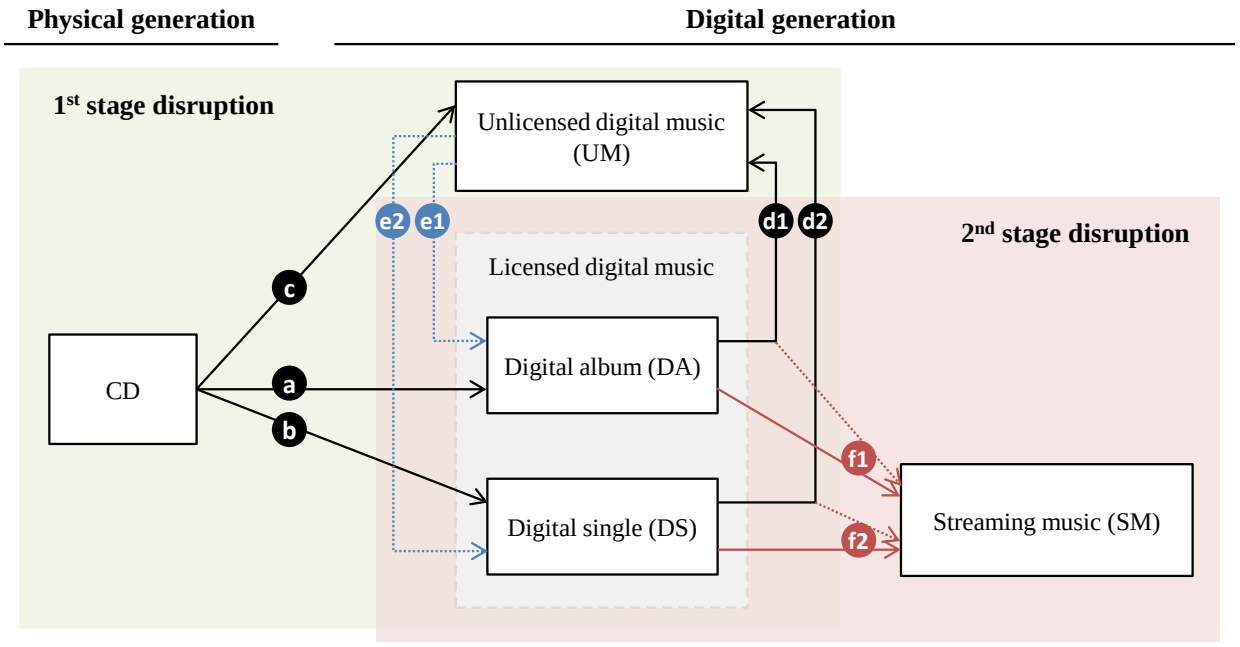
Digitization, Unbundling, Piracy, and Streaming:
Consumer Adoption amidst Disruptive Innovations in the Music Industry

A. Background and Objectives

Few industries have experienced disruptive technologies as intensively as the music industry. The Internet along with digital sound recording formats (e.g., MP3) has fundamentally changed the way music is packaged, distributed to, and consumed by consumers. Before the proliferation of the Internet, music was distributed primarily using physical media such as LP (Long Play), cassette, and later CD (Compact Disk). While the digital sound recording formats and the Internet as a distribution mechanism may seem innocuous, it has had a drastic impact on the music industry. First, it has transformed the industry from one that predominantly distributed and sold music as a bundle of songs on a physical medium to one that enabled the distribution of music as an individual song. Second, the Internet facilitates sharing of digital contents at minimal cost and provides consumers with various options to consume music without paying for it though many of those are illegal. Third, more recently, the Internet has enabled streaming of digital contents and has introduced streaming music channels such as Pandora and Spotify. Altogether, the digitization of music has created different ways music is consumed: As a *digital album*, which closely represents the existing bundle (CD); as a *digital single*, which is a consequence of unbundling; as *unlicensed digital music*, which is a product of piracy; and as *streaming music*, which is a form of re-bundling, but across a much larger number of songs and over time.



Note: a. Generation substitution; b. Unbundling; c. Attrition from CD; d1-d2. Attrition from digital album and digital single; e1-e2. Sampling effects on digital album and digital single; f1-f2. Streaming effects on digital album and digital single.

Figure 1. The first stage and the second stage disruption of digitization of music

Unlike typical migration found in many industries where a product of the successive generation replaces a product of the previous generation, the digitization of music has introduced various types of migration as illustrated in Figure 1. The demand for CD has migrated to digital album (*generation substitution*), to digital single (*unbundling*), and to unlicensed digital music (*attrition from CD*). A part of demand for digital album and digital single has migrated to unlicensed digital music (*attrition from digital album and digital single*), yet, at the same time unlicensed digital music has stimulated the demand for digital album

and digital single (*sampling effects on digital album and digital single*). Streaming music has substituted another part of the demand for digital album and digital single, and induced some part of the demand that would have migrated to unlicensed digital music in the absence of streaming music to migrate to streaming music (*streaming effects on digital album and digital single*). The factor that derives each of these migration types is unique and different. For instance, the *generation effect* has induced a part of the demand for CD to migrate to digital album, the *unbundling effect* has induced another part of the demand for CD to migrate to digital single, and the *piracy (or price) effect* has induced the remaining demand for CD to migrate to unlicensed digital music. In this proposed study, we will develop an empirical model to quantify the aforementioned types of demand migration in the music industry. By quantifying each of these migration types, we will answer the following questions: (i) What are the relative contributions of generation, unbundling, piracy, and streaming effects in the demand migration in the music industry? (ii) How do the introductions of licensed digital music and streaming music affect the piracy rate? and (iii) What are the overall impacts of unbundling, piracy, and streaming on the music industry?

