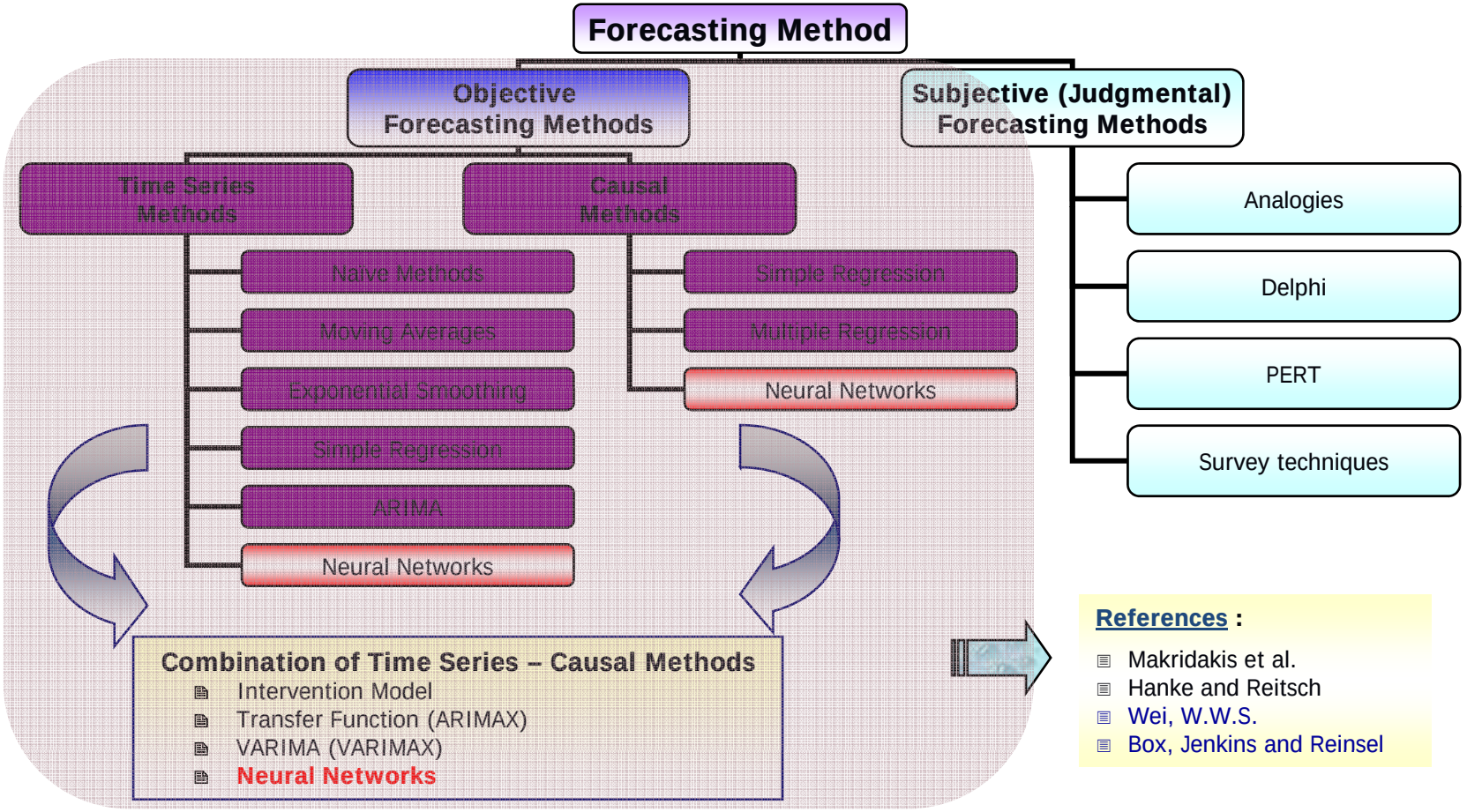
Teknik *Forecasting*

Pendekatan	**Basis**	**Teknik**	**Hasil**
Peramalan ekstrapolatif	Ekstrapolasi trend	Analisis rangkaian-waktu Teknik benang-hitam Teknik OLS Pembobotan eksponensial Transformasi data Metode katastrofi	Projeksi
Peramalan Teoretis	Teori	Pemetaan teori Analisis jalur Analisis Input-Output Pemrograman linier Analisis regresi Estimasi interval Analisis hubungan	Prediksi
Peramalan intuitif	Penilaian subjektif	Delphi konvensional Delphi kebijakan Analisis dampak-silang Penilaian kelayakan	Konjektur

Asumsi Peramalan Ekstrapolatif

1. Keajegan (*persistence*): Pola yang terjadi di masa lalu akan tetap terjadi di masa mendatang. Mis: jika konsumsi energi di masa lalu meningkat, ia akan selalu meningkat di masa depan.
2. Keteraturan (*regularity*): Variasi di masa lalu akan secara teratur muncul di masa depan. Mis: jika banjir besar di Jakarta terjadi setiap 16 tahun sekali, pola yg sama akan terjadi lagi.
3. Keandalan (*reliability*) dan kesahihan (*validity*) data: Ketepatan ramalan tergantung kepada keandalan dan kesahihan data yg tersedia. Mis: data ttg laporan kejahatan seringkali tidak sesuai dg insiden kejahatan yg sesungguhnya, data ttg gaji bukan merupakan ukuran tepat dari pendapatan masyarakat.

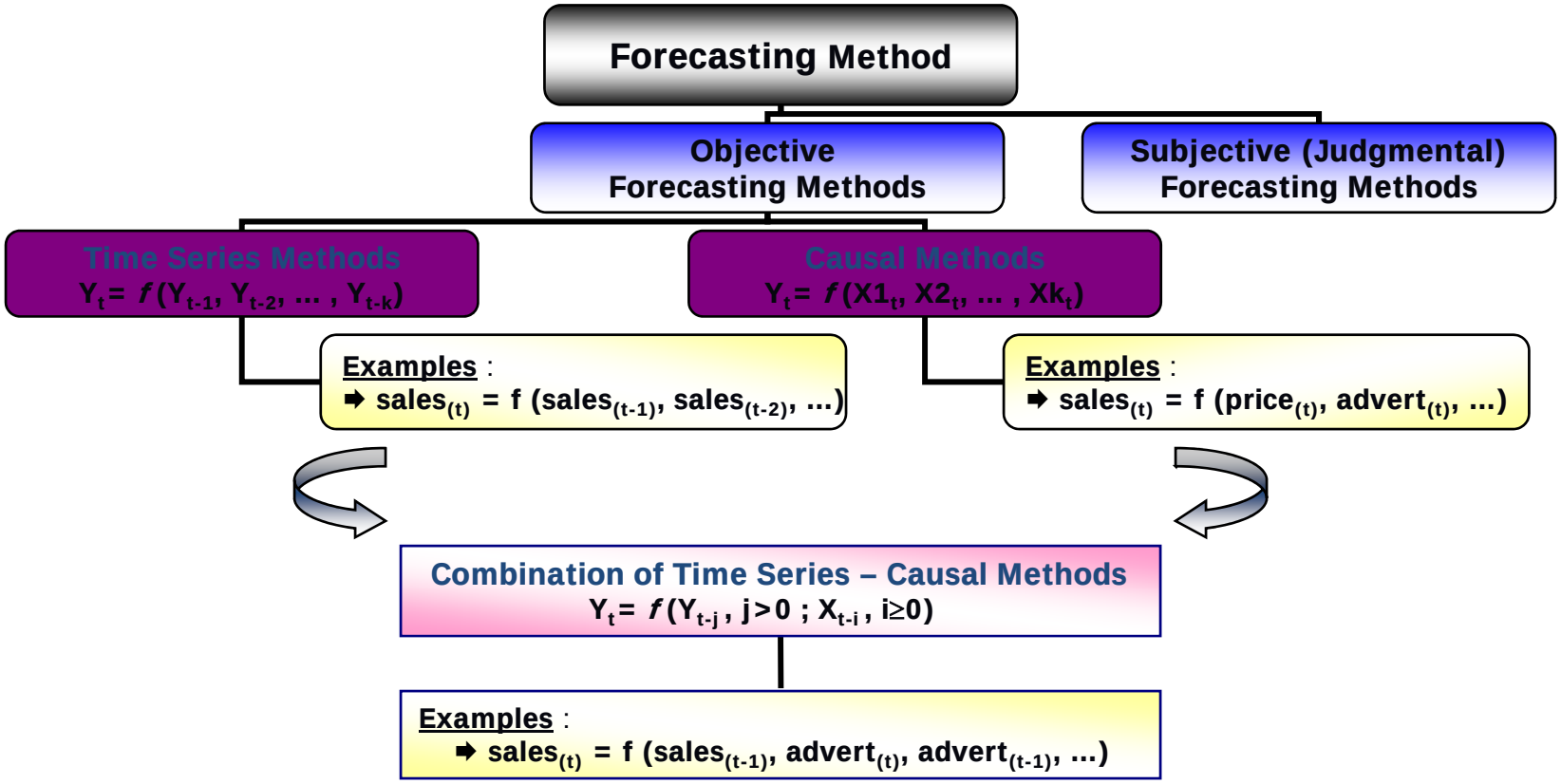
Klasifikasi Metode Peramalan ...



