Andrew Papanicolaou

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EMPLOYMENT

- North Carolina State University (Aug. 2023-present)
  Associate Professor in Department of Mathematics
- North Carolina State University (Aug. 2020-Aug. 2023)
  Assistant Professor in Department of Mathematics
- New York University Tandon School of Engineering (Sept. 2015-Aug. 2020)
  Assistant Professor in Department of Finance & Risk Engineering
- The University of Sydney (Jul. 2013-Jun. 2015)
  Lecturer in School of Mathematics & Statistics
- Princeton University (Sep. 2010-Jun. 2013)
  Post-Doctoral Researcher/Lecturer in Department of Operations Research & Financial Engineering

EDUCATION

- Brown University
  Ph.D. in Division of Applied Mathematics (May 2010)
  Thesis: New Methods in Theory & Applications of Nonlinear Filtering,
  Advisor: Boris Rozovsky
- University of Southern California
  M.S. in Financial Mathematics (May 2007)
- University of California at Santa Barbara B.S. in Mathematical Sciences (June 2003).

AWARDS

- NSF DMS-2319419, September 2023-August 2024, "Conference: 7th Eastern Conference on Mathematical Finance".
- John Griggs Faculty Award (May 2022), recognizing outstanding junior tenure track faculty research
- NSF DMS-1907518, August 2019-March 2022, "Deep Neural Networks for Solving Non-Markov Optimization Problems".
- University Research Challenge Fund, NYU Provost, June 1, 2019 - November 30, 2020, project title: "Machine Learning for Non-Markov Decision Problems."
- Goddard Junior Faculty Fellowship, NYU Steinhardt, June 2018.
- Fellow at the Institute for Pure and Applied Mathematics (IPAM), National Science Foundation, Spring 2015 Program on "Broad Perspectives and New Directions in Financial Mathematics."
- Australian Research Council, Discovery Early Career Research Award (DECRA), October 2015 (declined to accept).

PUBLICATIONS

1. Dai, Bolun, Prashanth Krishnamurthy, Andrew Papanicolaou, and Farshad Khorrami. "State constrained stochastic optimal control for continuous and hybrid dynamical systems using DFBSDE." *Automatica* 155 (2023): 111146.
DOI:10.1016/j.automatica.2023.111146

2. Papanicolaou, Andrew, Hao Fu, Prasanth Krishnamurthy, Brian Healy, and Farshad Khorrami. "An optimal control strategy for execution of large stock orders using long short-term memory networks." *Journal of Computational Finance* 26, no. 4 (2023).
DOI: 10.21314/JCF.2023.003

3. Papanicolaou, Andrew, Hao Fu, Prasanth Krishnamurthy, and Farshad Khorrami,"A Deep Neural Network Algorithm for Linear-Quadratic Portfolio Optimization with MGARCH and Small Transaction Costs." *IEEE Access* 11, (2023): 16774-16792.
DOI: 10.1109/ACCESS.2023.3245570

4. Avellaneda, Marco, Brian Healy, Andrew Papanicolaou, and George Papanicolaou. "Principal eigenportfolios for US equities." *SIAM Journal on Financial Mathematics* 13, no. 3 (2022): 702-744.
DOI:10.1137/20M1383501

5. Li, Thomas Nanfeng, and Andrew Papanicolaou. "Statistical arbitrage for multiple co-integrated stocks." *Applied Mathematics & Optimization* 86, no. 1 (2022): 12.
DOI:10.1007/s00245-022-09838-3

6. Papanicolaou, Andrew. "Consistent time-homogeneous modeling of SPX and VIX derivatives." *Mathematical Finance* 32, no. 3 (2022): 907-940.
DOI:10.1111/mafi.12348

7. Bossu, Sébastien, Peter Carr, and Andrew Papanicolaou. "Static replication of European standard dispersion options." *Quantitative Finance* 22, no. 5 (2022): 799-811.
DOI:10.1080/14697688.2022.2040743

