zemalja, u svim se socijalističkim zemljama i makroagregatima fluktuacije smanjuju s vremenom. To je bilo utvrđeno na osnovu upoređivanja koeficijenata fluktuacije za razdoblje 1955—65. sa razdobljem 1950—60. god.

Vrlo su interesantni rezultati izračunavanja prosečnih stopa rasta i njihovih trendova. Stope rasta u socijalističkim zemljama su prilično visoke, više nego u kapitalističkim zemljama. Međutim, sa jedinim izuzetkom Jugoslavije, one pokazuju u razdoblju 1950—65. god. negativan trend, znači — smanjuju se.

Svi podaci iz kojih proizlaze gornji rezultati su službeni podaci odnosnih zemalja, objavljeni velikom većinom u odnosnim statističkim godišnjacima. Autor nije tretirao pitanje u kolikoj meri ti podaci odgovaraju realnosti ni da li su upoređivane stope suštinski uporedive.

AŽUSTIRANJE, INTERPOLACIJA I EKSTRAPOLACIJA SEZONSKIH VREMENSKIH SERIJA

Branislav IVANOVIĆ

1. Ako se u toku vremenskog razmaka od N godina, svake godine meri n puta obeležje X i ako je x_{ij} njegova j-ta vrednost u i-toj godini, matrica

$$X = \begin{vmatrix} x_{11} & \cdot & \cdot & \cdot & \cdot & x_{1n} \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ x_{N_1} & \cdot & \cdot & \cdot & \cdot & x_{Nn} \end{vmatrix}$$

predstavljaće tada niz sezonskih vremenskih serija. Varijacije između podataka jedne iste godine i između odgovarajućih vrednosti podataka različitih godina mogu biti posledica aleatornog karaktera, sezonskog karaktera i opšte tendencije u razvoju posmatrane pojave. Ako je dovoljno dug posmatrani vremenski razmak, ciklički karakter pojave može se takođe afirmisati u opštoj tendenciji razvoja.

Ako je u pojavi jako naglašen sezonski karakter i ako su međusezonske varijacije više manje stabilne, relativne izravnate vrednosti u $(t+1)$-oj godini biće

$$(1.1) \qquad \theta^{*}_{t+1,i} = \sum_{j=i-1}^{i+1} k_{ji}\, \theta_{tj},$$

gde je

$$i \in \{1, \ldots, n\}, \qquad t \in \{1, \ldots, N-1\},$$

$$i = 1 \longrightarrow i-1 = n \text{ i } \theta_{t,i-1} = \theta_{t-1,n},$$

$$i = n \longrightarrow i+1 = n \text{ i } \theta_{t,i+1} = \theta_{t+1,1}$$

a koeficijenti k_{ji} su elementi zakona evolucije

$$(1.2)\quad K = \begin{vmatrix} k_{11} & k_{21} & 0 & 0 \; \dots & k_{n1} \\ k_{12} & k_{22} & k_{32} & 0 \; \dots & 0 \\ 0 & k_{23} & k_{33} & k_{43} \; \dots & 0 \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ 0 & 0 \; \dots & k_{n-2,n-1} & k_{n-1,n-1} & k_{n,n-1} \\ k_{1n} & 0 \; \dots \; 0 & & k_{n-1,n} & k_{nn} \end{vmatrix}$$

čije su vrednosti dobijene pomoću metode najmanjih kvadrata

$$(1.3)\qquad \vec{k}_i = \vec{\beta}_i^{\,\prime-1} \qquad i \in \{1, \dots, n\},$$

a elementi matrice i vektora $\vec{\beta}'_i$ dati su preko obrazaca

$$(1.4')\qquad \alpha_{sj} = \sum_{t=1}^{N-1} \theta_{ts}\,\theta_{tj}, \qquad < s,j > \leqslant \{i-1, i, i+1\}$$

$$(1.4'')\qquad \beta_{ij} = \sum_{t=1}^{N-1} \theta_{t+1,i}\,\theta_{tj}, \qquad i \in \{i-1, i\; i+1\}$$

Predviđanje budućih sezonskih vremenskih serija koje neposredno slede posmatrani vremenski period, vrši se preko relacija

$$(1.5)\qquad \hat{\theta}_{Ni} = \theta_{Ni}$$

$$\hat{\theta}_{N+r,i} = \sum_{j=i-1}^{i+1} k_{ji}\,\hat{\theta}_{N+r-1}, \quad r \in N, \quad i \in \{1, \dots, n\}$$

dok relacija

$$(1.6)\qquad \theta_{ti} = \sum_{j=i-1}^{i+1} c_{ji}\,\theta_{t+1,j}, \quad t \in E-, \quad i \in \{1, \dots, n\}$$

sa

$$(1.7)\qquad \vec{c}_i = \vec{\beta}'_i \begin{vmatrix} a_{i-1,i-1} & a_{i,i-1} & a_{i+1,i-1} \\ a_{i-1,i} & a_{ii} & a_{i+1,i} \\ a_{i-1,i+1} & a_{i,i+1} & a_{i+1,i+1} \end{vmatrix}$$

i

$$(1.8)\qquad a_{sj} = \sum_{t=1}^{N+1} \theta_{t+1,s}\,\theta_{t+1,j}, \qquad < s,j > \leqslant \{i-1, i, i+1\}$$

omogućava da se izvrši rekonstrukcija onih sezonskih vremenskih serija koje prethode posmatrani vremenski period.