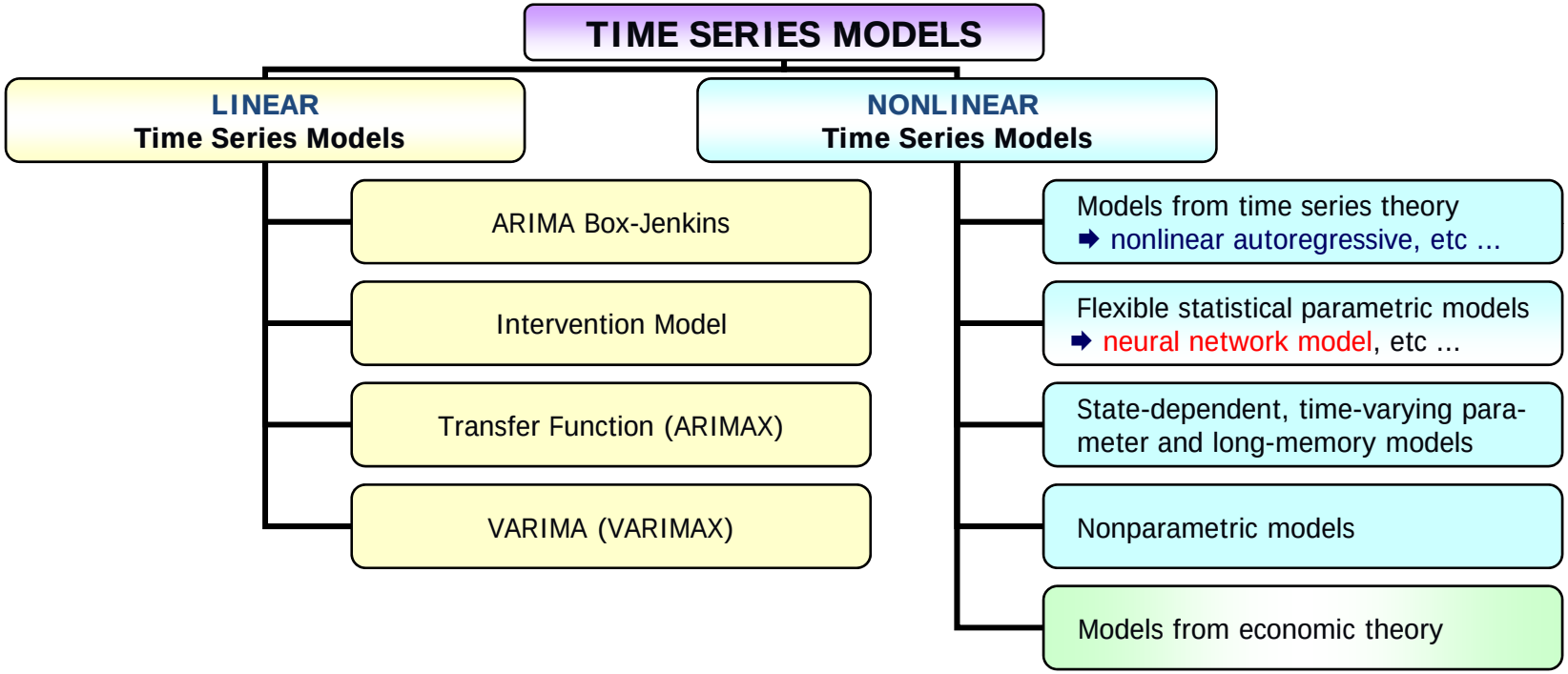
References :

- Makridakis et al.
- Hanke and Reitsch
- Wei, W.W.S.
- Box, Jenkins and Reinsel

Klasifikasi Metode Peramalan : Ilustrasi Model Matematis ...



Klasifikasi Model Time Series : Berdasarkan **Bentuk** atau **Fungsi** …



References :

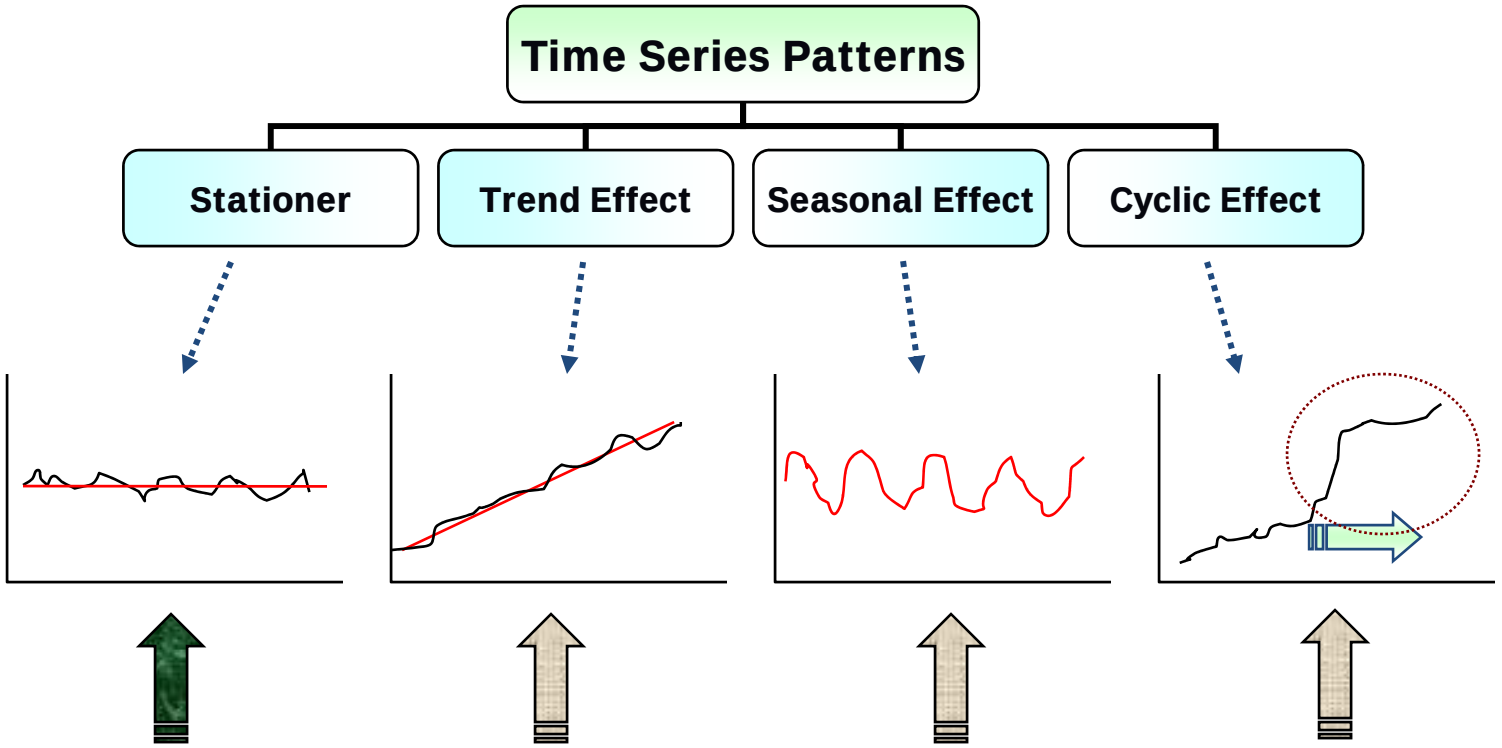
- Timo Terasvirta, Dag Tjostheim and Clive W.J. Granger, (1994) "Aspects of Modelling Nonlinear Time Series" Handbook of Econometrics, Volume IV, Chapter 48. Edited by R.F. Engle and D.I. McFadden

POLA DATA Time Series …

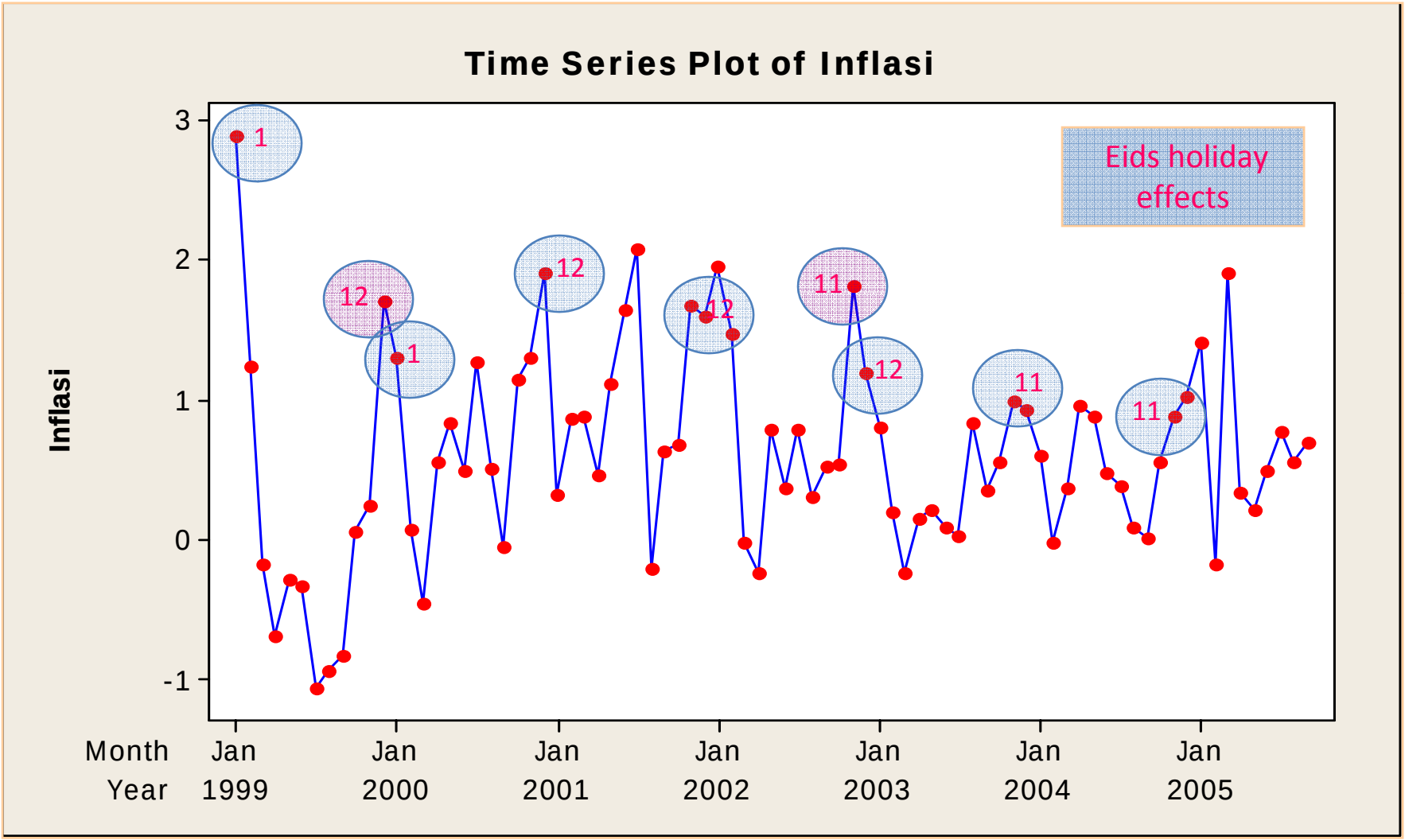
General Time Series “PATTERN”