B. Contributions

For the music industry, it is imperative to understand the relative contributions of each of the effects that derive demand migration in the music industry as the implications of each of these effects is rather different. While the generation, unbundling, and sampling effects have implications in terms of product design, the piracy effect has implications pertaining to piracy mitigation and conversion of non-paying consumers to paying consumers. In addition, a firmer understanding gained from examining different types of migration in the music industry will provide important implications in terms of product design and piracy to other industries that are undergoing disruptions caused by the digitization of contents and distribution channels, such as publishing, television, and movies. Our study also contributes to the literature by extending two research streams: literature on the impact of the Internet on the music industry and the literature on diffusion models.

C. Methodology

The study will be conducted in two phases. In Phase 1 (July – Dec. 2016), in addition to the data we have already collected (e.g., the sales of CD, digital album, digital single, Pandora's listener hours, piracy rate, etc.), we will collect the detailed unlicensed digital music consumption and additional streaming music consumption data. In Phase 2 (Jan. – June 2017), we will build a model and analyze the demand migration in the music industry focusing on the second stage disruption of digitization of music (i.e., the demand migration from downloadable digital music to streaming music).

For the analysis, we will take the multi-generation diffusion model approach. One of the main advantages of using the diffusion model approach (over other empirical techniques) is that the model works well with a relatively small number of observations and without decision variables such as price and advertising. Despite its advantage, the diffusion model approach has some limitations. Since the model uses aggregate market-level data, the model does not consider user heterogeneity and provides limited individual-level implications. Nonetheless, the diffusion model has been successfully applied to estimate sales in many industries, including music.

D. Pilot Study and Preliminary Results

As a pilot study, using a proxy measure for the unlicensed digital music consumption, we analyzed the first stage disruption of digitization of music (i.e., the demand migration from CD to downloadable digital music). We found that the piracy effect on the demand for CD has diminished about 15 percent every year since the music industry provided the option to legitimately "purchase" digital music (licensed digital music). In the presence of licensed digital music, the unbundling effect, not the piracy effect, is the dominant factor that derives the demand migration from physical to digital music and contributes the most to the decline in industry revenue. One unit demand for CD has migrated to 2.9 units demand for digital single, i.e., consumers bought only 2.9 songs among 12 songs bundled in a CD album.

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ACADEMIC EXPERIENCE

2012 –	Haskayne School of Business, University of Calgary, Calgary, AB. 2014 – present, Assistant Professor; 2012 – 2014, Visiting Assistant Professor
2011 – 2012	School of Business, Manhattan College, Riverdale, NY. Assistant Professor

EDUCATION

Aug. 2011	Ph.D. in Management Science. The University of Texas at Dallas, Richardson, TX.
Feb. 2005	M.S. in Management Engineering. KAIST Graduate School of Management, Seoul, Korea.
Feb. 2000	B.A. in Business Administration. Korea University, Seoul, Korea.

RESEARCH INTERESTS

The App/platform Economy, Diffusion of Information Technology, Evolution of Digital Markets, and Economics and Analytics of User Profiling.

JOURNAL PUBLICATIONS

1. Koh, B., S. Raghunathan, and B.R. Nault. Is voluntary profiling welfare enhancing? *MIS Quarterly*. Accepted. August 2015.
2. Hann, I.H., B. Koh, and M.F. Niculescu. The Double-Edged Sword of Backward Compatibility: The Adoption of Multi-Generational Platforms in the Presence of Intergenerational Services. *Information Systems Research*. 27(1), March 2016, 112-130.
3. Oh, J., B. Koh, and S. Raghunathan. Value Appropriation between the Platform Provider and App Developers in Mobile Platform Mediated Networks. *Journal of Information Technology*. 30(3), September 2015, 245-259.
4. Koh, B., B.P.S. Murthi, and S. Raghunathan. Shifting Demand: Online Music Piracy, Physical Music Sales, and Digital Music Sales. *Journal of Organizational Computing and Electronic Commerce*, 24(4), October 2014, 366-387.
5. Cavusoglu, H., B. Koh, and S. Raghunathan. Analysis of the Impact of Passenger Profiling for Transportation Security. *Operations Research*. 58(5), October 2010, 1287-1302.
6. Koh, B., and J. Oh. Determination of Revenue Streams Subject to Sharing in the Mobile Internet Market. *Review of Network Economics*. 5(3), 2006, 337-350.

WORK IN PROGRESS

1. The Economics of Backward Compatibility.
2. Is Big Data the Signal or the Noise? An Application to Mammogram Screening.
3. Digitization, Unbundling, and Piracy: Consumer Adoption amidst Disruptive Innovations in the Music Industry. With Il-Horn Hann and Srinivasan Raghunathan.
4. An Empirical Examination of Consumers' Voluntary Participation in Profiling. With Srinivasan Raghunathan.
5. Information Technology Investment and the Structure of Production. With Fengmei Gong and Barrie R. Nault.
6. The Impact of IT on the Relative Productivity of Transaction and Production Labor. With Kunsoo Han and Barrie R. Nault.
7. Vertically Differentiated Information Goods: Monopoly Power through Versioning. With Xueqi (David) Wei and Barrie R. Nault.

OTHER PUBLICATIONS

1. Hann, I.H., S. Viswanathan, and B. Koh. The Facebook App Economy. *University of Maryland, Center for Digital Innovation, Technology and Strategy (DIGITS), Research Report*. September 2011.
2. Koh, B., H. Song, Y. Ryu, S. Lee, and D. Kim. Effects of Regulation against Unlicensed Contents Sharing on the Contents Producers' Profit. *The Journal of the Korea Contents Association*. 10(2), February 2010, 320-329. (in Korean).
3. Oh, J. and B. Koh. IT outsourcing success factors and strategies. *Entrue Journal of Information Technology*, 4(2), 2005, 45-57. (in Korean).