Ako su intersezonske varijacije zanemarljive u odnosu na slučajne varijacije pojave, nećemo morati više da zadržavamo sezonsku komponentu varijacije u zakonu evolucije. Zato će sada zakon evolucije biti oblika

$$(1.9)\qquad K = [\beta_{ij}]\;[\alpha_{ij}]^{-1}$$

a odgovarajući niz ažustiranih sezonskih vremenskih serija biće

$$(1.10)\qquad \theta^* = \theta K.$$

Najzad, preko relacija

$$(1.11)\qquad \hat{\theta}_{Ni} = \theta_{Ni}$$

$$\hat{\theta}_{N+r,i} = \sum_{j=1}^{n} k_{ji}\,\hat{\theta}_{N+r-1,j}, \quad r \in N, \quad i \in \{1, \dots, n\}$$

možemo vršiti predviđanja budućih i preko

$$(1.12)\qquad \hat{\theta}_{1,i} = \theta_{1i}$$

$$\hat{\theta}_{ti} = \sum_{j=1}^{n} k_{ji}^{-1}\,\theta_{t+1,j}, \qquad t \in E_-, \quad i \in \{1, \dots, n\}$$

prethodne sezonske vremenske serije.

Ovaj postupak za ažustiranje i predviđanje sezonskih vremenskih serija nazvali smo G-metodom pri čemu je G-1 varijanta u kojoj se ne uzima u obzir sezonski karakter pojava a G-2 varijanta koja uključuje sezonsku komponentu u zakon evolucije.

Primetimo još da je za primenu varijante G-1 potrebno da broj godina u posmatranom periodu ne bude manji od broja sezona, tj. ne sme biti manji od četiri ako su podaci kvartalni niti manji od dvanaest ako su podaci mesečni. Uopšte, u početnoj matrici X broj redova ne sme da bude manji od broja kolona.

2. Kao primer uzeli smo izvoz Velike Britanije u vremenskom periodu od 1960. do 1967. god. zaključno. Tabela (1) daje mesečne podatke toga izvoza, izražene u milionima funti sterlinga. Posmatrajući mesečne proseke $(\bar{x})$ možemo zaključiti da je izvoz Velike Britanije bio značajniji s proleća i pri kraju godine dok je u avgustu i septembru bio najslabiji. Upoređenja radi, primenimo dobro poznatu Vašingtonsku metodu — varijantu X-11 — za izravnanje datog niza vremenskih serija. Dobijeni rezultati su prikazani u tabeli (2). Odmah se može zapaziti da su mesečni proseci sada vrlo bliski i da se, prema tome, izgubio sezonski karakter pojave. Takođe vidimo da je varijabilitet po kolona-

ma izravnatih vrednosti ostao visok i da je kod šest 'kolona (januar, april, juni, juli, avgust i septembar) viši nego kod originalnih podataka. Ako sada primenimo varijantu G-1, dobićemo izravnate vrednosti koje su date u tabeli (3). Kako varijanta G-1 zadržava sezonski karakter pojave to vidimo da su i izravnate vrednosti u prolećnjim mesecima kao i u novembru i decembru jače izražene. Varijabilitet se smanjio i samo je u aprilu i avgustu nešto viši nego kod originalnih vrednosti.

Tabela (4) odnosi se takođe na izvoz Velike Britanije i na isti vremenski razmak s razlikom što su sada podaci tromesečni. U tabeli (5) date su izravnate vrednosti pomoću metode X-11 a u tabelama (6) i (7) izravnate vrednosti preko varijanata G-1 i G.

3. Posle izvršene analize dobijenih rezultata, Statistički ured Ujedinjenih nacija odlučio je da se u publikacijama sezonskih vremenskih serija svetskog uvoza i izvoza, koje će ubuduće redovno objavljivati Centar za statistiku spoljne trgovine UN, primenjuje metoda G za izravnanje posmatranih i predviđanje budućih serija. U tom cilju izdat je nalog elektronskom centru UN da napravi plan za izvršenje svih potrebnih priprema i razradu Fortranovog programa metode G. Na projektovanju toga plana učestvovali su Sidney Cashton, direktor Elektronskog centra, i William Mackay, šef odeljenja za analizu sistema i programiranja, a definitivan program za obe varijante metode G obradio je Vicentu Dumitru, programer Elektronskog centra UN. Dok je za varijantu X-11 Vašingtonske metode potrebno oko pet stotina strana Fortranovog programa, dotle program za obe varijante metode G iznosi svega deset strana.

Tabela 1.

Izvoz Velike Britanije
1960—1967
(u milionima funti sterlinga)

God.	Jan.	Feb.	Mart	Apr.	Maj	Juni	Juli	Avg.	Sept.	Okt.	Nov.	Dec.	TOTAL
1960.	306.6	298.1	291.9	299.1	285.9	284.0	276.8	293.9	295.1	297.1	299.8	307.2	3535.4
1961.	310.0	306.7	304.0	309.2	310.2	315.2	314.2	314.3	300.0	306.0	320.8	301.5	3712.0
1962.	310.5	307.2	304.7	321.1	309.4	320.6	318.4	310.3	324.4	317.5	304.3	317.3	3765.8
1963.	319.3	321.7	342.4	317.4	347.8	338.3	345.6	340.0	346.0	350.7	344.4	348.7	4062.4
1964.	349.5	353.7	354.9	351.7	369.3	343.9	339.2	363.0	336.4	361.8	353.3	372.3	4248.9
1965.	368.3	371.4	376.3	403.2	370.2	407.9	421.0	407.3	416.8	390.6	415.3	421.3	4769.5
1966.	397.4	413.0	402.1	388.3	399.3	392.4	396.5	427.2	439.3	446.8	473.1	423.9	4999.4
1967.	444.4	448.0	434.6	438.6	438.7	440.7	430.1	393.8	407.9	394.3	367.1	377.8	5016.1
$\bar{x}$	347.7	349.3	376.5	357.0	376.4	350.6	352.6	335.8	320.1	351.5	376.5	370.4	
σ	40.6	54.7	58.4	44.0	53.5	48.3	51.3	40.4	52.1	50.2	58.9	56.9	

Tabela 2.