- Stationer
- Trend (linear or nonlinear)
- Seasonal (additive or multiplicative)
- Cyclic
- Calendar Variation

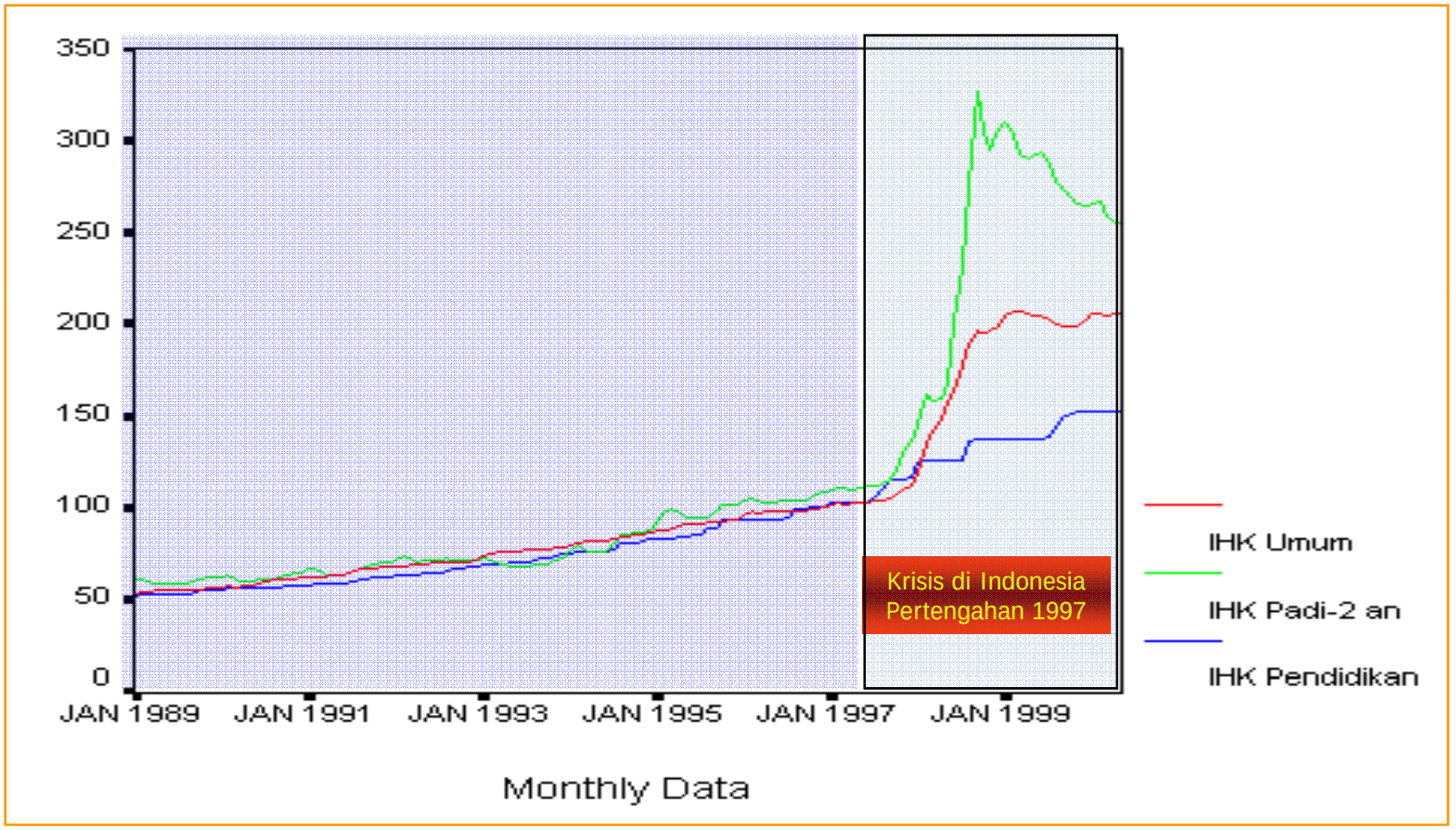
General of Time Series Patterns ...



Contoh DATA EKONOMI ... 1

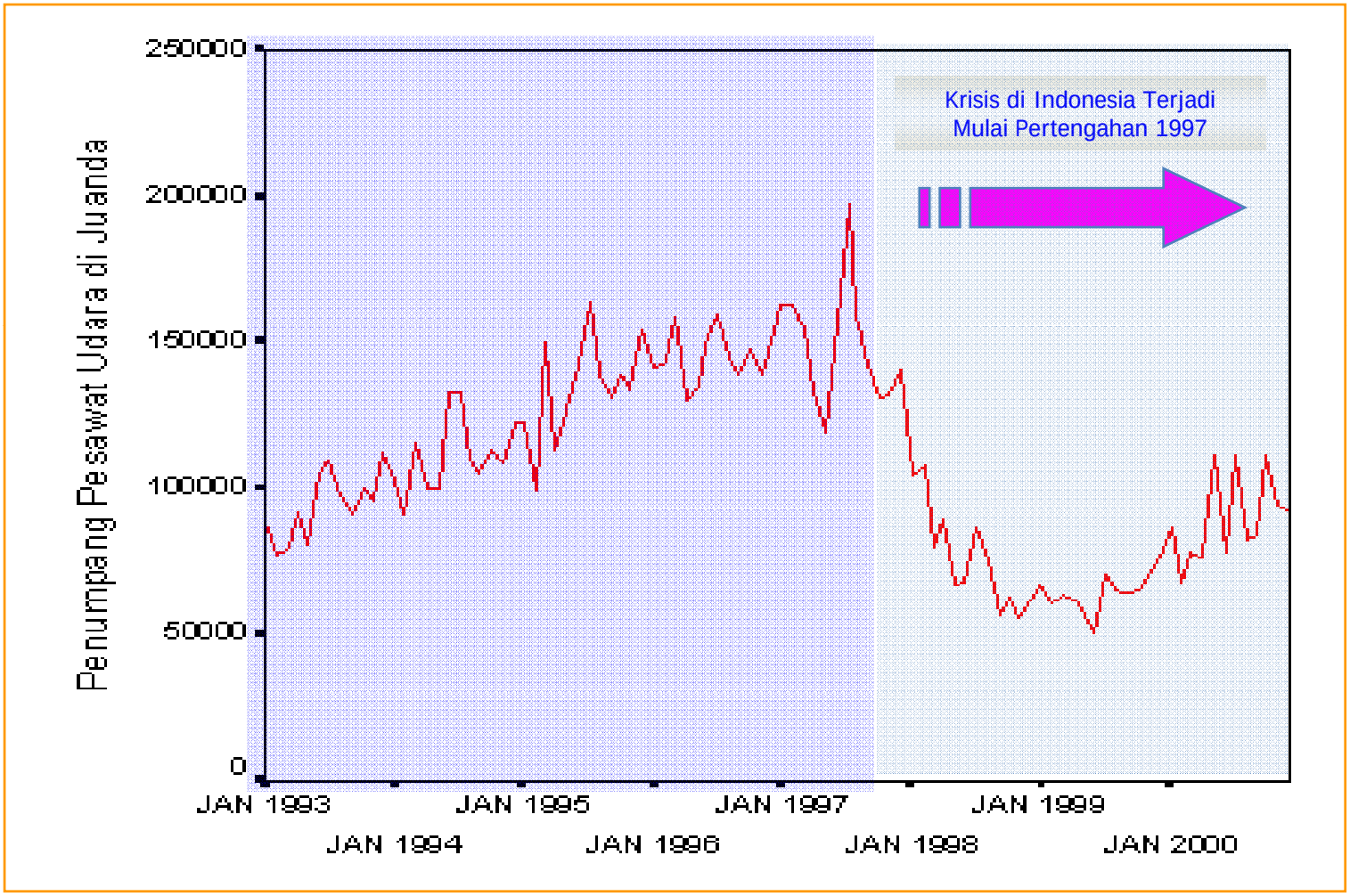


Contoh DATA EKONOMI ... 2



Reference : Badan Pusat Statistik (BPS) Indonesia

Contoh DATA EKONOMI ... 3



Reference : Dinas Perhubungan Jawa Timur

Model-model Time Series Regression

1. **Model Regresi untuk LINEAR TREND**

   $Y_t = a + b.t + error$ ⇨ t = 1, 2, … (dummy waktu)

