

UNSW SISTM Workshop Series

Partial Least Squares Path Modeling

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Course Description:

The workshop is intended to be an introduction to Partial Least Squares path modelling (PLS-PM) with an applied focus moving from basic to intermediate to advance topics respectively. In particular, discussions of PLS-PM usage will be within the context of survey based research. As such, we will examine how PLS-PM can be applied in a holistic fashion to theorize about one's model, develop empirical measures, and run tests of the validity (e.g., convergent, discriminant, nomological) for both theoretical and measurement models. A heavy demo/lab emphasis will be applied focusing on both the unique functionalities of PLS-Graph and XL-Stat.

Course Objectives:

The objectives are to have participants come away with:

- an intuitive understanding of the relative strengths and weaknesses of both covariance-based and component-based techniques,
- be able to set-up basic models correctly,
- be able to make sense of the analytical results in both exploratory and confirmatory modes.
- an a state of the art overview of recent advances in the Partial Least Squares method including higher order dimensional analysis, multi-group permutation analysis, interaction analysis, bootstrap cross-validation for fit assessment, plus latest developments from the recent PLS Symposium 2015 conference and PLS book (2013).

To best accomplish these objectives, students will be expected to actively participate in a combination of seminars and hands-on computer exercises. A large emphasis will be on modelling as opposed to how to setup pre-specified models using a particular software package.

Course Contents Day 1 & 2 – Basic to Intermediate:

- Introduction to Multiple Regression and Factor Analysis
- Covariance-Based Modeling – overview relative to other multivariate techniques, model specification/graphical approach, underlying algorithm, assessing model fit
- Introduction to Partial Least Squares
 - Working through the use of PLS-Graph and XL-Stat PLS-PM module – multiple regression, principle components analysis, PLS regression, PLS based structural equation modelling, underlying algorithm, formative vs. reflective indicators, Significance Testing through jackknifing, bootstrapping, and blindfolding resampling, AVE, composite reliability, cross loadings, and construct correlations for validity assessment.
- PLS-Graph and XL-Stat Hands-On Examples throughout the course (Software will be provided if you wish to use your own laptop. Please bring your data if you wish to use your own data for analysis.)

BIO OF DR WYNNE CHIN

Wynne W. Chin is currently the C.T. Bauer Professor of Decision and Information Sciences in the C.T. Bauer College of Business at the University of Houston and visiting Professor of SISTM at UNSW. He received his A.B. in Biophysics from U.C. Berkeley, MS in Biomedical/Chemical Engineering from Northwestern University, and an MBA and Ph.D. in Computers and Information Systems from the University of Michigan. Wynne has taught previously at the University of Calgary, Wayne State University, and the University of Michigan and has been a visiting fellow at Queens University, City University of Hong Kong, University of Canterbury, and the University of New South Wales. Wynne's research focuses on structural equation models related to Information technology adoption, sales force automation and electronic meeting support systems where he has developed measures for group cohesion, satisfaction, and consensus. Wynne has published in journals such as Information Systems Research, Data Base, Journal of Management Information Systems, MIS Quarterly, and Decision Sciences. Wynne is on the editorial board of Structural Equation Modeling journal, Journal of Information Technology, IEEE Transaction of Management, and previously Information Systems Research, Journal of AIS, Data Base (co-editor) and MIS Quarterly. Wynne has received best paper awards from the Journal of Personal Selling and Sales Management in 2003, the Administrative Sciences Association of Canada (IT division) in 1993 and 1998, a MIS Quarterly Reviewer of the Year in 1996, a Management Science Outstanding Reviewer award in 1996, and the First Biennial Award for Outstanding Ph.D. dissertation from the International Communication Association's Communications and Technology Division. He is one of the foremost exponent of the Partial Least Squares Path Modeling technique with his PLS-Graph software developed in 1990 used by more than 8000 researchers worldwide, ranked by two separate journal articles as one of the top 10 researchers in both IT Adoption/Acceptance and Human Computer Interaction, and recently received a World Class University (WCU) Professor designation in conjunction with Sogang University in South Korea and awarded as an AIS Fellow in 2013. Wynne's research has received over 26,000 citations, a top ten most cited article in MIS Quarterly and top five most cited in Information Systems Research, a Google Scholar H index of 44 that places him among the most impactful researchers in his discipline, and ranked third overall in first authored articles published in the top two IS journals - MISQ and ISR for the two decade period from 1990 through 2013. Born and raised in San Francisco, Wynne currently resides in Houston, Texas

References for further reading:

Covariance based SEM books

- Bollen, K. A. (1989) *Structural Equations with Latent Variables*. New York: John Wiley and Sons.
- Structural Equation Modeling With AMOS: Basic Concepts, Applications, and Programming, Second Edition (Multivariate Applications Series), Barbara M. Byrne, Routledge Academic; 2nd edition (July 28, 2009), ISBN-10: 0805863737, ISBN-13: 978-0805863734
- Principles and Practice of Structural Equation Modeling, 3rd Edition, Rex B. Kline, The Guilford Press; Third Edition (August 4, 2010), ISBN-10: 1606238760, ISBN-13: 978-1606238769
- Hoyle, R. H (ed), 1995. *Structural Equation Modeling. Concepts, Issues, and Applications*, SAGE.
- Schumacker, Randall E. & Lomax Richard G., 2004. A Beginner's Guide to Structural Equation Modeling, 2nd edition . Lawrence Erlbaum Assoc.

Of General Interest

- Bagozzi, R.P., *Causal Methods in Marketing*, John Wiley and Sons, New York, 1980.
- Chin, W. W. (1998). Issues and Opinion on Structural Equation Modeling, *MIS Quarterly*, Volume 22, Number 1, March 1998,
- Churchill, Gilbert A., Jr., "A Paradigm for Developing Better Measures of Marketing Constructs," *Journal of Marketing Research*, 16, 1, February, (1979), 64-73.
- Cronbach, Lee J., "Coefficient Alpha and the Internal Structure of Tests," *Psychometrika*, 16, September, (1951), 297-334.
- Cronbach, Lee J., "Test Validation," In *Educational Measurement*, R. L. Thorndike (Ed.), American Council on Education, Washington, D.C., 1971, 443-507.
- DeVellis, R. F. 2003. Scale Development: Theory and Applications, SAGE
- Diamantopoulos, Adamantios and Heidi M. Winklhofer, "Index Construction with Formative Indicators: An Alternative to Scale Development," *Journal of Marketing Research*, 38, 2, (2001), 269-277.
- Fornell, C.R. and D.F. Larcker, "Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research*, 18, February, (1981), 39-50.
- Gefen, D., Straub, D., and Boudreau, M.-C., "Structural Equation Modeling and Regression: Guidelines for Research Practice," *Communications of AIS*, Vol. 4, No. 7, pp. 1-80, 2000.
- Hair, J. H. Jr., Black, W.C., Babin, B.J., & Anderson, R.E., *Multivariate Data Analysis*, Prentice Hall, 2010.
- Podsakoff, Philip M., Scott B. MacKenzie, Jeong-Yeon Lee and Nathan P. Podsakoff, "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies," *Journal of Applied Psychology*, 88, 5, (2003), 879-903.
- Straub, D., Boudreau, M.-C., and Gefen, D. (2004). "Validation Guidelines for IS Positivist Research" *Communications of AIS* 13, Article 24, (2004), 380-427.
- Straub, Detmar W., "Validating Instruments in MIS Research," *MIS Quarterly*, 13, 2, June, (1989), 147-169.

PLS and PLS-Graph

Advanced Topics in PLS

- Lohmöller, J.B. (1989). Latent Variable Path Modeling with Partial Least Squares. Springer-Verlag, New York.
- Wold, H. & Jöreskog, K (Eds.) (1982). Systems Under Indirect Observation: Causality, Structure, Prediction, volume 2, Amsterdam: North-Holland.

Examples of IS Research using PLS

- Chan, Y.E. and S.L. Huff (1993). Assessing Information Systems Strategy. Proceedings of the Administrative Sciences Association of Canada - Information Systems Division, Lake Louise, Alberta, Canada. (14:4) June, 176-193.
- Chan, Yolande E. and Sid L. Huff. "Investigating Information Systems Strategic Alignment." In The Proceedings of the International Conference on Information Systems, December 1993.

