Structural equation analysis using Amos program for basic human and social science research

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Abstract

This article aims to study the method of using Amos program in structural equation analysis to analyze structural equations in the analysis of variables in Amos program. The population is 300 Amos users, the sample is 90 people, the tool is an online questionnaire, Google Sheets is composed of the following components: time, price, income. The study results found that the statistical analysis of all 3 indicators, the statistical value of every indicator has a variance and the relationship value of every indicator, which the statistical value of every indicator is positive.
***Keywords**:* Amos, Research, Analysis

Background and Statement of the Problem

Currently, there are many statistical analysis programs that can be used to analyze structural equation models, such as Lisrel, Mplus, EQS, SAS, PLS, and. However, the most well-known and widely used statistical analysis program that is very popular is AMOS (Analysis of Moment Structure). Amos is a development of a computer program for analyzing structural equation models (Structural Equation Modeling: SEM) that has great potential for data analysis. SPSS (Statistical Package for the Social Science for Windows) can also analyze data according to various models. Amos was introduced from Austria and is used in graduate school teaching. It is a program for master's and doctoral students and was first used at Chulalongkorn University since 2003.

The author hopes to apply the knowledge gained to create new research that is consistent with the current situation. He can apply all the basic principles of statistical analysis, including his direct experience in research, to analyze data with a large number of variables to obtain more accurate and precise analysis results. It is a preliminary data analysis to describe the properties and general characteristics of the collected variables. And it is a test of the preliminary agreement (Assumption) of the Structural Equation Modeling (SEM) analysis, including 1) completeness of the observed variable data, 2) checking the normal distribution of the data, 3) checking the relationship between the pairs of observed variables must not exceed 0.80 (Chaengsawang, 2012). The statistics used include frequency (Frequency: F), percentage distribution (Percent), mean (Mean: M), standard deviation (Standard deviation: S.D.), minimum (Minimum: MIN), maximum (Maximum: MAX), skewness (Skewness) and kurtosis (Kurtosis) as well as Chi-square statistics (Chi-square/ x2), which the skewness (Skewness) if calculated equal to 0 or close to 0 and the kurtosis is 3 or close to 3, it can be concluded that the data is normally distributed. And if the skewness value is greater than 0, it means that the data is skewed to the right or positively skewed. But if the skewness is less than 0, it means that the data is skewed to the left or negatively skewed. And if the kurtosis is less than 3, it means that the kurtosis of the data is negative. While if the kurtosis value is greater than 3, it means that the kurtosis of the data is positive. The graph of the data with negative kurtosis will be flatter than the graph of the data with positive kurtosis.

Model Identification

In the part of the model specification process by developing a structural equation model according to the hypothesis that will specify the relationship between the variables in the model that can explain the

relationship between the variables reasonably and can specify a specific model (Particular Model) in the form of a variance-covariance matrix that is consistent with the empirical data, there is another important step, which is model identification, which is a step related to the parameter estimation process. Or in other words, to make it easier to understand, it is the step of analyzing the data collected from the sample group (Samples) by solving the structural equation to find the desired parameter values. Which is the coefficient of the variable in the equation that the researcher does not yet know the value. The number of equations in the structural equation model must be at least equal to the number of parameters to be estimated in order to be able to estimate only one value of each parameter in the structural equation, or in other words, "the parameter can have only one value (unique)" (Wiratchai, 1999, Tenko & Marcoulides, 2006) because if the number of structural equations is less than the number of parameters to be estimated, it will not be possible to estimate the parameter value (the parameter can have multiple values) (Pedhazur, 1982). Therefore, the specific model that has passed the model identification process has 3 characteristics as follows:

1) Fit model (just-identified model) is a specific model that has the number of equations calculated equal to the number of unknown parameters in the model, and can estimate only one parameter value for each unknown parameter (the degrees of freedom are zero).

2) Over-identified model is a specific model that has the number of equations calculated more than the number of unknown parameters in the model, and can estimate only one parameter value for each unknown parameter (the degrees of freedom are positive).