CONFERENCE PRESENTATION

1. Has the Structure of Production Changed with IT?. *POMS Annual Conference*. Orlando, FL. May 6 – 9, 2016. (Scheduled; will be presented by co-author).
2. The Impact of IT on the Production Structure. *INFOMRS Annual Meeting*. San Francisco, CA. November 9 – 12, 2014. (Presented by co-author).
3. Digitization, Unbundling, and Piracy: Consumer Adoption amidst Disruptive Innovations in the Music Industry. *Conference on Information Systems and Technology (CIST)*. San Francisco, CA. November 8 – 9, 2014.
4. The Adoption of Multi-Generational Platforms in the Presence of Intergenerational Services. *Platform Strategy Research Symposium*. Boston University, Boston, MA. July 24, 2014.
5. Is Voluntary Profiling Welfare Enhancing? *Theory in Economics of Information Systems (TEIS)*, Banff, AB. March 21 – 24, 2014.
6. Digitization, Unbundling, and Piracy: Consumer Adoption amidst Disruptive Innovations in the Music Industry. *Workshop on Information Systems and Economics (WISE)*. Bocconi University, Milan, Italy. December 19 – 20, 2013.
7. The Adoption of Multi-generational Platform in the Presence of Intergenerational Services. *Conference on Information Systems and Technology (CIST)*. Minneapolis, MN. October 5 – 6, 2013.
8. Giving the Old Platform a New Lease on Life: The Unintended Effect of Backward Compatibility on Platform Adoption Decisions. *Workshop on Information Systems and Economics (WISE)*. Orlando, FL. December 15 – 16, 2012.

9. The Impact of Profiling Policy in Online Markets. *LG CNS / KrAIS Post-ICIS workshop*. St. Louis, MO. December 15, 2010.
10. Shift in Demand for Music: Causal Effect of Online File Sharing and Digital Music on Album Sales. *Workshop on Information Systems and Economics (WISE)*. Washington University in St. Louis, St. Louis, MO. December 11 – 12, 2010
11. An Analysis of Voluntary Profiling in Online Markets. *INFORMS Annual Meeting*. Austin, TX. November 7 – 10, 2010.
12. International Conference on Information Systems (ICIS) Doctoral Consortium. Phoenix, AZ. December 11 – 14, 2009.
13. A Modified Apex Game and its Application. *CORS-INFORMS International meeting*. Toronto, ON. June 14 – 17, 2009. (Presented by co-author).
14. Analysis of Profiling Policy. *BIG XII + MIS Research Symposium*. University of Nebraska-Lincoln, Lincoln, NE. April 4 – 5, 2009.
15. Analysis of the Impact of User Profiling for Security: Who Really Benefits from Profiling?. *Workshop on Secure Knowledge Management (SKM)*. University of Texas at Dallas, Richardson, TX. November 3-4, 2008.
16. A Framework for Deploying SLA utilizing Six Sigma. *The Conference of Korea Society of System Integration*. Seoul, Korea. November 23, 2005. (Best Paper Award).

INVITED TALKS

1. Digitization, Unbundling, and Piracy: Consumer Adoption amidst Disruptive Innovations in the Music Industry. *University of South Florida*, Tampa, FL. March 28, 2016.
2. Digitization, Unbundling, and Piracy: Consumer Adoption amidst Disruptive Innovations in the Music Industry. *Stevens Institute of Technology*, Hoboken, NJ. March 16, 2016.
3. The Adoption of Multi-Generational Platforms in the Presence of Intergenerational Services. *University of Calgary*, Calgary, AB. January 8, 2014.
4. Privacy, Price Discrimination and Voluntary Profiling in Online Markets. *Seoul National University*, Seoul, Korea. June 12, 2013.
5. The Lifecycle of Multi-Generation Platforms: Backward Compatibility and Lease on Life. *University of Calgary*, Calgary, AB. April 27, 2012.
6. The Lifecycle of Multi-Generation Platforms: Backward Compatibility and Lease on Life. *University of British Columbia*, Vancouver, BC. March 26, 2012.

RESEARCH GRANTS & FELLOWSHIP

April 2016	SSHRC Insight Grant.
July 2012	NET Institute Research Grant.
December 2010	University of Texas at Dallas, Research Small Grants.
2006 – 2011	University of Texas at Dallas, School of Management, Fellowship.
2003 – 2005	KAIST Graduate School of Management, Fellowship.
Fall 1999	Korea University, Scholarship.

TEACHING EXPERIENCE

University of Calgary

MGIS 317 Management Information Systems. Fall 2012, Winter & Fall 2014, Fall 2015.

MGIS 461 Telecommunication. Fall 2012.
MGIS 467 e-Business. Winter & Fall 2013, Fall 2014, Fall 2015.

Manhattan College

MGMT 307 Operation and Quality Management. Fall 2011, Spring 2012.
MGMT 406 Business Strategy. Fall 2011, Spring 2012.

University of Texas at Dallas

BA 3351 Introduction to Management Information Systems. Summer 2009, Spring 2010.

INDUSTRY WORK EXPERIENCE

2005 – 2006	PricewaterhouseCoopers (PwC), Seoul, Korea. Advisory Service, Associate Consultant.
2005	Korea Information Strategy Development Institute (KISDI), Seoul, Korea. Telecommunications and Broadcasting Division, Full-time researcher.
2004	KTF, Seoul, Korea, Part-time researcher.
2003 – 2004	Metanet Outsourcing, Seoul, Korea, Part-time researcher.
2000 – 2002	DaeYang E&C, Seoul, Korea. Management Planning Department, Staff.

ACADEMIC SERVICE

Conference Program Committee:

INFORMS Conference on Information Systems and Technology (CIST) 2013 – 2015.

Conference Session Chair:

INFORMS Conference on Information Systems and Technology (CIST) 2013, 2015, INFORMS Annual Meeting 2014.

Conference Cluster Chair:

Canadian Operational Research Society (CORS) annual conference eBusiness cluster 2016.

