

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Why would we transform variables in a Regression?

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Why would we transform variables in a Regression?

- Regression is a linear procedure.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Why would we transform variables in a Regression?

- Regression is a linear procedure.
- What happens if the relation between Y and X variable is not linear?

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Why would we transform variables in a Regression?

- Regression is a linear procedure.
- What happens if the relation between Y and X variable is not linear?

$$Y = \beta_0 + \beta_1 X$$

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Why would we transform variables in a Regression?

- Regression is a linear procedure.
- What happens if the relation between Y and X variable is not linear?

$$Y = \beta_0 + \beta_1 X$$



Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Why would we transform variables in a Regression?

- Regression is a linear procedure.
- What happens if the relation between Y and X variable is not linear?

$$Y = \beta_0 + \beta_1 X$$



Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Why would we transform variables in a Regression?

- Regression is a linear procedure.
- What happens if the relation between Y and X variable is not linear?

$$Y = \beta_0 + \beta_1 X$$

↑

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

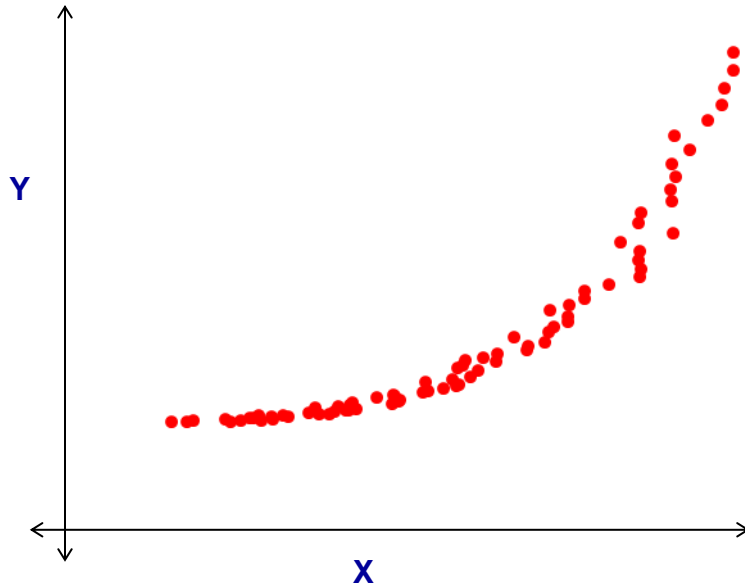
Why would we transform variables in a Regression?

- Regression is a linear procedure.
- What happens if the relation between Y and X variable is not linear?

$$Y = \beta_0 + \beta_1 X$$

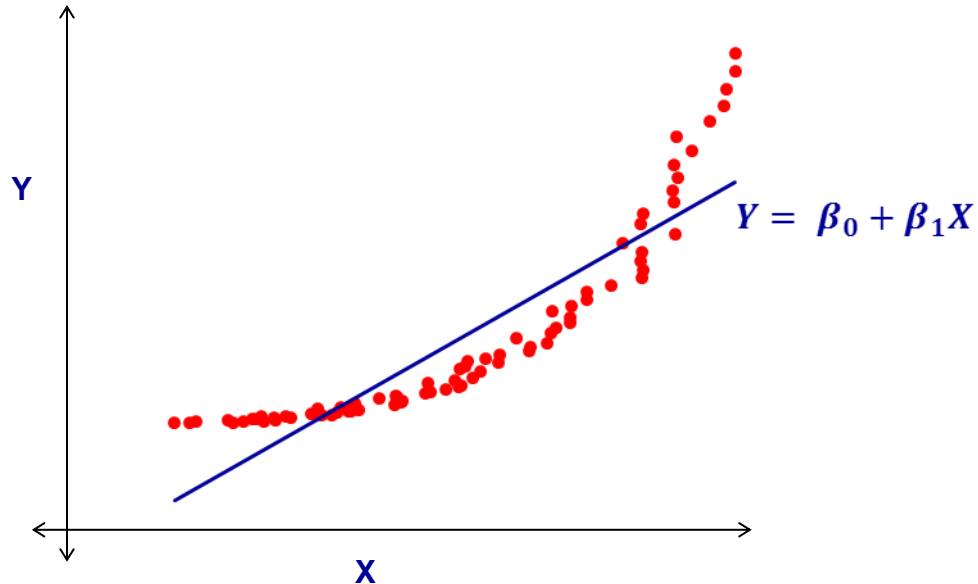
Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.



