**IE 7200 Supply Chain Engineering**

**Homework No. 2**

**Aven Samareh**

**Problem 1.**

Consider the model , Using an appropriate linear transform, derive equations to allow the determination of *a* and *b* through least squares method.

**Answer:**

This is the same as fitting exponential least-squares. The original function is in the form of,

Log (

log (

............................................................................................................................................. (1)

(1) is the exponential least-squares. If we take log of both sides we have, **log (** which this is in the form of linear model. Now that the regular least squares formula is , in which **Y=log (**, and **.** knowing the formula for least square fit to estimate the parameters are:

b

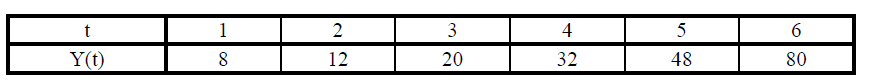
-

The best-fit values putting the value of A and Y we through least squares values are,

b=

a=

**Problem 2.** Consider the following data: Determine *a* and *b* in problem 1's model and forecast Y(8).



**Answer**:

log( which this is in the form of linear model. Now that the regular least squares formula is . substitute **Y=log (**, and **.** knowing the formula for least square fit to estimate the parameters are:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **t** | **y(t)** | **LOG(y(t))** | **t^2** | **Y(t)\*t** |
| 1 | 8 | 2.079441542 | 1 | 2.079441542 |
| 2 | 12 | 2.48490665 | 4 | 4.9698133 |
| 3 | 20 | 2.995732274 | 9 | 8.987196821 |
| 4 | 32 | 3.465735903 | 16 | 13.86294361 |
| 5 | 48 | 3.871201011 | 25 | 19.35600505 |
| 6 | 80 | 4.382026635 | 36 | 26.29215981 |
|  |  |  |  |  |
|  | **Sigma(y(t)))** | **Sigma (loy(t))** | **Sigma t^2** | **Sima Y(t)\*t** |
| 21 | 200 | 19.27904401 | 91 | 75.54756014 |
|  |  |  |  |  |
| **N=6** |  |  |  |  |

|  |  |
| --- | --- |
| **SUMMARY OUTPUT** | |
|  |  |
| **Regression Statistics** |  |
| Multiple R | 0.999496856 |
| R Square | 0.998993966 |
| Adjusted R Square | 0.998742457 |
| Standard Error | 0.030612463 |
| Observations | 6 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **ANOVA** | | | | | |
|  | **df** | **SS** | **MS** | **F** | **Significance F** |
| **Regression** | 1 | 3.722258577 | 3.722258577 | 3972.007012 | 3.79667E-07 |
| **Residual** | 4 | 0.003748491 | 0.000937123 |  |  |
| **Total** | 5 | 3.726007068 |  |  |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Coefficients** | **Standard Error** | **t Stat** | **P-value** | **Lower 95%** | **Upper 95%** | **Lower 95.0%** | **Upper 95.0%** |
| **Intercept** | **1.598992784** | 0.03 | 56.11 | 0.00 | 1.52 | 1.68 | 1.52 | 1.68 |
| **X Variable 1** | **0.461194634** | 0.01 | 63.02 | 0.00 | 0.44 | 0.48 | 0.44 | 0.48 |

**Problem 3.** Consider the quarterly sales data: a. Determine appropriate seasonal indices for each quarter. b. Use the indices and the time series model in predicting quarter values for year six.

**Answer:**

First compute the seasonal indices:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Year** | **Q1** | **Q2** | **Q3** | **Q4** | **Total** |
| 1 | 43 | 27 | 10 | 22 | 102 |
| 2 | 49 | 35 | 14 | 27 | 125 |
| 3 | 58 | 47 | 14 | 32 | 151 |
| 4 | 71 | 53 | 18 | 35 | 177 |
| 5 | 80 | 63 | 22 | 41 | 206 |
|  |  |  |  |  |  |
| **Total** | 301 | 225 | 78 | 157 | 761 |
| **Qtr Ave** | 60.2 | 45 | 15.6 | 31.4 | 38.05 |
|  |  |  |  |  |  |
| **SI** | **1.582129** | **1.182654** | **0.409987** | **0.82523** |  |

