

CURRICULUM VITAE

Peter A. Forsyth

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EDUCATION:

- 1977-79 Ph.D.
University of Western Ontario
London, Ontario, Canada
- 1975-77 M.Sc.
Australian National University
Canberra, Australia
- 1971-75 B.Sc.
University of Western Ontario
London, Ontario, Canada

EXPERIENCE:

- 2016 - present Distinguished Professor Emeritus
Cheriton School of Computer Science,
University of Waterloo, Waterloo, Ontario, Canada.
- 1993 - 2016 Professor
Cheriton School of Computer Science,
University of Waterloo
- 2009 - 2011 Associate Director (Computing and Infrastructure)
Cheriton School of Computer Science
University of Waterloo
- 2006 - 2008 Scientific Director
Institute for Quantitative Finance and Insurance
University of Waterloo
- 2002 - 2005 Associate (Vice) Director
Cheriton School of Computer Science
University of Waterloo

1995 - 1998	Director Institute for Computer Research University of Waterloo
1991 - 1993	Associate Chair (Graduate Studies) Department of Computer Science University of Waterloo
1987 - 1993	Associate Professor Department of Computer Science, University of Waterloo
1985 - 1987	President Dynamic Reservoir Systems, Calgary, Alberta, Canada.
1979 - 1985	Senior Simulation Scientist (and other positions) Computer Modelling Group, Calgary, Alberta, Canada.

Recent Awards

Co-winner (with K. Vetzal and G. Westmacott) of the Brockett-Shapiro Actuarial Journal award (2021) for the most valuable contribution to risk and insurance. This award, sponsored by the American Risk and Insurance Association (ARIA), recognizes the paper *Management of Portfolio Depletion Risk through Optimal Life Cycle Asset Allocation,* published in the North American Actuarial Journal in 2019.

Research Interests

Computational finance, numerical methods for optimal stochastic control, sparse matrix algorithms, nonlinear partial integro-differential equations.

Short Courses Taught

- Real options and finance: optimal stochastic control formulation and solution techniques. Seven hours of lectures, co-taught with Margaret Insley. Coruna, Spain, 2015.
- Numerical methods for Hamilton Jacobi Bellman equations in finance. This research level mini-course (eight hours of lectures) has been given in Singapore (2009), the Netherlands (2010), Vienna (2012), Coruna (Spain, 2012), Singapore (2013), Amsterdam (2015).
- Numerical PDE methods for path dependent options. Two day short course, combines lectures and Matlab exercises. Co-taught with Ken Vetzal. This course has been given in New York City (2001, 2003, 2004, 2005), Tokyo (2001), Toronto (2002), Ithaca, NY (2001, 2002) and Waterloo (2006, 2007, 2009, 2010).

- Convertible bonds: pricing theory and algorithms. One day short course, lectures and software demonstrations. Co-taught with Ken Vetzal, Elie Ayache. Given in New York City (2003), Paris (2004).

Commercially Developed Software

Dynamic Reservoir Simulator (developed with P.H. Sammon, A. Behie). Black oil reservoir simulation model for primary production, waterflooding, and coning. Duke Energy currently supports and markets this software. This package has been purchased by over thirty petroleum companies.

IMEX (developed with A. Behie, P.H. Sammon). Adaptive implicit black oil model. This code continues to be marketed and supported by the Computer Modelling Group, Calgary. Over 100 licenses sold.

Licensed Software Developed at Waterloo

WATSIT (developed with J. Kightley, S. Clift, E. D’Azevedo). Iterative sparse matrix solution package. This library has been purchased by such organizations as: HydroGeoLogic Inc. (Herndon, VA), Westinghouse Hanford (Richland, WA), Boeing (Seattle), Los Alamos National Laboratory, Lawrence Berkeley National Laboratory, Sandia National Laboratory, Phillips Petroleum (Bartlesville), TRW Safety Systems (Los Vegas), Desert Research Institute (Los Vegas), and Atomic Energy of Canada (Pinawa). This software has also been distributed to a number of academic sites.