3) Under-identified model is a specific model that has the number of equations calculated less than the number of unknown parameters in the model, and can estimate only one parameter value for each unknown parameter (the degrees of freedom are negative). Both over-identified model and under-identified model (just-identified model) Researchers can analyze the structural equation model but if the model is under-identified (MacCallum, Wegener, Uchino & Fabrigar, 1993), the examination of the characteristics of a single possible model should be performed before estimating the parameters. The characteristic of the desired model is the over-identified model, which can be considered as

Table 1 Model consistency test standards.

INDEX	CRITERION	CONSIDERATION
RELAVIVE CHI-SQUARE (X^2/DF)	<3.00	Passed the criteria
CFI	>0.90	Passed the criteria
IFI	>0.90	Passed the criteria
RMSEA	0.50-0.10	Passed the criteria
RMR	<0.05	Passed the criteria

Which from the data that has been run out of the Amos program must be compared with the standard table to check the consistency of this model to read the results or interpret the meaning of the structural equation analysis whether it passes or fails according to the criteria.

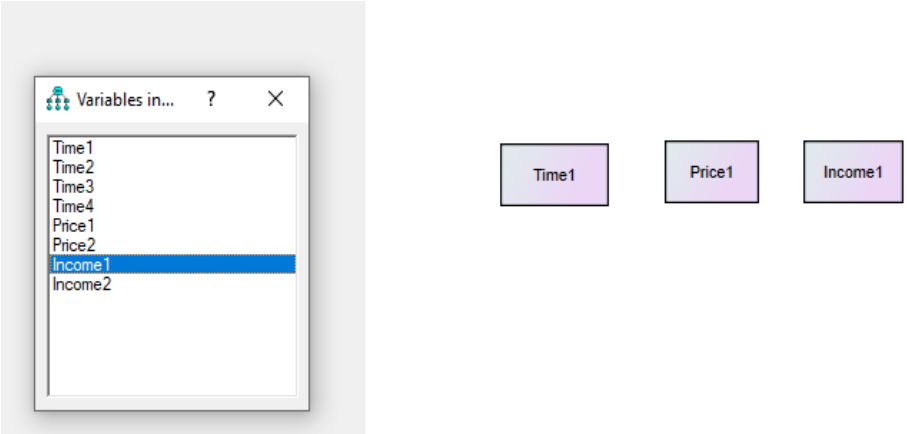

Figure 2 shows the import of variables. In this step, we will focus on importing data or observed variables called Observed Variables, which are symbolized by a rectangle with 3 indicators or variables.

They are very important because if you don't choose the right one, you will not be able to choose the variable to use in the structural equation analysis.

Connecting relationship lines using double-headed arrows

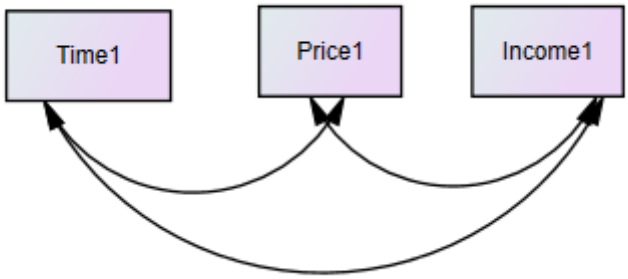

Figure 3 shows the linking of the 3 variables.

In this step, we will focus on linking the relationship between the variables or indicators, which must have a 2-headed arrow. Arrow key will make the 3 variables have a relationship with each other.

The result of running the program can be viewed from View the Output Path Diagram.

Figure 4 shows the results of the Unstandardized Estimates run. In this step, the results will be displayed in the number box. The numbers will appear on the curve, which is the Covariance variance in Time1 and Income1, which has the highest value of .65, followed by .63 and finally .59, respectively. It can be observed that the variance values are positive for all three indicators.

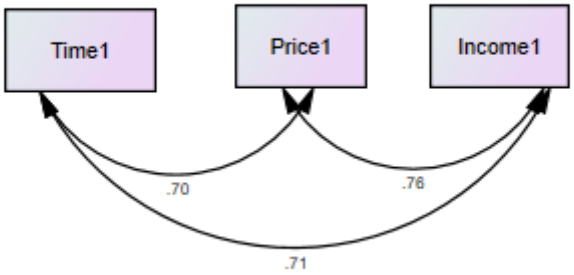

Figure 5 shows the results of running standardized estimates. In this step, the results will be displayed in the number box. The numbers will appear on the curve, which is the relationship between Time1 and Income1, with the highest value of .78, followed by .71 and finally .70, respectively. It can be observed that the relationship values are positive for all three indicators.