8. Avellaneda, Marco, Thomas Nanfeng Li, Andrew Papanicolaou, and Gaozhan Wang. "Trading signals in VIX futures." *Applied Mathematical Finance* 28, no. 3 (2021): 275-298.
DOI:10.1080/1350486X.2021.2010584

9. Amir-Ghassemi, Faryan, Andrew Papanicolaou, and Michael Perlow. "Aggregate alpha in the hedge fund industry: a further look at Best Ideas." *The Journal of Portfolio Management* 48, no. 3 (2022): 220-239.
DOI:10.3905/jpm.2021.1.313

10. Dai, Bolun, Prashanth Krishnamurthy, Andrew Papanicolaou, and Farshad Khorrami. "State constrained stochastic optimal control using LSTMs." In 2021 *American Control Conference (ACC)*, pp. 1294-1299. IEEE, 2021.
DOI: 10.23919/ACC50511.2021.9482832.

11. Bossu, Sébastien, Peter Carr, and Andrew Papanicolaou. "A functional analysis approach to the static replication of European options." *Quantitative Finance* 21, no. 4 (2021): 637-655.
DOI: 10.1080/14697688.2020.1810857

12. Avellaneda, Marco, Brian Healy, Andrew Papanicolaou, and George Papanicolaou. "PCA for implied volatility surfaces." *The Journal of Financial Data Science* 2, no. 2 (2020): 85-109.
DOI: 10.3905/jfds.2020.1.032

13. Chandra, Shiva, and Andrew Papanicolaou. "Singular Perturbation Expansion for Utility Maximization with Order-ϵ Quadratic Transaction Costs." Forthcoming, *International Journal of Theoretical and Applied Finance* (2019).
DOI: 10.1142/S0219024919500390

14. Avellaneda, Marco, and Andrew Papanicolaou. "Statistics of VIX futures and applications to trading volatility exchange-traded products." *International Journal of Theoretical and Applied Finance* 22, no. 01 (2019): 1850061.
DOI: 10.1142/S0219024918500619

15. Amaral, Lucas Rabechini, and Andrew Papanicolaou. "Price impact of large orders using Hawkes processes." *The ANZIAM Journal* 61, no. 2 (2019): 161-194.
DOI: 10.1017/S1446181119000038

16. Papanicolaou, Andrew. "Backward SDEs for control with partial information." *Mathematical Finance* 29, no. 1 (2019): 208-248.
DOI: 10.1111/mafi.12174

17. Papanicolaou, Andrew. "Extreme-strike comparisons and structural bounds for SPX and VIX options." *SIAM Journal on Financial Mathematics* 9, no. 2 (2018): 401-434.
DOI. 10.1137/141001615

18. Papanicolaou, Andrew, and Konstantinos Spiliopoulos. "Dimension reduction in statistical estimation of partially observed multiscale processes." *SIAM/ASA Journal on Uncertainty Quantification* 5, no. 1 (2017): 1220-1247.
DOI: 10.1137/16M1085930

19. Fouque, J-P., Andrew Papanicolaou, and Ronnie Sircar. "Perturbation analysis for investment portfolios under partial information with expert opinions." *SIAM Journal on Control and Optimization* 55, no. 3 (2017): 1534-1566.
DOI: 10.1137/15M1006854

20. Lee, Sangmin, and Andrew Papanicolaou. "Pairs trading of two assets with uncertainty in co-integration's level of mean reversion." *International Journal of Theoretical and Applied Finance* 19, no. 08 (2016): 1650054.
DOI:10.1142/S0219024916500540

21. Papanicolaou, Andrew. "Analysis of VIX markets with a time-spread portfolio." *Applied Mathematical Finance* 23, no. 5 (2016): 374-408.
DOI: 10.1080/1350486X.2017.1290534