PCG5 This sparse iterative solver is embedded in simulation software (Visual Modflow, Modflow Surfact) developed by HydroGeoLogic Inc (Herndon, VA). Since 2005, about 300 licenses have been sold.

Consulting Experience

Research related consulting for such organizations as: Aquanty Inc. (Waterloo), TGINet/Cornell (Tokyo), SunLife of Canada, NOVA Corporation (Calgary), the Electric Power Research Institute (Mountain View, CA), Smithville Bedrock Remediation Corporation (Smithville Ont.), Los Alamos National Laboratory, Phillips Petroleum (Bartlesville), US Environmental Protection Agency, Oak Ridge National Laboratory, Lawrence Berkeley National Laboratory, NASA ICASE (Langley, VA), and HydroGeoLogic (Herndon, VA).

Editorial Boards

- Journal of Computational Finance (Editor-in-Chief, 2008-2013, Associate Editor, 2003-2008, 2013-2023)
- Applied Mathematical Finance (Associate Editor, 2004-2023)
- Encyclopedia of Quantitative Finance (section co-editor (with D. Lamberton), PDEs and Numerical Methods, 2007-2008).

- Applied Numerical Mathematics (guest co-editor, special issue on Iterative Methods, 2008).
- Advances Water Resources (Associate Editor, 1998-2001)

Recent Research Service

- Member, organizing committee, SIAM Conference on Financial Mathematics and Engineering, Austin, 2016.
- Member, MITACS Research Management Committee (2008-11).
- Scientific Director, Institute for Quantitative Finance and Insurance (Waterloo, now WATRISQ, 2006-2008).
- Member of organizing committee, Fields Institute numerical analysis year (2001-2002).
- NSF Panel member (*Computational Mathematics* (2001)).
- Grant selection committee member, CITO, *Modelling and simulation*, 1998-2000.
- Director, Institute for Computer Research (Waterloo, 1995-1998). Organized over twenty-five short courses with industrial participants; also coordinated Waterloo submissions to ORDCF and CFI related to Bell Canada University Laboratory research initiative (total funding received from Bell, ORDCF and CFI in excess of \$20 million over three years).
- Workshops, Conferences Co-organized
 - Conference on Computational Methods in Finance, University of Waterloo, July, 2007
 - Workshop on Real Options in Telecommunications, University of Waterloo, May 2003
 - Workshop on Computational Methods and Applications in Finance, Fields Institute, University of Toronto, February 2002

Graduate Student Supervision

PhD

C. Ni (2024, co-supervisor Li)	J. Wang (2010)
P. van Staden (2020, Queensland, principal supervisor D.M. Dang)	Z. Chen (2008)
K. Ma (2015)	A. Belanger (2008, co-supervisor G. Labahn)
S.T. Tse (2012, co-supervisor J. Wan)	S. Kennedy (2007, co-supervisor G. Labahn)
Y. Huang (2011)	S. Clift (2007)
	Y. d'Halluin (2004)