Izravnate vrednosti izvoza Velike Britanije
(pomoću metode X-11)

God.	Jan.	Feb.	Mart	Apr.	Maj	Juni	Juli	Avg.	Sept.	Okt.	Nov.	Dec.	TOTAL
1960.	306.6	298.1	291.9	299.1	285.9	284.0	276.8	293.9	295.1	297.1	299.8	307.2	3535.4
1961.	310.0	306.7	304.0	309.2	310.2	315.2	314.2	314.3	300.0	306.0	320.8	301.5	3712.0
1962.	310.5	307.2	304.7	321.1	309.4	320.6	318.4	310.3	324.4	317.5	304.3	317.3	3765.8
1963.	319.3	321.7	342.4	317.4	347.8	338.3	345.6	340.0	346.0	350.7	344.4	348.7	4062.4
1964.	349.5	353.7	354.9	351.7	369.3	343.9	339.2	363.0	336.4	361.8	353.3	372.3	4248.9
1965.	368.3	371.4	376.3	403.2	370.2	407.9	421.0	407.3	416.8	390.6	415.3	421.3	4769.5
1966.	397.4	413.0	402.1	388.3	399.3	392.4	396.5	427.2	439.3	446.8	473.1	423.9	4999.4
1967.	444.4	448.0	434.6	438.6	438.7	440.7	430.1	393.8	407.9	394.3	367.1	377.8	5016.1
$\bar{x}$	350.8	352.5	351.4	353.6	353.9	355.4	355.2	356.2	358.2	358.1	359.8	358.8	4623.7
σ	46.4	51.3	47.4	47.5	47.5	49.5	51.6	46.5	52.2	47.9	55.0	45.0	557.4

Tabela 3.

Izravnate vrednosti izvoza Velike Britanije
(pomoću metode G-1)

God.	Jan.	Feb.	Mart	Apr.	Maj	Juni	Juli	Avg.	Sept.	Okt.	Nov.	Dec.	TOTAL
1961.	329.1	295.9	315.2	306.5	310.6	311.0	306.0	281.8	264.1	292.7	317.2	316.3	3646.4
1962.	315.4	297.3	325.9	313.6	333.7	293.4	332.2	302.1	282.9	338.4	302.3	309.9	3747.2
1963.	327.1	322.4	369.8	331.7	364.8	342.6	325.3	324.5	308.1	336.1	339.0	341.3	4032.6
1964.	329.4	360.4	400.3	355.5	382.9	359.2	359.5	339.4	322.7	348.8	397.9	384.0	4340.1
1965.	391.2	393.7	397.3	399.6	434.1	417.1	407.9	360.5	348.6	404.8	446.7	426.7	4828.3
1966.	384.9	385.7	451.7	412.4	445.2	399.2	395.9	408.0	376.9	410.4	450.9	446.2	4967.5
1967.	400.8	438.4	436.9	437.0	416.4	410.3	416.3	395.4	392.4	435.1	415.9	432.4	5027.4
$\bar{x}$	354.0	356.3	385.3	365.2	384.0	361.8	363.3	344.5	328.0	366.6	381.4	379.5	
σ	33.7	49.7	48.0	47.6	47.2	45.4	40.7	43.1	43.9	47.2	57.0	53.2	

Tabela 4.

Izvoz Velike Britanije
1960—1967
(u milionima funti sterlinga)

God.	I kvartal	II kvartal	III kvartal	IV kvartal	TOTAL
1960.	920.1	899.6	814.5	902.6	3536.8
1961.	936.2	933.9	874.3	937.1	3681.5
1962.	931.9	982.2	902.8	976.6	3793.5
1963.	997.7	1031.9	974.2	1072.6	4076.4
1964.	1080.4	1090.7	975.7	1108.8	4255.6
1965.	1121.7	1200.8	1142.2	1254.5	4719.2
1966.	1266.7	1198.6	1206.0	1372.7	5044.0
1967.	1333.0	1334.2	1178.6	1162.5	5008.3
$\bar{x}$	1073.5	1084.0	1008.5	1098.4	
σ	148.0	141.0	139.2	151.5	

Tabela 5.

Izravnate vrednosti izvoza Velike Britanije
(pomoću metode X-11)

God.	I kvartal	II kvartal	III kvartal	IV kvartal	TOTAL
1960.	899.9	878.3	865.1	891.6	3534.9
1961.	916.4	911.5	928.6	924.5	3681.1
1962.	914.3	958.1	958.4	961.5	3792.3
1963.	982.1	1006.1	1033.8	1053.2	4075.1
1964.	1067.0	1063.7	1034.0	1086.8	4251.5
1965.	1110.1	1171.7	1209.5	1228.1	4719.4
1966.	1222.1	1232.9	1275.4	1343.6	5073.9
1967.	1321.8	1303.3	1245.6	1196.0	5066.7
$\bar{x}$	1054.2	1065.7	1068.8	1085.7	
σ	146.1	145.6	145.6	149.6	

Tabela 6.

Izravnate vrednosti izvoza Velike Britanije
(pomoću metode G-2)

God.	I kvartal	II kvartal	III kvartal	IV kvartal	TOTAL
1961.	924.8	887.4	965.3	912.0	3689.3
1962.	947.5	938.6	970.0	942.3	3798.3
1963.	1013.9	1042.4	1016.4	1007.9	4080.6
1964.	1018.6	1146.9	1031.8	1060.2	4257.5
1965.	1162.1	1193.8	1204.4	1167.7	4728.0
1966.	1190.7	1410.2	1185.5	1256.9	5043.3
1967.	1111.4	1446.0	1178.7	1270.4	5006.5
$\bar{x}$	1052.7	1152.1	1078.9	1088.2	
σ	96.1	200.9	98.6	135.0	
Prognozirane relativne vrednosti u narednim godinama					
1968.	0.2817	0.1935	0.2845	0.2437	
1969.	0.2239	0.2624	0.2451	0.2678	
1970.	0.2363	0.2895	0.2255	0.2472	

Tabela 7.

