






SAARC Training Workshop Program "Identification, Comparison and Scenario Based Application of Power Demand/ Load Forecasting Tools"

Long Term Power Demand Forecasting using Regression Model

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ISLAMABAD

Contents

- Growth rate
- Intensity
- Elasticity
- Methods of power demand forecasting

Growth Rate

- Electric power demand is proportional to GDP and population growth rate; we usually use 'Growth Rate' for analyzing the relation between power demand and GDP or population.
- When GDP growth rate is 8% in a country, Power demand growth rate is 10%.
- When population growth rate is 1% per year in a country, power demand growth rate is 4%.

Intensity

- 'Intensity' is the ratio between energy consumption and economic data.
- Intensity to GDP, Population and Industrial output are used for energy demand forecast models.
- Example 1: Energy Intensity to Population

  = Primary Energy Supply / Population

Intensity

- Example 2: Energy Intensity to GDP

  = Primary Energy Supply / GDP

- Example 3: Energy Intensity to Industrial Output

  = Primary Energy Supply / Industrial Output

Elasticity

- ‘Elasticity’ is useful to analyze relation between economic growth and power consumption.
- Power Consumption Elasticity to GDP

  = Power Consumption Growth Rate/GDP Growth Rate

Elasticity

- <Example>
  - Power generation (+self) of Pakistan

    56,739 GWh in 2000 135,381 GWh in 2012

    Growth rate 7.5%

  - Real GDP (2005 constant)

    5,765 Bill Rs. in 2000 9,522 bill Rs. in 2012

    Growth rate 4.3%

Elasticity

- Elasticity

Energy Consumption Elasticity to GDP = 7.5 % / 4.3 %

= 1.7

Approach for Long Term Power Demand Forecasting

- Intensity approach
  - Intensity approach is frequently used for power demand forecasting for all kind of sectors.
  - Power demand = intensity * Denominator

Approach for Long Term Power Demand Forecasting

Sector	Denominator Selected
Agriculture Sector	GDP of Agriculture Sector
Industry Sector	GDP of Industry Sector
Commercial & Service Sector	GDP of Commercial & Service Floor Area of Buildings
Residential Sector	Population Number of Households

Approach for Long Term Power Demand Forecasting

- Elasticity approach
  - It is the popular approach in energy demand modelling.
  - It is based on the following formula:

$$E_T = E_{T-1} * (1+G.R \text{ of } G)^a * (1+G.R \text{ of } P)^b$$

Approach for Long Term Power Demand Forecasting

Where,

E is the Electricity Demand (Sales GWh)

G and **P** are the Independent Variables (GDP, Population)

T is the Current Year,

T-1 is the Previous year,

a, **b** are the elasticities of independent variables. (GDP, Population respectively)

G.R. is Growth rate

Concept of Power Demand Forecasting

- For the forecasting, the following procedures are studied by the analysts in preparation stage:
  - Social & Economic Forecasting
  - Energy Demand Forecasting
  - Peak Demand Forecasting