H. Windcliff (2003)
D. Pooley (2003)
R. Zvan (2000, co-supervisor K. Vetzal)

A. Unger (1995, co-supervisor E. Sudicky)

MMath

M. Chen (2023, co-supervisor Li) (MMath)
M. Shirazi (2023, co-supervisor Li) (MMath)
Y. Guo (2020, co-supervisor Li)
B. Na (2020, co-supervisor Li)
B. Xu (2018, co-supervisor G. Labahn)
C. Shan (2014, co-supervisor G. Labahn)
J. Lippa (2013, co-supervisor G. Labahn)
A. Asare (2013, co-supervisor G. Labahn)
P. Azimzadeh (2013)
H. Su (2013, co-supervisor G. Labahn)
M. Ma (2013, co-supervisor G. Labahn)
X. Peng (2013)
Z. Wang (2012, co-supervisor G. Labahn)
X. Guan (2012)
C. Morley (2011, co-supervisor G. Labahn)
J. Babbitt (2011, co-supervisor G. Labahn)
D. Fagnan (2011, co-supervisor G. Labahn)
Y. Sohrabi (2011)
W. Xiao (2010)
D. Saraph (2010, co-supervisor G. Labahn)
B. Wang (2010)
J. Aquan-Asee (2009, co-supervisor G. Labahn)
M. Yu (2007)
J. Kraus (2007, TU Munich, co-supervisors, Zagst, Grau)
L. Xiao (2006, co-supervisor, K. Vetzal)
J. Wang (2005)
P. Lizak (2004)
A. Grau (2003)
C. Cheng (2002)
M.C. Lam (2002)
W. Morland (2001)
H. Windcliff (2000)
Y. d'Hallion (2000, co-supervisor G. Labahn)
M. Fitzgerald (1999)
D. Pooley (1999, co-supervisor R.B. Simpson)
L. Wang (1998)
T. Zvi (1998)
E. Carr (1997)
S. Friedman (1996)
H. Li (1996)
R. Zvan (1996)
B.Y. Shao (1994)
S. Clift (1993)
Y. Qian (1993)
J. Dickinson (1993)
P. Chin (1991, co-supervisor W.L. Seward)
M.C. Kropinski (1990)
F.W. Letniowski (1989)
T. Natalisa (1988)
W.S. Nugroho (1988)

Students Currently Supervised

Zeyu Zhang (joint with Li) (MMath)

Yuan Li (joint with Li) (MMath)

PhD Examining Committees

K. Andersson (Mathematics, Utrecht) 2023.
J. Zhang (Statistics) 2018.
N. Leung (CS, Toronto) 2017.
F. Cong (Mathematics, Delft) 2016.
B. Kimmel (CS) 2016.

A. Rajabi (CS) 2016.
S. Amarala (CS) 2015.
O. Ardakanian (CS) 2015.
M. Ruijter (Mathematics, Delft) 2015.
K. Zhou (Systems Engineering, CUHK) 2014.

A. Tayal (CS) 2014.
 K. Miller (Applied Mathematics) 2012.
 J. Witte (Mathematics, Oxford) 2012.
 H.T. Hwang (Earth Sciences) 2012.
 V. Surkov (CS, Toronto) 2009.
 A. Rohani (ECE) 2006.
 H. Li (Mathematics, Calgary) 2006.
 R. Maji (Earth Sciences) 2005.
 M. Steigleider (CS) 2005.
 M. Ayatollah (ECE) 2004.
 K. Lau (Computer Science, UHKST) 2004.
 A. Borji (ECE) 2004.
 W. Annable (Earth Sciences) 2003.
 Y. Wang (ECE) 2000.
 V. Van (ECE) 1999.
 J. VanderKwaak (Earth Sciences) 1999.
 P. Zwart (Mechanical Engineering) 1999.
 J. Grad (Applied Mathematics) 1997.
 K. MacQuarrie (Earth Sciences) 1997.
 L. Zhang (Earth Sciences) 1997.
 I. Murray (Applied Math) 1994.
 M. Ibaraki (Earth Sciences) 1994.
 C. Mendoza (Earth Sciences) 1992.
 R. Heywood (Mechanical Engineering) 1992.
 R. Therrien (Earth Sciences) 1992.
 A. Bajor (Chem. Eng., Toronto) 1990.
 S. Ormiston (Mechanical Engineering) 1990.
 W. Drennan (Applied Mathematics) 1988.
 E. Fraga (CS) 1988.