Izravnate vrednosti izvoza Velike Britanije
(pomoću metode G-1)

God.	I kvartal	II kvartal	III kvartal	IV kvartal	TOTAL
1961.	936.2	955.8	870.9	932.6	3695.4
1962.	933.7	982.1	887.1	1000.8	3803.6
1963.	981.3	1012.1	972.5	1068.9	4034.7
1964.	1042.7	1068.2	1012.0	1113.9	4236.8
1965.	1191.8	1189.3	1137.2	1148.8	4667.1
1966.	1235.7	1238.4	1206.9	1332.2	5013.4
1967.	1303.3	1328.0	1167.1	1292.1	5090.5
$\bar{x}$	1089.2	1110.6	1036.2	1127.0	
σ	141.0	131.9	125.6	134.8	
Prognozirane relativne vrednosti u narednoj godini					
1968.	0.2620	0.2622	0.2301	0.2456	

PROJECTION PROGRAMME SOURCE STATEMENT

IBFTC V-D PR LIST, REF

THE V-D ADJUSTMENT PROGRAMME

Written in Fortran IV, March 1969, by Vincentiu Dumitru for IBM 7044 at the International Computing Centre, United Nations — New York.

THE PROGRAMME PROVIDES THE ADJUSTMENT AND PROJECTION OF DATA AS PER THE ATTACHED REQUEST PAPERS OF MR. B. IVANOVICI, CHIEF, U. N. TRADE SECTION, USING TWO METHODS.
IT CONSISTS OF A MAIN PROGRAMME PLUS A I.B.M. MATRIX INVERSE SUBROUTINE *MINV*-IBM APLICATION PRORGAMME, H20-0205-O, SYSTEM/360 SCIENTIFIC SUBROUTINE PACKAGE-.

SELECTION OF OPTIONS AND DATA FORMAT.

A) CONTROL SERIES CARDS.

— DATA CARDS FOR EACH SERIES ARE PRECEDED BY THIS CARD.-
— COL. 1. *I* PUNCH.
— COLS. 2-7. SERIES IDENTIFICATION CODE. MUST BE IDENTICAL TO COLS. 75—80 IN THE SERIES DATA CARDS. (NUMERIC AND/OR ALPHABETIC).
— COLS. 8—67 SERIES TITLE. APPEARS AT THE OF PRINTED OUTPUT.

OF SERIES.
— COLS. 71—73.
— IF*1*IN COL. 71 AND*O*IN COL. 72, ONLY METHOD ONE WILL BE APPLIED.
— IF*0*IN COL. 71 AND*2*IN COL. 72, ONLY METHOD TWO WILL BE APPLIED.
— IF*1*IN COL. 71 AND*2*IN COL. 72, BOTH METHODS WILL BE APPLIED.
— IF,1,IN COL. 73, THE INTERMEDIATE COMPUTATIONS WILL NOT BE PRINTED.
— COLS. 74—75. NUMBER OF DATA CARDS IN SERIES (SEE COL. 80).
— COLS. 76—77. NUMBER OF DATA FIELDS ON EACH CARD.
— COL. 78. MAY BE*1* OR SPACE. IF *1*, ONLY THE INITIAL MATRIX AND FINAL COMPUTED MATRIX WILL BE PRINTED.
— COL. 79—80. THE NUMBER OF YEARS FOR WHICN THE SERIES IS TO BE EXTENDED (NUMERIC). THE SUM OF COL. 80 AND COLS. 74—75 MUST BE NOT GREATER THAN 100.

B) DATA CARDS.
— COLS. 73—74. LAST TWO DIGITS OF YEAR.
— COLS. 75—80 SERIES IDENTIFICATION CODE.
DATA CARDS IMMEDIATELY FOLLOW THE TITLE CARD.
EACH CARD MAY CONTAIN UP TO ONE CALENDAR YEAR OF DATA.
DATA FOR MONTH IS PUNCHED IN A 6-DIGIT FIELD,
WITH IMPLIED DECIMAL POINTER AFTER THE 4TH DIGIT.

C) A CARD PUNCHED*7*IN COL. 1 MUST FOLLOW THE FINAL DATA CARD.

```
DOUBLE PRECISION AMAT, D, A3
DIMENSION DATIN (24, 100), AMAT (24, 24), BMAT (24,24), CMAT (24, 24)
DIMENSION CTL (16), DTC (24), FMT (20), FMT2 (20), ADTL (100), WDAT (24, 100)
DIMENSION LI (24), MI (24), FMT3 (20), NYR(100), A3 (3, 3), B3 (3), C3 (3)
```