2. **Model Regresi untuk Data SEASONAL (variasi konstan)**

   $Y_t = a + b_1 D_1 + \ldots + b_{S-1} D_{S-1} + error$

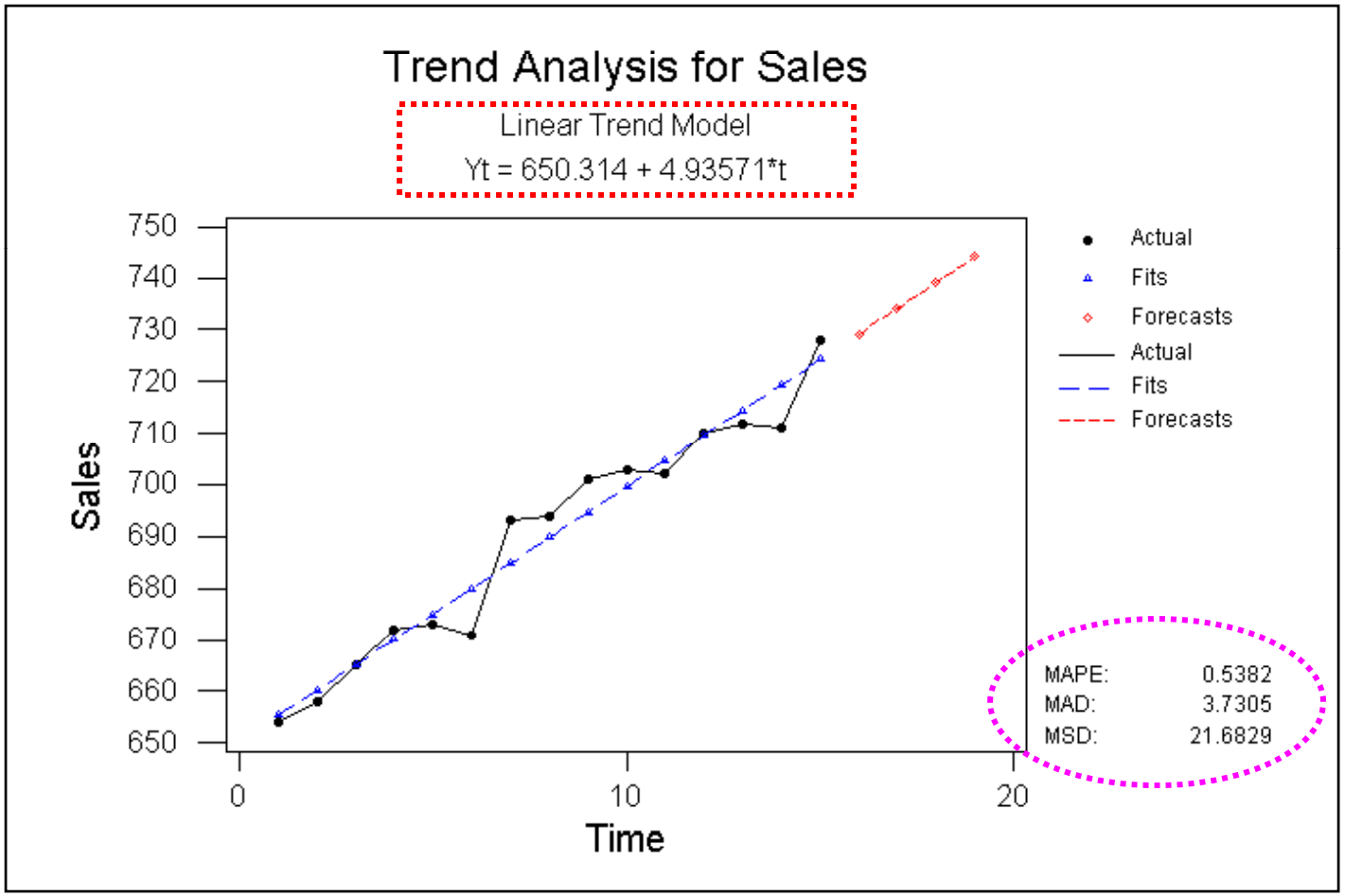
   dengan : $D_1, D_2, \ldots, D_{S-1}$ adalah dummy waktu dalam satu periode seasonal.

3. **Model Regresi untuk Data dengan LINEAR TREND dan SEASONAL (variasi konstan)**

   $Y_t = a + b.t + c_1 D_1 + \ldots + c_{S-1} D_{S-1} + error$

   ➲ Gabungan model 1 dan 2.

Problem 4: Hasil Regresi Trend dg MINITAB … (continued)

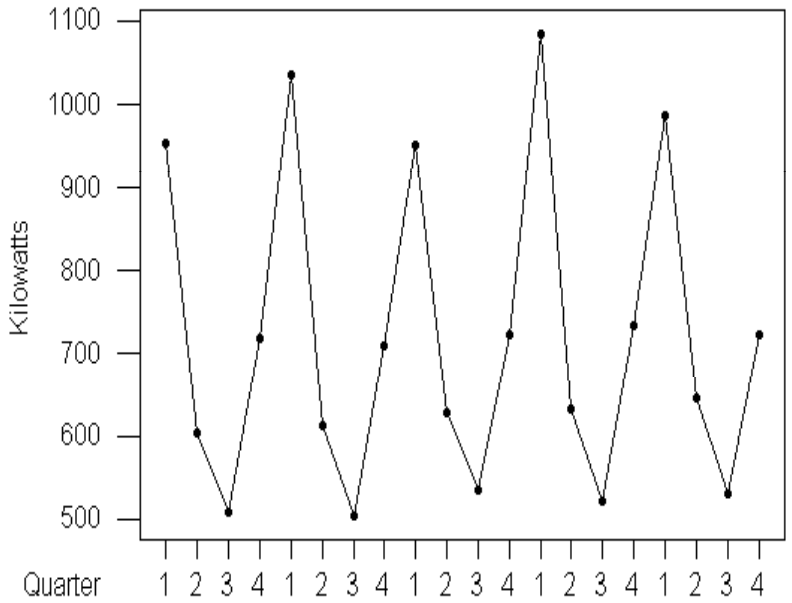


Problem 4: Hasil Regresi Trend dg MINITAB … (continued)

↓	C1	C2	C3	C4	C5	C6
	Year	Weekly	Sales	FITS1	RESI1	FORE1
1	2005	1	654	655.250	-1.25000	729.286
2	2005	2	658	660.186	-2.18571	734.221
3	2005	3	665	665.121	-0.12143	739.157
4	2005	4	672	670.057	1.94286	744.093
5	2005	5	673	674.993	-1.99286	
6	2005	6	671	679.929	-8.92857	
7	2005	7	693	684.864	8.13571	
8	2005	8	694	689.800	4.20000	
9	2005	9	701	694.736	6.26429	
10	2005	10	703	699.671	3.32857	
11	2005	11	702	704.607	2.60714	
12	2005	12	710	709.543	0.45714	
13	2005	13	712	714.479	-2.47857	
14	2005	14	711	719.414	-8.41429	
15	2005	15	728	724.350	3.65000	

Problem 5: Regresi Data **Seasonal** … (Data Electrical Usage)

	Tahun	Kuartal	t	Kilowatts
1	2000	1	1	953
2	2000	2	2	604
3	2000	3	3	508
4	2000	4	4	718
5	2001	1	5	1036
6	2001	2	6	612
7	2001	3	7	503
8	2001	4	8	710
9	2002	1	9	952
10	2002	2	10	628
11	2002	3	11	534
12	2002	4	12	723
13	2003	1	13	1085
14	2003	2	14	632
15	2003	3	15	522
16	2003	4	16	733
17	2004	1	17	988
18	2004	2	18	645
19	2004	3	19	530
20	2004	4	20	724



Time Series Plot (Data seasonal)

Problem 5: Hasil regresi dengan MINITAB …

```
MTB > Regress 'Kilowatts' 3 'Kuartal-1'-'Kuartal-3'

The regression equation is
Kilowatts = 722 + 281 Kuartal.1 - 97.4 Kuartal.2 - 202 Kuartal.3

Predictor         Coef     SE Coef           T        P
Constant        721.60       13.79       52.32    0.000
Kuartal.1       281.20       19.51       14.42    0.000
Kuartal.2       -97.40       19.51       -4.99    0.000
Kuartal.3      -202.20       19.51      -10.37    0.000

S = 30.84       R-Sq = 97.7%     R-Sq(adj) = 97.3%

Analysis of Variance
Source            DF          SS          MS          F        P
Regression         3      646802      215601     226.65    0.000
Residual Error    16       15220         951
Total             19      662022
```

Problem 6: Regresi Data **Trend Linear** dan **Seasonal** …

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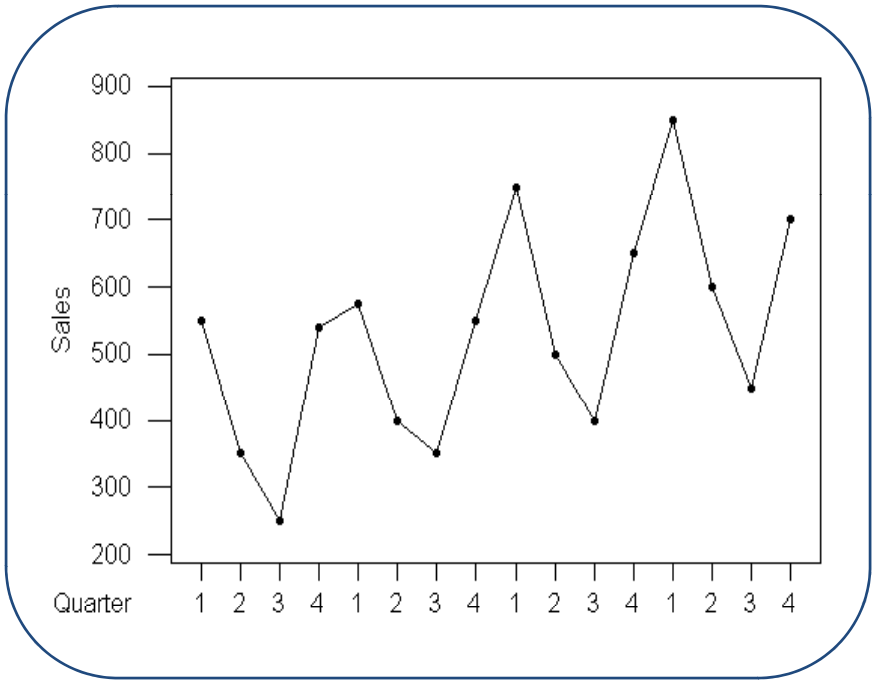
↓	C1	C2	C3	C4	C5
	Year	Quarter	t	Sales	
1	2001	1	1	550	
2	2001	2	2	350	
3	2001	3	3	250	
4	2001	4	4	540	
5	2002	1	5	575	
6	2002	2	6	400	
7	2002	3	7	350	
8	2002	4	8	550	
9	2003	1	9	750	
10	2003	2	10	500	
11	2003	3	11	400	
12	2003	4	12	650	
13	2004	1	13	850	
14	2004	2	14	600	
15	2004	3	15	450	
16	2004	4	16	700	



Time Series Plot (Data trend dan seasonal)