Workshop Program/Paper Review Committee:

Post-ICIS LG CNS / KrAIS Workshop 2013 – 2015.

Conference Discussant:

Workshop on Information Systems and Economics (WISE) 2013, 2015, Theory in Economics of Information Systems (TEIS) Workshop 2013.

Conference Associate Editor:

International Conference on Information Systems (ICIS) 2016, European Conference on Information Systems (ECIS) 2015, 2016.

Journal Associate Editor:

Business & Information Systems Engineering (Economics and Value of IS special issue), Information Technology & Management (Ad-hoc).

Ad-hoc Reviewer:

Management Science, Information Systems Research, MIS Quarterly, Production and Operations Management, Decision Science, Information Technology and Management, International Journal of Web Services Research, Journal of Electronic Commerce Research, Electronic Commerce Research and Applications, Asia Pacific Journal of Information Systems, Korea Society of IT Service Journal, International Conference on Information Systems (ICIS) 2009 – 2013, Pacific

Asia Conference on Information Systems (PACIS) 2013, Workshop on Information Technologies and Systems (WITS) 2010, 2012, IEEE International Conference on Web Services 2010, 2011.

STUDENT SUPERVISION

Doctoral Committee member:

Fengmei Gong, Haskayne School of Business, Management Information Systems. Winter 2015.

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Sukhpreet Kaur Dhaliwal, Computer Science. Winter 2015.
Trong Tan Ho, Computer Science. Fall 2014.

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Associate Professor
Robert H. Smith School of Business
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EDUCATION

2000	Ph.D., Operations and Information Management, The Wharton School, University of Pennsylvania "Competition in Electronic Markets" (Eric Clemons, Paul Kleindorfer, David Reibstein, Lorin Hitt, David Croson)
1994	Diplom, Computer Science and Business Administration, Technical University Darmstadt, Darmstadt, Germany

FORMER POSITIONS AND PRESENT POSITIONS

2008 –	Associate Professor, Robert H. Smith School, University of Maryland
	Co-Director for the Center of Digital Innovation, Technology, and Strategy
2002 – 2008	Assistant Professor, Marshall School of Business, University of Southern California
2000 – 2002	Assistant Professor, GSIA, Carnegie Mellon University

PUBLICATIONS

Articles in refereed journals

1. Hann, I.H. and J.H. Oh, "Demand and Supply-side Dynamics of Piracy Propagation in P2P Networks," *INFORMS Journal on Computing*, forthcoming.
2. Qiu, Y., Gopal, A., and Hann, I.H., "Synthesizing Professional and Market Logics: A Study of iOS App Entrepreneurs," *Information Systems Research*, conditionally accepted.
3. Hann, I.H., Niculescu, M.F., and Koh, B., "The Adoption of Multi-Generational Platforms in the Presence of Intergenerational Services," *Information Systems Research*, forthcoming.
4. Wang, A.C., Zhang, M. and Hann, I.H., "Social Bias in Online Product Ratings: A Quasi-Experiment," *Information Systems Research*, forthcoming.
5. Hinz, O., Spann, M., and Hann, I.H., "Can't Buy Me Love, or Can I? Social Capital Attainment Through Conspicuous Consumption," *Information Systems Research*, Vol. 26, No. 4, September 2015, pp. 859 – 870.
6. Hann, I.H., Roberts, J., Slaughter, S. and Fielding, R., "What is the Economic Value of Volunteering in Open Source Software Communities: An Empirical Analysis of the Apache Projects," *Information Systems Research*, Vol. 24, No. 3, September 2013, pp. 520-538.
7. Hinz, O., Hann, I.H., and Spann, M., "Price Discrimination in E-Commerce? An Examination of Dynamic Pricing in Name-Your-Own-Price Markets," *MIS Quarterly*, Vol. 35, No. 1, June 2011.
8. Abbas, A. and Hann, I.H., "Measuring Risk Aversion in a Name-Your-Own-Price Channel," *Decision Analysis*, Vol. 7, No. 1, March 2010, pp. 123-136.
9. Hann, I. H., Hui, K.L., Lee, T., and Png, I., "Consumer Privacy and Marketing Avoidance: A Static Model," *Management Science*, Vol. 54, No. 6, June 2008, pp. 1094-1103.
10. Hann, I. H., Hui, K.L., Lee, T., and Png, I., "Overcoming Information Privacy Concerns: An Information Processing Theory Approach," *Journal of Management Information Systems*, Vol. 24, No. 2, pp. 13–42, Fall 2007.

11. Hann, I. H., Hui, K.L., Lai, Y.L., Lee, T., and Png, I., "Who Gets Spammed?" *Communication of the ACM*, Vol. 49, No. 10, October 2006.
12. Roberts, J., Hann, I.H. and Slaughter, S., "Understanding the Motivations, Participation, and Performance of Open Source Software Developers: A Longitudinal Study of the Apache Projects," *Management Science*, Vol. 52, No 7, July 2006.
13. Terwiesch, C., Savin, S., and Hann, I.H., "Online Haggling at a Name-Your-Own Price Retailer: Theory and Application," *Management Science*, Vol. 51, No. 3, March 2005.
14. Hann, I.H. and Terwiesch, C., "Measuring the Frictional Costs of Online Transactions: The Case of a Name-Your-Own-Price-Channel," *Management Science*, Vol. 49, No. 11, November 2003.
15. Clemons, E.K., Hann, I.H., and Hitt, L., "Price Dispersion and Differentiation in Online Travel: An Empirical Investigation," *Management Science*, Vol. 48, No. 4, April 2002.
16. Clemons, E.K., Hann, I.H., "Rosenbluth International: Strategic Transformation of a Successful Enterprise," *Journal of Management Information Systems*, Vol. 16, No. 2, Fall 1999.