Concept of Power Demand Forecasting

- Social & Economic indicator forecasting

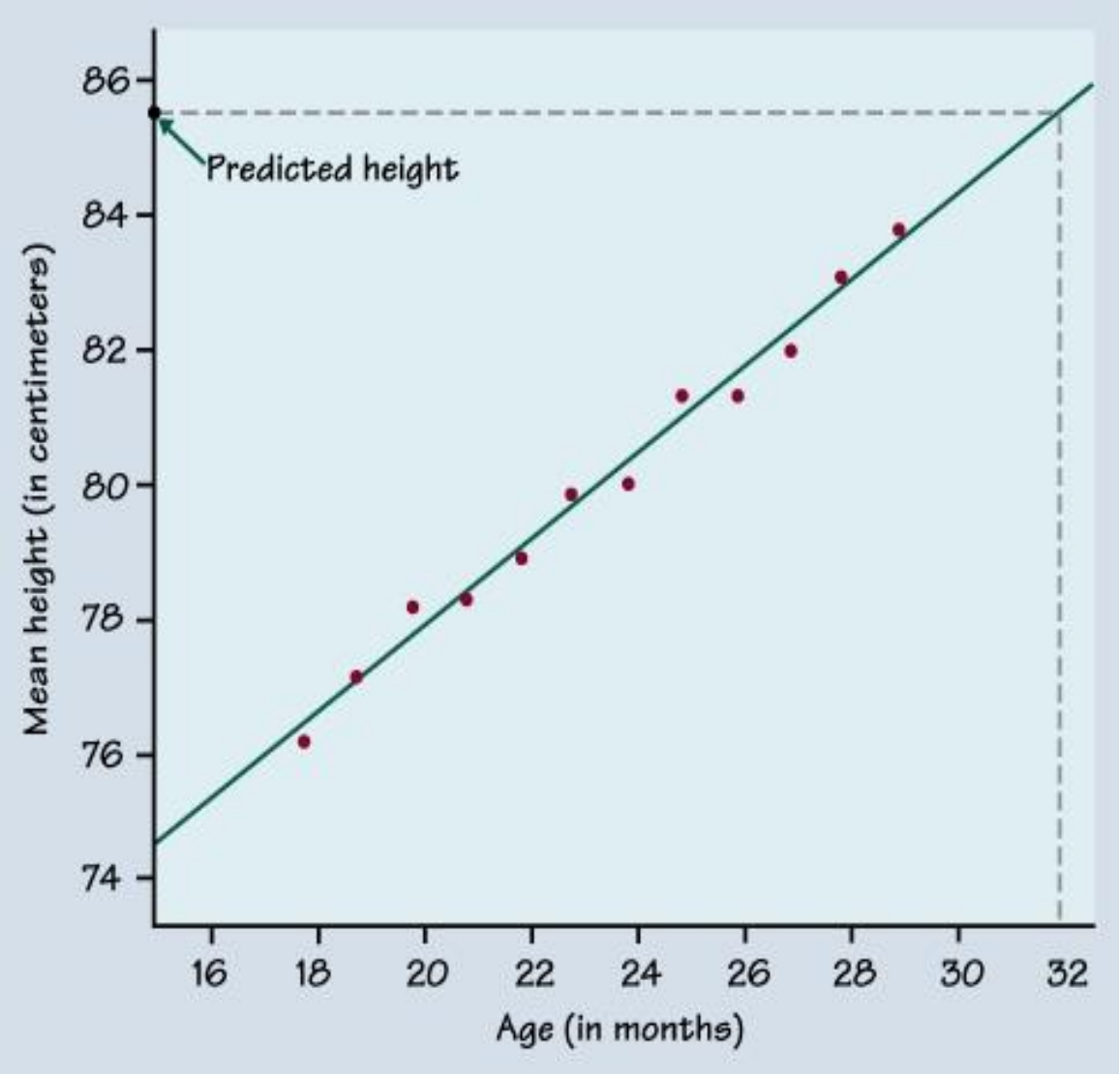
  ➢ The social and economic indicators are forecasted for energy demand forecasting model.

Indicators
Population
Population (by area)
No. of Households
GDP
GDP (by sector)
Income (per capita)
GDP (per capita)

