

# Ruodu Wang, Ph.D.

Curriculum Vitae

University Research Chair & Associate Professor  
Department of Statistics and Actuarial Science  
University of Waterloo  
Mathematics 3, 200 University Avenue West  
Waterloo, Ontario, Canada N2L 3G1

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Website: <http://sas.uwaterloo.ca/~wang>

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## Employment

University Research Chair, University of Waterloo	2018.07 - present
Associate Professor of Actuarial Science (tenured), University of Waterloo	2017.07 - present
Assistant Professor of Actuarial Science, University of Waterloo	2012.08 - 2017.06

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## Education

Ph.D. Mathematics, Georgia Institute of Technology. Advisor: Liang Peng	2012.05
M.S. Financial Mathematics, Peking University. Advisor: Jingping Yang	2009.06
B.S. Mathematics, Peking University	2006.06

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## Research Areas

Probability · Statistics · Quantitative Risk Management  
Actuarial Science · Financial Engineering · Operations Research

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## Editorial Duties

Co-Editor, <i>ASTIN Bulletin - The Journal of the International Actuarial Association</i>	2018 - present
Co-Editor, <i>European Actuarial Journal</i>	2016 - present
Associate Editor, <i>Acta Mathematicae Applicatae Sinica (English Series)</i>	2016 - present
Member of the Editorial Advisory Board, <i>Dependence Modeling</i>	2014 - present

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## Research Grants

The Society of Actuaries CAE Research Grant (one of many Co-PIs)	2018 - 2021
NSERC Discovery Accelerator Supplement (RGPAS-2018-522590, PI)	2018 - 2021
NSERC Discovery Grant (RGPIN-2018-03823, PI)	2018 - 2023
International Research Partnership Grant, University of Waterloo (Co-PI)	2016 - 2018
NSERC Discovery Grant (RGPIN-435844-2013, PI)	2013 - 2018

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## Visiting Positions (> 1 month)

Risklab, Department of Mathematics, ETH Zurich	2018.05 - 2018.06
Risklab, Department of Mathematics, ETH Zurich	2017.04 - 2017.07
Institute of Applied Mathematics, Chinese Academy of Sciences	2016.07 - 2016.08
School of Mathematical Sciences, Peking University	2016.03 - 2016.04
Risklab, Department of Mathematics, ETH Zurich	2015.08 - 2015.12
China Institute for Actuarial Science, Central University of Finance and Economics	2014.07 - 2014.08
Risklab, Department of Mathematics, ETH Zurich	2013.09 - 2013.11
School of Mathematical Sciences, Peking University	2013.06 - 2013.07
School of Mathematical Sciences, Peking University	2012.06 - 2012.07

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## Awards

NSERC Discovery Accelerator Supplement Award (125 awardees per year in Canada across all scientific and engineering fields)	2018
University Research Chair, University of Waterloo	2018
The Faculty of Mathematics Golden Jubilee Research Excellence Award, University of Waterloo	2017
Annual Department Teaching Award, Statistics and Actuarial Science, University of Waterloo	2017
Laha Travel Award 2012, Institute of Mathematical Statistics	2012
Bob Price Fellowship, School of Mathematics, Georgia Institute of Technology	2011

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## Publications and Manuscripts

### Refereed Journal Articles

Forthcoming

- [47] Shen, J., Shen, Y., Wang, B. and Wang, R. (2019+). Distributional compatibility for change of measures. *Finance and Stochastics*, forthcoming.
- [46] Wang, B., Wang, R. and Wang, Y. (2019+). Compatible matrices of Spearman's rank correlation. *Statistics and Probability Letters*, forthcoming.
- [45] Asimit, V., Peng, L., Wang, R. and Yu, A. (2019+). An efficient approach to quantile capital allocation and sensitivity analysis. *Mathematical Finance*, forthcoming.
- [44] Embrechts, P., Liu, H., Mao, T. and Wang, R. (2019+). Quantile-based risk sharing with heterogeneous beliefs. *Mathematical Programming*, forthcoming.
- [43] Puccetti, G., Rigo, P., Wang, B. and Wang, R. (2019+). Centers of probability measures without the mean. *Journal of Theoretical Probability*, forthcoming.
- [42] Jakobsons, E. and Wang, R. (2019+). Negative dependence in matrix arrangement problems. *Annals of Operations Research*, forthcoming.