Next, deseasonalize the data by dividing each quarterly data by its SI:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year** | **Q1** | **Q2** | **Q3** | **Q4** |
| 1 | 27.17857 | 22.83 | 24.39103 | 26.65924 |
| 2 | 30.97093 | 29.59444 | 34.14744 | 32.71815 |
| 3 | 36.65947 | 39.74111 | 34.14744 | 38.77707 |
| 4 | 44.87625 | 44.81444 | 43.90385 | 42.41242 |
| 5 | 50.56478 | 53.27 | 53.66026 | 49.68312 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Year Qtr** | **X** | **Y** | **X^2** | **XY** |
| **Y1Q1** | 1 | 27.17857 | 1 | 27.17857 |
| **Y1Q2** | 2 | 22.83 | 4 | 45.66 |
| **Y1Q3** | 3 | 24.39103 | 9 | 73.17308 |
| **Y1Q4** | 4 | 26.65924 | 16 | 106.6369 |
| **Y2Q1** | 5 | 30.97093 | 25 | 154.8547 |
| **Y2Q2** | 6 | 29.59444 | 36 | 177.5667 |
| **Y2Q3** | 7 | 34.14744 | 49 | 239.0321 |
| **Y2Q4** | 8 | 32.71815 | 64 | 261.7452 |
| **Y3Q1** | 9 | 36.65947 | 81 | 329.9352 |
| **Y3Q2** | 10 | 39.74111 | 100 | 397.4111 |
| **Y3Q3** | 11 | 34.14744 | 121 | 375.6218 |
| **Y3Q4** | 12 | 38.77707 | 144 | 465.3248 |
| **Y4Q1** | 13 | 44.87625 | 169 | 583.3912 |
| **Y4Q2** | 14 | 44.81444 | 196 | 627.4022 |
| **Y4Q3** | 15 | 43.90385 | 225 | 658.5577 |
| **Y4Q4** | 16 | 42.41242 | 256 | 678.5987 |
| **Y5Q1** | 17 | 50.56478 | 289 | 859.6013 |
| **Y5Q2** | 18 | 53.27 | 324 | 958.86 |
| **Y5Q3** | 19 | 53.66026 | 361 | 1019.545 |
| **Y5Q4** | 20 | 49.68312 | 400 | 993.6624 |
| **Total** | **210** | **761** | **2870** | **9033.759** |

Forecast for the next four quarters, using least squares estimates.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Coefficients** | **Standard Error** | **t Stat** | **P-value** | **Lower 95%** | **Upper 95%** | **Lower 95.0%** | **Upper 95.0%** |
| **Intercept** | **21.5775** | 1.2399 | 17.4031 | 0.0000 | 18.9726 | 24.1824 | 18.9726 | 24.1824 |
| **X Variable 1** | **1.5688** | 0.1035 | 15.1573 | 0.0000 | 1.3514 | 1.7863 | 1.3514 | 1.7863 |

Using Y=a + bX, given a= 21.5775, and b=1.5688 we have,

y(21)= 21.5775+1.5688(21) = **54.52250427**

y(22)= 21.5775+1.5688(22) = **56.0913142**

y(23)= 21.5775+1.5688(23) = **57.66012413**

y(24)= 21.5775+1.5688(24) = **59.22893406**

**Problem 5.** A particular product is being evaluated for its economic order quantity. Storage is charged at $2 per unit per month, and this product does not share the particular storage facility with any other product. Purchase order cost is $85, interest rate is 25 percent per year, and capital cost of the product is $200. The demand rate for the product is 3000 units per year. Determine the EOQ value.

**Answer:**

Given:

W = warehousing cost/unit of inventory/unit time = 2$/unit/month = 2 \*12=24 unit/year

P = Ordering cost =Purchase order cost is $85 per order

i=25% per year

C = Cost/item (capital investment cost)= $200 per unit

I = Interest charges/unit of inventory/unit time = 0.25\*200= 50 per unit-year

D = Demand rate or depletion rate units/year =3000 units per year

Assume the case of one product

= = **0.0163**

Q=== 72.21 **units**

**Problem 6.** Determine the total annual inventory cost for the product in the previous problem.

**Answer:**

**TC = Total cost/unit** = TC= C++ (H)(Q)

=200+= **202.354 $**

**Problem 7.** At what time intervals should the product of the previous problem be reviewed for reorder purposes.

**Answer:**

**T = Time between orders (cycle time)** = T== **0.0243 years**

**Problem 8.** Reevaluate the EOQ, total annual inventory cost, and the ordering time interval, if the product in the previous problem is now one of many that use the same general storage area.