Problem 6: Hasil regresi dengan MINITAB …

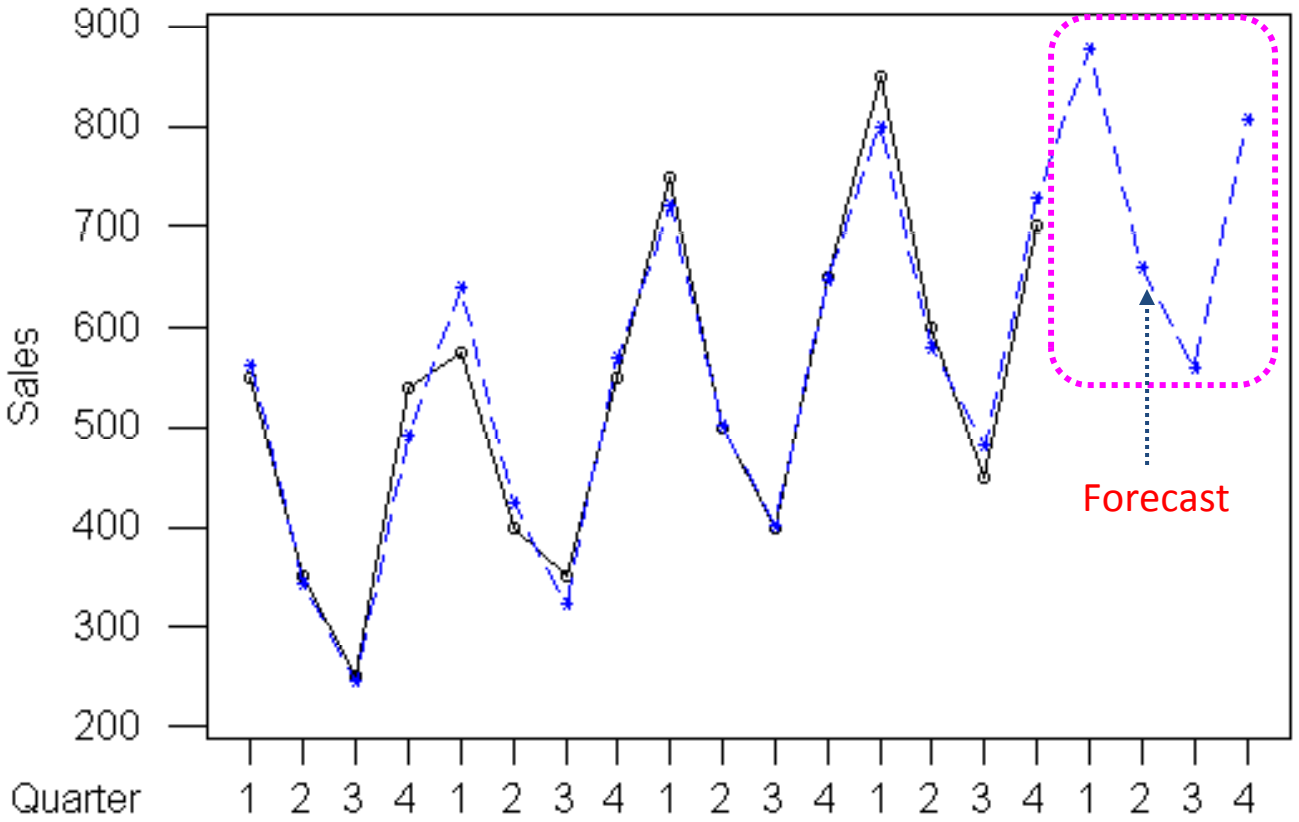
	Year	Quarter	t	Sales	Kuartal.1	Kuartal.2	Kuartal.3	Kuartal.4	RESI1	FITS1
1	2001	1	1	550	1	0	0	0	-12.9375	562.938
2	2001	2	2	350	0	1	0	0	5.8125	344.188
3	2001	3	3	250	0	0	1	0	5.8125	244.188
4	2001	4	4	540	0	0	0	1	48.3125	491.688
5	2002	1	5	575	1	0	0	0	-66.8125	641.813
6	2002	2	6	400	0	1	0	0	-23.0625	423.063
7	2002	3	7	350	0	0	1	0	26.9375	323.063
8	2002	4	8	550	0	0	0	1	-20.5625	570.563
9	2003	1	9	750	1	0	0	0	29.3125	720.688
10	2003	2	10	500	0	1	0	0	-1.9375	501.938
11	2003	3	11	400	0	0	1	0	-1.9375	401.938
12	2003	4	12	650	0	0	0	1	0.5625	649.438
13	2004	1	13	850	1	0	0	0	50.4375	799.563
14	2004	2	14	600	0	1	0	0	19.1875	580.813
15	2004	3	15	450	0	0	1	0	-30.8125	480.813
16	2004	4	16	700	0	0	0	1	-28.3125	728.313
17	2005	1	17	*	1	0	0	0	*	878.438
18	2005	2	18	*	0	1	0	0	*	659.688
19	2005	3	19	*	0	0	1	0	*	559.688
20	2005	4	20	*	0	0	0	1	*	807.188

Dummy Variable

Problem 6: Hasil regresi dengan MINITAB …

```
MTB > Regress 'Sales' 4 't' 'Kuartal.1'-'Kuartal.3'

The regression equation is
Sales = 413 + 19.7 t + 130 Kuartal.1 - 108 Kuartal.2 - 228 Kuartal.3

16 cases used 4 cases contain missing values

Predictor        Coef     SE Coef          T        P
Constant       412.81       26.99      15.30    0.000
t              19.719       2.012       9.80    0.000
Kuartal.1      130.41       26.15       4.99    0.000
Kuartal.2     -108.06       25.76      -4.19    0.001
Kuartal.3     -227.78       25.52      -8.92    0.000

S = 35.98      R-Sq = 96.3%     R-Sq(adj) = 95.0%

Analysis of Variance

Source            DF          SS          MS          F        P
Regression         4      371967       92992      71.82    0.000
Residual Error    11       14243        1295
Total             15      386211
```

Problem 6: Hasil regresi dengan MINITAB …



Time Series Plot (Data dan Ramalannya)

Perbandingan ketepatan ramalan antar metode …

Kasus Sales Video Store

Model	Kriteria kesalahan ramalan		
	MSE	MAD	MAPE
Double M.A.	66.6963	6.68889	0.9557
Holt's Method	28.7083	4.4236	0.6382
Regresi Trend	21.6829	3.73048	0.5382

Holt's Method :
Alpha (level): 0.202284
Gamma (trend): 0.234940

Kasus Sales Data Kuartalan

Model	Kriteria kesalahan ramalan		
	MSE	MAD	MAPE
Winter's Method	4372.69	52.29	9.67
Regresi Trend & Seasonal	890.215	23.2969	4.3122

Winter's Method :
Alpha (level): 0.4
Gamma (trend): 0.1
Delta (seasonal): 0.3

Contoh

- Tahun 2000:

  Penjualan mobil = Rp. 300 M

  Indeks harga mobil = 135
- Tahun 2001:

  Penjualan mobil = Rp. 350 M

  Indeks harga mobil = 155

Pertanyaan:

- Berapa peningkatan nominal ?
- Berapa peningkatan riilnya ?

Perhitungan

- Peningktan Nominal

- Rp. 350 M – Rp. 300 M

  = Rp. 50 M

- Peningktan Riil

Penjualan tahun 2000

(Rp. 300M) (100/135)

= Rp. 222,222 M

Penjualan tahun 2001

(Rp. 350M) (100/155)

= Rp. 225,806 M

Peningkatan:

225,806M – 222,222 M

= Rp. 3,584 M

Mr. Aringanu akan menganalisis laju pertumbuhan penjualan toko yang menjual 70% mebeler dan 30% alat rumah tangga.

Tahun	Penj	IH Mebel	IH ART	IH	Penj. Riil
1983	42.1	111.6	105.3	109.7	38.4
1984	47.2	117.2	108.5	114.6	41.2
1985	48.4	124.2	109.8	119.9	40.4
1986	50.6	128.3	114.1	124.0	40.8
1987	55.2	136.1	117.6	130.6	42.3
1988	57.9	139.8	122.4	134.6	43.0
1989	59.8	145.7	128.3	140.5	42.6
1990	60.7	156.2	131.2	148.7	40.8

Trend
Tahun Pertama Tahun Dasar

Thn	X	Penj (Y)	X^2	XY
1990	0	108	0	0
1991	1	119	1	119
1992	2	110	4	220
1993	3	122	9	366
1994	4	130	16	520
JMH	10	589	30	1225

Trend
Titik Tengah sbg tahun Dasar

Thn	X	Penj (Y)	X^2	XY
1990	-2	108	4	-216
1991	-1	119	1	-119
1992	0	110	0	0
1993	1	122	1	122
1994	2	130	4	260
JMH	0	589	10	47

Trend Eksponensial

Thn	X	Penj (Y)	Log Y	X log Y
1990	-2	108	2.0334	-4.0668
1991	-1	119	2.0755	-2.0755
1992	0	110	2.0414	0
1993	1	122	2.0864	2.0864
1994	2	130	2.1139	4.2279
JMH	0	589	10.351	0.1719

Trend Kuadratik

Thn	X	Y	X^2	X^3	X^4	XY	X^2Y
1981	-5	2	25	-125	625	-10	50
1982	-3	5	9	-27	81	-15	45
1983	-1	8	1	-1	1	-8	8
1984	1	15	1	1	1	15	15
1985	3	26	9	27	81	78	234
1986	5	37	25	125	625	185	925
Jlh	0	93	70	0	1414	245	1277

Naïve Model

- The **recent periods** are the best predictors of the future.

1. **The simplest model for stationary data is**

$$\Rightarrow \quad \hat{Y}_{t+1} = Y_t$$

2. **The simplest model for trend data is**

$$\Rightarrow \quad \hat{Y}_{t+1} = Y_t + (Y_t - Y_{t-1}) \quad \text{or}$$

$$\Rightarrow \quad \hat{Y}_{t+1} = Y_t \frac{Y_t}{Y_{t-1}}$$

3. **The simplest model for seasonal data is**

$$\Rightarrow \quad \hat{Y}_{t+1} = Y_{(t+1)-s}$$

Average Methods

1. Simple Averages

- obtained by finding the **mean for all the relevant values** and then **using this mean to forecast the next period**.

$$\hat{Y}_{t+1} = \sum_{t=1}^{n} \frac{Y_t}{n}$$

for stationary data

2. Moving Averages

- obtained by finding the **mean for a specified set of values** and then **using this mean to forecast the next period**.

$$M_t = \hat{Y}_{t+1} = \frac{(Y_t + Y_{t-1} + \ldots + Y_{t-n+1})}{n}$$

for stationary data

Average Methods … (continued)

3. Double Moving Averages

- one set of moving averages is computed, and then a second set is computed as a moving average of the first set.