2019

- [41] Shen, J., Shen, Y. and Wang, R. (2019). Random locations of periodic stochastic processes. *Stochastic Processes and their Applications*, **129**, 878–901.

2018

- [40] Embrechts, P., Liu, H. and Wang, R. (2018). Quantile-based risk sharing. *Operations Research*, **66**(4), 936–949.
- [39] Li, L., Shao, H., Wang, R. and Yang, J. (2018). Worst-case Range Value-at-Risk with partial information. *SIAM Journal on Financial Mathematics*, **9**(1), 190–218.
- [38] Cai, J., Liu, H. and Wang, R. (2018). Asymptotic equivalence of risk measures under dependence uncertainty. *Mathematical Finance*, **28**(1), 29–49.

2017

- [37] Cai, J., Liu, H. and Wang, R. (2017). Pareto-optimal reinsurance arrangements under general model settings. *Insurance: Mathematics and Economics*, **77**, 24–37.
- [36] Furman, E., Wang, R. and Zitikis, R. (2017). Gini-type measures of risk and variability: Gini shortfall, capital allocations, and heavy-tailed risks. *Journal of Banking and Finance*, **83**, 70–84.
- [35] Bernard, C., Rüschenendorf, L., Vanduffel, S. and Wang, R. (2017). Risk bounds for factor models. *Finance and Stochastics*, **21**(3), 631–659.
- [34] Liu, H. and Wang, R. (2017). Collective risk models with dependence uncertainty. *ASTIN Bulletin*, **47**(2), 361–389.

2016

- [33] Wang, B. and Wang, R. (2016). Joint mixability. *Mathematics of Operations Research*, **41**(3), 808–826.
- [32] Embrechts, P., Hofert, M. and Wang, R. (2016). Bernoulli and tail-dependence compatibility. *Annals of Applied Probability*, **26**(3), 1636–1658.
- [31] Bignozzi, V., Mao, T., Wang, B. and Wang, R. (2016). Diversification limit of quantiles under dependence uncertainty. *Extremes*, **19**(2), 143–170.
- [30] Wang, R. (2016). Regulatory arbitrage of risk measures. *Quantitative Finance*, **16**(3), 337–347.
- [29] Han, X. and Wang, R. (2016). Computation of credit portfolio loss distribution by a cross entropy method. *Journal of Applied Mathematics and Computing*, **52**(1), 287–304.
- [28] Jakobsons, E., Han, X. and Wang, R. (2016). General convex order on risk aggregation. *Scandinavian Actuarial Journal*, **2016**(8), 713–740.

2015

- [27] Puccetti, G. and Wang, R. (2015). Extremal dependence concepts. *Statistical Science*, **30**(4), 485–517.
- [26] Embrechts, P. and Wang, R. (2015). Seven proofs for the subadditivity of Expected Shortfall. *Dependence Modeling*, **3**, 126–140.
- [25] Embrechts, P., Wang, B. and Wang, R. (2015). Aggregation-robustness and model uncertainty of regulatory risk measures. *Finance and Stochastics*, **19**(4), 763–790.
- [24] Wang, R. (2015). Current open questions in complete mixability. *Probability Surveys*, **12**, 13–32.
- [23] Wang, R., Bignozzi, V. and Tsanakas, A. (2015). How superadditive can a risk measure be? *SIAM Journal on Financial Mathematics*, **6**(1), 776–803.
- [22] Mao, T. and Wang, R. (2015). On aggregation sets and lower-convex sets. *Journal of Multivariate Analysis*, **138**, 170–181.
- [21] Wang, R. and Ziegel, J. (2015). Elicitable distortion risk measures: A concise proof. *Statistics and Probability Letters*, **100**, 172–175.
- [20] Wang, B. and Wang, R. (2015). Extreme negative dependence and risk aggregation. *Journal of Multivariate Analysis*, **136**, 12–25.
- [19] Yang, J., Chen, Z., Wang, F. and Wang, R. (2015). Composite Bernstein copulas. *ASTIN Bulletin*, **45**(2), 445–475.
- [18] Wang, R., Peng, L. and Yang, J. (2015). CreditRisk<sup>+</sup> model with dependent risk factors. *North American Actuarial Journal*, **19**(1), 24–40.
- [17] Puccetti, G. and Wang, R. (2015). Detecting complete and joint mixability. *Journal of Computational and Applied Mathematics*, **280**, 174–187.