Administrative Duties

Member, Business at Waterloo Committee (2016)
 Member, School Advisory Committee on Appointments (2015-2016)
 Member, Director Search Committee, School of Accounting and Finance (2015)
 Member, UW Pension and Benefits Committee (2014-2016)
 Member, UW Registered Pension Plan Investment Committee (2014-2016)
 Member, Faculty Association Academic Freedom and Tenure Committee (2012-2016)
 Member, School Advisory Committee on Appointments (2011-2012)
 Member, CS Graduate Committee (2011-14)
 Member, University Senate (2010-2012)
 Member, University Committee on Information Systems and Technology (2009-10).
 Chairman, CS Computing Facility Committee (2009-2011).
 Member, Engineering Faculty Promotion and Tenure Committee (2007-08).
 Scientific Director, Institute for Quantitative Finance and Insurance (2006-2008).
 Associate Director, Computing and Financial Management Program (2005-2008).
 Member, School of Computer Science Promotion and Tenure Committee (2005-07, 2009-10).
 Member, School of Computer Science Director Selection Committee (2005).
 Member, Dean of Mathematics Selection Committee (2004-2005).
 Member, University Senate (2004-2007).
 Associate Director, School of Computer Science (2002-2005).
 Member, External Relations Committee (2002-2005).
 Member, CS Computing Facility Committee (2002-2005).
 Member, CS Budget Committee (2002-2005).
 Member, Science Faculty Promotion and Tenure Committee (2001-2002).
 Member, Computer Science Governance Committee (2001).
 Member, Eyton Chair selection Committee (2000-2001).

Member, Mathematics Faculty Promotion and Tenure Committee (1998-2001)
Member, Graduate Committee (CS) (1997-2002)
Member, Engineering Faculty Promotion and Tenure Committee, (1996-97)
Member, Chair selection Committee (CS), (1996-1997).
Member, Promotion and Tenure Committee(CS) (1995-97)
Director, Institute for Computer Research (1995-98)
Associate Chairman, Graduate Studies (1991 - 1993)
Chairman, Graduate Committee (CS) (1991 - 1993)
Member, Promotion and Tenure Committee (CS) (1991 - 1992)
Member, Graduate Committee (CS) (1990-91)
Chairman, PhD Comprehensive Committee (1989-90)
Member, PhD Comprehensive Committee (1988-89)
Member, Curriculum Committee, (1987-90)
Member, Graduate Committee (Applied Mathematics) (1987-90)

Research Grants

2017-2023 NSERC Discovery grant. \$43,000/year.

2016-2018 Global Risk Institute. A multi-period mean-variance approach to risk and return in climate change policy. \$60,000 per year (with M. Insley (PI)).

2013-2016 Global Risk Institute. Long-horizon and longevity risks in insurance. \$188,000 per year (with K.S. Tan (PI), T. Coleman, M. Hardy, J. Li).

2012-2015 NSERC Collaborative Research and Development (CRD). Matching for Scotia-bank grant. \$38,000 per year (co-PI with G. Labahn).

2011-2014 Scotiabank. Implied Volatility Surfaces, Local Volatility Models and Low Dimensional Hedging Strategies for Arithmetic and Geometric Baskets. \$25,000/year (co-PI with G. Labahn).

2010-2015 NSERC Discovery grant. \$40,000/year. (Deferred to end in 2017).

2009-2012 Credit Suisse Research Grant \$70,200/year (co-PI with Y. Li and A. Heunis).

2008-2011 Tata Consultancy Services Research Grant. \$25,000/year (co-PI with G. Labahn).

2006-2011 Morgan Stanley Equity Market Microstructure Research Grant. \$20,000/year.

2005-2010 NSERC Discovery grant. \$64,000/year.

2003-2005 ITO33, Paris. Numerical methods for jump diffusion and jump volatility models, \$23,000/year (co-PI with K. Vetzal).

2001-2005 NSERC Discovery grant. \$57,000/year.