**Answer:**

problem is now one of many that use the same general storage area.

Hm== =**0.01233**

Q=== 83.02 **units**

**TC = Total cost/unit**= TC= C++(H)(Q)

=200+=**202.046 $**

**T = Time between orders (cycle time)** = T==**0.028 years**

**Problem 9.** In an attempt to establish an ABC classification, a firm wants to analyze its inventory of 5000 items. Following is a random sample of 20 of their items: Following the usual guidelines for ABC breakdown, indicate the items which will be classified in each category and find the percentage of value for each classification.

**Answer**:

The classification rules are :

* Category **A items** include roughly **10-20%** of items that typically account for **70-80%** of total dollar value
* Category **B items** include roughly **30-40%** of items that typically account for **15-20%** of total dollar value
* Category **C items** include roughly **40-50%** of items that typically account for **5-10%** of total dollar value

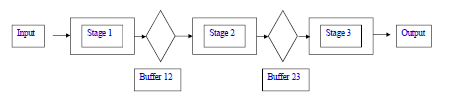
|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Item number** | **Annual Usage** | **Usage percentage** | **Item number** | **Annual Usage** | **Cumulative** | **Number** | **Value** |
| 1 | 1500 | 0.592534071 | 12 | 600 | 600 | C items 50% | 7.68% |
| 2 | 12000 | 4.740272566 | 6 | 750 | 1350 |
| 3 | 2200 | 0.86904997 | 9 | 800 | 2150 |
| 4 | 50000 | 19.75113569 | 15 | 1200 | 3350 |
| 5 | 9600 | 3.792218053 | 1 | 1500 | 4850 |
| 6 | 750 | 0.296267035 | 7 | 2000 | 2000 |
| 7 | 2000 | 0.790045428 | 3 | 2200 | 9050 |
| 8 | 11000 | 4.345249852 | 20 | 2900 | 11950 |
| 9 | 800 | 0.316018171 | 19 | 3500 | 15450 |
| 10 | 15000 | 5.925340707 | 17 | 4000 | 19450 |
| 11 | 13000 | 5.135295279 | 5 | 9600 | 29050 | B items 30% | 25.95% |
| 12 | 600 | 0.237013628 | 14 | 9900 | 38950 |
| 13 | 42000 | 16.59095398 | 16 | 10200 | 49150 |
| 14 | 9900 | 3.910724867 | 8 | 11000 | 60150 |
| 15 | 1200 | 0.474027257 | 2 | 12000 | 72150 |
| 16 | 10200 | 4.029231681 | 11 | 13000 | 85150 |
| 17 | 4000 | 1.580090855 | 10 | 15000 | 100150 | A items 20% | 66.39% |
| 18 | 61000 | 24.09638554 | 13 | 42000 | 142150 |
| 19 | 3500 | 1.382579498 | 4 | 50000 | 192150 |
| 20 | 2900 | 1.14556587 | 18 | 61000 | 253150 |
| **Total** | **253150** |  |  |  |  |  |  |

1. Initially we sort the data based on smallest to largest
2. Then we find the cumulative annual usage
3. Based on the guidelines we do the classification
4. To find the value we do the following sample calculations:

For class C:

Sum of all annual usage/ total annual usage =(19450/253150 )\*100=66.39%

**Problem 4.** A production line has three production stations, A, B, and C. In-process storage is possible between the stations, but at the monthly cost of $100 for storage between A and B and $150 between B and C. The storage would offset any station downtime in the preceding station(s). Income per item produced is $5 and the maximum monthly production rate is 1000 units. If the downtimes for stations A, B, and C are 5, 3, and 7 percent, respectively, determine the optimum income-cost relationship from the four possible configurations of in-process inventory management. Assume the station downtimes are statistically independent.



*Given,*

*B12* = of $100 for storage between A

*B23=* $150 between B and C.

Income per item produced is $5

maximum monthly production rate is 1000 units

*dA=.05*

*dB=.03*

*dC=.07*

*Oi* = output (in percentage of time) from *i*th stage

*O*1 = 1 – *d1*=.95

*O*2 = 1 – *d*2=.97

*O*3 = 1 – *d*3=.93

Total income produced for items: 5\*1000=5000$