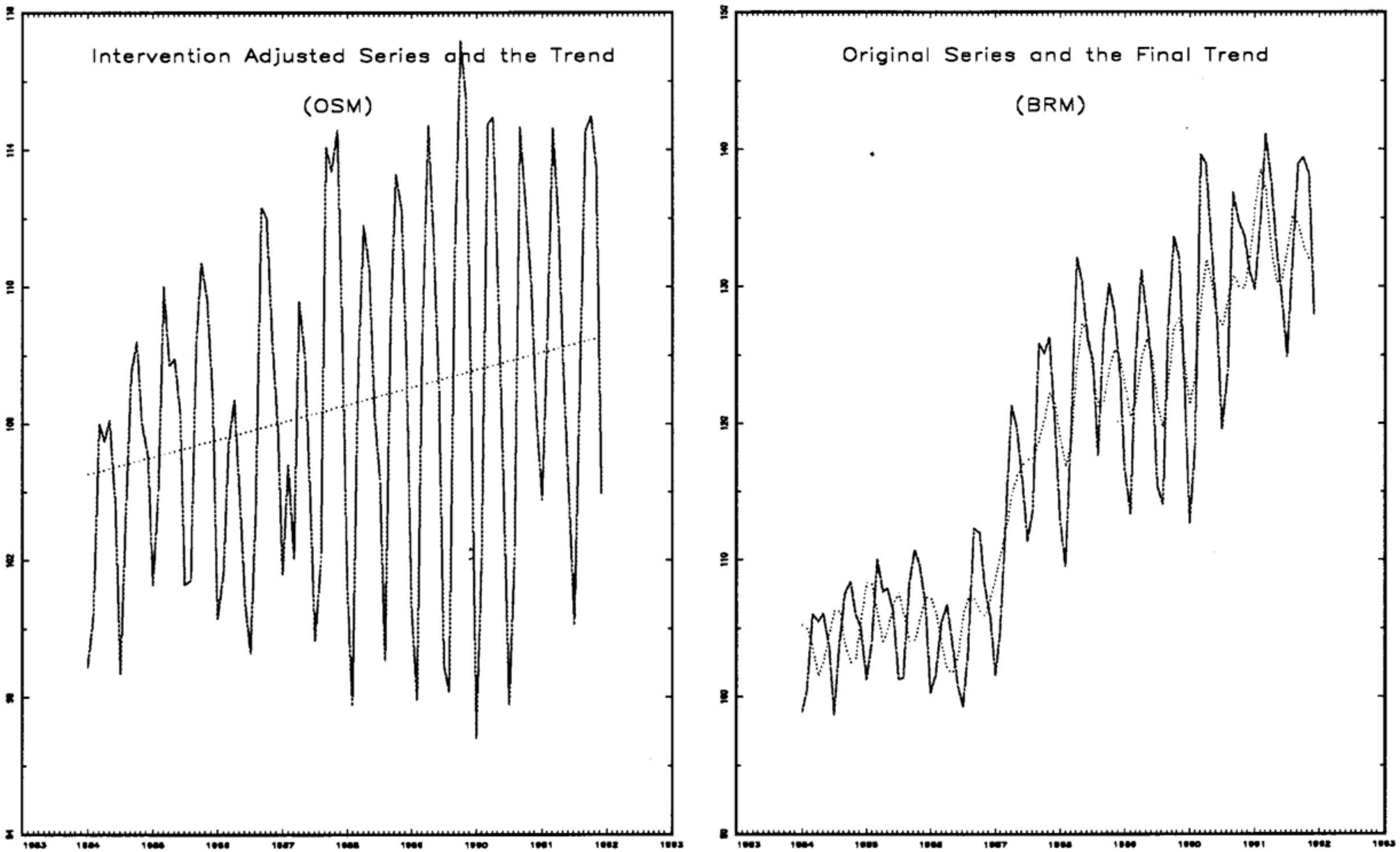

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