Book chapters

1. Roberts, J., Hann, I.H., and Slaughter, S., "Communication Networks in an Open Source Software Project," in Open Source Systems, eds. E. Damiani, B. Fitzgerald, W. Scacchi, M. Scotto, and G. Succi, Springer-Verlag, New York, 2006, pp. 297-306.

Articles in conference proceedings

1. Qiu, Y., Hann, I.H., and Gopal, A., "From invisible hand to visible hand: platform governance and institutional logic of independent Mac developers, 2001-2012," Academy of Management Conference, Philadelphia, PA, August 2014.
2. Hann, I.H., Koh, B., and Niculescu, M. "The Adoption of Multi-Generational Platforms in the Presence of Intergenerational Services," Platform Strategy Research Symposium, Boston University, July 2014.
3. Qiu, Y., Hann, I.H., and Gopal, A., "From invisible hand to visible hand: platform governance and institutional logic of independent Mac developers, 2001-2012," 34th International Conference on Information Systems, General IS Topics Track, Milan, Italy, December 2013.
4. Qiu, Y., Gopal, A., and Hann, I.H., "Synthesizing Professional and Market Logics: A Study of Independent iOS App Entrepreneurs," 32nd International Conference on Information Systems, Break-through Ideas Track, Shanghai, China, December 2011.
5. Ye, S., Hann, I.H., and Viswanathan, S.. "Truck, Barter, and Exchange: An Empirical Investigation of Reciprocity in Online P2P Barter Markets," 32nd International Conference on Information Systems, Shanghai, China, December 2011.
6. Hinz, O., Spann, M., and Hann, I.H., "Prestige Goods and Social Status in Virtual Worlds," Paper 190. In: Proceedings of the 31st International Conference on Information Systems, Completed Research Track, St. Louis, MO, December 2010.
7. Hinz, O., Hann, I.H., and Spann, M., "The Validity of Decision Making in Virtual Worlds: An Experimental Test of Altruism, Fairness, and Presence," 18th European Conference on Information Systems (ECIS), Pretoria, South Africa, June 2010.
8. Hann, I. H., Hui, K.L., Lee, T., and Png, I., "Analyzing Information Privacy Concerns: An Information Processing Theory Approach," Proceedings of the 40th Hawaii International Conference on System Sciences (HICSS), Hawaii, January 2007.
9. Hann, I.H., Roberts, J. and , Slaughter, S., "Why Developers Participate in Open Source Software Projects: An Empirical Investigation," Proceedings of the 25th International Conference on Information Systems, Completed Research Track, Washington, D.C., December 2004.

10. Hann, I.H., Roberts, J., Slaughter, S. and Fielding, R., "Economics of Open Source Software: Can Project Participation Be Explained by Career Concerns?" In: Proceedings of the 23rd International Conference on Information Systems, Completed Research Track, Barcelona, December 2002.
11. Hann, I. H., Hui, K.L., Lee, T., and Png, I., "Online Information Privacy: Measuring the Cost-Benefit Trade-off," In: Proceedings of the 23rd International Conference on Information Systems, Completed Research Track, Barcelona, December 2002.
12. Hann, I.H., Roberts, J., Slaughter, S., and Fielding, R., "Why Do Developers Contribute to Open Source Projects: First Economic Evidence," In: Proceedings of the Meeting Challenges and Surviving Success: 2nd Workshop on Open Source Software Engineering, International Conference on Software Engineering, Orlando, May 2002.
13. Clemons, E. and Hann, I.H., "Rosenbluth International: Strategic Transformation of a Successful Enterprise," Proceedings of the 32nd Hawaii International Conference on System Sciences (HICSS), January 1999.

NON-PUBLISHED PAPERS

Completed working papers

1. Kim, K. and Hann, I.H., "Democratizing Access to Capital: Credit Availability, Internet Connectivity, and Crowdfunding," Status: under review at *Information Systems Research, 1st round*.
2. Ye, S., Viswanathan, S., Hann, I.H., "The Value of Reciprocity in Online Barter Markets: An Empirical Investigation," Working Paper, January 1, 2016.
3. Al-Hasan, A., Hann, I.H., Viswanathan, S., "Information Spillover and Strategic Behaviors in Open Innovation Crowdsourcing Contests: An Empirical Investigation," Working Paper, March 2014.
4. Hann, I.H., Roberts, J., and Slaughter, S., "Motivation of Open Source Software Contributors," Working Paper, April 2013.
5. Hann, I.H. and Oh, J.H., "From Piracy to Business Intelligence: A Functional Data Analysis of P2P Traffic," Draft, March 2013.

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PROFESSIONAL EXPERIENCE

1999 – Present	Assistant/Associate/Full Professor, University of Texas at Dallas, School of Management
2007 – 2014	Area Coordinator for Information Systems, UT-Dallas
2004 – 2005	Visiting Professor, Dept. of Management Studies, The Indian Institute of Technology, Madras, India
1997 - 1998	Visiting Fellow, School of Computing, National University of Singapore, Singapore
1990 - 1999	Assistant and Associate Professor, Bowling Green State University, Dept. of Accounting and MIS
1989-1990	Teaching Fellow, Katz Graduate School of Business, University of Pittsburgh
1986	Systems Executive, National Institute of Information Technology, Madras, India

EDUCATION

1986 - 1990	Ph. D. in Business Administration Joseph M Katz Graduate School of Business University of Pittsburgh, Pittsburgh
1984 - 1986	Post Graduate Diploma in Management Indian Institute of Management, Calcutta, India
1979 - 1984	Bachelor of Technology (Electrical Engineering) Indian Institute of Technology, Madras, India

RESEARCH

RESEARCH INTERESTS

Economics of Information Security, Online Reviews, Recommendation Systems, IT in Supply Chains/Networks

REFEREED JOURNAL PUBLICATIONS

51. Kwark, Y., J. Chen, and S. Raghunathan. Platform or Wholesale? A Strategic Tool for Online Retailers to Benefit from Product Reviews, ***MIS Quarterly***, Accepted in March 2016.

