PLS-SEM Presents

Structural Equation Modeling Using SmartPLS: A Partial Least Squares Path Modeling Tool

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Smart PLS

Introduction to PLS, Latent Constructs, SEM and SmartPLS

Introduction to PLS

- Sometimes called “Projection to Latent Structures” due to general strategy
  - **X variables** (the ‘predictors’) and **Y variables** (the ‘dependents’) are reduced to principal components.
  - While original X variables may be multicollinear, the X components used to predict Y will be orthogonal.
- PLS sometimes called “component-based SEM”
  - In contrast to covariance-based SEM
- PLS is a predictive technique which can handle many independent variables.

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Typical SEM Analyses

- ***Latent variables*** are not directly observable
  - Cannot be directly measured
  - Attitudes, beliefs, feelings of loyalty and satisfaction.
- SEM path modeling associates observable variables (called ***items***, ***indicators***) with these latent variables
- However, in PLS latent variables are actually linear composites of the associated observed variables
  - So the latent variables in PLS can be expressed as exact linear functions of their indicators.

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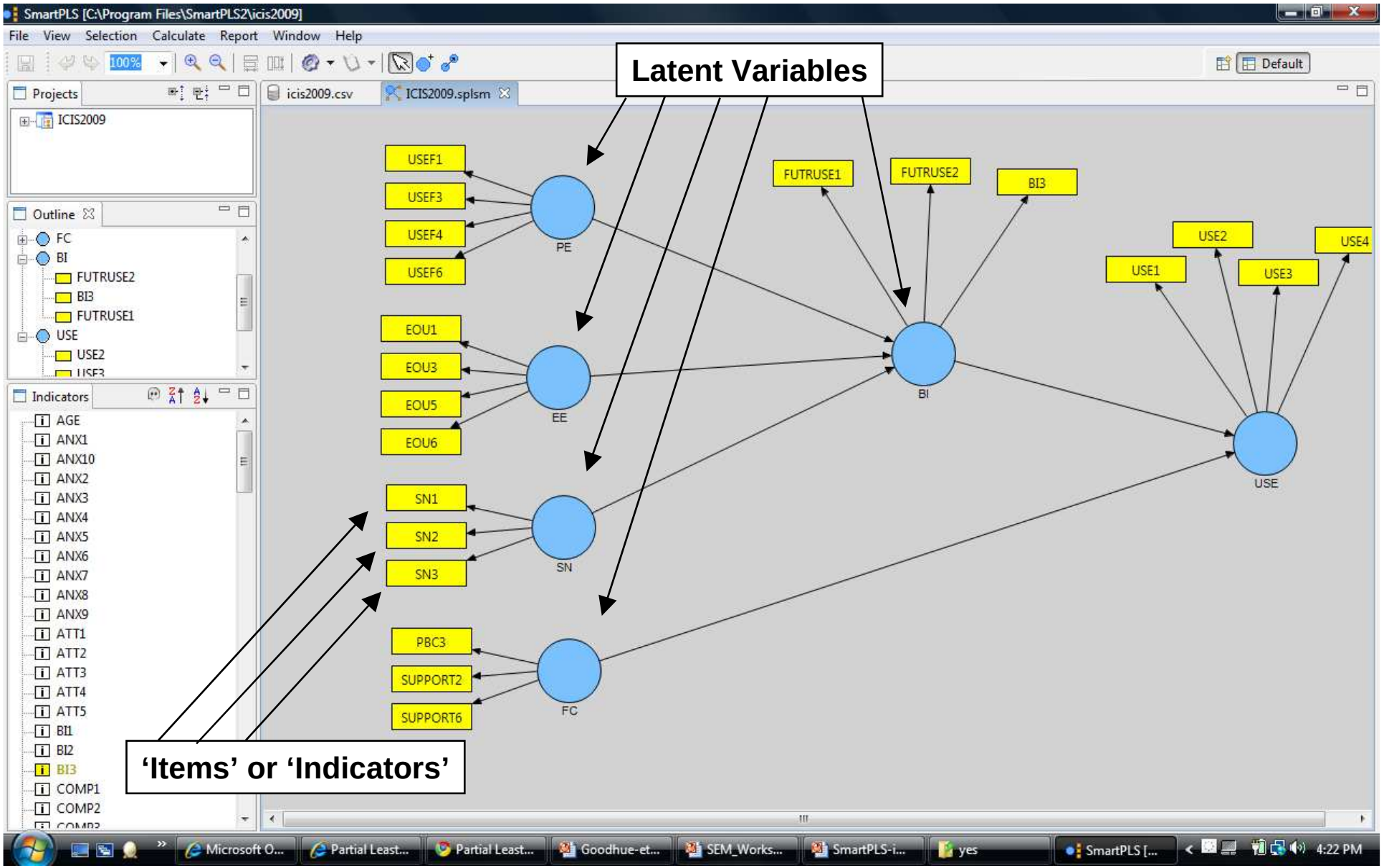
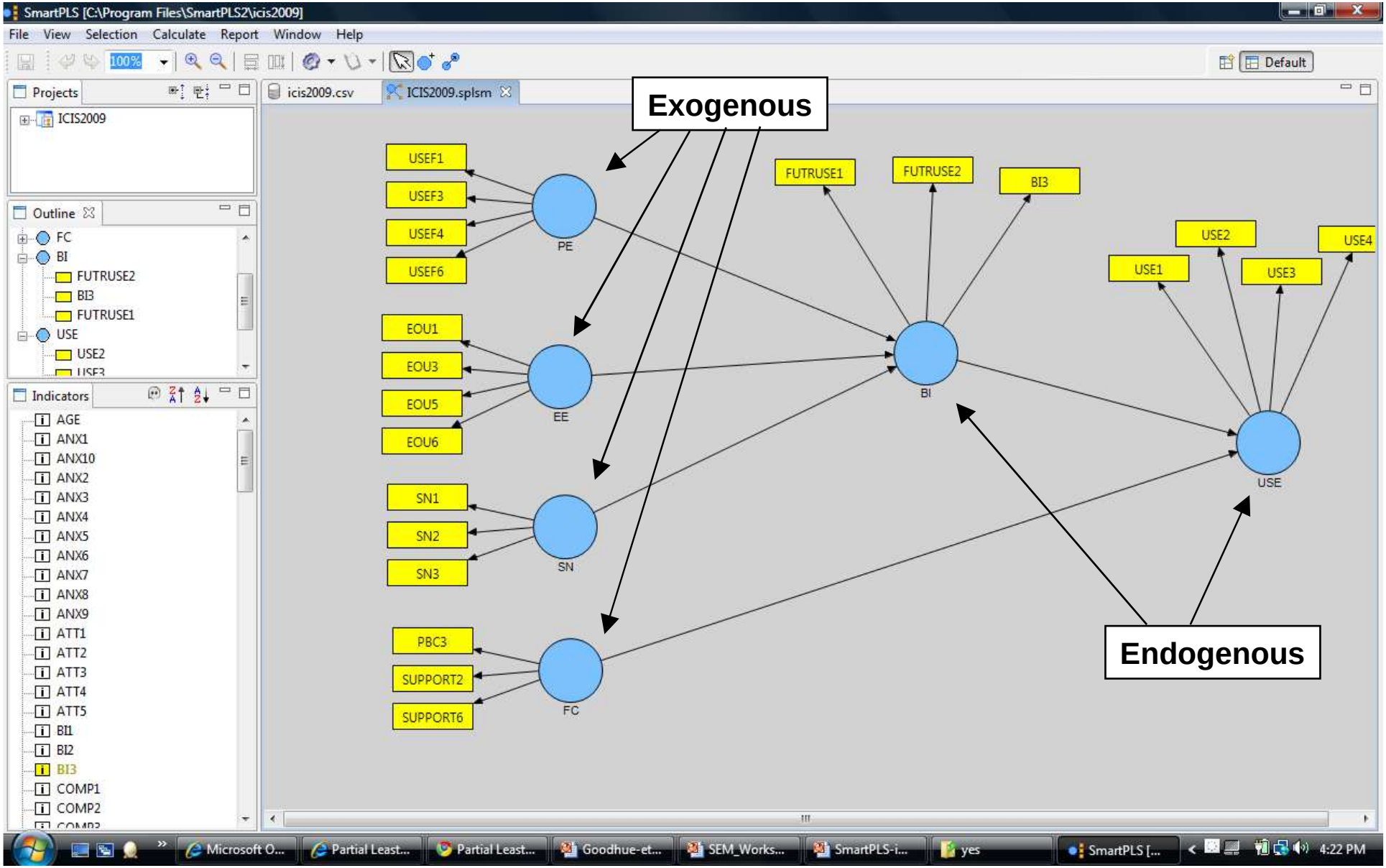
UTAUT Model from Saudi Arabia Project - 1