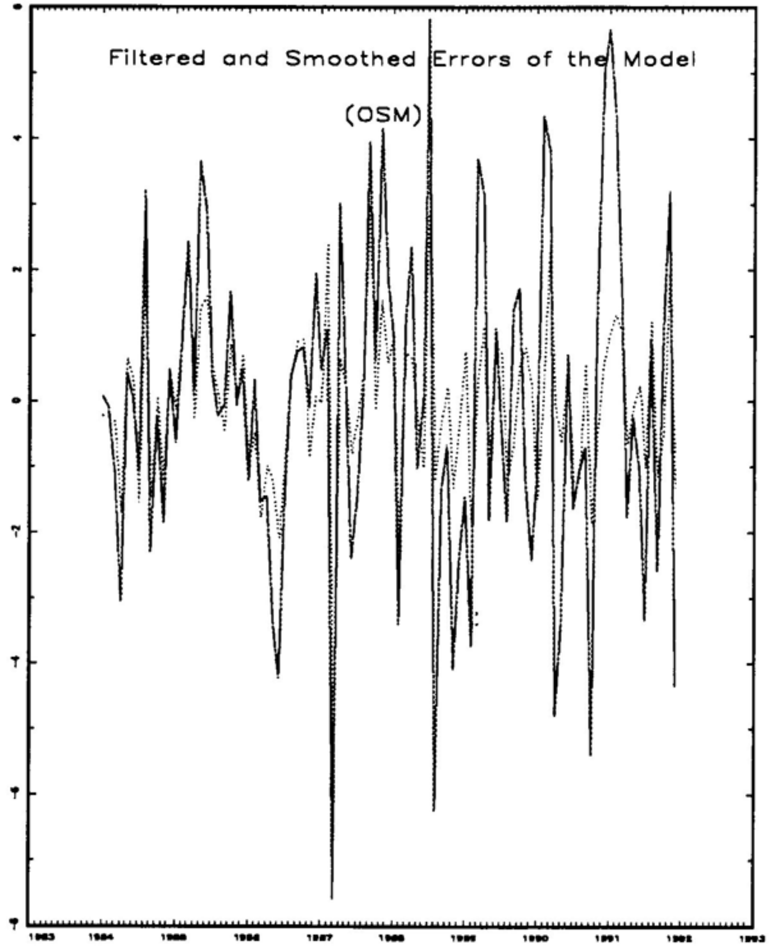

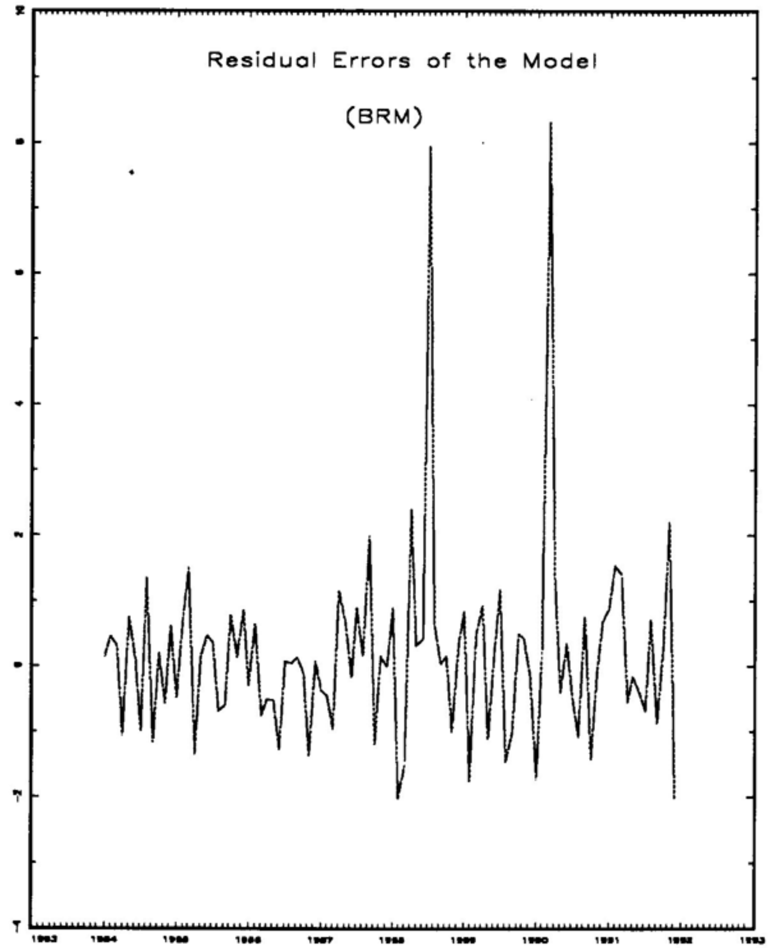

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