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Quantitative Research Methods to Assess Agricultural Technology Adoption

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Conceptual Framework

- The use of new agricultural technologies has been found to be a function of farm and farmer characteristics and specific features of the particular technology (Feder, Just, & Zilberman, 1985; Marra &Carlson, 1987; Rahm & Huffman, 1984)

- A considerable set of literature has developed regarding factors that influence the adoption of new technologies by farmers through use of innovativeness theory (Feder et al., 1985; Griliches, 1957; Rogers, 1995)

- Adoption and diffusion theory has been widely used to identify the factors that influence an individual's decision to adopt or reject an innovation

- The perceived newness of the idea for the individual determines his or her reaction to it

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Conceptual Framework

- Regers (1995, p11) identified five characteristics of an innovation that affect an individual's adoption decision:

- Relative advantage: how the innovation is better than existing technology
- Compatibility: the degree to which an innovation is seen as consistent with existing experiences, needs, and beliefs of adopters
- Complexity: how difficult the innovation is to understand and use
- Trialability: the degree to which the innovation may be used on a limited basis
- Observability: the degree to which the results of an innovation are visible to others

Hypothesis

- A basic hypothesis regarding technology transfer is that the adoption of an innovation will tend to take place earlier on larger farms than on smaller farms

- It has been hypothesized that larger farmers would be more receptive to innovation than their smaller neighbors and that this was largely due to cost issues

Conceptual Framework

- Land ownership is widely believed to encourage the adoption of new technologies
- Profitability is likely to be another significant farm-level factor influencing the decision to adopt
- Farmers with access to large financial resources have the ability to adopt innovations earlier
- The human capital of the farmer is also assumed to have a significant bearing on the decision to adopt new technologies
- Most adoption studies have attempted to measure human capital through the farmer’s age and their education or years of experience growing the crop
- The agricultural system in which the farmer primarily specializes is likely to also influence the farmer’s agricultural experience and human capital.
- The particular soil type on the farm may also influence the adoption decision and account for any potential regional differences

Methodological Framework

- Conventional regression analysis (Ordinary Least Squares or OLS) cannot accommodate zero observations on the dependent variable, and the failure of OLS to deal properly with such data led to the development of estimators built on the principle of maximum likelihood (MLE)

- Limited Dependent Variable (LDV) models are estimated using MLE; the most common of these that are used in adoption literature are the **logit model** (which corresponds to a logarithmic distribution function) and the **probit model** (which assumes an underlying normal distribution)

- Anemiya (1985) concluded that the choice of which continuous probability distribution to use cannot be justified on theoretical grounds

- In this workshop, we are going to use **Logit model**.

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Methodological Framework

- **Research Question**: Farm and farmer determinants for the adoption of the X-WLI technology among “WLI” farmers are to be identified and estimated

- This research question is to be tested empirically by the following model (**Logit Model**): A binary logistic regression is to be used to regress the dependent variable, Y, of whether the farmer had adopted X_WLI technology : Prob (event) = Prob (Y,1 represents ith farmer adopted, and 0, otherwise)

$$Y = \begin{cases} 1 : \text{adopted} \\ 0 : \text{otherwise} \end{cases}$$

- Against the estimated factors affecting adoption of this X_WLI technology variables (Liao,1994). The parameter estimates **(**β**)** predict the log odds (logit) of the dependent variable (Y). Thus, the prediction equation is (Garson, 2009):

$$Y = Ln(odds(event)) = Ln\left(\frac{prob(event)}{prob(nonevent)}\right) = Ln\left(\frac{prob(event)}{1-prob(event)}\right)$$

Methodological Framework

- Let Xi represents the set of variables including socio-economic, farming, institutional factors, etc which influence the adoption decisions of the ith farmer.

- For the farmer Zi is an indirect utility derived from the adoption decision, which is a linear function of k explanatory variables (X), and is expressed as:

$$Z_i = \beta_0 + \sum_{i=1}^{n} \beta_i X_{ki}$$

Where:

$\beta 0$: Is the intercept term (constant), and $\beta 1, \beta 2, \beta 3, .., \beta i$ are the coefficients associated with each explanatory variable X1, $X2, X3, .., Xi$. These factors explain the X-WLI adoption decision, or the probability that the ith farmer adopts X-WLI technology:

$$P_i = \frac{e^{z_i}}{1 + e^{z_i}}$$

Pi: The probability that the ith farmer's adoption decision and (1-Pi) is the probability that Yi=0

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Methodological Framework

- The *odds* (Y=1 versus Y=0) to be used can be defined as the ratio of the probability that a farmer adopts (Pi) to the probability of non-adoption (1-Pi), namely odds = Pi/(1-Pi).