THE V-D ADJUSTMENT PROGRAMME

```
      DIMENSION FMT4 (25), ASTR (24, 24), AUNI (24, 24), FMT
     5 (25), IXE (3)
      DIMENSION WDT2 (24, 10C)
      DATA Z/6HZ, /,T/6HT /,TOT/6H TOTAL/, FORI/6H (1H,/
      DATA FORL/6HF9.2) /,FOR/6HF9.2, /,FORX/6H4X,
     /,FORT/6HF 10.2,/
      DATA FORI2/6H(1H, /,FORX2/6H10X, /,A/6HA6, /,FOR4/
     /6HF9.4,/
      DATA FOR3L/6HF10.4) /,AN/6H19 /,AYR/6HYEAR /,FOR4L/
     /6HF9.4)
      DATA FIN/6H12, /,FAN/6HA2, /,FX/6H2X,/,FORX3/6H5X,/
      DATA AS/6H** /,AVG/6H MEAN /,SGM/6H SIGMA/,FOR3/
     /6HF10.4,/
      DATA FOR5/6HF 10.2,/,FOR5L/6HF10.2)/
      NL = 0
      GO TO 800
   10 READ (5, 11) (CTL (J), J = 1, 12) MT1, MT2, NINT, NL, NC,
     NP, IP
   11 FORMAT (A1, A6, 10A6, 3X, I1, I1, I1, I2, I2, I1, I2)
      IF (CTL (1). EQ. Z) GO TO 7000
      IF (CTL(1). EQ .T) GO TO 15
      GO TO 10
   15 I = 0
      FMT (1) = FORI
      FMT (2) = FAN
      FMT (3) = FIN
      FMT (4) = FX
      FMT (5) = FORT
      FMT (6) = FX
      FMT (7) = FAN
      NT = NC — 1
      DO 1 K = 1, NT
    1 FMT (K + 7) = FOR
      FMT (NC + 7) = FORL
      FMT 2 (1) = FORI2
      FMT2 (2) = FORX2
      FMT2 (3) = A
      FMT2 (4) = FORX
      DO 2 K = 1, NT
    2 FMT2 (K + 4) = FOR
      FMT2 (NC + 4) = FORL
      FMT3 (1) = FORI2
      FMT5 (1) = FORI2
      DO 3 K = 1, NT
      FMT5 (K + 1) = FOR5
    3 FMT3 (K + 1) = FOR3
      FMT3 (NC + 1) = FOR3L
      FMT5 (NC +1) = FOR5L
      FMT4 (1) = FORI
      FMT4 (2) = FAN
      FMT4 (3) = FIN
      FMT4 (4) = FORX
      FMT4 (5) = FOR4
      FMT4 (6) = FX
      FMT4 (7) = FAN
      DO 4 K = 1, NT
```

```
    4 FMT4 (K + 7) = FOR4
      FMT4 (NC + 7) = FOR4L
   20 I = I + 1
      READ (5, 21) (DATIN (J, I), J = 1, 12), NOY, AID
   21 FORMAT (12F6. 2, I2, A6)
      IF (I. GE. 2) GO TO 25
      NOYP = NOY
      NYR (1) = NOY
      LYS = NOYP + NL — 1
   25 IF (AID. NE. CTL (2) ) GO TO 5000
      IF ( (NOYP + I — 1). NE. NOY) GO TO 5000
      NYR (I) = NOY
      IF (NOY. LT. LYS) GO TO 20
      WRITE (2, 100)
      WRITE (6, 100)
  100 FORMAT (1H1, 41X, 49HUNITED NATIONS — E. S. A. —
      STATISTICAL OFFICE, NEW YORK 1K/1H, 50X, 30H
      INTERNATIONAL COMPUTING CENTRE/1H, 53X 24HV-D
      ADJUSTM 2ENT PROGRAMME)
      WRITE (2 ,105) (CTL (J), J = 3, 12)
      WRITE (6, 105) (CTL (J), J = 3, 12)
  105 FORMAT (1HO, 33X. 11A6)
      WRITE (2, 110) AID
      WRITE (6, 110) AID
  110 FORMAT (1HO,     14HINITIAL MATRIX, 46X, 6HSERIES,
      2X, A6)
      WRITE (2, 115) AYR, TOT
      WRITE (6, 115) AYR, TOT
  115 FORMAT (1HO, A4, 6X, A6)
      DTL = 0. 0
      DO 140 I = 1, NL
      DO 120 J = 1, NC
      DTL = DTL + DATIN (J, I)
      ADTL (I) = 0. 0
  120 DTC (J) = DTC (J) + DATIN (J, I)
      ADTL (I) = DTL
      WRITE (2, FMT) AN, NYR (I), DTL, AS (DATIN (K, I),
      K = NC)
      WRITE (6, FMT) AN, NYR (I), DTL, AS, (DATIN (K, I),
      K = 1, NC)
      DTL = .O
  140 CONTINUE
      WRITE (2, 222)
      WRITE (6, 222)
      WRITE (2, FMT2) TOT, (DTC (J), J = 1, NC)
      WRITE (6, FMT2) TOT, (DTC (J), J = 1, NC)
      FNL = NL
      DO 150 J = 1, NC
  150 DTC (J) = DTC (J)/FNL
      WRITE (2, FMT2) AVG, (DTC (J), J = 1, NC)
      WRITE (6, FMT2) AVG, (DTC (J), J = 1, NC)
      DO 200 I = 1, NL
      DO 200 J = 1, NC
      WDAT (J, I) = DATIN (J, I)/ADTL (I)
  200 CONTINUE
```



```
      DO 201 I = 1, NL
      DO 201 J = 1, NC
      DATIN (J, I) = DATIN (J, I) — DTC (J)
  201 DATIN (J, I) = DATIN (J, I)*DATIN (J, I)
      DO 203 J = 1, NC
  203 DTC (J) = O. O
      DO 205 I = 1, NL
      DO 205 J = 1, NC
  205 DTC (J) = DTC (J) + DATIN (J, I)
      DO 207 J = 1, NC
  207 DTC (J) = SQRT (DTC (J)/FNL)
      WRITE (2, FMT2) SGM, (DTC (J), J = 1, NC)
      WRITE (6, FMT2) SGM, (DTC (J), J = 1, NC)
      IF (NP. EQ. 1) GO TO 240
      WRITE (2, 210) AID
  210 FORMAT (1HI,     15HRELATIVE MATRIX, 45X, 6HSERI-
      ES, 2X, A6)
      WRITE (2, 222)
      WRITE (6, 222)
  222 FORMAT (1HO)
      DO 240 I = 1, NL
      WRITE (2, FMT 3)   (WDAT (J, I), J = 1, NC)
      DO 240 J = 1, NC
      WDT2 (J, I) = WDAT (J, I)
  240 CONTINUE
      STAB = WDAT (1, 2)
      DO 245 I = 1, 24
      DTC (I) = 0.0
      DO 245 J = 1,24
      AMAT (J, I) = 0.0
      ASTR (J, I) = 0.0
      AUNI (J, I) = 0.0
      BMAT (J, I) = 0.0
      CMAT (J, I) = 0.0
  245 CONTINUE
      NTL = NL — 1
      DO 250 L = 1, NC
      DO 250 M = 1, NC
      DO 250 K = 1, NTL
      ASTR (M, L) = ASTR (M, L) + (WDAT (M, K)*WDAT
      (L, K) )
      BMAT (M, L) = BMAT (M, L) + (WDAT (L, K)*WDAT
      (M, K + 1) )
  250 CONTINUE
      M2 = 0
      IF ( (MT1. EQ. 0). AND. (MT2. EQ. 2) ) GO TO 1000
```