- 2000-2003** Bell Canada University Labs. Computational Finance: Real options, telecommunications, and corporate finance \$135,000/year (co-PI) (with K. Vetzal(co-PI), P. Boyle, G. Labahn, K.S. Tan).
- 1999-2002** NSERC Strategic, Royal Bank. Computational Finance: algorithms for option pricing and hedging. \$128,000/year (PI) (with K. Vetzal, P. Boyle, G. Labahn).
- 1998-2001** NSERC Strategic. New computational approaches for modelling surface water-groundwater systems. \$131,000/year (with E. Sudicky (PI), E. Frind, N. Kouwen, D. Rudolph, R. Soulis, J. Sykes, H. Whiteley).
- 1998-2000** CITO. Computational support for modelling in Engineering & Finance.\$50,000 /year (with W.P. Tang, R.B. Simpson, A. George, P. Boyle, K. Vetzal).
- 1997-2001** NSERC operating grant. \$45,000/year.
- 1996-98** Smithville Environmental Restoration Project, ITRC and WCGR. Simulation of DNAPL contaminants in fractured rock. \$60,000/year (with E. Sudicky).
- 1995-1998** US EPA. Simulation of groundwater flow at the Smithville site. \$80,000/year (with E. Sudicky (PI), K. Novakowski).
- 1995-1998** Information Technology Research Center. Research into numerical solution of partial differential equations. \$75,000/year (with A. George, R. Simpson, W.P. Tang).
- 1995** Haley and Aldrich (Boston), Gartner-Lee (Markham), Waterloo Center for Groundwater Research. Simulation and video animation of NAPL extraction methods. \$29,000 (with E. Sudicky).
- 1995** Solvents in Groundwater Consortium. Simulation of vacuum extraction methods for VOC's. \$20,000 (with E. Sudicky).
- 1994** Waterloo Center for Groundwater Research. Visualization of DNAPL contamination. \$13,600 (with E. Sudicky).
- 1994** NSERC Equipment Grant. Video recording equipment for scientific visualization. \$42,000 (with R.H. Bartels).
- 1993** Solvents in Groundwater Consortium. Three dimensional simulation of NAPL contamination. \$19,000 (with E. Sudicky).
- 1993-1995** Information Technology Research Center. Research into numerical solution of partial differential equations. \$40,000/year (with R. Simpson, W.P. Tang).
- 1993-1997** NSERC operating grant. \$28,000/year.
- 1990-1993** NSERC operating grant. \$25,000/year.
- 1988-1990** NSERC operating grant. \$23,000/year.

- 1988-1992** Information Technology Research Center. Research into numerical solution of partial differential equations. \$80,000/year (with R. Simpson, W.P. Tang, W.L. Seward).
- 1985** Energy Mines and Resources. Development of new software technology for reservoir simulation. \$80,000 (with A. Behie, P. Sammon).

List of Research Contributions - Peter A. Forsyth

Refereed Journal Publications

1. C. Ni, Y. Li and P. A. Forsyth, “*Optimal Asset Allocation in a High Inflation Regime: a Leverage-feasible Neural Network Approach*,” (to appear in *Quantitative Finance*, 2024)
2. P. A. Forsyth, K. R. Vetzal and G. Westmacott, “*Optimal performance of a tontine overlay subject to withdrawal constraints*,” *ASTIN Bulletin* 54 (2024) 94-128.
3. P. M. van Staden, P. A. Forsyth and Y. Li, “*Across-time risk-aware strategies for outperforming a benchmark*,” *European Journal of Operational Research* 313:2 (2024) 776-800.
4. P. A. Forsyth, P. van Staden, Y. Li, “*Beating a constant weight benchmark: easier done than said*,” *International Journal of Theoretical and Applied Finance* 24:4 (2023) paper 2350011 (electronic) 1-24.
5. P. van Staden, P. A. Forsyth, Y. Li, “*Beating a benchmark: dynamic programming may not be the right numerical approach*,” *SIAM Journal on Financial Mathematics* 14:2 (2023) 407-451.
6. P. A. Forsyth and K. R. Vetzal, “*Multi-period Mean Expected-Shortfall Strategies: Cut your losses and ride your gains*,” *Applied Mathematical Finance* 29:5 (2022) 402-438.
7. C. Ni, Y. Li, P. A. Forsyth, R. Carroll, “*Optimal asset allocation for outperforming a stochastic benchmark target*,” *Quantitative Finance* 22:9 (2022) 1595-1626.
8. P. A. Forsyth, “*A stochastic control approach to defined contribution plan decumulation: the nastiest, hardest problem in finance*,” *North American Actuarial Journal* 26:2 (2022) 227-251.
9. P. A. Forsyth, “*Short term decumulation strategies for underspending retirees*,” *Insurance: Mathematics and Economics* 102 (2022) 56-74.
10. M. Insley, T. Snoddon, P.A. Forsyth, “*Strategic interactions and uncertainty in decisions to curb greenhouse gas emissions*,” *Frontiers of Economics in China* 16:2 (2021) 214-262.