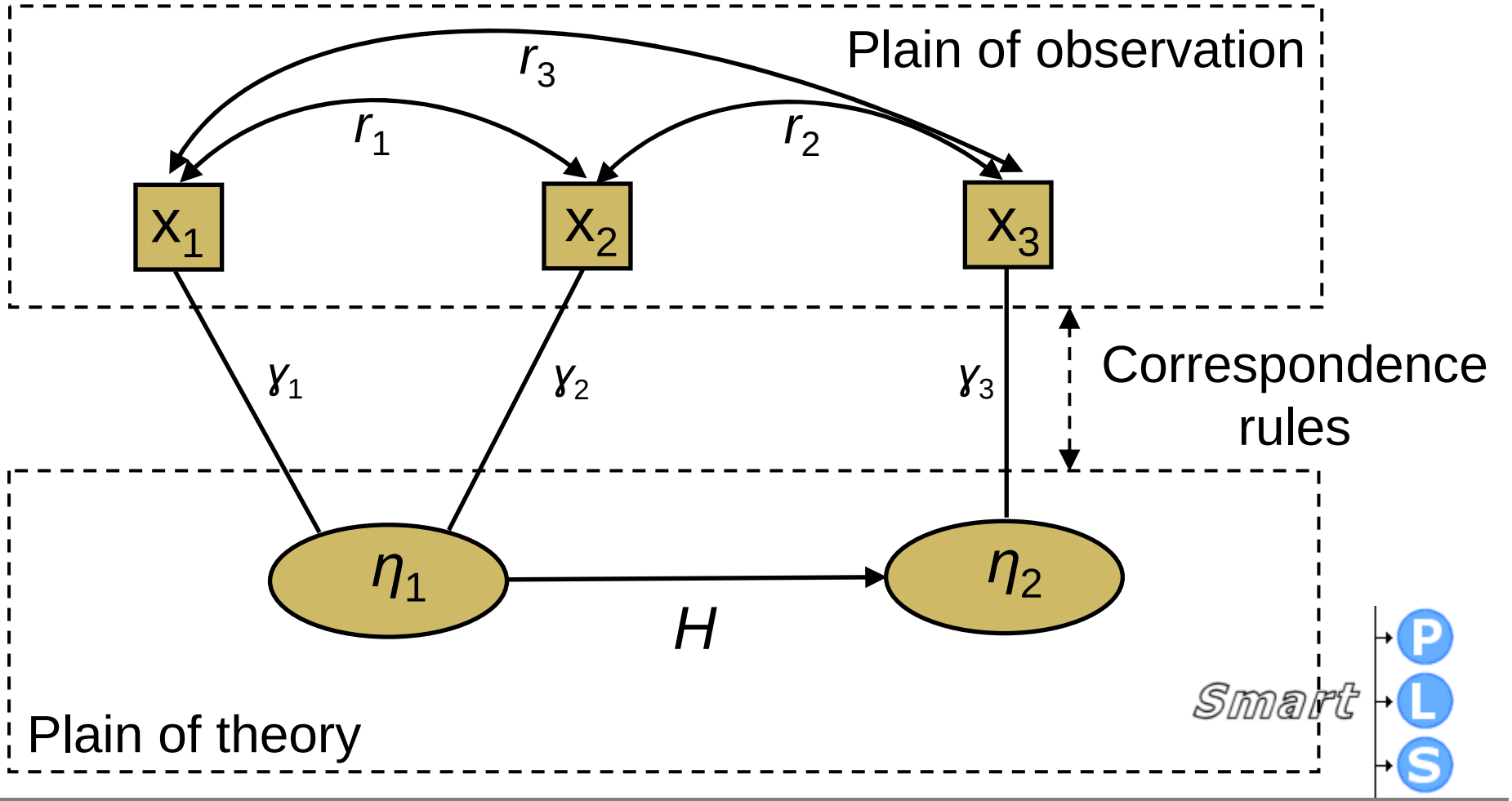
Endogenous & Exogenous Variables

- ***Exogenous variables*** (ξ) are independent variables not presumed to be caused by other variables in the model.