(i). $$M_t = \hat{Y}_{t+1} = \frac{(Y_t + Y_{t-1} + \ldots + Y_{t-n+1})}{n}$$

(ii). $$M'_t = \frac{(M_t + M_{t-1} + \ldots + M_{t-n+1})}{n}$$

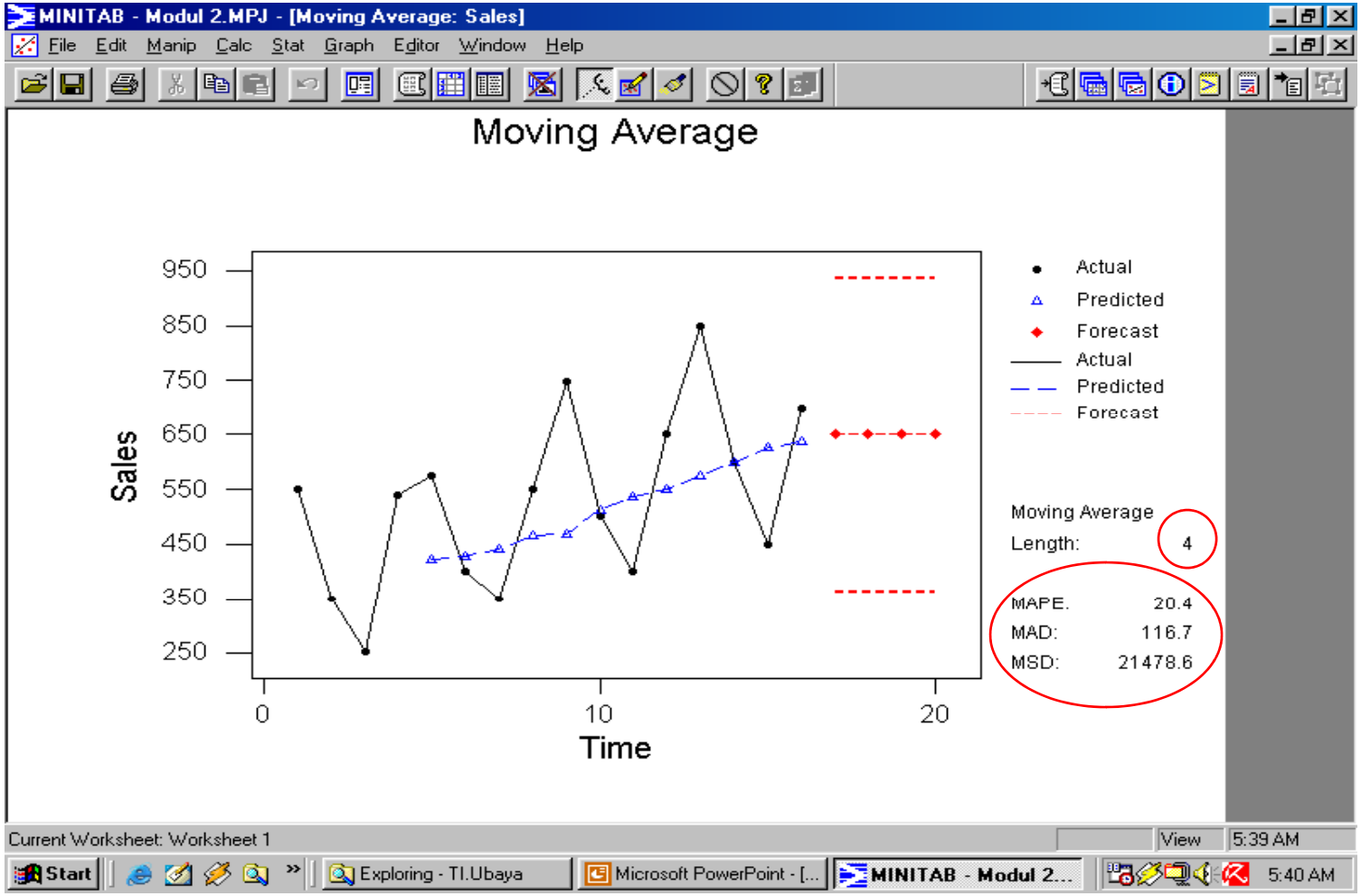
(iii). $$a_t = 2M_t - M'_t$$

(iv). $$b_t = \frac{2}{n-1}(M_t - M'_t)$$

$$\Rightarrow \quad \hat{Y}_{t+p} = a_t + b_t p$$

for a linear trend data

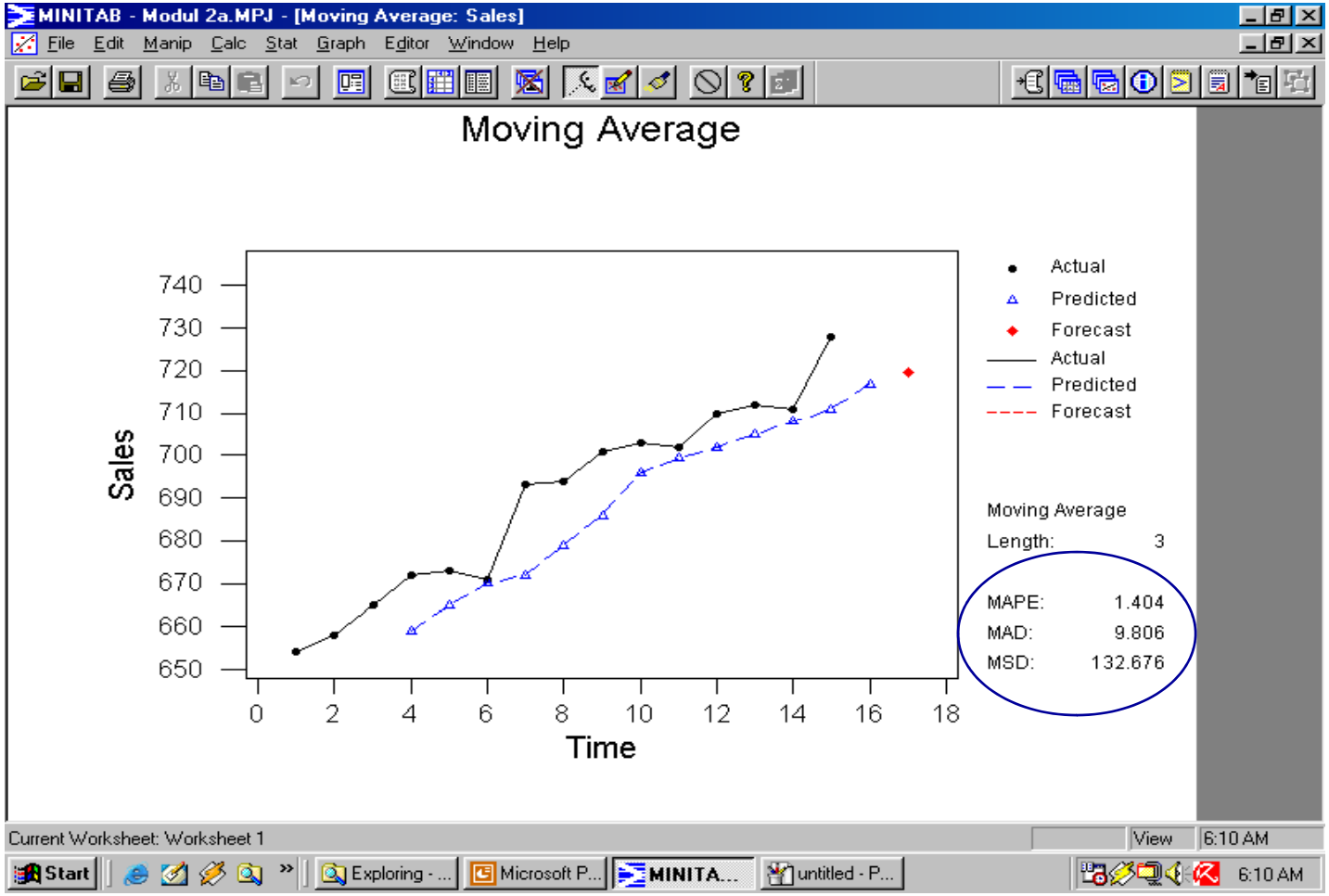
MINITAB implementation



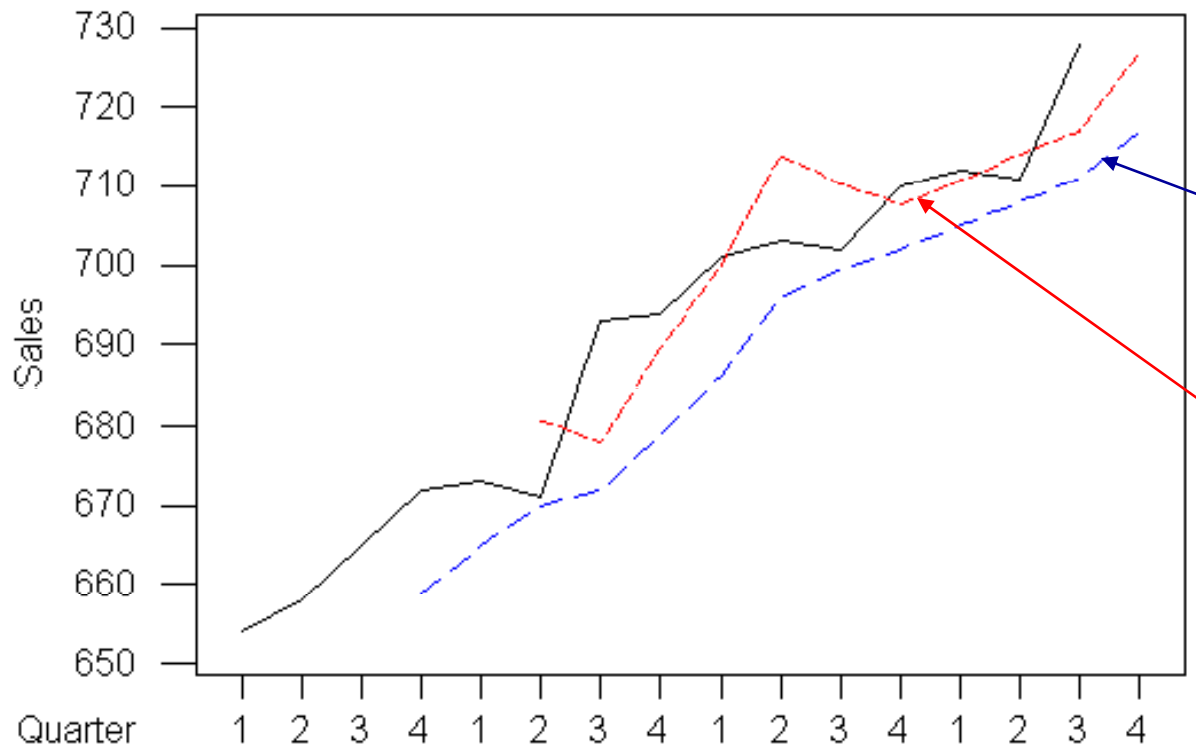
MINITAB implementation … (continued)