2014

- [16] Peng, L. and Wang, R. (2014). Interval estimation for bivariate t-copulas via Kendall's tau. *Variance*, **8**(1), 43–54.

- [15] Wang, R. (2014). Sum of arbitrarily dependent random variables. *Electronic Journal of Probability*, **19**(84), 1–18.
- [14] Embrechts, P., Puccetti, G., Rüschendorf, L., Wang, R. and Beleraj, A. (2014). An academic response to Basel 3.5. *Risks*, **2**(1), 25–48.
- [13] Peng, L., Qi, Y. and Wang, R. (2014). Empirical likelihood test for high-dimensional linear models. *Statistics and Probability Letters*, **86**, 85–90.
- [12] Wang, R. (2014). Asymptotic bounds for the distribution of the sum of dependent random variables. *Journal of Applied Probability*, **51**(3), 780–798.
- [11] Bernard, C., Jiang, X. and Wang, R. (2014). Risk aggregation with dependence uncertainty. *Insurance: Mathematics and Economics*, **54**, 93–108.

2013

- [10] Puccetti, G., Wang, B. and Wang, R. (2013). Complete mixability and asymptotic equivalence of worst-possible VaR and ES estimates. *Insurance: Mathematics and Economics*, **53**(3), 821–828.
- [9] Zhang, R., Peng, L. and Wang, R. (2013). Tests for covariance matrix with fixed or divergent dimension. *Annals of Statistics*, **41**(4), 2075–2096.
- [8] Wang, R., Peng, L. and Qi, Y. (2013). Jackknife empirical likelihood test for equality of two high dimensional means. *Statistica Sinica*, **23**(2), 667–690.
- [7] Wang, R., Peng, L. and Yang, J. (2013). Bounds for the sum of dependent risks and worst Value-at-Risk with monotone marginal densities. *Finance and Stochastics*, **17**(2), 395–417.
- [6] Wang, R., Peng, L. and Yang, J. (2013). Jackknife empirical likelihood for parametric copulas. *Scandinavian Actuarial Journal*, **2013**(5), 325–339.

2009 - 2012

- [5] Peng, L., Qi, Y., Wang, R. and Yang, J. (2012). Jackknife empirical likelihood method for some risk measures and related quantities. *Insurance: Mathematics and Economics*, **51**(1), 142–150.
- [4] Puccetti, G., Wang, B. and Wang, R. (2012). Advances in complete mixability. *Journal of Applied Probability*, **49**(2), 430–440.
- [3] Wang, R. and Peng, L. (2011). Jackknife empirical likelihood intervals for Spearman’s rho. *North American Actuarial Journal*, **15**(4), 475–486.
- [2] Wang, B. and Wang, R. (2011). The complete mixability and convex minimization problems for monotone marginal densities. *Journal of Multivariate Analysis*, **102**(10), 1344–1360.
- [1] Yang, J., Qi, Y. and Wang, R. (2009). A class of multivariate copulas with bivariate Fréchet marginal copulas. *Insurance: Mathematics and Economics*, **45**(1), 139–147.