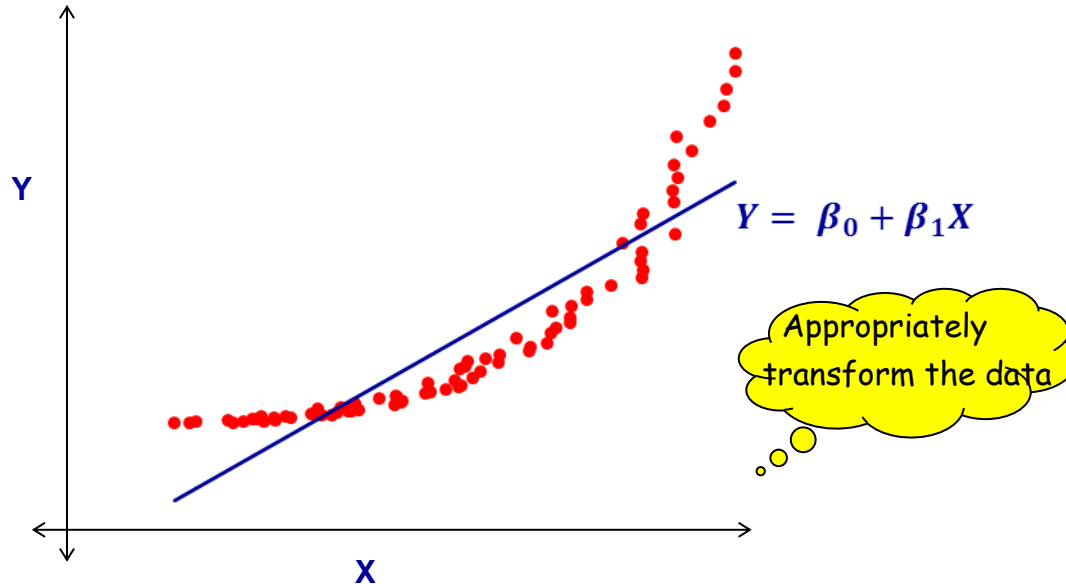
Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.



Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.



Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Various transformations that can be used...

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Various transformations that can be used...

- Invert one or more variables.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Various transformations that can be used...

- Invert one or more variables.
- Take a square of a variable.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Various transformations that can be used...

- Invert one or more variables.
- Take a square of a variable.
- Take a square root.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Various transformations that can be used...

- Invert one or more variables.
- Take a square of a variable.
- Take a square root.
- ...
- ...

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Various transformations that can be used...

- Invert one or more variables.
- Take a square of a variable.
- Take a square root.
- ...
- ...



Bit of Trial and
Error required

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Various transformations that can be used...

- Invert one or more variables.
- Take a square of a variable.
- Take a square root.
- ...
- ...



Bit of Trial and
Error required

- Take the Natural log transformation.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Various transformations that can be used...

- Invert one or more variables.
- Take a square of a variable.
- Take a square root.
- ...
- ...



Bit of Trial and
Error required

- Take the Natural log transformation.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

Various transformations that can be used...

- Invert one or more variables.
- Take a square of a variable.
- Take a square root.
- ...
- ...



- Take the Natural log transformation.

Log-log Model

Semi-log Model

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Natural Log function. Some properties...

- The symbol we will use for Natural Log is “LN”
- If $\text{LN}(A) = B$, then $A = \text{EXP}(B)$, where “EXP” is the exponential function.
- $\text{LN}(A) + \text{LN}(B) = \text{LN}(A*B)$
- $\text{LN}(A) - \text{LN}(B) = \text{LN}(A/B)$
- $\text{LN}(1) = 0$
- $\text{LN}(0)$ is not defined
- $\text{LN}(\text{-ve number})$ is not defined

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Natural Log function. Some properties...