- ***Endogenous variables*** (η) are variables assumed to be caused by other variables in the model.

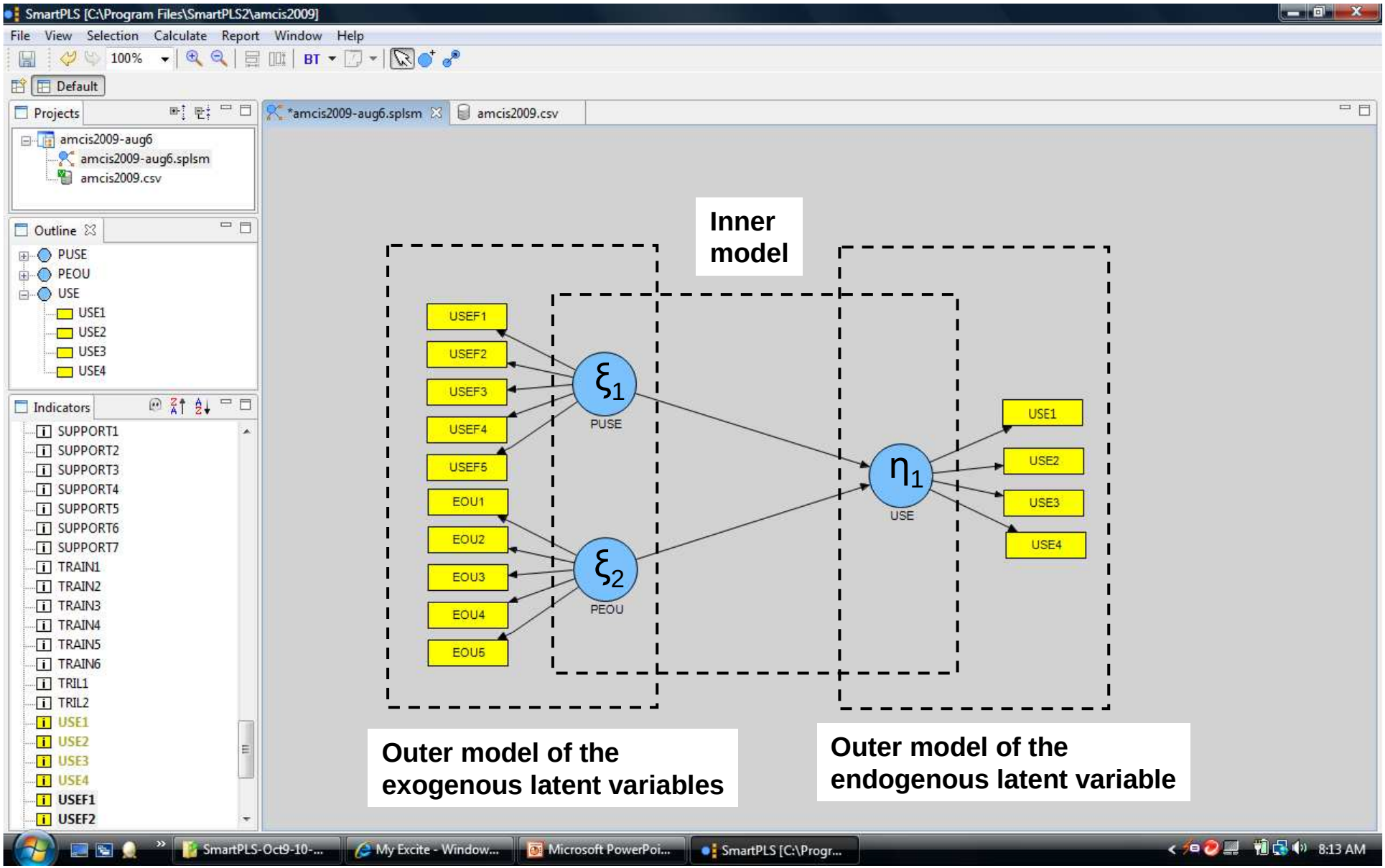
UTAUT Model from Saudi Arabia Project - 2