METHOD I

```
      WRITE (6, 253) MTI
      WRITE (2, 253) MTI
```

```
253  FORMAT (1H1, 118X, 6HMETHOD, 1X, I2)
     BMULT = 1.0
     EPS = 1.0
     DO 255 L = 1, NC
     DO 255 M = 1, NC
     IF (ABS (ASTR (M, L) ). GE. EPS) GO TO 255
     IF (ASTR (M, L). EQ. O. O) GO TO 255
     EPS = (ASTR (M, L) )
255  CONTINUE
     FACT = 1.0
     DO 260 K = 1,8
     IF (EPS. GE. 1.0) GO TO 260
     EPS = EPS*10.0
     FACT = FACT*10.0
260  CONTINUE
270  CONTINUE
     AMULT = FACT*BMULT
     DO 300 L = 1, NC
     DO 300 M = 1, NC
     AMAT (M, L) = ASTR (M, L)*AMULT
300  CONTINUE
     IF (NP. EQ. 1) GO TO 350
     IF (BMULT. GT. 1.0) GO TO 350
     WRITE (2, 310) AMULT, AID
310  FORMAT (1HO, 22HA-MATRIX MULTIPLIED BY, 1X, F10. 1,
     27X, 6HSERIES, 2X, A6)
     WRITE (2, 222)
     DO 320 I= 1, NC
320  WRITE (2, FMT3)     (AMAT (J, I), J = 1, NC)
     WRITE (2, 330)   AID
     WRITE (2, 222)
330  FORMAT (1H1,     8HB-MATRIX, 52X, 6HSERIES 2X, A6)
     DO 340 I = 1, NC
340  WRITE (2, FMT3) (BMAT (J, I), J = 1, NC)
350  CONTINUE
     CALL MINV (AMAT, NC, 24, D, LI, MI, MIC, MFL)
     IF (DABS (D). GT. 0.0) GO TO 370
360  WRITE (2, 365) AID
     WRITE (6, 365) AID
365  FORMAT (1HO, 24HTHE A-MATRIX OF SERIES,   A6, 2X,
     11HIS SINGULAR)
     BMULT = BMULT*10.0
     IF (MIC. EQ. 0) GO TO 367
     IF (AMULT. LE. 10000.0) GO TO 270
367  CONTINUE
     WRITE (2, 368)
368  FORMAT (1HO, 49HTOO MANY TRAPS IN SUBROUTINE
     MINV FOR THIS SERIES)
```



```
     GO TO 800
370  CONTINUE
     DO 371 I = 1,24
     DO 371 J =1,24
371  AMAT (J, I) = AMAT (J, I)*AMULT
     WRITE (2, 373) AID
373  FORMAT  (1HO,         9HINVERSE-A,  57X,  6HSERIES,
     2X, A6)
     WRITE (2, 222)
     DO 375 I = 1, NC
375  WRITE (2, FMT5) (AMAT (J, I), J = 1,NC)
     WRITE (2, 376) AID
376  FORMAT (1H1, 20HINDENTITY MATRIX AUNI, 46X, 6HSE-
     RIES, 2X, A6)
     DO 377 I = 1, NC
     DO 377 J = 1, NC
     DO 377 K = 1, NC
     AUNI (J, I) = AUNI (JI) + ASTR (K, I)*AMAT (J, K)
377  CONTINUE
     WRITE (2, 222)
     DO 378 I = 1, NC
378  WRITE (2, FMT3) (AUNI (J, I), J = 1, NC)
     DO 380 L = 1, NC
     DO 380 M = 1, NC
     CMAT (M, L) = 0.0
     DO 380 K = 1, NC
     CMAT (M, L) = CMAT (M, L) + BMAT (L, K)*AMAT
     (K, M)
380  CONTINUE
     IF (NP. EQ. 1) GO TO 400
     WRITE (2, 390) AID
390  FORMAT (1H1,      8HC-MATRIX, 52X 6HSERIES, 2X, A6)
     WRITE (2, 222)
     DO 395 I = 1, NC
395  WRITE (2, FMT3) (CMAT (J, 1), J = 1, NC)
400  CONTINUE
     DO 420 L = 1, NL
     DO 420 M = 1, NC
     DATIN (M, L) = 0.0
420  CONTINUE
     DO 450 L = 1, NL
     DO 450 M = 1, NC
     DO 450 K = 1, NC
     DATIN (M, L + 1) = DATIN (M, L + 1) + WDAT (K,
     L)*CMAT (M, K)
450  CONTINUE
     IF (IP. LT. 2) GO TO 465
     I 1 = NL + 1
     I 2 = NL + IP — 1
     DO 460 L = I 1, I2
     DO 460 M = 1, NC
     DO 460 K = 1, NC
460  DATIN (M, L + 1) = DATIN (M, L + 1) + DATIN (K, L)*
     CMAT (M, K)
465  I3 = NL + IP
3000 CONTINUE                                        FROM
```

```
      WRITE (2, 470) AID
470   FORMAT (1H1,        24HCOMPUTED RELATIVE MATRIX,
      36X, 6HSERIES, 2X, A6)
      WRITE (2, 222)
      DO 500 I = 2, NL
      WRITE (2, FMT3)    DATIN (J, I), J = 1, NC)
500   CONTINUE
      DO 550 I = 1, NL
      DO 550 J = 1, NC
      WDAT (J, I) = DATIN (J, I)*ADTL (I)
550   CONTINUE
      WRITE (2, 222)
      WRITE (6, 222)
      WRITE (2, 570) AID
      WRITE (6, 575) AID
570   FORMAT (1H1,    23HFINAL  ADJUSTED  MATRIX,  37X,
      6HSERIES, 2 X, A6)
575   FORMAT (1H0,    23HFINAL  ADJUSTED. MATRIX,  37X,
      6HSERIES, 2 X, A6)
      WRITE (6, 580) AYR, TOT
      WRITE (2, 580) AYR, TOT
580   FORMAT (1HO, A4, 6X, A6/)
      DTL = 0.0
      DO 590 I = 2, NL
      DO 585 J = 1, NC
      DTL = DTL + WDAT (J, I)
585   DTC (J) = DTC (J) + WDAT (J, I)
      WRITE  (2,  FMT)  AN,  NYR  (I),  DTL,  AS;  (WDAT  (K,  I),
      K = 1, NC)
      WRITE  (6,  FMT)  AN,  NYR  (I),  DTL,  AS,  (WDAT  (K,  I),
      K = 1, NC)
      DTL = 0.0
590   CONTINUE
      WRITE (2, 222)
      WRITE (6, 222)
      WRITE (2, FMI2) TOT, (DTC (J), J = 1, NC)
      WRITE (6, FMIT2) TOT, (DTC (J), J = 1, NC)
      FNL = NL — 1
      DO 650 J = 1, NC
650   DTC (J) = DTC (J)/FNL
      WRITE (2, FMT2) AVG, (DTC (J), J = 1, NC)
      WRITE (6, FMT2) AVG, (DTC (J), J = 1, NC)
      DO 701 I = 2, NL
      DO 701 J =1, NC
      WDAT (J, I) = WDAT (J, I) — DTC (J)
701   WDAT (J, I) = WDAT (J, I)*WDAT (J, I)
      DO 703 J = 1, NC
703   DTC (J) = 0.0
      DO 705 I = 2, NL
      DO 705 J = 1, NC
```



```
705   DTC (J) = DTC (J) + WDAT (J, I),
      DO 707 J = 1, NC
707   DTC (J) = SQRT (DTC (J)/FNL)
      WRITE (2, FMT2) SGM, (DTC (J), J = 1, NC)
      WRITE (6, FMT2) SGM, DTC (J) J = 1, NC)
      WRITE (2, 750) AID
      WRITE (6, 750) AID
750   FORMAT (1H1,      23HRELATIVE PROJECTED DATA, 37X,
      6HSERIES, 2X, A6)
      WRITE (2, 115) AYR, TOT
      WRITE (6, 115) AYR, TOT
      DTL = 0.0
      DO 770 I = I1, I3
      NPY = NOYP + I — 1
      DO 760 J = 1, NC
760   DTL = DTL + DATIN (J, I)
      DTLF = 1.0-DTL
      IF (M2. EQ. 1) DATIN (NC, I) = DTLF
      IF (M2. EQ.1) DTL = 1.0
      WRITE  (2,  FMT4)  AN,  NPY,      DTL,  AS  (DATIN  (K,  I),
      K  =  1,  NC)
      WRITE  (6,  FMT4)  AN,  NPY,       DTL,  AS,  (DATIN  (K,  I),
      K  =  1,  NC)
      DTL = 0.0
770   CONTINUE
800   CONTINUE
      DO  900  =  1,  100
      DO 900 J = 1,24
      DATIN (J, I) = 0.0
      WDAT (J, I) = 0.0
900   CONTINUE
      DO 907 I = 1,24
      DO 907 J = 1,24
      CMAT (J, I) = 0.0
907   CONTINUE
      K = LP—1
910   DTC (J) = 0.0
      IF (NL. EQ. O) GO TO 920
      IF (M2. EQ. 1) GO TO 920
      IF (MT2. EQ. 2) GO TO 1007
920   CONTINUE
      DO 930 I = 1,100
      DO 930 J = 1,24
      WDAT (J, I) = 0.0
      WDT2 (J, I) = 0.0
930   CONTINUE
      GO TO 10
5000  WRITE (6, 5001) AID
5001  FORMAT  (1HO,  6HSERIES,  2X,  A6,  2X,  17HIS  A  MIXED
      SERIES)
      GO TO 800
7000  REWIND 2
      STOP
```