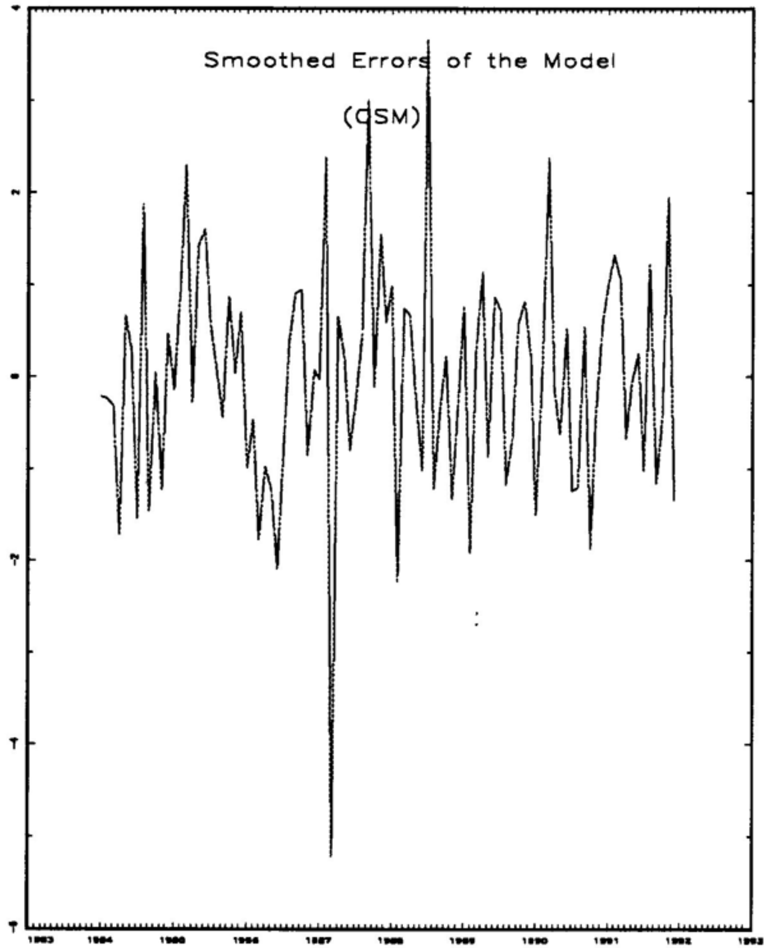

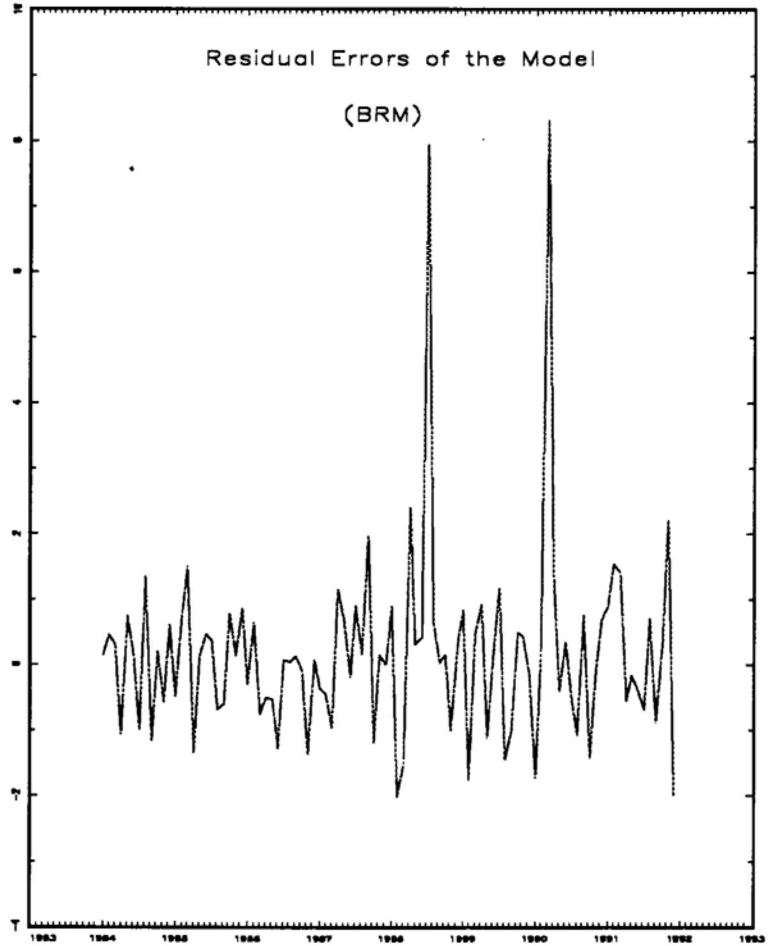