22. Fouque, Jean-Pierre, Andrew Papanicolaou, and Ronnie Sircar. "Filtering and portfolio optimization with stochastic unobserved drift in asset returns." *Communications in Mathematical Sciences* 13, no. 4 (2015): 935-953.
DOI: 10.4310/CMS.2015.v13.n4.a5

23. Papanicolaou, Andrew, and Konstantinos Spiliopoulos. "Filtering the maximum likelihood for multiscale problems." *Multiscale Modeling & Simulation* 12, no. 3 (2014): 1193-1229.
DOI: 10.1137/140952648

24. Fuertes, Carlos, and Andrew Papanicolaou. "Implied filtering densities on the hidden state of stochastic volatility." *Applied Mathematical Finance* 21, no. 6 (2014): 483-522.
DOI: 10.1080/1350486X.2014.891357

25. Papanicolaou, Andrew, and Ronnie Sircar. "A regime-switching Heston model for VIX and S&P 500 implied volatilities." *Quantitative Finance* 14, no. 10 (2014): 1811-1827.
DOI: 10.1080/14697688.2013.814923

26. Papanicolaou, Andrew. "Dimension reduction in discrete time portfolio optimization with partial information." *SIAM Journal on Financial Mathematics* 4, no. 1 (2013): 916-960.
DOI: 10.1137/16M1085930

27. Papanicolaou, Andrew. "Nonlinear filters for hidden Markov models of regime change with fast mean-reverting states." *Multiscale Modeling & Simulation* 10, no. 3 (2012): 906-935.
DOI: 10.1137/110819937

28. Papanicolaou, Andrew. "Filtering for fast mean-reverting processes." *Asymptotic analysis* 70, no. 3-4 (2010): 155-176.
DOI: 10.3233/ASY-2010-1011

INVITED TALKS AND SEMINARS

1. *Market Microstructure, Quantitative Trading, High Frequency, and Large Data* "Implied impermanent loss: a cross-sectional analysis of decentralized liquidity pools" Chicago, IL.

2. *Mathematical Modeling in Finance: Remembering Marco Avellaneda (April 2024)* "Eigen portfolio construction: Name space vs rank space" New York, NY.

3. *UNCC Department of Mathemaics Colloquium (April 2024)* "Principal Eigenportfolios and Primary Factors " Charlotte,NC.

4. *NC State Operations Research Seminar (October 2023)* "The Expected Impermanent Loss in Decentralized Liquidity Provision: Cross-Sectional Evidence from Cryptocurrency Options" Raleigh, NC.

5. *Peer-to-Peer Financial Systems Workshop 2023 (P2PFISY) (September 2023)* "Yield Farming for Liquidity Provision" Rome, It.

6. *Duke Probability Seminar (April 2023)* "Principal Eigenportfolios and Primary Factors" Durham, NC.

7. *KSIAM-MINDS-NIMS International Conference on Machine Learning and PDEs: Theory, Algorithms, and Its Applications (August 2022)* "Partial Information Learning in General-Sum Nash Games" Seoul, Korea.

8. *CFMAR Virtual Seminar in UCSB PSTAT Department (April 2021)* "Consistent Inter-Model Specification for Time-Homogeneous SPX Stochastic Volatility and VIX Market Models" Santa Barbara, CA.

9. *Rutgers-Princeton Finance Seminar (December 2020)* "Principal Eigenportfolios for U.S. Equities" Rutgers, NJ.

10. *Frontiers in Quantitative Finance Seminar (May 2020)* "PCA for Implied Volatility Surfaces" Oxford, UK.

11. *Princeton ORFE Department (February 2020)* "PCA for Implied Volatility Surfaces" Princeton, NJ.

12. *Lehigh University Industrial & Systems Engineering (February 2020)* "PCA for Implied Volatility Surfaces" Lehigh, PA.

13. *NC State Math Dept. (February 2020)* "PCA for Implied Volatility Surfaces" Raleigh, NC.

14. *UCLA Probability Seminar (January 2020)* "PCA for Implied Volatility Surfaces" Los Angeles, CA.