- Chan, Yolande E., and Sid L. Huff. "Strategic Information Systems Alignment." *Business Quarterly* (August 1993): 51-55.
- Chan, Yolande E., and Sid L. Huff. "The Development of Instruments to Assess Information Systems and Business Unit Strategy and Performance." In *Research in Strategic Management and Information Technology*, edited by J. Henderson and N. Venkatraman, JAI Press, 1994.
- Chin, W. W. and A. Gopal,. (1995). Adoption intention in GSS: Relative importance of beliefs. *Database*. 26:2&3, 42-64.
- Gopal. A., R.P. Bostrom, and W.W. Chin (1992-3). Applying Adaptive Structuration Theory to Investigate the Process of Group Support Systems Use. *Journal of Management Information Systems*. 9:3 (Winter) 45-69.
- Grant, R.A. and C.A. Higgins (1991). The Impact of Computerized Performance Monitoring on Service Work: Testing a Causal Model. *Information Systems Research*. 2:2 (June) 116-142.
- Igbaria, M. (1990). End-User Computing Effectiveness: A Structural Equation Model. *Omega International Journal of Management Science*. 18:6, 637-652.
- Igbaria, M. and J.H. Greenhaus (1992). Determinants of MIS Employees' Turnover Intentions: A Structural Equation Model. *Communications of the ACM*. 35:2 (February), 35-49.
- Jones, E., Sundaram, S., & Chin, W. W. (2002). Factors Leading to Sales Force Automation Use: A Longitudinal Analysis. *Journal of Personal Selling and Sales Mgmt*, 22(3), pp. 145-156.
- Limayem, M., Hirt, S., and Chin, W. (2001) Intention Does Not Always Matter: The Contingent Role Of Habit On IT Usage Behavior. The 9th European Conference on Information Systems: Global Co-operation in the New Millennium, June 27-29, 2001, Bled, Slovenia
- Mathieson, K., Peacock, E., & Chin, W. W. (2001). Extending the Technology Acceptance Model: The Influence of Perceived User Resources. *The Data Base for Advances in Information Systems*, 32(3), 86-112.
- Rivard, S. and S.L. Huff (1988). Factors of Success for End-User Computing. *Communications of the ACM*. 31:5 (May) 552-561.
- Sambamurthy, V. and W. W. Chin (1994). The Effects of Group Attitudes Toward Alternative GDSS Designs on the Decision-making Performance of Computer-Supported Groups. *Decision Sciences*, 25:2, 215-241.
- Thompson, R.L. C.A. Higgins, and J.M. Howell (1991). Personal Computing: Toward a Conceptual Model of Utilization. *MIS Quarterly*, (March) 125-143.
- Thompson, R.L., C.A.Higgins, and J.M. Howell (1994). Influence of Experience on Personal Computer Utilization: Testing a Conceptual Model. *Journal of Management Information Systems*, 11:1 (Summer) 167-187.
- Chin, W. W. (2010). How to Write Up and Report PLS Analyses. In V. E.Vinzi, W. W. Chin, J. Henseler & H. Wang (Eds.), *Handbook of Partial Least Squares Concepts, Methods and Applications*, Berlin: Springer-Verlag, 650-690.
- Chin, W. W. & Dibbern, J. (2010). A Permutation Based Procedure for Multi-Group PLS Analysis: Results of Tests of Differences on Simulated Data and a Cross Cultural Analysis of the Sourcing of Information System Services Between Germany and the USA, In V. E.Vinzi, W. W. Chin, J. Henseler & H. Wang (Eds.), *Handbook of Partial Least Squares Concepts, Methods and Applications*, 171-193.
- Chin, W. W. (2010). Bootstrap Cross-Validation Indices For PLS Path Model Assessment. In V. E.Vinzi, W. W. Chin, J. Henseler & H. Wang (Eds.), *Handbook of Partial Least Squares Concepts, Methods and Applications*, Berlin: Springer-Verlag, 83-97.
- Henseler, J. & Chin, W. W. (2010). A Comparison of Approaches for the Analysis of Interaction Effects Between Latent Variables Using Partial Least Squares Path Modeling, *Structural Equation Modeling Journal*, 17(1), pp. 82-109. (SEM journal has an ISI web of knowledge 5 year average citation impact factor of 5.113)
- Marcoulides, G. A., Chin, W. W., Saunders, C. (2009). A Critical Look at Partial Least Squares Modeling, *MIS Quarterly*, 33(1), 171-175.
- Chin, W. W., Peterson, R. A., Brown, S. P. (2008). Structural Equation Modeling in Marketing: Some Practical Reminders, *Journal of Marketing Theory and Practice*, 16(4), 287-298.
- Chin, W. W., Marcolin, B. L., & Newsted, P. R. (2003). A Partial Least Squares Latent Variable Modeling Approach For Measuring Interaction Effects: Results From A Monte Carlo Simulation Study And Electronic Mail Emotion/Adoption Study. *Information Systems Research*, 14 (2), 189-217.
- Chin, W. W. (1998). Issues and Opinion on Structural Equation Modeling. *MIS Quarterly*, 22(1), pp. vii – xvi.
- Chin, W. W. (1995). [Partial Least Squares is to LISREL as principal components analysis is to common factor analysis](#). *Technology Studies*, 2, pp. 315-319.

Chin, W. W. & Newsted, P. R. (1995). The importance of specification in causal modeling: The case of end-user computing satisfaction. *Information Systems Research*, 6(1), pp. 73-81.