11. P. A. Forsyth, K. Vetzal, G. Westmacott, “*Optimal control of the decumulation of a retirement portfolio with variable spending and dynamic asset allocation*,” ASTIN Bulletin 51:3 (2021) 905-938.
12. P. M. van Staden, Duy-Minh Dang, P. A. Forsyth, “*Practical investment consequences of the scalarization parameter formulation in dynamic mean-variance portfolio optimization*,” International Journal of Theoretical and Applied Finance 24:5 (2021) Article 2150029, 1-49.
13. P. M. van Staden, Duy-Minh Dang, P. A. Forsyth, “*On the distribution of terminal wealth under dynamic mean-variance optimal investment strategies*,” SIAM Journal on Financial Mathematics 12 (2021) 774-792.
14. P. A. Forsyth, “*Two stage decumulation strategies for DC plan investors*,” International Journal for Theoretical and Applied Finance, 24:1 (2021) Article 2150007, 1-31.
15. P. M. van Staden, Duy-Minh Dang, P. A. Forsyth, “*The surprising robustness of dynamic Mean-Variance portfolio optimization to model misspecification errors*,” European Journal of Operational Research 289:2 (2021) 774-792.
16. P. A. Forsyth, K. R. Vetzal, G. Westmacott, “*Optimal asset allocation for DC pension decumulation with a variable spending rule*,” ASTIN Bulletin 50:2 (2020) 419-447.
17. P. A. Forsyth, “*Optimal dynamic asset allocation for DC plan accumulation/decumulation: Ambition-CVAR*,” Insurance: Mathematics and Economics 93 (2020) 230-245.
18. P. A. Forsyth, “*Multi-period mean-CVAR asset allocation: is it advantageous to be time consistent?*” SIAM Journal on Financial Mathematics 11:2 (2020) 358-384.
19. M. Insley, P.A. Forsyth, “*Climate Games: Who’s on first? What’s on second?*” l’Actualite Economique 95:2-3 (2019) 287-322.
20. P. M. van Staden, D-M Dang and P.A. Forsyth, “*Mean-quadratic variation portfolio optimization: A desirable alternative to time-consistent mean-variance optimization?*” SIAM Journal on Financial Mathematics 10:3 (2019) 815-856.
21. P.A. Forsyth, K.R. Vetzal and G. Westmacott, “*Management of portfolio depletion risk through optimal life cycle asset allocation*,” North American Actuarial Journal 23:3 (2019) 447-468.
22. P.A. Forsyth and K.R. Vetzal, “*Optimal asset allocation for retirement savings: deterministic vs. time consistent adaptive strategies*,” Applied Mathematical Finance 26:1 (2019) 1-37.
23. Y. Li and P.A. Forsyth, “*A data driven Neural Network approach to optimal asset allocation for target based defined contribution pension plans*,” Insurance: Mathematics and Economics 86 (2019) 189-204.