METHOD I I

```
1000 CONTINUE
     WRITE (2, 1001) AID
1001 FORMAT (1H1,     8HA-MATRIX, 52X, 6HSERIES, 2X, A6)
     WRITE (2, 222)
     DO 1002 I = 1, NC
1002 WRITE (2, FMT3)    (ASTR (J, I), J = 1, NC)
     WRITE (2, 222)
     WRITE (2, 1003) AID
1003 FORMAT (1H1, 8HB-MATRIX, 52X, 6HSERIES, 2X, A6)
     DO 1005 I = 1, NC
1005 WRITE (2, FMT3) (BMAT (J, I), J = 1, NC)
1007 CONTINUE
     DO 1008 I = 1,100
     DO 1008 J = 1,24
     WDAT (J, I) = WDT2 (J, I)
1008 CONTINUE
     WRITE (2, 1009) MT2
     WRITE (6, 1009) MT2
1009 FORMAT (1H1, 118X, 6HMETHOD, 1X, I2)
     DO 1010 L = 1,100
     DO 1010 M = 1,24
     DATIN (M, L) = 0.0
1010 CONTINUE
     DO 2000 LP = 1, NC
     K = LP—1
     L = LP + 1
     DO 1015 I = 1,3
     B3 (I) = 0.0
     DO 1015 J = 1,3
1015 A3 (J, I) = 0.0
     DO 1150 I = 1,3
     M = K + I
     IF (M. GT. NC) M = M — NC
     IF (L. GT. NC) L = L — NC
     B3 (I) = BMAT (L, M)
     IXE (I) = M
     DO 1150 J = 1,3
     N = K + J
     IF (N. GT. NC) N = N — NC
1150 A3 (J, I) = ASTR (N, M)
     IF (NINT. EQ. 1) GO TO 1240
1170 WRITE (2, 1200)
1200 FORMAT (1H1, 50X, 25HINTERMEDIATE COMPUTATIONS//)
1210 DO 1240 I = 1,3
     WRITE (2, 1230) (A3 (J, I), J = 1,3), B3 (I)
1230  FORMAT (1H, 40X, 3F8. 4, 10X, F8. 4)
1240 CONTINUE
     CALL MINV (A3, 3, 3, D, LI, MI, MIC, MFL)
     IF (D. EQ. O. O. OR. MIC. EQ. 1. OR. MFL. EQ. 1. OR.
     MFL. EQ. 3) M2 = 1
     DO 1250 I = 1,3
     C3 (I) = 0.0
     DO 1250 J = 1,3
1250 C3 (I) = C3 (1) + A3 (J, I)*B3 (J)
     IF (NINT. EQ. 1) GO TO 1281
```



```
     WRITE (2, 1153)
1153 FORMAT (1HO)
     DO 1270 I = 1,3
1270 WRITE (2, 1280) (A3 (J, I), J = 1,3), C3 (I)
1280 FORMAT (1H, 37X, 3F9. 1, 10X, F8. 4)
1281 CONTINUE
     IE 1 = I XE (1)
     IE 2 = I XE (2)
     IE 3 = I XE (3)
     IF (LP. EQ. NC) GO TO 1283
     CMAT (LP + 1, IE1) = C3 (1)
     CMAT (LP + 1, IE2) = C3 (2)
     CMAT (LP + 1, IE3) = C3 (3)
     GO TO 1285
1283 CONTINUE
     CMAT (1, IE1) = C3 (1)
     CMAT (1, IE2) = C3 (2)
     CMAT (1, IE3) = C3  (3)
1285 CONTINUE
     IF (NINT. EQ. 1) GO TO 1291
     WRITE  (2,  1290)  IE1,  IE2,  IE3
1290 FORMAT (1HO,    3 (2X, I4)  )
1291 CONTINUE
     IF (LP. EQ. (NC — 1) ) GO TO 1400
     IF (LP. EQ. NC) GO TO 1450
     DO 1300 I = 1, NL
     DATIN (IE2, I + 1) = C3 (1)*WDAT (IE1, I) + C3 (2)*
     WDAT (IE2, I) + C3 (3)*WDAT (IE3,
     1300  CONTINUE
     GO TO 1490
1400 CONTINUE
     NZ = NL — 1
     DO 1430 J = 1, NZ
     J1 = J
     J2 = J
     J3 = J + 1
1430 DATIN   (IE2, J + 1) = C3 (1)*WDAT (IE1,  J1,) + C3 (2)*
     WDAT (IE2, J2) + C3 (3)* 1WDAT (IE3, J3)
     DATIN (IE2, NL + 1) = 0.0
     GO TO 1490
1450 CONTINUE
     DATIN (IE2, 2) = STAB
     DO 1470 J = 2, NL
     J1 = J-1
     J2 = J
     J3 = J
1470 DATIN (IE2, J + 1) = C3 (1)*WDAT  (IE1,  J1) + C3 (2)*
     WDAT (IE2, J2) + C3 (3)* 1 WDAT (IE3, J3)
1490 CONTINUE
     IF (NINT. EQ. 1) GO TO 2000
     WRITE (2, 222)
     WRITE (2, 1153)
     DO 1500 I = 1, NL
1500 WRITE (2, FMT3) (DATIN (J, I) J = 1, NC)
2000 CONTINUE
     WRITE (2, 222)
     WRITE (2, 2500) AID
```

```
2500 FORMAT (1HO, 20HC-MARTIX,   TRANSPOSED., 40X, 6HSE-
     RIES, 2X, A6)
     WRITE (2, 222)
     DO 2700 I =1, NC
2700 WRITE (2, FMT3) (CMAT (J, I), J = 1, NC)
     I1 = NL + 1
     I2 = NL
     I3 = NL + 1
     M2 = 1
     GO TO 3000
4000 CONTINUE
     WRITE (2, 4005) AID
     WRITE (6, 4005) AID
4005 FORMAT (1HO, 24HA SUBMATRIX OF A-SERIES,  A6, 2X,
     11HIS SINGULAR)
     GO TO 800
     END
```