## Other Publications

- [1] Major, J., Wang, R. and Woolstenhulme, M. (2015). The most dangerous model: A natural benchmark for assessing model risk. *Society of Actuaries Monograph: Enterprise Risk Management Symposium, 2015*.

## Submitted Manuscripts

- [14] Wang, R. and Zitikis, R. (2018). Weak comonotonicity.  
*arXiv*: <https://arxiv.org/abs/1812.04827>.
- [13] Wang, R. and Wei, Y. (2018). Risk functionals with convex level sets.  
*SSRN*: <http://ssrn.com/abstract=3292661>.
- [12] Mao, T., Wang, B. and Wang, R. (2018). Sums of standard uniform random variables.  
*arXiv*: <https://arxiv.org/abs/1811.11981>.
- [11] Embrechts, P., Schied, A. and Wang, R. (2018). Robustness in the optimization of risk measures.  
*SSRN*: <http://ssrn.com/abstract=3254587>.
- [10] Wang, R. and Ziegel, J. (2018). Scenario-based risk evaluation.  
*SSRN*: <http://ssrn.com/abstract=3235450>.
- [9] Liu, F., Cai, J., Lemieux, C. and Wang, R. (2018). Convex risk functionals: representation and applications.  
*SSRN*: <http://ssrn.com/abstract=3216336>.
- [8] Wang, R. and Wei, Y. (2018). Characterizing optimal allocations in quantile-based risk sharing.  
*SSRN*: <http://ssrn.com/abstract=3173503>.
- [7] Vovk, V. and Wang, R. (2018). Combining p-values via averaging.  
*SSRN*: <http://ssrn.com/abstract=3166304>.
- [6] Boonen, T., Liu, F. and Wang, R. (2017). Competitive equilibria in a comonotone market.  
*SSRN*: <http://ssrn.com/abstract=3091424>.
- [5] Wang, R., Xu, Z. Q. and Zhou, X. Y. (2017). Dual utilities under dependence uncertainty.  
*SSRN*: <http://ssrn.com/abstract=3078374>.
- [4] Wang, R., Wei, Y. and Willmot, G. (2017). Characterization, robustness and aggregation of signed Choquet integrals.  
*SSRN*: <http://ssrn.com/abstract=2956962>.
- [3] Mao, T. and Wang, R. (2017). A model-free continuum of degrees of risk aversion.  
*SSRN*: <http://ssrn.com/abstract=2907499>.
- [2] Liu, F. and Wang, R. (2016). A theory for measures of tail risk.  
*SSRN*: <http://ssrn.com/abstract=2841909>.
- [1] Mao, T. and Wang, R. (2016). Risk aversion in regulatory capital principles.  
*SSRN*: <http://ssrn.com/abstract=2658669>.

## Dissertation

- [1] Wang, R. (2012). Some questions in high-dimensional data analysis and risk management. *Ph.D. Thesis*. Georgia Institute of Technology, USA.

## Books

- [1] Wang, R. (2011). *Sanguosha: The Royal Road*. (Non-academic, in Chinese.) Publishing House of Electronics Industry, Beijing. ISBN-9787121126833.
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## Academic Advising

### Postdoctoral fellows at the University of Waterloo

Peng Liu (with A. Schied)	2018 - present
Daniel Linders (with F. Yang, short term)	2015
Assistant Professor of Actuarial Science, University of Illinois Urbana-Champaign (2017)	
Tiantian Mao (with J. Cai and D. Landriault)	2014 - 2015
Associate Professor of Statistics and Finance, University of Science and Technology of China (2017)	

### Ph.D. students at the University of Waterloo

Daniel Matheson (with Y. Shen)	2019 - present
Yuyu Chen (with K. S. Tan)	2018 - present
Yunran Wei (with G. Willmot)	2015 - present
Jie Shen (with Y. Shen)	2014 - 2018
Risk Modelling Researcher, Canadian Imperial Bank of Commerce (2018)	
Haiyan Liu (with J. Cai)	2013 - 2017
Assistant Professor of Actuarial Science, Michigan State University (2017)	