24. P.A. Forsyth, G. Labahn, “ ϵ -Monotone Fourier methods for optimal stochastic control in finance,” *Journal of Computational Finance* 22:4 (2019) 25-71.
25. P. van Staden, D-M. Dang and P.A. Forsyth, “Time-consistent mean-variance portfolio optimization: a numerical impulse control approach,” *Insurance: Mathematics and Economics* 83 (2018) 9-28.
26. K.L. Miller, S.J. Berg, J.H. Davison, E.A. Sudicky, P.A. Forsyth, “Efficient uncertainty quantification in fully-integrated surface and subsurface hydrologic simulations,” *Advances in Water Resources* 111 (2018) 381-394.
27. P.A. Forsyth and K.R. Vetzal “Dynamic mean variance asset allocation: tests for robustness,” *International Journal of Financial Engineering* 4:2 (2017) 1750021 (electronic).
28. P.A. Forsyth and K.R. Vetzal, “Robust asset allocation for long-term target-based investing,” *International Journal of Theoretical and Applied Finance* 20:3 (2017) 1750017 (electronic).
29. K. Ma, P.A. Forsyth “An unconditionally monotone numerical scheme for the two factor uncertain volatility model,” *IMA Journal of Numerical Analysis* 37 (2017) 905-944.
30. D.M. Dang, P.A. Forsyth, K.R. Vetzal, “The 4% strategy revisited: A pre-commitment optimal mean-variance approach to wealth management,” *Quantitative Finance* 17 (2017) 335-351.
31. P. Azimzadeh, P.A. Forsyth, “Weakly chained matrices and impulse control,” *SIAM Journal on Numerical Analysis* 54 (2016) 1341-1364.
32. C. Reisinger, P.A. Forsyth, “Piecewise constant policy approximations to Hamilton-Jacobi-Bellman equations,” *Applied Numerical Mathematics* 103 (2016) 27-47.
33. K. Ma, P.A. Forsyth, “Numerical solution of the Hamilton-Jacobi-Bellman formulation for continuous time mean variance asset allocation under stochastic volatility,” *Journal of Computational Finance* 20:1 (2016) 1-37.
34. D.M. Dang, P.A. Forsyth, Y. Li, “Convergence of the embedded mean-variance optimal points with discrete sampling,” *Numerische Mathematik* 132 (2016) 271-302.
35. D.M. Dang, P.A. Forsyth, “Better than pre-commitment mean-variance portfolio allocation strategies: a semi-self-financing Hamilton-Jacobi-Bellman equation approach,” *European Journal of Operational Research* 250 (2016) 827-841.
36. P. Azimzadeh, P.A. Forsyth, “The existence of optimal bang-bang controls for GMxB contracts,” *SIAM Journal on Financial Mathematics* 6 (2015) 117-139.