- The symbol we will use for Natural Log is “LN”
- If $\text{LN}(A) = B$, then $A = \text{EXP}(B)$, where “EXP” is the exponential function.
- $\text{LN}(A) + \text{LN}(B) = \text{LN}(A*B)$
- $\text{LN}(A) - \text{LN}(B) = \text{LN}(A/B)$ In Excel... =LN()
- $\text{LN}(1) = 0$
- $\text{LN}(0)$ is not defined
- $\text{LN}(\text{-ve number})$ is not defined

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$

The Semi-log Model: $LN(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots$

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

→ **The Log-log Model:** $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$

The Semi-log Model: $LN(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots$

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$

→ **The Semi-log Model:** $LN(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots$

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$

The Semi-log Model: $LN(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots$

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$

Linear Regression for Business Statistics


Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$




When the natural log of X_1 increases by one unit, then the natural log of Y increases by β_1 units, all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$




When the **natural log of X_1** increases by one unit, then the natural log of Y increases by β_1 units, all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$




When the **natural log of X_1** increases by one unit, then the **natural log of Y** increases by β_1 units, all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$



When the **natural log of X_1** increases by one unit, then the **natural log of Y** increases by **β_1 units**, all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$

When the **natural log of X_1** increases by one unit, then the **natural log of Y** increases by β_1 **units**, all other variables remaining at the same level.

$$LN(Sales) = \beta_0 + \beta_1 LN(Price) + \beta_2 LN(AdExp) + \beta_3 LN(PromExp)$$

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$

When the **natural log of X_1** increases by one unit, then the **natural log of Y** increases by β_1 **units**, all other variables remaining at the same level.

$$LN(Sales) = \beta_0 + \beta_1 LN(Price) + \beta_2 LN(AdExp) + \beta_3 LN(PromExp)$$

$$LN(Sales) = 4.7 - 0.55LN(Price) + 0.46LN(AdExp) + 1.43LN(PromExp)$$

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$

When the **natural log of X_1** increases by one unit, then the **natural log of Y** increases by β_1 **units**, all other variables remaining at the same level.


$$LN(Sales) = \beta_0 + \beta_1 LN(Price) + \beta_2 LN(AdExp) + \beta_3 LN(PromExp)$$

$$LN(Sales) = 4.7 - 0.55LN(Price) + 0.46LN(AdExp) + 1.43LN(PromExp)$$

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$



When the **natural log of X_1** increases by one unit, then the **natural log of Y** increases by β_1 **units**, all other variables remaining at the same level.

$$LN(Sales) = \beta_0 + \beta_1 LN(Price) + \beta_2 LN(AdExp) + \beta_3 LN(PromExp)$$



$$LN(Sales) = 4.7 - 0.55LN(Price) + 0.46LN(AdExp) + 1.43LN(PromExp)$$


If the company increases the natural log of promotion expenditure by one unit then the natural log of unit sales of the toy will increase by 1.43 units, all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$



When the **natural log of X_1** increases by one unit, then the **natural log of Y** increases by β_1 **units**, all other variables remaining at the same level.

$$LN(Sales) = \beta_0 + \beta_1 LN(Price) + \beta_2 LN(AdExp) + \beta_3 LN(PromExp)$$


$$LN(Sales) = 4.7 - 0.55LN(Price) + 0.46LN(AdExp) + 1.43LN(PromExp)$$




If the company increases the **natural log of promotion expenditure** by one unit then the natural log of unit sales of the toy will increase by 1.43 units, all other variables remaining at the same level.


Linear Regression for Business Statistics

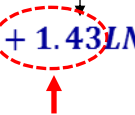
Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$



When the **natural log of X_1** increases by one unit, then the **natural log of Y** increases by β_1 units, all other variables remaining at the same level.

$$LN(Sales) = \beta_0 + \beta_1 LN(Price) + \beta_2 LN(AdExp) + \beta_3 LN(PromExp)$$



$$LN(Sales) = 4.7 - 0.55LN(Price) + 0.46LN(AdExp) + 1.43LN(PromExp)$$


If the company increases the **natural log of promotion expenditure** by one unit then the **natural log of unit sales** of the toy will increase by 1.43 units, all other variables remaining at the same level.


Linear Regression for Business Statistics

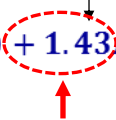
Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$



When the **natural log of X_1** increases by one unit, then the **natural log of Y** increases by β_1 units, all other variables remaining at the same level.

$$LN(Sales) = \beta_0 + \beta_1 LN(Price) + \beta_2 LN(AdExp) + \beta_3 LN(PromExp)$$


$$LN(Sales) = 4.7 - 0.55LN(Price) + 0.46LN(AdExp) + 1.43LN(PromExp)$$


If the promotion expenditure increases by one percentage then the Unit sales will increase by 1.43 percent, all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$