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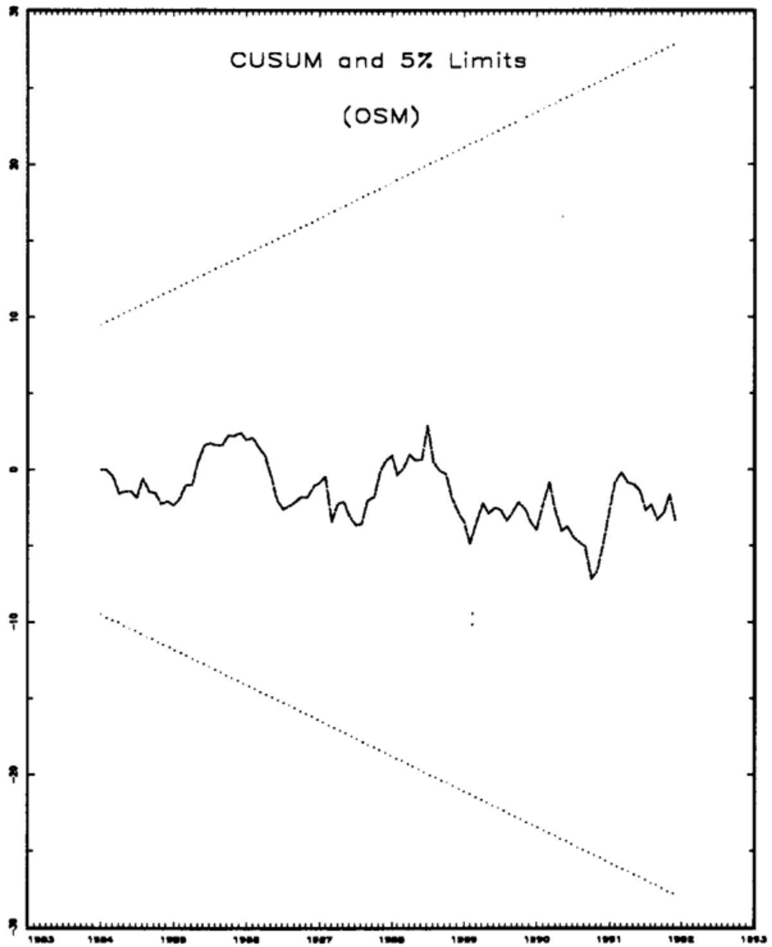