Regression Analysis

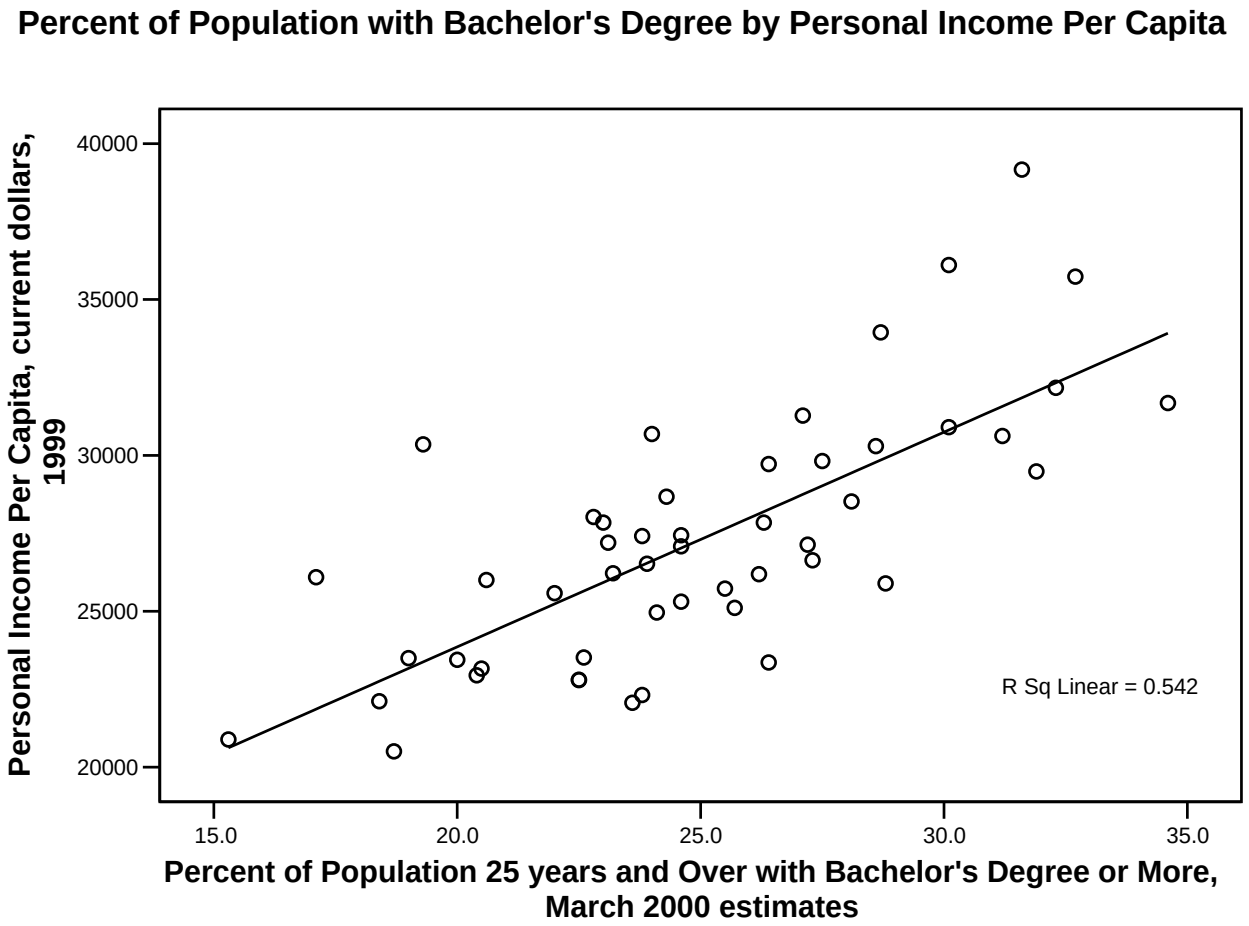
- Regression is a procedure that produces a line of best-fit for data.
- Must have an explanatory (x) and a response variable (y)
- Use regression line to predict values of y corresponding to unmeasured values of x

Regression Analysis



Regression Line

- Regression line is the best straight line description of the plotted points



Things to Remember

- Regressions focuses on direct association, not the causes of association.
- The independent variable must preceded the dependent variable in time.
- The two variables must be plausibly lined by a theory.

Regression Coefficient

- The regression coefficient is the slope of the regression line.

$$\beta_1 > 0 \Rightarrow \text{Positive Association}$$

$$\beta_1 < 0 \Rightarrow \text{Negative Association}$$

$$\beta_1 = 0 \Rightarrow \text{No Association}$$

Regression Analysis

- Simple Regression Equation

$$Y = \beta_1 x + \beta_2$$

Where

Y = Demand of Electricity (GWh)

X = Price of Electricity

Multiple Regression Analysis

- Multiple regression is a practical extension of simple regression model.
- It allows one to build model with several independent variables.
- The multiple regression equation is:

$$\hat{Y} = a + b_1X_1 + b_2X_2 + \ldots + b_pX_p$$

Multiple Regression Analysis

Where,

a = Y-axis intercept.

b_i = slope of regression for i^{th} independent variable (X_i).

p = number of independent variables in model.

Statistical Test

R: R-Square ($0<R^2<1$). Better close to 1

AR: Adjusted R. ($0<R^2<1$) Better close to 1, if the samples are small.

DW: Durbin Watson Stat. ($0<DW<4$). Good condition $1<DW<3$

DF: Deg. of Freedom (>1).

t-value ABS(t-value) > 2


THANKS