	Year	Quarter	t	Sales	AVER1	FITS1	RESI1	FORE1
1	2001	1	1	550	*	*	*	650
2	2001	2	2	350	*	*	*	650
3	2001	3	3	250	*	*	*	650
4	2001	4	4	540	422.50	*	*	650
5	2002	1	5	575	428.75	422.50	152.50	
6	2002	2	6	400	441.25	428.75	-28.75	
7	2002	3	7	350	466.25	441.25	-91.25	
8	2002	4	8	550	468.75	466.25	83.75	
9	2003	1	9	750	512.50	468.75	281.25	
10	2003	2	10	500	537.50	512.50	-12.50	
11	2003	3	11	400	550.00	537.50	-137.50	
12	2003	4	12	650	575.00	550.00	100.00	
13	2004	1	13	850	600.00	575.00	275.00	
14	2004	2	14	600	625.00	600.00	0.00	
15	2004	3	15	450	637.50	625.00	-175.00	
16	2004	4	16	700	650.00	637.50	62.50	
17	2005	1	17					
18	2005	2	18					

Moving Averages Result … (continued)



Moving Averages **VS** Double Moving Averages Results



MA or Moving Averages

DMA or Double Moving Averages

MSE.MA = **132.67**, MSE.DMA = **63.7**

Exponential Smoothing Methods

✓ **Single Exponential Smoothing** ⇨ for **stationary** data

$$\hat{Y}_{t+1} = \alpha Y_t + (1-\alpha)\hat{Y}_t$$

✓ Exponential Smoothing Adjusted for **Trend** : **Holt's Method**

1. The exponentially smoothed series :

$$A_t = \alpha\, Y_t + (1-\alpha)\,(A_{t-1} + T_{t-1})$$

2. The trend estimate :

$$T_t = \beta\,(A_t - A_{t-1}) + (1-\beta)\,T_{t-1}$$

3. Forecast **p** periods into the future :

$$\hat{Y}_{t+p} = A_t + pT_t$$

Exponential Smoothing Adjusted for **Trend** and **Seasonal** Variation : **Winter's Method**

1. The exponentially **smoothed** series :

$$A_t = \alpha \frac{Y_t}{S_{t-L}} + (1-\alpha)\,(A_{t-1} + T_{t-1})$$

2. The **trend** estimate :

$$T_t = \beta(A_t - A_{t-1}) + (1-\beta)T_{t-1}$$

3. The **seasonality** estimate :

$$S_t = \gamma \frac{Y_t}{A_t} + (1-\gamma)S_{t-1}$$

4. **Forecast *p*** periods into the future :

$$\hat{Y}_{t+p} = (A_t - pT_t)S_{t-L+p}$$

Three parameters models

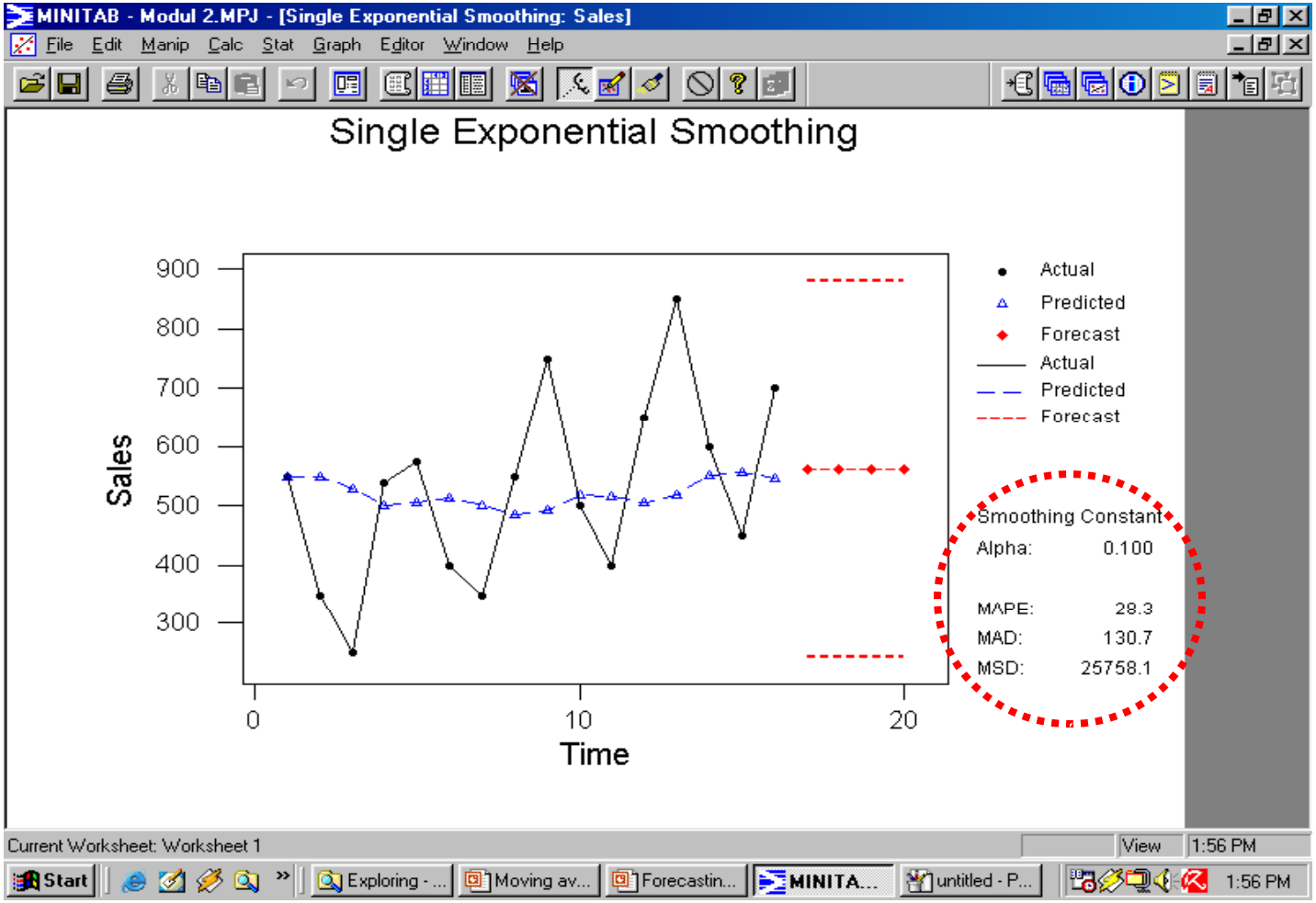
SES: MINITAB implementation

	Year	Quarter	t	Sales	FITS1	RESI1	FITS2	RESI2
1	2001	1	1	550	550.000	0.000	550.000	0.000
2	2001	2	2	350	550.000	-200.000	550.000	-200.000
3	2001	3	3	250	530.000	-280.000	430.000	-180.000
4	2001	4	4	540	502.000	38.000	322.000	218.000
5	2002	1	5	575	505.800	69.200	452.800	122.200
6	2002	2	6	400	512.720	-112.720	526.120	-126.120
7	2002	3	7	350	501.448	-151.448	450.448	-100.448
8	2002	4	8	550	486.303	63.697	390.179	159.821
9	2003	1	9	750	492.673	257.327	486.072	263.928
10	2003	2	10	500	518.406	-18.406	644.429	-144.429
11	2003	3	11	400	516.565	-116.565	557.771	-157.771
12	2003	4	12	650	504.909	145.091	463.109	186.891
13	2004	1	13	850	519.418	330.582	575.243	274.757
14	2004	2	14	600	552.476	47.524	740.097	-140.097
15	2004	3	15	450	557.228	-107.228	656.039	-206.039
16	2004	4	16	700	546.505	153.495	532.416	167.584
17	2005	1	17		561.855		632.966	
18	2005	2	18		561.855		632.966	
19	2005	3	19		561.855		632.966	
20	2005	4	20		561.855		632.966	