Results of the program run from Text Output

Results of the program run from Text Output: Estimates shows the results of the run from Text Output.

	Estimate	S.E.	C.R.	P	Label
Time1	4.020	.049	82.649	***	
Price1	3.948	.043	91.585	***	
Income1	3.886	.047	82.191	***	

Covariances: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Price1	<-->	Income1	.623	.051	12.144	***	
Price1	<-->	Time1	.586	.051	11.443	***	
Income1	<-->	Time1	.652	.056	11.554	***	

Correlations: (Group number 1 - Default model)

			Estimate
Price1	<-->	Income1	.762
Price1	<-->	Time1	.696
Income1	<-->	Time1	.706

This step will show the results in the number box. The numbers will appear in the table above. There are variance values and correlation values. All three indicators have positive statistical values.

Summary and discussion of results

1. AMOS is a program that uses statistics to analyze the relationship between variables and factors in the same way as Multiple regression, Path Analysis, and Factor analysis. It is a well-known statistical analysis program that is widely used and very popular. AMOS will provide researchers with more convenience in analyzing because of the adjustment of the structural equation model and the connection between the Error Term values in the alternative models. It is easy to link the Error Term values of different matrices by using a linkage diagram.

2. From the structural equation analysis (Structure Equipment Modeling: SEM), Dole used (Confirmatory Factor Analysis: CFA) to analyze 3 indicators as follows: Time1 and Price1, Income1. The results are curves, i.e., the Covariance variance in Time1 and Income1 has the highest value of .65, followed by .63 and finally .59, respectively. It can be observed that the variance values are positive for all three indicators, as shown in Figure 3. The results are curves, i.e., the Correlation relationship in Time1 and Income1 has the highest value of .78, followed by .71 and finally .70, respectively. It was found that the relationship values are positive for all three indicators, as shown in Figure 4.

Suggestions

The analysis to test the variables should study the importance of the variables and the statistical values to understand them deeply so that the program users can reduce errors that may occur and will not encounter problems when running the results. The analysis starts with drawing a model from the theory and should study the latent variable definition and the indicator definition that are observable variables are also studied in the same theory. The analysis will be analyzed simultaneously with the model answers obtained from the models.

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Reference

Chaengsawang, N. (2012). *Analysis of the relationship between accounting data and the return on securities of listed companies in the Stock Exchange of Thailand* (Doctoral dissertation, Graduate School, Sripatum University).

Hooper, D., Coughlan, J., & Mullen, M. (2008). Structural equation modelling: Guidelines for determining model fit. *Electronic Journal of Business Research Methods, 6*(1), 53–60.

Kline, R. B. (2015). *Principles and practice of structural equation modeling* (4th ed.). Guilford Press.

MacCallum, R. C., Wegener, D. T., Uchino, B. N., & Fabrigar, L. R. (1993). The problem of equivalent models in applications of covariance structure analysis. *Psychological Bulletin, 114*(1), 185–199.

Pedhazur, E. J. (1982). *Multiple regression in behavioral research*. Holt, Rinehart and Winston.

Pedhazur, E. J. (1982). *Multiple regression in behavioral research: Explanation and prediction* (2nd ed.). Harcourt Brace College Publishers.

Rangsungnern, K. (2011). *Factor analysis with SPSS and AMOS for research*. C.Ed Se-Education.

Schumacker, R. E., & Lomax, R. G. (2010). *A beginner's guide to structural equation modeling* (3rd ed.). Lawrence Erlbaum Associates.

Wanichbancha, K. (2013). *Statistical analysis: Statistics for management and research*. Chulalongkorn University Printing House.

Wanichbancha, K. (2008). *Multivariate data analysis*. Department of Statistics, Faculty of Commerce and Accountancy, Chulalongkorn University.

Wiratchai, N. (1999). *Modellisrail: Statistical analysis for research* (3rd ed.). Chulalongkorn University Press.