50. Cezar, A. H. Cavusoglu, and S. Raghunathan. Sourcing Information Security Operations: The Role of Risk Interdependency and Competitive Externality on Outsourcing Decisions, ***Production and Operations Management***, Accepted in March 2016.

49. Koh, B., S. Raghunathan, and B. Nault. Is Voluntary Profiling Welfare Enhancing?, ***MIS Quarterly***, Accepted in August 2015.

48. Lee, C. H., X Geng and S. Raghunathan. Mandatory Security Standards and Organizational Information Security, ***Information Systems Research***, Accepted in August 2015.

47. Raghunathan, S., S. Sarkar. Competitive Bundling in Information Markets: A Seller-Side Analysis. ***MIS Quarterly***, Accepted in July 2015.

46. Koh, B., J. Oh, S. Raghunathan. The Value Appropriation between the Platform Provider and App Developers in the Mobile Platform Mediated Network. ***Journal of Information Technology***, Vol. 30, August 2015. 245-259.

45. Koh., B. B.P.S. Murthi, S. Raghunathan. Note on Shift in Demand for Music: Online Music Piracy, Physical Music, and Digital Music Sales. ***Journal of Organizational Computing and Electronic Commerce***, October 2014.

44. Li, X. S. Raghunathan. Pricing and Disseminating Customer Data with Privacy Awareness. ***Decision Support Systems***, Vol. 59. March 2014. 63-73.

43. Kwark, Y., J. Chen., S. Raghunathan. Online Product Reviews: Implications for Retailers and Competing Manufacturers, ***Information Systems Research***, March 2014. 93-110

42. Ganesh, M., C. Rajendran, S. Raghunathan. Distribution and Equitable Sharing of Value From Collaborative Planning, Forecasting, and Replenishment Across Supply Chain Firms, ***IEEE Transactions on Engineering Management***, Vol. 61, May 2014, 225-236.

41. Cezar, A., H. Cavusoglu, S. Raghunathan. Information Security Outsourcing: Contracting Issues and Security Implications, ***Management Science***, Vol. 60, 3, March 2014, 638-657.

40. Ganesh, M., C. Rajendran, S. Raghunathan. The Value of Information Sharing in a Multi-Product, Multi-Level Supply Chain: Impact of Product Substitution, Demand Correlation, and Partial Information Sharing, ***Decision Support Systems***, Vol. 58, Feb. 2014, pp. 79-94.

39. Cavusoglu, H., B. Mai., S. Raghunathan, Y. Kwark. Passenger Profiling in the Presence of Strategic Attackers, ***INFORMS Journal on Decision Analysis***, Mar. 2013, pp. 65-81.

38. Lee, C., X. Geng, S. Raghunathan. Contracting Information Security in the Presence of Double Moral Hazard, ***Information Systems Research***, June 2013, pp. 295-311.

37. Mishra, B. S. Raghunathan. Information Sharing in a Supply Chain with Horizontal Competition: The Case of Discount Based Incentive Scheme Contracting Information Security in the Presence of Double Moral Hazard, ***Theoretical Economic Letters***, Nov. 2012, pp. 373-378.

36. Cavusoglu, H., H. Cavusoglu, S. Raghunathan. Value of and Interaction between Production Postponement and Information Sharing Strategies for Supply Chain Firms, ***Production and Operations Management,*** Vol. 21, Issue 3, May/June 2012, pp. 470-488.

35. Menon, N., H. Ogut, S. Raghunathan, Cyber Security Risk Management: Public Policy Implications of Correlated Risk and Imperfect Ability to Prove Loss, ***Risk Analysis***, Vol. 31, No. 3, March 2011, 497-512.

34. Cavusoglu, K., B. Koh, S. Raghunathan, An Analysis of the Impact of Passenger Profiling for Transportation Security, ***Operations Research***, Vol. 58, No. 5, Sep/Oct 2010, 1287-1302.

33. Bandhopadhyay, T., V. Jacob, S. Raghunathan. Information Security in Networked Supply Chains: Impact of Network Vulnerability and Supply Chain Integration on Incentives to Invest, ***Information Technology and Management***, Vol. 11, No. 1, March 2010, 7-23.

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7. Raghunathan, S., A Structured Modeling Based Methodology to Design Decision Support Systems, ***Decision Support Systems***, October, 1995

6. Raghunathan, S., R. Krishnan, and J. May, On Using Belief Maintenance Systems to Assist Mathematical Modeling, ***IEEE Transactions on Systems, Man, and Cybernetics***, February, 1995

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REFEREED CONFERENCE PROCEEDINGS/PRESENTATIONS

Ayvaci, M., Cavusoglu, H., Raghunathan, S., Incentivizing Health Information Exchange Adoption through Alternative Payment Models, ***Workshop on Information Systems Economics (WISE)***, Dallas, Dec. 2015.

Li, L., Chen, J., Raghunathan, S., Impact of Recommender Systems on Product Advertising and Price Competition in Electronic Marketplaces, ***Workshop on Information Systems Economics (WISE)***, Dallas, Dec. 2015.

Li, L., Chen, J., Raghunathan, S., Recommender Systems Rethink: Implications for an Electronic Marketplace with Competing Manufacturers, ***International Symposium on Information Systems***, Hyderabad, Jan. 2015.

Li, L., Chen, J., Raghunathan, S., Recommender Systems Rethink: Implications for an Electronic Marketplace with Competing Manufacturers, ***Workshop on Information Systems Economics (WISE)***, Auckland, Dec. 2014.

Koh, B., Hann. I. H., Raghunathan, S., Digitization, Unbundling, and Piracy: Consumer Adoption amidst Disruptive Innovations in the Music Industry**,** ***Conference on Information Systems and Technology (CIST***), San Francisco, 2014.