### Master's students at the University of Waterloo

Daiwen Dai (2017), Yuchen Zhang (2014), Xiao Jiang (with C. Bernard, 2013)

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## Regular Courses

### University of Waterloo

ACTSC446/846 - Mathematics of Financial Markets	Fall 2014; Winters 2013, 2018, 2019
ACTSC625 - Casualty and Health Insurance Mathematics	Winters 2013, 2014, 2015, 2017
ACTSC631 - Financial Mathematics III	Spring 2015
ACTSC964 - Topics in Quantitative Risk Management	Winters 2017, 2018
ACTSC970 - Finance I	Fall 2016

ACTSC971 - Finance II	Winter 2015
ACTSC991 - Topics in Actuarial Science - Copulas and Dependence Modeling	Winter 2014
ACTSC991 - Topics in Actuarial Science - Risk Measurement	Spring 2015

### Georgia Institute of Technology

MATH1522 - Linear Algebra for Calculus	Spring 2012
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## Invited Short Courses and Minicourses

### Chinese Academy of Sciences

Minicourse - Risk Measurement under Model Uncertainty (4 hours)	Spring 2016
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### Peking University

Short Course - Theory and Practice of Risk Measurement (20 hours)	Spring 2016
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### ETH Zurich

FIM Minicourse - Risk Aggregation and Fréchet Problems (10 hours)	Fall 2015
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### University of Milan-Bicocca

Minicourse - Risk Aggregation and Fréchet Problems (10 hours)	Fall 2015
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## Invited Academic Presentations

### Conferences

- 2018 4th European Actuarial Journal Conference (Leuven, *Keynote Speaker*), Robust Techniques in Quantitative Finance (Oxford), Optimal Insurance (Beijing)
- 2017 8th Advanced Mathematical Methods in Finance (Amsterdam), 4th Dependence Modeling (Aegina), RiskLab Mini-Workshop (Zurich)
- 2016 Stochastic Control and Finance (Hong Kong), Random Complex Structures and Data Analysis (Beijing), Financial Engineering and Risk Management (Guangzhou), 44th Statistical Society of Canada Meeting (St. Catherines)
- 2015 Dependence and Risk Measures (Milan), Quantitative Risk Management (Oberwolfach), 7th Advanced Mathematical Methods in Finance (Lausanne), Youth Probability Forum (Beijing), Financial and Insurance Risk Management (Beijing), CORS/INFORMS 2015 (Montreal)
- 2014 11th Vilnius Conference on Probability and Statistics (Vilnius), Dependence Modeling (Brussels), Insurance Mathematics (Quebec City), High-dimensional Dependence and Copulas (Beijing)

2013 ICSA - Canada Chapter 2013 (Toronto), Statistical Science for Society (Waterloo), Young Mathematician Forum (Beijing)

2012 Quantitative Finance and Risk Management (Changchun)

### Seminars and Colloquia

2018 UC Berkeley (IEOR), Stanford (Management Sci & Eng), Columbia (Stat), Singapore UTD (Engineering Systems), NU Singapore (RMI), ETH Zurich (Math), Ryerson (Math), Cornell (ORIE), Waterloo (Pure Math)

2017 UW-Madison (Risk & Insurance), Connecticut (Math), Wuhan U (Math & Stat), Beijing NU (Ecology), Qufu NU (Stat), USTC (Management), CAS (Applied Math), Peking (Math), U Salzburg (Math), Milano-Bicocca (Econ & Stat), Ryerson (Math), Laval (Actuarial)

2016 U Michigan (Stat), Georgia State (Risk Management & Insurance), USTC (Management), Qufu NU (Stat), CUHK (Systems Engineering), Tsinghua (Econ & Management), CAS (Applied Math), Peking (Math), CUFU (Actuarial), BTBU (Math)

