**TIME SERIES ANALYSIS**

**PRACTICAL – 3**

**Submitted By: Ridam Singhal(5040)**

**AIM:** To fit straight line, parabolic curve and exponential to the given data. Also estimate the amount for the given year and the curve of best fit.

**PRACTICAL:** The following data shows life insurance carried per family in the US from 1960 to 1970:

|  |  |
| --- | --- |
| Year | Average Amount (in Dollars) |
| 1960 | 10200 |
| 1961 | 10800 |
| 1962 | 11400 |
| 1963 | 12200 |
| 1964 | 13300 |
| 1965 | 14700 |
| 1966 | 15900 |
| 1967 | 17200 |
| 1968 | 18400 |
| 1969 | 19500 |
| 1970 | 20900 |

1. Fit a straight line to the data.
2. Fit a second degree parabola to the data.
3. Fit an exponential curve to the data.
4. Estimate insurance amount for 1971 with every method and compare.
5. Which of the method computed in the above three parts appears to be the line of best fit? Explain your choice.

**CALCULATIONS:**

1. Fitting a straight line :

TABLE 3.1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Year(t) | Average Amount (in Dollars)  Y(t) | x  (t-1965) | x² | xy | Trend Values  Ye = a+bx |
| 1960 | 10200 | -5 | 25 | -51000 | 9413.641 |
| 1961 | 10800 | -4 | 16 | -43200 | 10521.8228 |
| 1962 | 11400 | -3 | 9 | -34200 | 11630.0046 |
| 1963 | 12200 | -2 | 4 | -24400 | 12738.1864 |
| 1964 | 13300 | -1 | 1 | -13300 | 13846.3682 |
| 1965 | 14700 | 0 | 0 | 0 | 14954.55 |
| 1966 | 15900 | 1 | 1 | 15900 | 16062.7318 |
| 1967 | 17200 | 2 | 4 | 34400 | 17170.9136 |
| 1968 | 18400 | 3 | 9 | 55200 | 18279.0954 |
| 1969 | 19500 | 4 | 16 | 78000 | 19387.2772 |
| 1970 | 20900 | 5 | 25 | 104500 | 20495.459 |
|  | ∑Y(t)=164500 | ∑x =0 | ∑x² =110 | ∑xy =121900 |  |

n=11, substituting these values in: ∑Y(t) = na + b∑x and ∑xy = a∑x +b∑ x²

We get a = 1108.182 and b = 14954.55

Straight Line: Y=a+bx

And estimated values of Y have been tabulated in Table 3.1

R² = 0.988151

Estimated value of insurance amount for 1971:

As x=6, $21603.64.

GRAPH 3.1

1. Fitting of a second degree parabola to the curve:

TABLE 3.3

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Year(t) | Average Amount (in Dollars) (Yt) | x | x² | x³ | x⁴ | xy | x²y | ax²+bx+c |
| 1960 | 10200 | -5 | 25 | -125 | 625 | -51000 | 255000 | 9978.32225 |
| 1961 | 10800 | -4 | 16 | -64 | 256 | -43200 | 172800 | 10747.69304 |
| 1962 | 11400 | -3 | 9 | -27 | 81 | -34200 | 102600 | 11592.35521 |
| 1963 | 12200 | -2 | 4 | -8 | 16 | -24400 | 48800 | 12512.30876 |
| 1964 | 13300 | -1 | 1 | -1 | 1 | -13300 | 13300 | 13507.55369 |
| 1965 | 14700 | 0 | 0 | 0 | 0 | 0 | 0 | 14578.09 |
| 1966 | 15900 | 1 | 1 | 1 | 1 | 15900 | 15900 | 15723.91769 |
| 1967 | 17200 | 2 | 4 | 8 | 16 | 34400 | 68800 | 16945.03676 |
| 1968 | 18400 | 3 | 9 | 27 | 81 | 55200 | 165600 | 18241.44721 |
| 1969 | 19500 | 4 | 16 | 64 | 256 | 78000 | 312000 | 19613.14904 |
| 1970 | 20900 | 5 | 25 | 125 | 625 | 104500 | 522500 | 21060.14225 |
|  | ∑Y(t) = 164500 | ∑x = 0 | ∑x²=110 | ∑ x³=0 | ∑ x⁴=1958 | ∑xy =121900 | ∑ x²y =1677300 |  |

Substituting the above values in the equation:

∑Y(t) = na + b∑x + c∑x²

∑xy = a∑x + b∑x² + c∑ x³

∑ x²y = a∑x² + b∑ x³ + c∑ x⁴

We get, a = 37.64569, b = 1108.182, and c = 22803.13

Substituting these values in parabolic curve, we have tabulated the estimated values of Y in Table 3.2.

Parabolic Curve: y=ax²+bx+c

R² = 0.997045.

Estimated value of insurance amount for 1971:

as x=6 , $22582.42.

GRAPH 3.2

1. Fitting an exponential curve:

TABLE 3.3

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Year(t) | Average Amount (in Dollars) (Yt) | x | logY(y) | x² | xy | ae^bx |
| 1960 | 10200 | -5 | 9.230143 | 25 | -46.1507 | 9991.1528 |
| 1961 | 10800 | -4 | 9.287301 | 16 | -37.1492 | 10769.499 |
| 1962 | 11400 | -3 | 9.341369 | 9 | -28.0241 | 11608.481 |
| 1963 | 12200 | -2 | 9.409191 | 4 | -18.8184 | 12512.823 |
| 1964 | 13300 | -1 | 9.495519 | 1 | -9.49552 | 13487.617 |
| 1965 | 14700 | 0 | 9.595603 | 0 | 0 | 14538.35 |
| 1966 | 15900 | 1 | 9.674074 | 1 | 9.674074 | 15670.939 |
| 1967 | 17200 | 2 | 9.752665 | 4 | 19.50533 | 16891.761 |
| 1968 | 18400 | 3 | 9.820106 | 9 | 29.46032 | 18207.689 |
| 1969 | 19500 | 4 | 9.87817 | 16 | 39.51268 | 19626.133 |
| 1970 | 20900 | 5 | 9.947504 | 25 | 49.73752 | 21155.078 |
|  | ∑Y(t) = 164500 | ∑x =0 | ∑logY=105.4316 | ∑x²=110 | ∑xy =8.251994 |  |

Substituting the above values in the equation :

∑logY = n A+ b∑x

∑xy = A∑x + b∑x²

We get , A = ln(a) = 9.584545455 , therefore a = 14538.35276

b = 0.075018091

Substituting these values in exponential curve, we have tabulated the estimated values of Y in Table 3.3.

Exponential Curve :y=ae^bx

R² = 0.996255.

Estimated value of insurance amount for 1971:

as x=6, $ 22803.13.

GRAPH 3.3

**RESULT:**

1. Straight line has been fitted in GRAPH 3.1, and the estimated insurance amount for 1971 is $21603.64.
2. Two degree parabolic curve has been plotted in GRAPH 3.2, and the estimated insurance amount for 1971 is $22582.42.
3. Exponential curve has been plotted in GRAPH 3.3, and the estimated insurance amount for 1971 is $22803.13.

**CONCLUSION:**

1. Two degree parabolic curve is the line of best fit, as the coefficient of determination is maximum (R2 = 0.996255)
2. Best estimated value for the insurance amount for the year 1971 is $22582.42.