↑

When the **natural log of X_1** increases by one unit, then the **natural log of Y** increases by β_1 units, all other variables remaining at the same level.

$$LN(Sales) = \beta_0 + \beta_1 LN(Price) + \beta_2 LN(AdExp) + \beta_3 LN(PromExp)$$

$$LN(Sales) = 4.7 - 0.55LN(Price) + 0.46LN(AdExp) + 1.43LN(PromExp)$$


↑

If the **promotion expenditure** increases by one percentage then the Unit sales will increase by 1.43 percent, all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$



When the **natural log of X_1** increases by one unit, then the **natural log of Y** increases by β_1 units, all other variables remaining at the same level.

$$LN(Sales) = \beta_0 + \beta_1 LN(Price) + \beta_2 LN(AdExp) + \beta_3 LN(PromExp)$$



$$LN(Sales) = 4.7 - 0.55LN(Price) + 0.46LN(AdExp) + 1.43LN(PromExp)$$


If the **promotion expenditure** increases by **one percentage** then the Unit sales will increase by 1.43 percent, all other variables remaining at the same level.


Linear Regression for Business Statistics


Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$



When the **natural log of X_1** increases by one unit, then the **natural log of Y** increases by β_1 units, all other variables remaining at the same level.

$$LN(Sales) = \beta_0 + \beta_1 LN(Price) + \beta_2 LN(AdExp) + \beta_3 LN(PromExp)$$



$$LN(Sales) = 4.7 - 0.55LN(Price) + 0.46LN(AdExp) + 1.43LN(PromExp)$$


If the **promotion expenditure** increases by **one percentage** then the **Unit sales** will increase by 1.43 percent, all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$



When the **natural log of X_1** increases by one unit, then the **natural log of Y** increases by β_1 units, all other variables remaining at the same level.

$$LN(Sales) = \beta_0 + \beta_1 LN(Price) + \beta_2 LN(AdExp) + \beta_3 LN(PromExp)$$


$$LN(Sales) = 4.7 - 0.55LN(Price) + 0.46LN(AdExp) + 1.43LN(PromExp)$$




If the **promotion expenditure** increases by **one percentage** then the **Unit sales** will increase by **1.43 percent**, all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$




One percentage increase in X_1 corresponds to a β_1 percentage increase in Y , all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$




One percentage increase in X_1 corresponds to a β_1 percentage increase in Y ,
all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$




One percentage increase in X_1 corresponds to a β_1 percentage increase in Y ,
all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$




One percentage increase in X_1 corresponds to a β_1 percentage increase in Y , all other variables remaining at the same level.

... an *Elasticity interpretation*. β_1 is the elasticity of Y with respect to X_1

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$




One percentage increase in X_1 corresponds to a β_1 percentage increase in Y , all other variables remaining at the same level.

... an *Elasticity interpretation*. β_1 is the elasticity of Y with respect to X_1

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$




One percentage increase in X_1 corresponds to a β_1 percentage increase in Y , all other variables remaining at the same level.

... an *Elasticity interpretation*. β_1 is the **elasticity** of Y with respect to X_1

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.


The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$



One percentage increase in X_1 corresponds to a β_1 percentage increase in Y , all other variables remaining at the same level.

... an *Elasticity interpretation*. β_1 is the **elasticity** of Y with respect to X_1

The Semi-log Model: $LN(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots$



One unit increase in X_1 corresponds to a $100 \cdot \beta_1$ percentage increase in Y , all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$

One percentage increase in X_1 corresponds to a β_1 percentage increase in Y , all other variables remaining at the same level.

... an *Elasticity interpretation*. β_1 is the **elasticity** of Y with respect to X_1

The Semi-log Model: $LN(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots$

One unit increase in X_1 corresponds to a $100 \cdot \beta_1$ percentage increase in Y , all other variables remaining at the same level.

Linear Regression for Business Statistics

Natural Log transformation in a Regression Model.

The Log-log Model: $LN(Y) = \beta_0 + \beta_1 LN(X_1) + \beta_2 LN(X_2) + \dots$

One percentage increase in X_1 corresponds to a β_1 percentage increase in Y , all other variables remaining at the same level.

... an *Elasticity interpretation*. β_1 is the **elasticity** of Y with respect to X_1

The Semi-log Model: $LN(Y) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots$

One unit increase in X_1 corresponds to a $100 \cdot \beta_1$ percentage increase in Y , all other variables remaining at the same level.