2015 Liverpool (Math), Cass Business School (Actuarial), U Vienna (Math), U Amsterdam (Econ), Mannheim (Math), EPF Lausanne (Finance), U Toronto (Stat)

2014 Peking (Math), USTC (Management), Fudan (Management), Milano-Bicocca (Econ & Stat), U Bern (Stat), McGill (Math & Stat)

2013 Peking (Math), Tsinghua (Econ & Management), VU Brussels (Econ), ETH Zurich (Math), U Freiburg (Math), U Lyon 1 (Actuarial), U Minnesota (IMA), Georgia State (Risk Management & Insurance), Georgia Tech (Math)

2012 Waterloo (Stat), Illinois State (Stat), Northern Illinois (Stat)

2011 Georgia Tech (Math), Peking (Math)

## Scientific Service

### Affiliated Member

Waterloo Artificial Intelligence Institute	2018 - present
RiskLab, ETH Zurich	2015 - present
Centre for Computational Mathematics, Waterloo	2015 - present
Big Data Research Lab, Waterloo	2014 - present
Waterloo Research Institute in Insurance, Securities and Quantitative Finance	2012 - present

### Conference Organizing Committee

WatSAF <sup>1</sup> on Quantitative Risk Management and Financial Technology (Chair), UW, Canada	2019.04
Workshop on Risk Measurement and Regulatory Issues in Business, Montreal, Canada	2017.09
Workshop on Random Complex Structures and Data Analysis in Finance, Beijing, China	2016.08

4th Québec-Ontario Workshop on Insurance Mathematics, UW, Canada	2016.02
6th Annual Graduate Student Probability Conference, Georgia Tech, Atlanta, USA	2012.04
5th Annual Graduate Student Probability Conference, Georgia Tech, Atlanta, USA	2011.04
Conference Scientific Committee	
2nd International Workshop on Optimal (Re)Insurance, Beijing, China	2018.07
6th International Gerber-Shiu Workshop, Beijing, China	2016.06
PhD Committee	
Ou Dang, Statistics and Actuarial Science, Waterloo	
Ahmed Abdalrahman, Electrical and Computer Engineering, Waterloo	
Sajad Shiravi Khozani, Civil and Environmental Engineering, Waterloo	
Edgars Jakobsons, Mathematics, ETH Zurich	defended in 2016
Fangda Liu, Statistics and Actuarial Science, Waterloo	defended in 2015
External Program Review	
Applied Mathematics, Ryerson University	2018

## Peer-review Service

### Statistics and Probability Journals

Annals of Applied Statistics, Bernoulli, Biometrika, Extremes, Journal of Business and Economic Statistics, Journal of Multivariate Analysis, Journal of the Royal Statistical Society - Series A, ...

### Quantitative Finance and Economics Journals

Finance and Stochastics, Journal of Banking and Finance, Journal of Economic Dynamics and Control, Mathematical Finance, SIAM Journal on Financial Mathematics, ...

### Operations Research Journals

Annals of Operations Research, European Journal of Operational Research, Operations Research, Mathematics of Operations Research, ...

### Actuarial Science Journals

ASTIN Bulletin, European Actuarial Journal, Insurance: Mathematics and Economics, Journal of Risk and Insurance, Scandinavian Actuarial Journal, North American Actuarial Journal, ...

### Grants

FRQNT (Canada), NSERC Discovery (Canada)

Total: 53 journals, 110 papers, 3 grant proposals

## Personal

Born in Beijing (1984), citizen of China, permanent resident of Canada

Number of countries visited: 50

Number of continents visited: 7

Number of invited academic talks: 84 (in 14 countries)

Number of courses taught: 17 regular courses, 1 short course, 3 minicourses (in 6 institutions)

Society of Actuaries Exams Passed: P, FM, MLC, MFE and C (2009)

Erdős Number: 3 (Ruodu Wang ← Ričardas Zitikis ← Endre Csáki ← Paul Erdős)