15. *IAQF Thalesians Seminar (January 2020)* "PCA for Implied Volatility Surfaces" New York, NY.

16. *Stanford University, Advanced Financial Technologies Laboratory Seminar (December 2019)* "PCA for Implied Volatility Surfaces" Stanford, CA.

17. *Illinois Institute of Technology, Applied Mathematics Seminar (October 2019)* "Tensor PCA for Implied Volatility Surfaces" Chicago, Ill.

18. *U. of Connecticut Proability Seminar (September 2019)* "Tensor PCA for Implied Volatility Surfaces" Hartford, CT.

19. *Courant Mathematical Finance Seminar (Apr. 2019)* "Reduced Order Representation of Implied Volatility Surfaces" New York, NY.

20. *Machine Learning and Statistics Seminar (Feb. 2019)* "Implied Vol. PCA" Knoxville, TN.

21. *Laboratoire LJLL-UPMC, INRIA-UPMC Seminar (Feb. 2019)* "Représentation réduite des surfaces de volatilité implicites." (talk given in English) Paris, France.

22. *UC Irvine, Applied and Computational Mathematics Seminar (Nov. 2018)* "Consistent Inter-Model Specification for Time-Homogeneous SPX Stochastic Volatility and VIX Market Models" Irvine, CA.

23. *Tulane U., Probability and Statistics Seminar (Nov. 2018)* "Consistent Inter-Model Specification for Time-Homogeneous SPX Stochastic Volatility and VIX Market Models" New Orleans, LA.

24. *3rd Eastern Conference on Mathematical Finance (October 2018)* "Statistics of VIX futures and their applications to trading volatility exchange-traded products" Chicago IL.

25. *Johns Hopkins U. Applied Math Student Seminar (Oct. 2018)* "Consistent Inter-Model Specification for Time-Homogeneous SPX Stochastic Volatility and VIX Market Models" Baltimore, MA.

26. *U. of Toronto/Fields Institute (February 2018)* "Mean Reversion in VSTOXX & VIX Futures" Toronto, Canada

27. *U. of Connecticut Mathematical Finance Seminar (February 2018)* "Mean Reversion in VSTOXX & VIX Futures" Hartford, CT.

28. *Qplum (Sept 2017)* "A Quantitative Approach to Contango in VIX Futures" Jersey City, NJ

29. *Sydney Dynamics Group (Aug 2017)* "A Quantitative Approach to Contango in VIX Futures" Sydney, NSW, Australia

30. *U. of Chicago, Market Microstructure and High-Frequency Data (June 2017)* "Trading Illiquid Goods: Market Making as a Sequence of Sealed-Bid Auctions, with Analytic Results" Chicago, IL.

31. *Worcester Polytechnic Stochastic Analysis and Financial Mathematics Common Seminar Series (May 2017)* "Trading in VIX Derivatives" Worcester, MA.

32. *IAQF Thalesians Seminar (April 2017)* "Trading in VIX Derivatives" New York, NY.

33. *Stevens Institute of Technology Financial Engineering Seminar Series (December 2016)* "Analysis of VIX Markets with a Time-Spread Portfolio" Hoboken, NJ.

34. *1st Eastern Conference on Mathematical Finance (March 2016)* "Numerical Methods for Backward SDEs for Control with Partial Information" Worcester, MA.

35. *IPAM workshop on Commodity Markets and their Financialization (May 2015)* "Investment in Commodities ETFs and Management of Contango " Los Angeles, CA.

36. *Groupe de Travail: Finance mathématique, probabilités numériques et statistique des processus (January 2015)* "Extreme-Strike Comparisons and Structural Bounds for the VIX and SPX Options Markets" Paris, France.

37. *London Mathematical Finance Seminar Series (January 2015)* "Extreme-Strike Comparisons and Structural Bounds for the VIX and SPX Options Markets" London, UK.