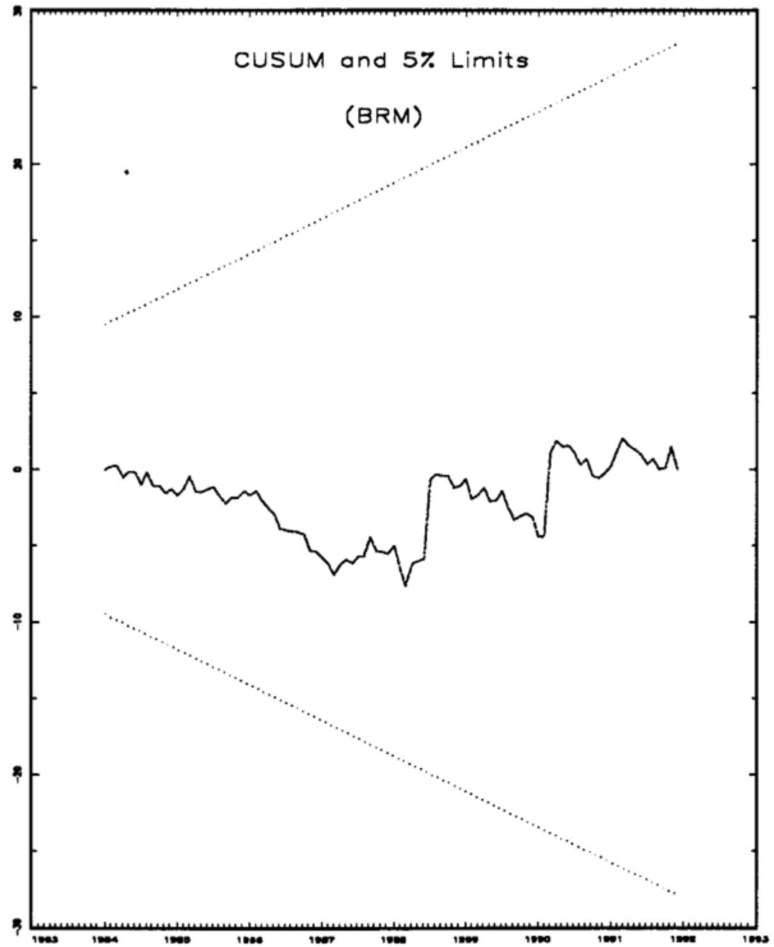

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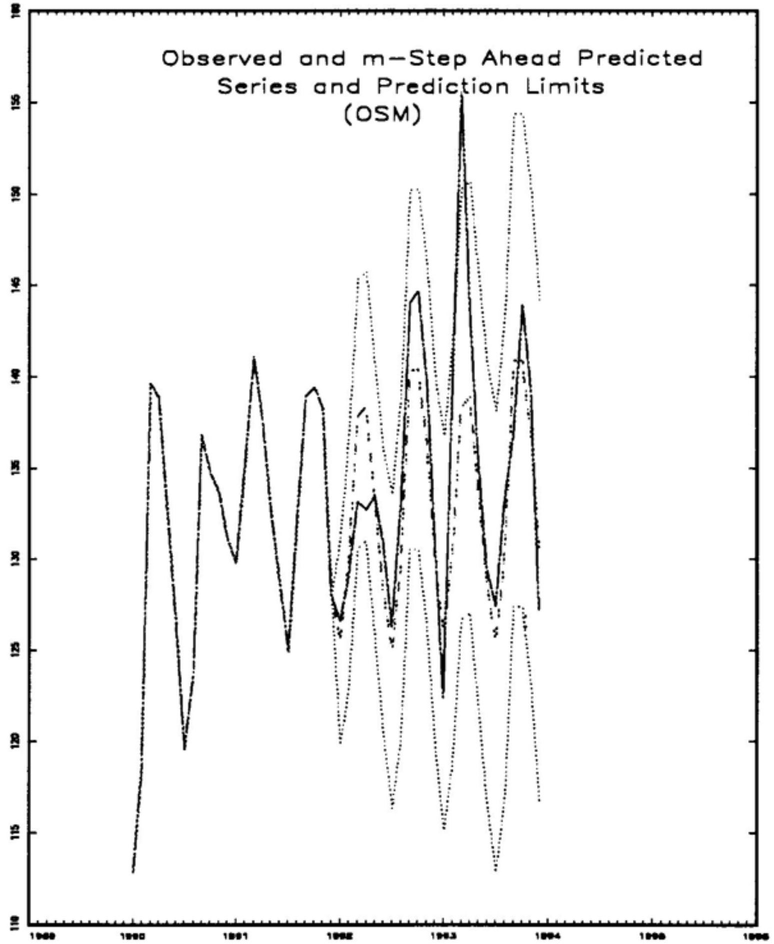