Byungwan Koh, Il-Horn Hann and Srinivasan Raghunathan. Creative Destruction in the Music Industry: The Impact of Digital Music on Music Sales. ***Workshop on Information Systems Economics (WISE)***, Milan, Dec. 2013.

Kwark, Y., Chen, J., Raghunathan, S. User-Generated Content and Product design of Competing Firms. ***Conference on Systems and Technology***, Minneapolis, Oct. 2013. **Nominated for the Best Paper Award**

Kwark, Y., Chen, J., Raghunathan, S. Platform or Wholesale: A Strategic Tool for Online Retailers to Benefit from Reviews, ***International Symposium on Information Systems***, Goa, Jan. 2013.

Geng, X.. Lee, C. H. Raghunathan S. Mandatory Security Standards and Organizational Information Security ***Workshop on Information Systems Economics (WISE)***, Orlando, FL, Dec. 2012.

Kwark, Y., Chen, J., Raghunathan, S. Platform or Wholesale: Different Effects on Retailers of Online Product Reviews. ***International Conference on Information Systems***, Dec. 2012

Kwark, Y., Chen, J., Raghunathan, S. Online Product Reviews: Implications for Retailers and Competing Manufacturers. ***Conference on Information Systems and Technology***, Phoenix, AZ, Oct. 2012

Geng, X.. Lee, C. H. Raghunathan S. Security Standardization in the Presence of Unverifiable Control. ***Workshop on Economics of Information Security (WEIS)***, Fairfax, VA, June 2011.

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Koh, Byungwan. Murthy, B. P. S. Raghunathan S. Shift in Demand for Music: Causal Effect of Online Music Piracy and Digital Music on Album Sales. ***Workshop on Information Systems Economics (WISE) 2010***

Asunur, C. Cavusoglu, H. Raghunathan, S. Information Security Outsourcing Contracts and Implications. ***Workshop on Economics of Information Security (WEIS)***, Cambridge, MA, June 2010.

Hao, J., S. Menon, S. Raghunathan, S. Sarkar. A Comparison of RBB and RBR Mechanisms in Sponsored Search, ***Workshop on Information Technology and Systems (WITS) 2009***

Hao, J., S. Menon, S. Raghunathan, S. Sarkar. A Comparison of RBB and RBR Mechanisms in Sponsored Search, ***Conference on Information Systems and Technology (CIST)***, San Diego, 2009.

Li, X, S. Raghunathan**.** Incentive-Compatible Mechanism for Disseminating and Sharing Sensitive Data, ***Workshop on Information Technology and Systems (WITS) 2008***

Li, X, S. Raghunathan**.** Incentive-Compatible Mechanism for Sensitive Data, ***Workshop on Information Systems Economics (WISE) 2008***

Asunur, C., Cavusoglu, H., S. Raghunathan, Impact of Competition on Firms' Decisions to Outsource IT Security, ***The Secure Knowledge Management Workshop (SKM)***, Dallas, 2008

Asunur, C., S. Raghunathan, S. Sarkar. A Bayesian Decision Model in the Existence of faking, Proceedings of the ***Workshop on Information Technology and Systems (WITS) 2007***

Ganesh, M., C Rajendran, S. Raghunathan, The Value of Information Sharing in a Multi-Product Supply Chain with Product Substitution, ***POMS Conference***, Dallas, May 2007.

Cavusoglu, H., B. Mishra, S. Raghunathan, Configuration of Intrusion Detection Systems, ***The Secure Knowledge Management Workshop (SKM),*** Brooklyn, NY, September, 2006,
Won the Best Paper Award.

Cavusoglu, H., S. Raghunathan, and H. Cavusoglu, How do Security Technologies Interact with Each Other to Create Value: The Analysis of Firewall and Intrusion Detection System, ***Workshop on Information Systems and Economics (WISE)***, Irvine, CA, December 2005.

Cavusoglu, H., H. Cavusoglu, S. Raghunathan, Recent Issues in Responsible Vulnerability Disclosure, ***Workshop on Economics of Information Security (WEIS)***, Boston, MA, June 2005.

Bandhopadhyay, T., V. Jacob, and S. Raghunathan, Security Investment Strategies for Supply Chain Partnering Firms: Effects of Physical Connectivity and Shared Information Assets. Proceedings of the ***Workshop on Information Technology and Systems (WITS) 2004***

Cavusoglu, H., H. Cavusoglu, and S. Raghunathan, How to Disclose Software Security Vulnerabilities Responsibly? Proceedings of the ***Workshop on Information Technology and Systems (WITS) 2004***, **Nominated for the Best Paper Award**.

Cavusoglu, H. and S. Raghunathan, Configuration of Intrusion Detection Systems: Decision and Game Theoretic Approaches, ***Proceedings of ICIS,*** 2003, **Nominated for the Best Paper Award**.

Ogut, H., H. Cavusoglu, and S. Raghunathan, Intrusion Detection Policies for IT Security Breaches, ***Workshop on Information Technology and Systems (WITS) 2003***, **Received the Best Paper Award**.

Cavusoglu, H., B. Mishra, and S. Raghunathan, Effective Design of IT Security Architecture, ***Proceedings of the Second Annual Conference on the Economics of IT Security 2003***.

Cavusoglu, H., B. Mishra, and S. Raghunathan, Optimal Design of Information Technology (IT) Security Architecture, ***Proceedings of ICIS***, 2002.

Demirhan, D., V. Jacob, and S. Raghunathan, Strategic IT Investments: Impact of Switching Cost and Declining Technology Cost, ***Proceedings of ICIS***, 2002.

Mishra, B., A. Prasad, and S. Raghunathan, Quality and Profits under Open Source versus Closed Source, ***Proceedings of ICIS***, 2002.

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S. Raghunathan, Toward Computer-Assisted Qualitative Analysis for Model Development: Theory and Algorithms, ***Proceedings of HICSS-25***,1992.