38. *New Directions in Financial Mathematics and Mathematical Economics (Jul. 2014)* "Control with Partial Information", Banff, Alberta Canada.

39. University of Sydney Financial Mathematics Seminar "Mean-Field Games in Finance" (Nov. 14, 21, and 28, 2013) Sydney, NSW.

40. *The 5th Western Conference on Mathematical Finance (May 2013)* "Filtering the Maximum Likelihood for Multiscale Problems" Stanford, CA.

41. *Applied Mathematics Colloquium at Caltech (Nov. 2012)* "Dimension Reduction in Discrete Time Portfolio Optimization with Partial Information" Pasadena, CA.

42. *Boston University Department of Mathematics & Statistics (Oct. 2012)* "Dimension reduction of the Bellman equations for maximum expected utility with partial information in discrete time" Boston, MA.

43. *IMS on Finance: Probability and Statistics (FPS), Workshop on Probability and Statistics in Finance (May 2012)* "Option Pricing with Filtering of Partial Information" Berkeley, CA.

44. *Humboldt-Princeton Conference (Oct. 2011)* "Nonlinear Filters For Hidden Markov Models Of Regime Change with Fast Mean-Reverting States" Berlin, Germany.

45. *Princeton-Lausanne Conference (May 2011)* Discussion for L. Mancini's "The Term Structure of Variance Swaps, Risk Premia and the Expectation Hypothesis" Lausanne, Switzerland.

46. *Princeton University, Department of ORFE Stochastic Analysis Seminar (Feb. 2010)* "Nonlinear Filtering for Telescoping Markov Chains and Applications to Evolving Images" Princeton, NJ.

47. *UC Irvine Applied Mathematics Seminar (Jan. 2010)* "Nonlinear Filtering for Telescoping Markov Chains and Applications to Evolving Images" Irvine, CA.

CONTRIBUTED TALKS

1. *7th Shanghai-Edinburgh-UCL Fintech Conference (Nov. 2023)* "Yield Farming for Liquidity Provision" Online.

2. *2023 SIAM Financial Mathematics and Engineering (Jun. 2023)* "Manoeuvring and Investing in Yield Farms" Philadelphia, PA.

3. *AMS Spring Southeastern Sectional Meeting (Mar. 2023)* "Partial-Information Learning Algorithms in General-Sum Nash Games" Atlanta, GA.

4. *SIAM MDS (Sept. 2022)* "Principal Eigenportfolios and Primary Factors" San Diego, CA.

5. "PCA for Implied Volatility Surfaces" SIAM Annual Meeting (July 2021)

6. "Consistent Inter-Model Specification for Time-Homogeneous SPX Stochastic Volatility and Vix Market Models" SIAM Conference in Financial Mathematics (June 2021)

7. "Trade Signals in VIX Futures" American Mathematical Society Joint Mathematics Mathematics Meeting (Jan. 2021)

8. AMS Joint Mathematics Meeting (Jan. 2019) "Nonlinear Filtering and Non-Markov Control in Financial Portfolio Optimization." Baltimore, MD.

9. *10th World Congress of the Bachelier Finance Society (June 2018)* "Statistics of VIX & VSTOXX Futures with Applications to Trading Volatility Exchange-Traded Products" Dublin, Ireland.

10. *2018 SIAM Annual Meeting (June 2018)* "Consistent Inter-Model Specification for Stochastic Volatility and VIX Market Models " Portland, OR.

11. *First Congress of Greek Mathematicians (June 2018)* "Consistent Inter-Model Specification for Stochastic Volatility and VIX Market Models" Athens, Greece.

12. *INFORMS Annual Meeting (Oct 2017)* "Trading Illiquid Goods: Market Making as a Sequence of Sealed-Bid Auctions." Houston, TX.

13. SIAM Conference on Financial Mathematics (Nov 2016) "Analysis of VIX Markets with a Time-Spread Portfolio." Austin, TX.