37. H.-T. Hwang, Y.-J. Park, E.A. Sudicky, P.A. Forsyth “*A parallel computational framework to solve flow and transport in integrated surface-subsurface hydrologic systems,*” *Environmental Modelling and Software* 61 (2014) 39-58.
38. P.A. Forsyth, K.R. Vetzal “*An optimal stochastic control framework for determining the cost of hedging of variable annuities,*” *Journal of Economic Dynamics and Control* 44 (2014) 29-53.
39. S.T. Tse, P.A. Forsyth, Y. Li, “*Preservation of scalarization optimal points in the embedding technique for continuous time mean variance optimization,*” *SIAM Journal on Control and Optimization* 52 (2014) 1527-1546.
40. D.M. Dang, P.A. Forsyth “*Continuous time mean-variance optimal portfolio allocation under jump diffusion: a numerical impulse control approach,*” *Numerical Methods for Partial Differential Equations* 30 (2014) 664-698.
41. J. Babbin, P.A. Forsyth, G. Labahn, “*A comparison of iterated optimal stopping and local policy iteration for American options under regime switching,*” *Journal of Scientific Computing* 58 (2014) 409-430.
42. S.T. Tse, P.A. Forsyth, J.S. Kennedy, H. Windcliff, “*Comparison between the mean variance optimal and mean quadratic variation optimal trading strategies,*” *Applied Mathematical Finance* 20 (2013) 415-449.
43. Y. Huang, P.A. Forsyth, G. Labahn, “*Inexact arithmetic considerations for direct control and penalty methods: American options under jump diffusion,*” *Applied Numerical Mathematics* 72 (2013) 33-51.
44. P.A. Forsyth, J.S. Kennedy, S.T. Tse, H. Windcliff, “*Optimal trade execution: a mean quadratic variation approach,*” *Journal of Economic Dynamics and Control* 36 (2012) 1971-1991.
45. Y. Huang, P.A. Forsyth, G. Labahn, “*Combined fixed point and policy iteration for HJB equations in finance,*” *SIAM Journal on Numerical Analysis* 50 (2012) 1849-1860.
46. Y. Huang, P.A. Forsyth, G. Labahn, “*Iterative methods for the solution of a singular control formulation of a GMWB pricing problem,*” *Numerische Mathematik* 122 (2012) 133-167.
47. J. Wang and P.A. Forsyth, “*Comparison of mean variance like strategies for optimal asset Allocation problems.*” *International Journal of Theoretical and Applied Finance* 15:2 (2012) (33 pages: DOI: 10.1142/S0219024912500148).
48. I. Huang and P.A. Forsyth, “*Analysis of a penalty method for pricing a Guaranteed Minimum Withdrawal Benefit (GMWB).*” *IMA Journal on Numerical Analysis* 32 (2012) 320-351.

49. Y. Huang, P.A. Forsyth, G. Labahn, “*Methods for American options under regime switching,*” SIAM Journal on Scientific Computing 33 (2011) 2144-2168.
50. P.A. Forsyth, “*A Hamilton Jacobi Bellman approach to optimal trade execution.*” Applied Numerical Mathematics 61 (2011) 241-265.
51. J. Wang and P.A. Forsyth, “*Continuous time mean variance asset allocation: a time consistent strategy.*” European Journal of Operational Research 209 (2011) 184-201.
52. Z. Chen, P.A. Forsyth “*Implications of a regime-switching model on natural gas storage valuation and optimal operation,*” Quantitative Finance 10 (2010) 159-176.
53. J. Wang, P.A. Forsyth. “*Numerical solution of the Hamilton Jacobi Bellman Formulation for continuous time mean variance asset allocation.*” Journal of Economic Dynamics and Control 34 (2010) 207-230.
54. A. C. Belanger, P.A. Forsyth, G. Labahn, “*Valuing the guaranteed minimum death benefit clause with partial withdrawals,*” Applied Mathematical Finance 16 (2009) 451-496.
55. J.S. Kennedy, P.A. Forsyth, K.R. Vetzal, “*Dynamic hedging under jump diffusion with transaction costs,*” Operations Research 57 (2009) 541-559.
56. Y. Huang, P.A. Forsyth, K.R. Vetzal, “*Valuing guarantees on spending funded by endowments,*” Canadian Applied Mathematics Quarterly 17 (2009) 661-702.
57. Z. Chen, K.R. Vetzal, P.A. Forsyth, “*The effect of modelling parameters on the Value of GMWB Guarantees,*” Insurance: Mathematics and Economics 43 (2008) 165-173.
58. A.C. Belanger, P.A. Forsyth, “*Infinite reload options: pricing and analysis,*” Journal of Computational and Applied Mathematics 222 (2008) 54-81.
59. Z. Chen, P.A. Forsyth, “*A Numerical scheme for the impulse control formulation for pricing variable annuities with a Guaranteed Minimum Withdrawal Benefit (GMWB),*” Numerische Mathematik 109 (2008) 535-569.
60. S.S. Clift, P.A. Forsyth, “*Numerical solution of two asset jump diffusion models,*” Applied Numerical Mathematics 58 (2008) 743-782.
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