Two-Level Concept of Empirical Research



TAM Model from Saudi Arabia Project



Why Use PLS Path Modeling?

- (Almost) No distributional assumptions
- Less stringent data requirements (controversial)
- Complex models (many latent variables and indicators)
- Small sample size (controversial)
- Formative constructs
- Focus on prediction
- Explicit estimation of latent variable scores.

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Less Stringent Data Requirements

- Robust with different scale types:
  - Metric
  - Quasi-metric (e.g. Likert scales)
  - Dichotomous (e.g. dummy variables)
- No distributional assumptions
  - Data may be . . .
    - . . . non-normal
    - . . . skewed
    - . . . Kurtotic
  - The observations may be interrelated.

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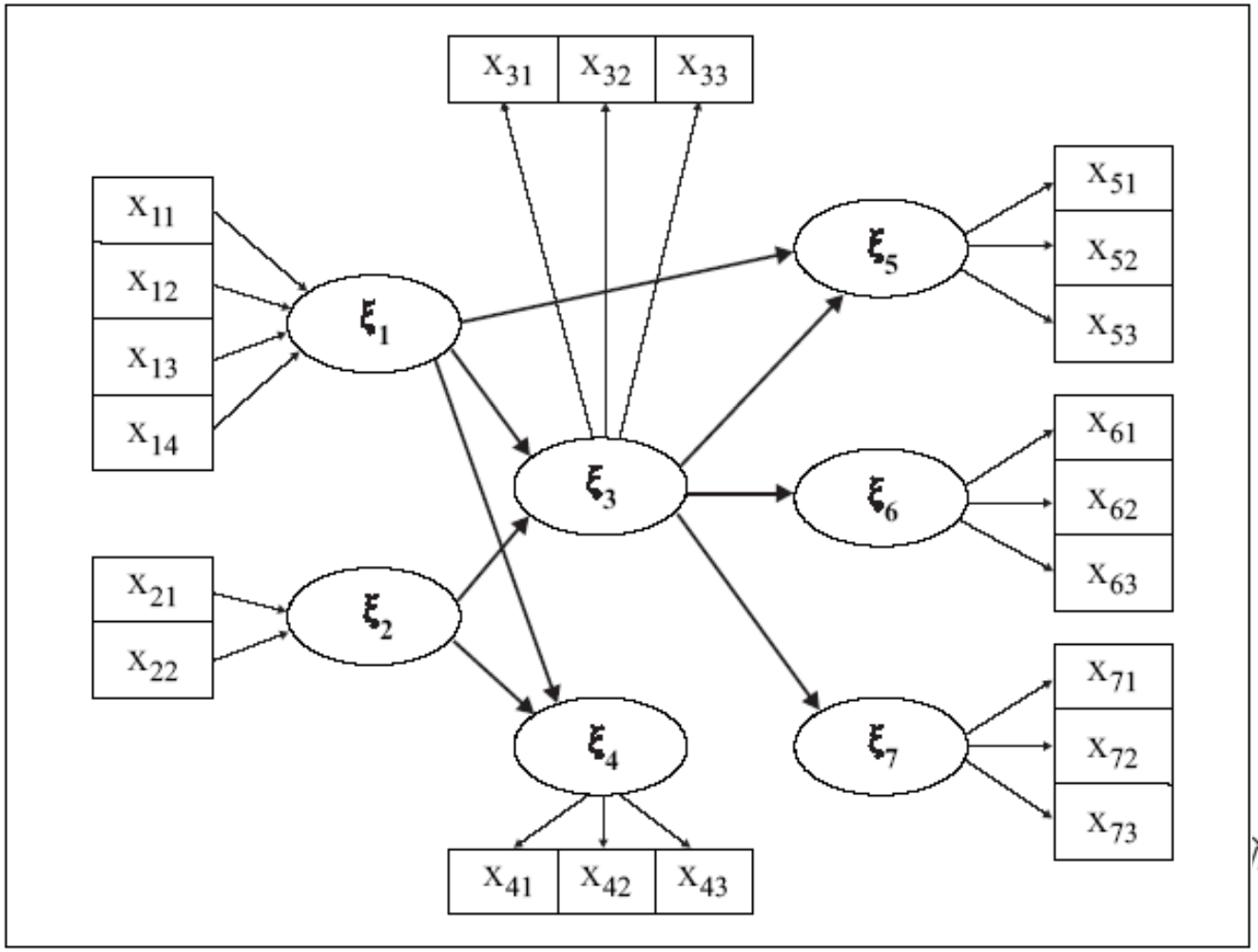
More Complex Models



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Smaller Sample Size

- Minimal recommended sample size
  - ***Ten times*** the number of maximum arrowheads pointing on a latent variable
    - the ***structural*** model, or
    - a ***measurement*** model
- ***But***, in terms of inference statistics..
  - The minimal recommended number of observations is too small to identify even moderate effects.
  - Defining the population and the sampling plan remains crucial for representativeness.

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Focus on Prediction

- PLS optimizes the ***explained variance*** of the endogenous variables.
- PLS delivers ***latent variable scores***.
- PLS generally produces ***less accurate*** path coefficients compared to covariance-based SEM.
- In PLS, there is ***no global optimization criterion***, so model comparisons can be more difficult.
  - Restricts theory testing

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Summary Comparison of PLS-SEM and CB-SEM Approaches

Basis of Comparison	PLS-SEM	CB-SEM
Objective:	Prediction oriented	Theory oriented: Parameter oriented
Approach:	Variance based	Covariance based
Assumptions:	Predictor specification (nonparametric)	Multivariate normal distribution and independent observations (parametric)
Relationship between a latent variable and its measures	Can be modeled in either formative or reflective mode	Typically only reflective indicators
Implications:	Optimal for prediction accuracy	Optimal for parameter accuracy
Model complexity:	Large complexity (e.g., 100 constructs, 1000 indicators)	Small to moderate complexity (e.g., < 100 indicators)
Sample size:	Power analysis based on the portion of the model with largest number of predictors. Recommendations for minimum number of observations range from 30 to 100 cases.	Ideally based on power analysis of specific model. Recommendations for the minimum number of observations range from 200 to 800.