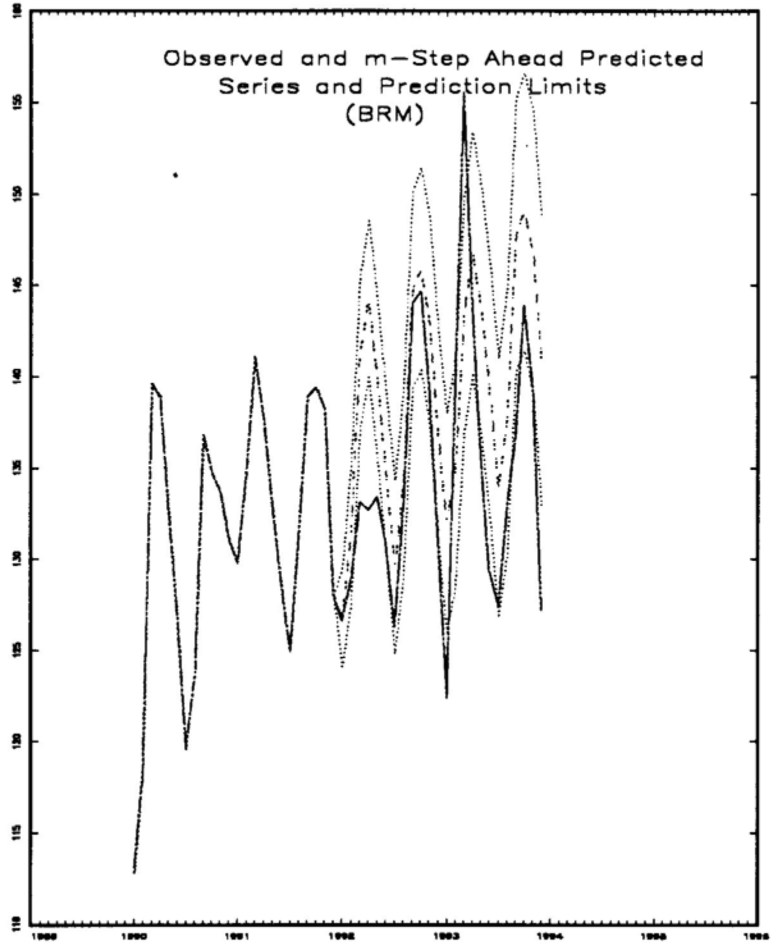

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