(Rad primljen juna 1969.)

ADJUSTMENT, INTERPOLATION AND EXTRAPOLATION OF SEASONAL TIME SERIES

by Branislav IVANOVIĆ

Summary

If in the course of N years one measures characteristic X each year n times and if x_{ij} is its j-th value in the i-th year, the matrix x_{ij} represents a time series. The variations of values in one year and the values corresponding to different years can result from random factors, seasonal influences and the general tendencies of movemnts of the examined phenomen. If the series is sufficiently long a cyclical characteristic can manifest itself.

If the seasonal influences are very pronounced and the tendency of interseasonal variations more or less stable the relative adjusted values of the year (t+1) are given in (1.1), the coefficients k_{ij} are elements of the law of movement (1.2) calculated by the use of (1.3), where the elements of matrix A_{ii} are given by (1.4') and (1.4").

Forecasts of future series are given in (1.5) while (1.6) enables us to reconstruct earlier series.

If the interseasonal variation is insignificant in relation to random variation of the phenomenon there is no further question of seasonal influences on the law of movement. The new law of movement then is given by (1.9) and the adjusted series in (1.10)

On the basis of (1.11) we can forecast future series and with the aid of (1.2) reconstruct earlier series.

We use exports of Great Britain in the period 1960—1967 for application and comparison of this method.

The monthly data for exports are give in Table (1) while Table (4) presents the quarterly values. Tables (2) and (5) represent adjusted values obtained by method X-11, Tables (3) and (7) by method G-1, and Table (6) by method G-2.

Finally, let us note that the Fortran programme drawn up by Mr. Vincentu Dumitru, of the UN Electronic Centre, for two alternatives of the proposed method contains no more than ten pages.