- By taking the natural log, we get the prediction equation for an individual farmer:

$$Ln\left(\frac{P_i}{1-P_i}\right) = Ln\ odds = \beta_0 + \sum_{i=1}^{n} \beta_i X_{ki} = Z_i$$

Where: Zi is also referred to as the log of the *odds* ratio in favor of adoption

What is needed:

1. Cleaned database with a summary statistics of the, and, variables to be used in the analysis

2. Excel / SPSS softwares

3. Minimum knowledge on statistics and quantitative analysis

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How to proceed with the SPSS:

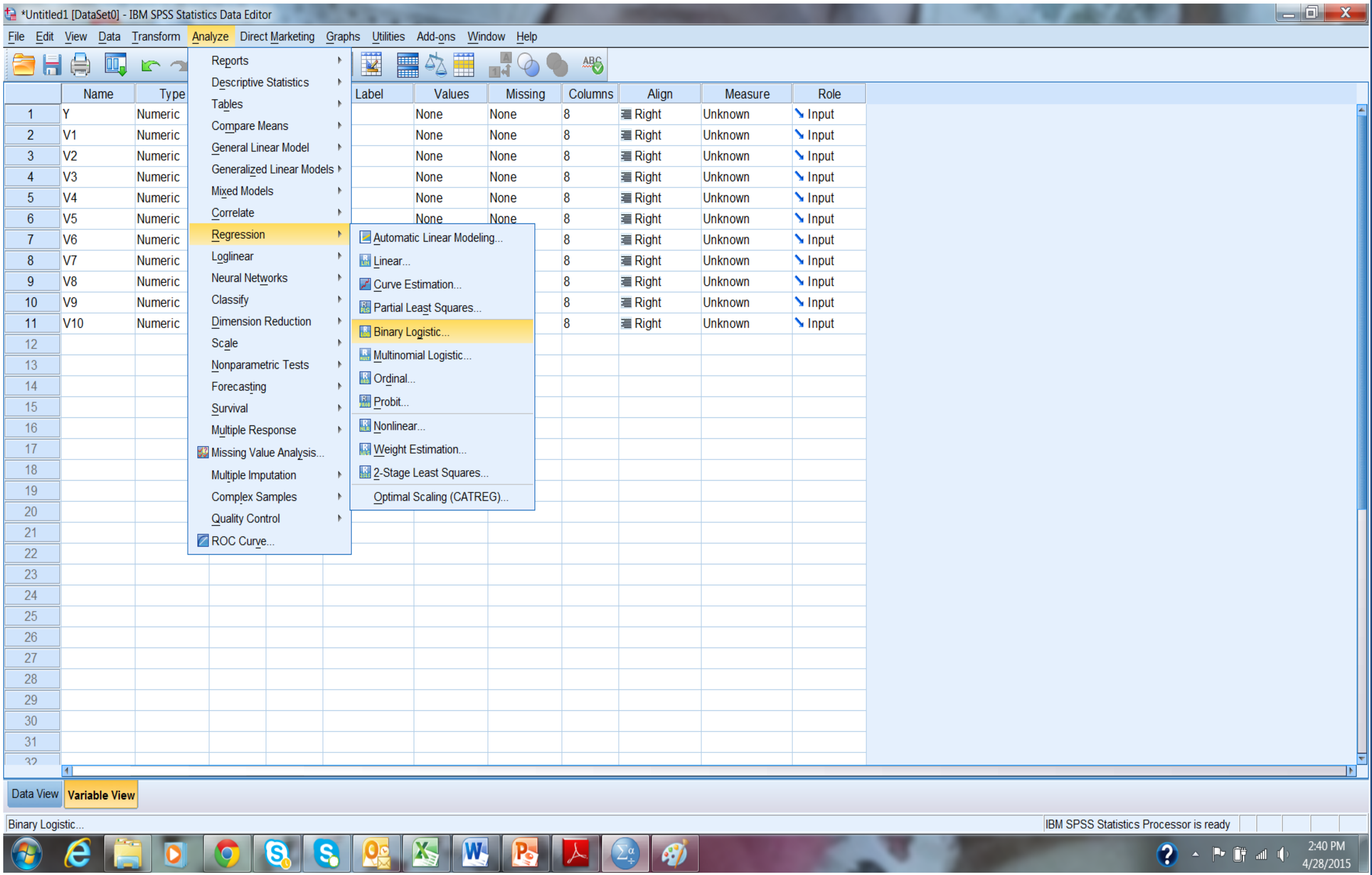
Step 1: Database / variables in Excel

Step 2: Selection of the main significant variables (on the basis of the theory)

Step 3: Open SPSS software and then type in database or run an existing query

Practical Example

Step 4: Proceed with SPSS..Analyze…Regression…Binalry logistic



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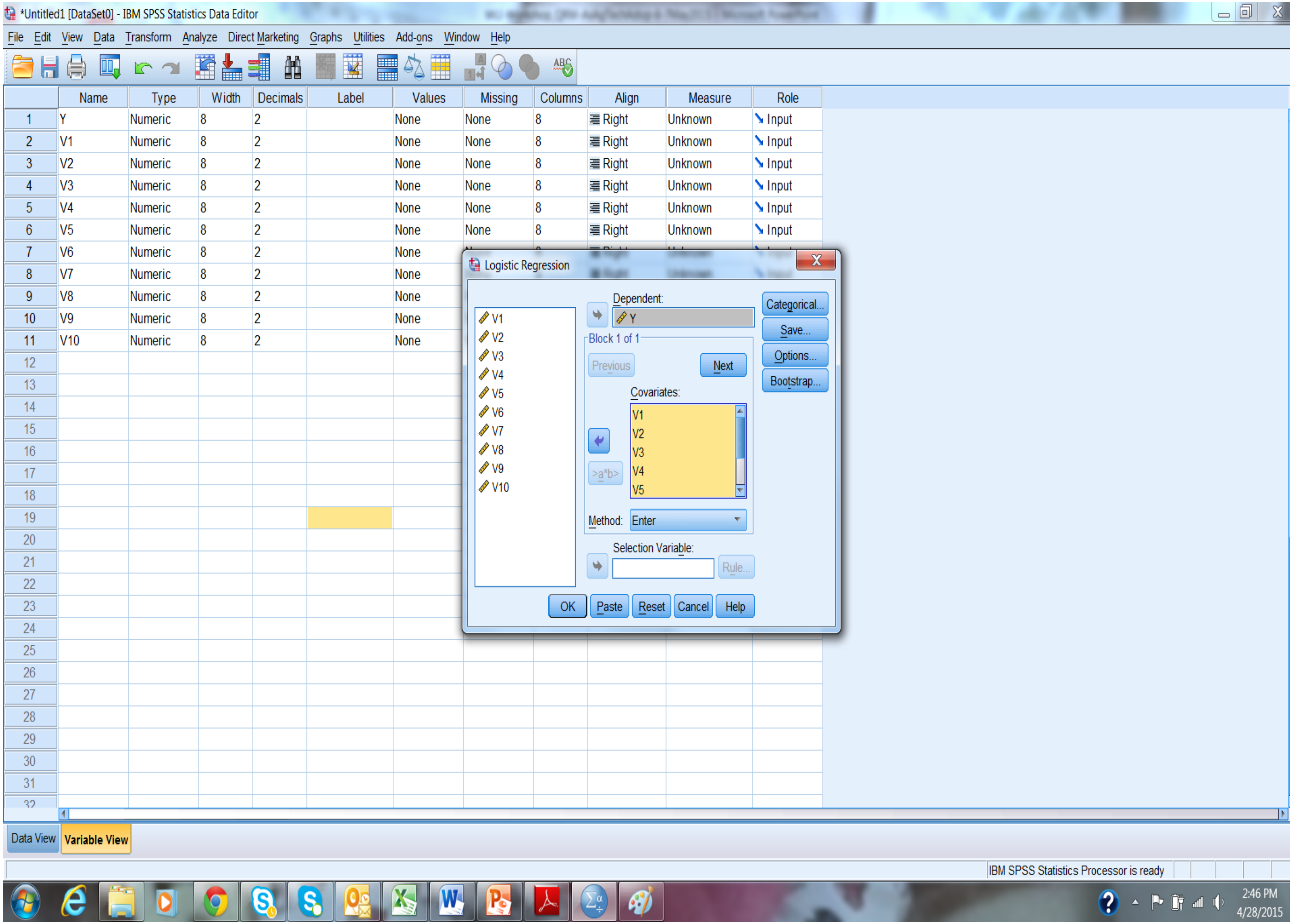
Practical Example