14. AMS Sectional Meeting, (April 2016) "Numerical Methods for Backward SDEs for Control with Partial Information" Athens GA

15. AMS Central Fall Sectional Meeting (Oct. 2015) "Backward SDEs for Control with Partial Information." Loyola University, Ill.

16. SIAM Conference on Financial Mathematics and Engineering (Nov. 2014) "Perturbation Analysis on Decision-Making for Investment Portfolios Under Partial Information" Chicago, Illinois.

17. AMS Joint Mathematics Meeting, SIAM Minisymposium on Recent Advances in Financial Mathematics (Jan. 2014) "Dimension Reduction in Discrete Time Portfolio Optimization with Partial Information" Baltimore, Maryland.

18. Quantitative Methods in Finance (Dec. 2013) "A Regime-Switching Heston Model for VIX and S&P 500 Implied Volatilities" Sydney, New South Wales.

19. AMS Spring Eastern Sectional Meeting Boston College (Apr. 2013) "A Regime- Switching Heston Model for VIX and S&P 500 Implied Volatilities" Chestnut Hill, Massachusetts.

20. AMS Joint Mathematics Meeting, Special Session on Financial Mathematics (Jan. 2013) "Asymptotic Expansion of Regime-Switching Models for Consistent Pricing of VIX and S&P500 Derivatives" San Diego, California.

21. SIAM Conference on Financial Mathematics and Engineering (Jul. 2012) "Option Pricing with Filtering of Partial Information" Minneapolis, Minnesota.

22. Stochastic Modeling Techniques and Data Analysis International Conference (Jun. 2010) "Nonlinear Filtering for Telescoping Markov Chains and Applications to Evolving Images" Chania Crete, Greece.

MEDIA COVERAGE   News article published on Risk.net discussing insight offered by VIX research: *"VIX curve gave warning of February volatility spike"*

STUDENTS

PhD Students
- Soham Mudalgikar (expected May 2024)

- Yangfan Cui (expected May 2025)

- Marwen Zrida "Portfolio Management and Asset Pricing amid Contagion and Illiquidity Risks: A Stochastic and Deep Learning Approach" (May 2022) Co-advisor to Prof. Negash Medhin

- Sebastien Bossu, "Static replication of European options and dynamic replication of correlation swaps" (October 2021) Co-advised with Stephane Crepey and Peter Carr, defended at Paris Saclay.

- Tom Li, "Optimal Pairs Trading Strategies Utilising the Stochastic Control Approach" (May 2019)

Masters Thesis Students
- Yangfan Cui, NYU Tandon (2019)
- Chang Liu, NYU Tandon (2018)
- Kourosh Ghobadi, NYU Tandon (2018)
- Zhao Ma, NYU Tandon (2018)
- Ruijing Yang, NYU Tandon (2018)
- Shiva Chandra, NYU Tandon (2017),
- Lucas Amaral, NYU Tandon (2017),
- Yonghyun Kwon, NYU Tandon (2017)
- Sangmin Lee, NYU Tandon (2016),
- Carlos Fuertes, Princeton (2011)

SERVICE ACTIVITIES

- Conference Organizer, "7th Annual Eastern Conference on Mathematical Finance" October 2023 ECMF2023
- Conference Organizer, "New Ideas & Cutting-Edge Developments in Fin-Tech" May 2018 QUANTFIN2018
- Conference Organizer, "2nd Annual Eastern Conference on Mathematical Finance" November 2017 ECMF2017
- Associate Editor, Stochastic Models (Taylor & Francis) 2020-present
- Associate Editor, Risk and Decision Analysis (IOS Press) 2017-2019
- Journals Refereed for (most frequently):

    – Mathematical Finance: An International Journal of Mathematics, Statistics, and Financial Economics (Wiley)
    – Quantitative Finance (Taylor & Francis)
    – Applied Mathematical Finance (Taylor & Francis)
    – SIAM Journal on Financial Mathematics (SIAM Publishing)
    – International Journal of Theoretical and Applied Finance (World Scientific)