PAPERS UNDER REVIEW

User-Generated Content and Product Design of Competing Firms ***Management Science***, Under Second Round of Reviews, (with Young Kwark and Jianqing Chen)

Digitization, Unbundling, and Piracy: Consumer Adoption amidst Disruptive Innovations in the Music Industry ***Management Science***, Under Second of Reviews, (with Byungwan Koh and Il Horn Hann)

Recommender Systems Rethink: Implications for an Electronic Marketplace with Competing Manufacturers ***Information Systems Research,*** To be Submitted for Second Round of Reviews (with Lusi Li and Jianqing Chen)

Timing the Use of Breast Cancer Risk Information in Biopsy Decision Making, ***Production and Operations Management***, To be Submitted for Second Round of Reviews, (with Mehmet Ayvaci, Mehmet Ahsen and Z Gharibi)

Role of Payment Mechanisms in the Value and Adoption of Health-Information Exchanges (HIEs), ***Management Science***, Under First Round of Reviews, (with Mehmet Ayvaci and Huseyin Cavusoglu)

Bullwhip Effect Arising from a Multi-Product Firm with Interdependent Demands and Correlated Forecasting Errors, ***Operations Research***, Under First Round of Reviews, (with Xiaohang Yue and Chris Tang)

WORK-IN-PROGRESS

Impact of Faking in Adversarial Classification Contexts (with Asunur Cezar and Sumit Sarkar)

Optimal Aggregation and Classification under Anchoring Bias and an Application to Mammography (with Mehmet Ayvaci and Mehmet Ahsen)

Impact of Recommender Systems on Product Advertising and Price Competition in Electronic Marketplaces (with Lusi Li and Jianqing Chen)

Competitive Mobile Marketing and its Impact on the Mobile Eco System (with Asunur Cezar)

Deliberate Vagueness in Healthcare Guidelines (with Mehmet Ayvaci and Yeongin Kim)

Ph.D. STUDENTS SUPERVISED

Yeongin Kim, in progress

Lusi Li, in progress

Young Kwark, Graduated in Fall 2013, Placement: The University of Florida, Gainesville

Chul Ho Lee, Graduated in Summer 2012, Placement: Xavier University, Cincinnari

Byungwan Koh, Graduated in Summer 2011, Placement: Manhattan College, New York

Asunur Cezar, Graduated in Summer 2009, Initial Placement: Middle East Technical University, Cypress.

Hulusi Ogut, Graduated in Summer 2006, Initial Placement: Tobb University of Economics and Technology

Huseyin Cavusoglu, Graduated in Summer 2003, Initial Placement: Tulane University

Didem Demirhan, Graduated in Fall 2002, Initial Placement: University of Nevada at Las Vegas

TEACHING

COURSES

Ph.D.: Seminar in Information Systems

Graduate: IS Auditing, Control, and Security, Database Management, Systems Analysis, Design, and Project Management

Undergraduate: Accounting Information Systems, Client/Server Systems Development, Artificial Intelligence, Decision Support and Expert Systems, IS Auditing, Control, and Security, Database Management, Systems Analysis and Design, Introduction to MIS

Good to Excellent teaching evaluations; Nominated for the outstanding graduate faculty award by the MBA association during 1997. (BGSU)

CURRICULUM DEVELOPMENT

Revamped the MS in Information Technology and Management degree program, UT Dallas

Revamped the core undergraduate introduction to MIS course, UT Dallas

Developed and introduced certification programs in Business Intelligence, Enterprise Systems, and Health IT, UT Dallas

Developed and introduced a new undergraduate specialization "Information Systems Audit and Control" in 1997.

Developed and introduced the Accounting Information Systems track in the Master of Accountancy program. (BSGU)

Introduced new courses in Client/Server Application Development, and IS Auditing and Control at the undergraduate and graduate levels. (BGSU)

Restructured the MBA program to include integrated core courses, flexibility in elective courses, and unique culminating experiences. (BGSU)

UNIVERSITY SERVICE ACTIVITIES

Served as the area coordinator for the information systems area (2007 – 2014)

> Primary accomplishment include increasing the graduate enrollment from 120 to 800, increasing the undergraduate enrollment from 100 to 400, introduction of several certificate programs, restructuring of graduate and undergraduate programs, setting up an industry advisory board, organizing the first MIS department chairs' conference, and developing and launching the MS in Business Analytics degree program.

Served on various committees including tenure/promotion review, teaching, faculty recruitment, faculty senate, and others both at UT Dallas and BGSU

PROFESSIONAL SERVICE

Senior Editor, Journal of Electronic Commerce Research (August 2013 – Present)
Guest Associate Editor, MIS Quarterly, 2013
Associate Editor, Information Systems Research (2005- 2008)
Guest Associate Editor, Management Science (2005 - 2008)
Associate Editor, Information Technology and Management (2005 - Present)

Program Committee Member, WITS 2009-2015
Program Committee Member, IT Conference, ISB, Hyderabad, India, 2006-2012
Program Committee Member, ICIS 2001
Program Committee Member, CIST INFORMS Meeting, 2001, 2011-2015

PROFESSIONAL HONORS AND AWARDS

NET Institute Award, New York University, 2013

Finalist for Best Paper Award, CIST 2013

Invited Panel Member, President's Cyberspace Policy Review: Cyber Insurance Market Panel, March 2010.

SAP Certified Associate, 2009

Best Paper Award, The Secure Knowledge Management Workshop (SKM) 2006

Finalist for Best Paper Award, WITS 2004

Best Paper Award, WITS 2003

Finalist for Best Paper Award, ICIS 2003

Finalist, Outstanding Graduate Faculty award, Bowling Green State University, 1997.

Good International Business Scholar Award, College of Business Administration, Bowling Green State University, 1997.

Robert A Patton Scholarly Achievement Award, Bowling Green State University, 1994.