Step 5: Select dependent (Y) and the independents (Xk) variables and press OK



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Practical Example

Step 6: Interpretation of the empirical results

*Output1 [Document1] - IBM SPSS Statistics Viewer

a. Residual Chi-Squares are not computed because of redundancies.

Block 1: Method = Enter

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	12.494	8	.130
	Block	12.494	8	.130
	Model	12.494	8	.130

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	56.820[a]	.221	.295

a. Estimation terminated at iteration number 5 because parameter estimates changed by less than .001.

Classification Table[a]

Observed			Predicted Y .00	Predicted Y 1.00	Percentage Correct
Step 1	Y	.00	18	7	72.0
		1.00	9	16	64.0
	Overall Percentage				68.0

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	V1	.000	.000	4.874	1	.027	1.000
	V2	.256	.171	2.247	1	.134	1.291
	V3	-.004	.003	1.508	1	.219	.996
	V4	-.011	.010	1.007	1	.316	.990
	V5	-.039	.065	.362	1	.547	.962
	V6	.000	.000	.023	1	.879	1.000
	V7	2.138	1.239	2.977	1	.084	8.486
	V8	-.002	.029	.004	1	.947	.998
	Constant	-1.100	1.889	.339	1	.560	.333

a. Variable(s) entered on step 1: V1, V2, V3, V4, V5, V6, V7, V8.

Double click to edit Pivot Table | IBM SPSS Statistics Processor is ready | H: 256, W: 534 pt

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Practical Example

Step 6: Interpretation of the empirical results

1. **Validity of the model:**

A) Test of **Hosmer and Lemeshow** (if the model fit with the binary regression): The hypothesis (H0) is to test if there is no difference (Ha: difference) between the observed and predicted values

If p-value less than 0.05: A poor fit for a binary logistic regression model
If p-value more than 0.05: A strong fit for a binary logistic regression model

B) The overall percentage of correct predictions (**higher is better**)

2. **Empirical results:**

A) The coefficients (β), their magnitude, sign (+; -) and their significance (Sig.1,5 or 10% level)
B) Exp (β): Gives the exponential of expected value of β raised to the value of the logistic regression coefficient, which is the predicted change in odds for a unit increase in the corresponding explanatory variable.

Variables in the Empirical Binary Logistics Model: For discussion

Acronym	Description	Type of measure	Expected Sign
Dependent variables			
ADOP	Whether a farmer has adopted or not	Dummy (1 if yes, 0 if no)	
Explanatory variables			
AGE	Household head's age	Years	-
EDUC	Educational background of the household head		+
FSIZ	Household in number of people	Numbers	+
FEXP	Household head's farming experience	Years	+
LABE	Labor force size	Active labor force numbers	+
TENUR	Status of land ownership	1, fully owned; 2, rented; 3, shared	?
OFFA	Farmer has any off-farm activity	Dummy (1 if yes, 0 if no)	?
INCO	Level of family income	Total income (US$) per year	+
CRED	Obtained credit	Dummy (1 if yes, 0 if no)	+
CBOS	Member to CBO's	Dummy (1 if yes, 0 if no)	+
VLIVST	Importance of livestock in the farming system	Dummy (1 if yes, 0 if no)	+
CONT	Contact with research, extension	Dummy (1 if yes, 0 if no)	+
KNT	Knowledge of the new technology	Dummy (1 if yes, 0 if no)	+
ATTI	Attitudes of farmer toward X-WLI technology	Dummy (1, feels that will have positive effects, 0 if negative)	+
SPE_VAR	**Specific Technology Variable (Marketing, irrigated crop, etc…)**		

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Thank You

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