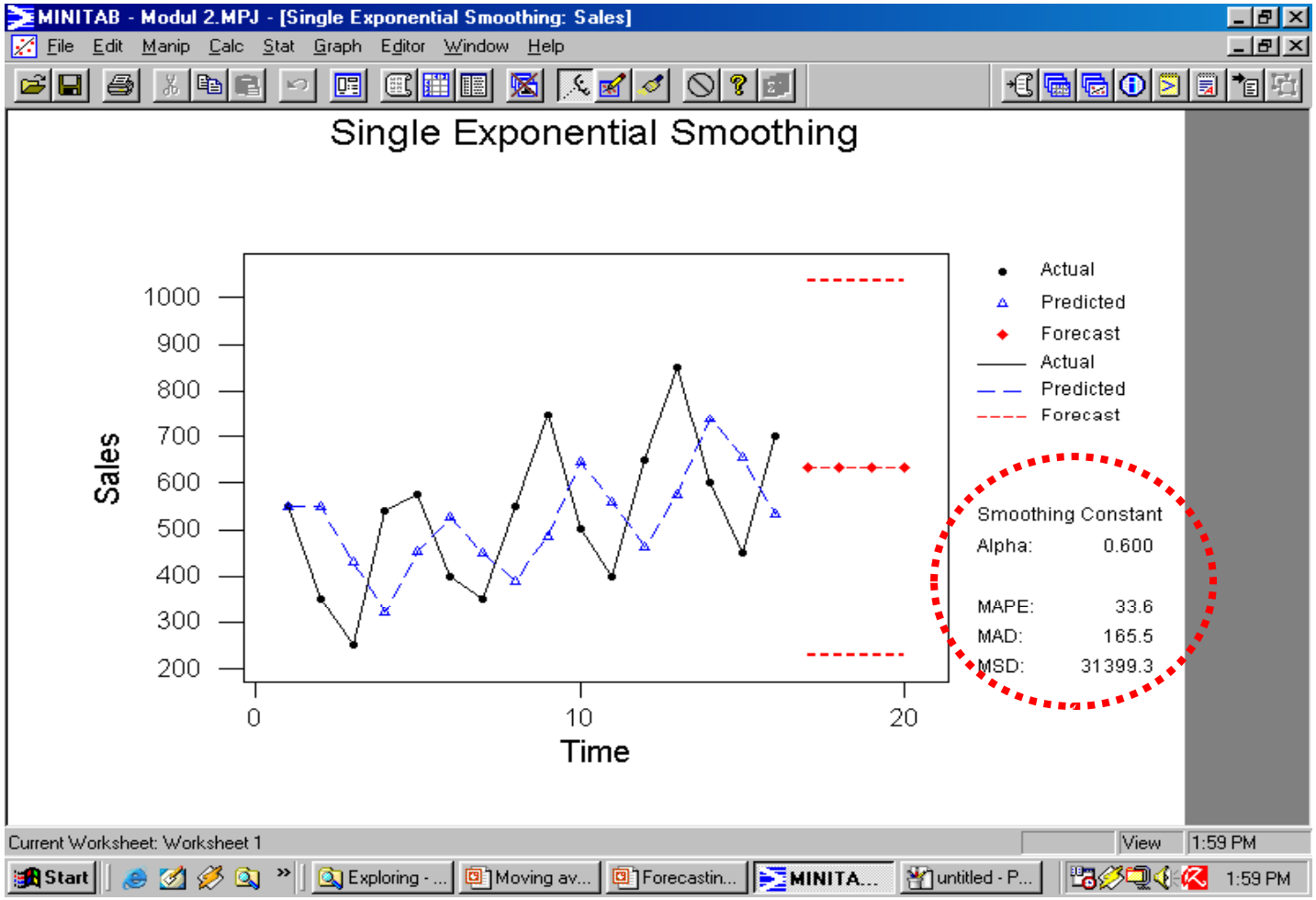
SES dengan alpha 0,1

SES dengan alpha 0,6

SES: MINITAB implementation … (continued)



SES: MINITAB implementation … (continued)

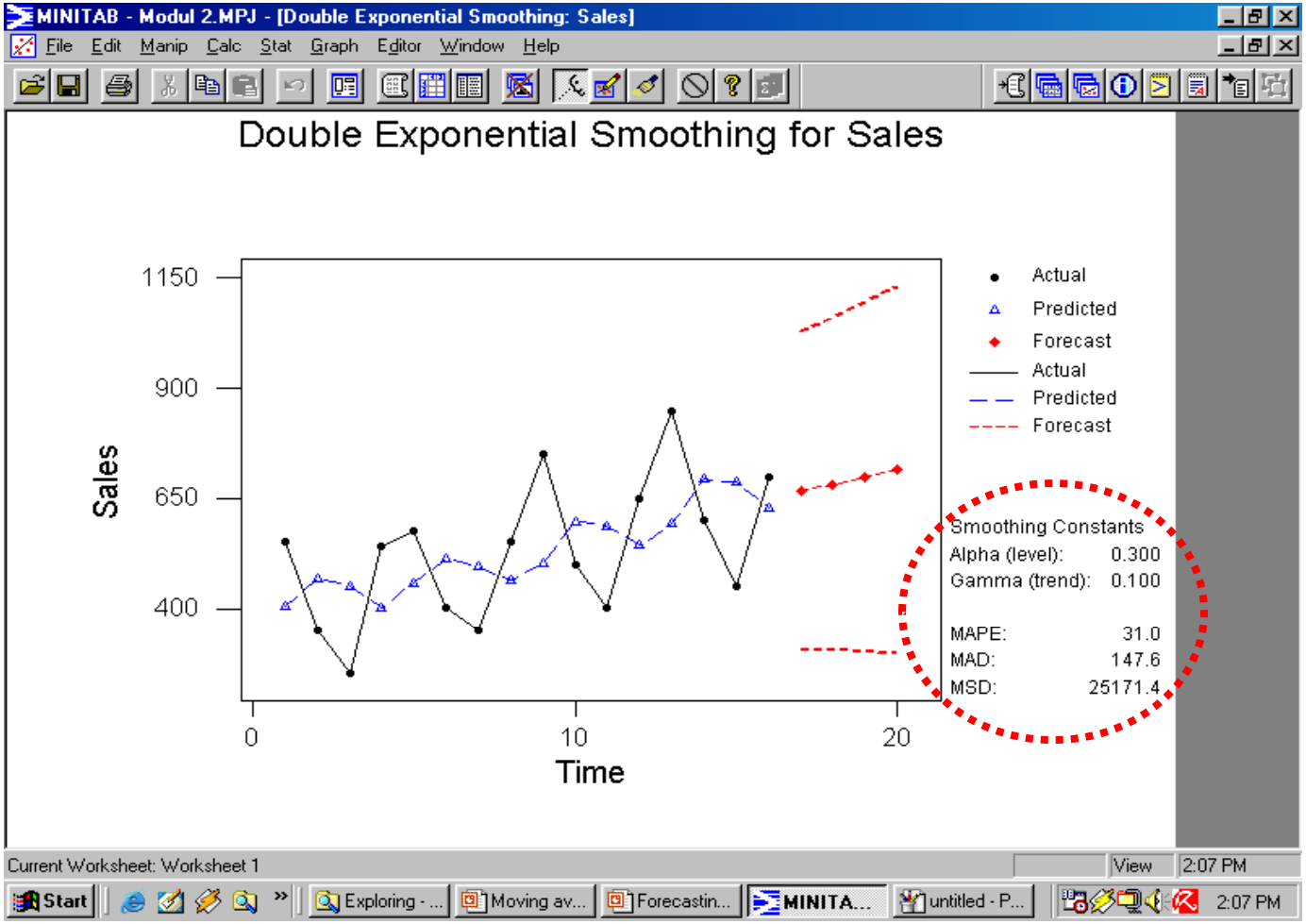


DES (Holt's Methods): MINITAB implementation … (continued)

↓	C1	C2	C3	C4	C5	C6	C7	C8
	Year	Quarter	t	Sales	SMOO1	TREN1	FITS1	RESI1
1	2001	1	1	550	447.599	21.1018	403.713	146.287
2	2001	2	2	350	433.091	17.5408	468.701	-118.701
3	2001	3	3	250	390.442	11.5219	450.632	-200.632
4	2001	4	4	540	443.375	15.6629	401.964	138.036
5	2002	1	5	575	493.826	19.1418	459.038	115.962
6	2002	2	6	400	479.078	15.7528	512.968	-112.968
7	2002	3	7	350	451.381	11.4078	494.831	-144.831
8	2002	4	8	550	488.952	14.0242	462.789	87.211
9	2003	1	9	750	577.084	21.4349	502.977	247.023
10	2003	2	10	500	568.963	18.4793	598.518	-98.518
11	2003	3	11	400	531.210	12.8560	587.442	-187.442
12	2003	4	12	650	575.846	16.0341	544.066	105.934
13	2004	1	13	850	669.316	23.7777	591.880	258.120
14	2004	2	14	600	665.166	20.9849	693.094	-93.094
15	2004	3	15	450	615.305	13.9004	686.150	-236.150
16	2004	4	16	700	650.444	16.0242	629.206	70.794
17	2005	1	17				666.468	
18	2005	2	18				682.492	
19	2005	3	19				698.517	

DES dengan alpha 0,3 dan beta 0,1

DES: MINITAB implementation … (continued)



Winter's Methods: MINITAB implementation

↓	C1	C2	C3	C4	C5	C6	C7	C8	C9
	Year	Quarter	t	Sales	LEVE1	TREN1	SEAS1	FITS1	RESI1
1	2001	1	1	550	434.647	-13.7353	1.28846	573.867	-23.867
2	2001	2	2	350	412.461	-14.5804	0.86740	368.496	-18.496
3	2001	3	3	250	385.321	-15.8363	0.67216	271.419	-21.419
4	2001	4	4	540	410.498	-11.7350	1.18546	422.700	117.300
5	2002	1	5	575	417.766	-9.8347	1.31483	513.789	61.211
6	2002	2	6	400	429.218	-7.7060	0.88676	353.839	46.161
7	2002	3	7	350	461.192	-3.7380	0.69818	283.322	66.678
8	2002	4	8	550	458.502	-3.6332	1.19669	546.868	3.132
9	2003	1	9	750	501.087	0.9886	1.36941	598.076	151.924
10	2003	2	10	500	526.786	3.4597	0.90548	445.220	54.780
11	2003	3	11	400	547.315	5.1666	0.70798	370.207	29.793
12	2003	4	12	650	548.755	4.7939	1.19303	661.149	-11.149
13	2004	1	13	850	580.412	7.4802	1.39793	758.033	91.967
14	2004	2	14	600	617.789	10.4699	0.92519	532.322	67.678
15	2004	3	15	450	631.201	10.7641	0.70946	444.794	5.206
16	2004	4	16	700	619.875	8.5551	1.17390	765.885	-65.885
17	2005	1	17					878.499	
18	2005	2	18					589.335	
19	2005	3	19					457.987	

Winter's Methods dengan alpha 0,4; beta 0,1 dan gamma 0,3

Winter's Methods: MINITAB implementation ... (continued)