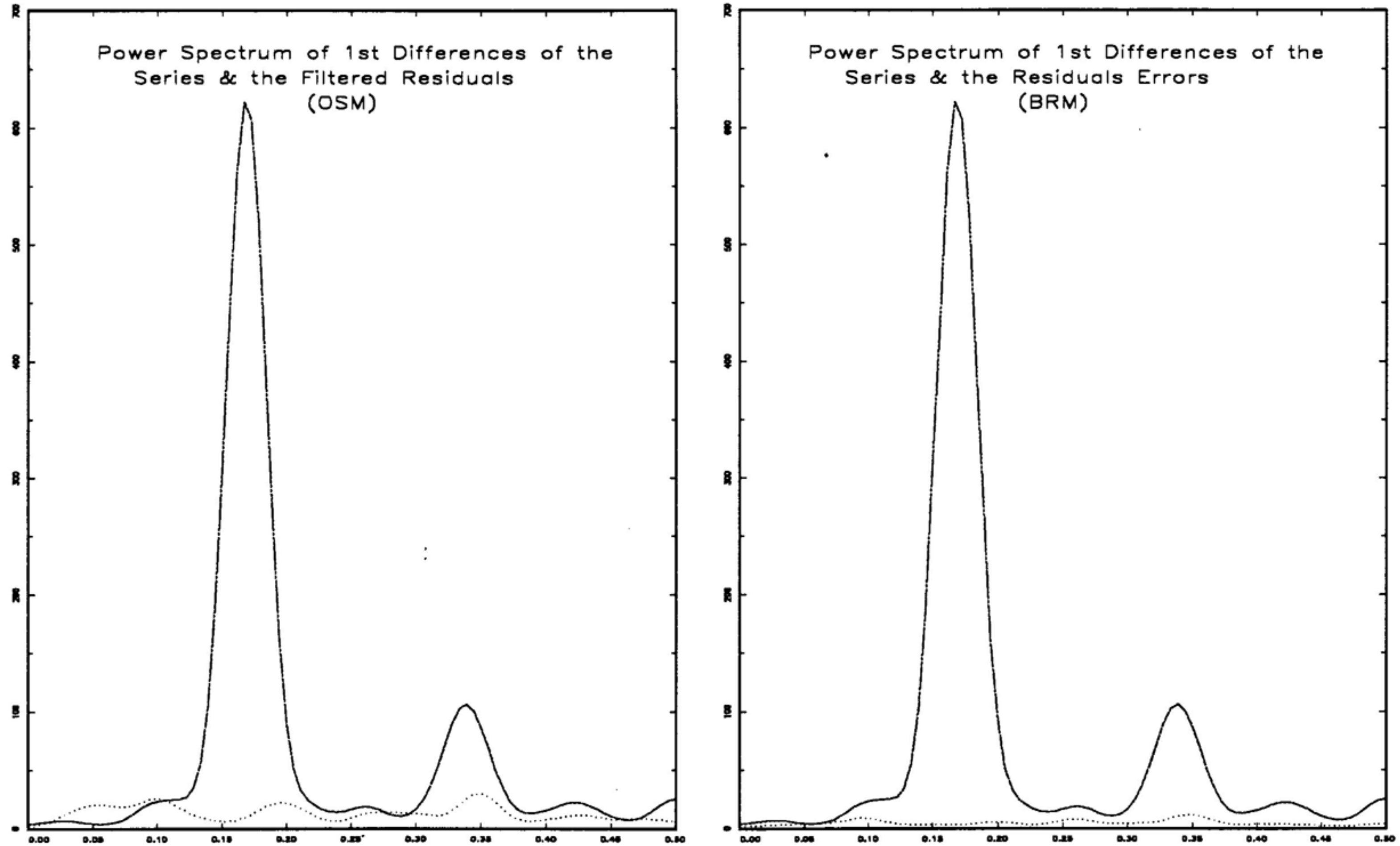

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