

# Paul Sangrey

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## EDUCATION

**University of Pennsylvania**

PH.D. ECONOMICS

**Grove City College**

B.S. MATHEMATICS AND ECONOMICS

Philadelphia, PA | May 2019

Grove City, PA | May 2013

## WORK EXPERIENCE

**AMAZON : SCOT TOPLINE FORECASTING** | ECONOMIST I & ECONOMIST II Seattle, WA | June 2019 – Present

- Proposed and led the science effort to build the next generation of daily demand forecasting at Amazon. The new system is interpretable (our stakeholders can understand and control the forecast), accurate (it is as accurate as the high-tuned production system is), and scalable (we can forecast dozens of series simultaneously). For example, we can control how the drivers of the forecast reacted to COVID-19. We configured the response in less than an hour and decreased the average forecast error in the United States by  $\approx 30\%$  relative to the published forecast, which was produced by multiple scientists and business leaders over the course of several months.
- Peer led a team of 2-3 scientists to develop a reconciliation engine that combines forecasts at different levels of aggregation at scale. This effort enables various scientists to each focus on optimizing specific aspects of the forecast while simultaneously maintaining the forecast coherence our customers expect.
- Created a forecast that disaggregated Amazon's Prime member forecast into forecasts of Prime members who shop on Amazon.com and members who use their forecast entirely for digital benefits. This forecast was developed in only a few weeks, entered into Amazon's Prime team's annual planning, satisfied a VP-level goal for the organization, and led to a promotion from Economist I to Economist II.
- Developed a Tableau application and built a SQL backend to evaluate proposed and production forecasts in systematic ways. It enables rigorous, repeated evaluation of forecasting models along standard set of qualitative and quantitative metrics.
- Proposed a science architecture for SCOT Topline Forecasting. Topline forecasts demand and drives Amazon Consumer's short- and long-run planning, including hiring, transportation contracts, and Wall Street guidance. The proposed architecture decomposes forecasting into a series of distinct components with well-defined interfaces and a series of science libraries to disentangle ownership between the engineering and science teams thereby enabling faster iteration across both teams.

**UNIVERSITY OF PENNSYLVANIA** | INSTRUCTOR, RESEARCH ASSISTANT, AND RECITATION INSTRUCTOR

Philadelphia, PA | August 2014 - August 2018

- Taught International Economics twice covering both international trade and international finance. This class attracted students from both inside and outside of economics and attracted both domestic and international students. I received an average evaluation measuring how much the students learned of 3.5/5 compared to a class average's evaluation of 2.4/5.
- Led recitations for both econometrics and introduction to microeconomics classes.
- Researched both econometrics and macroeconomics as an assistant to multiple professors.

## PAPERS

**SUMAS: STATE-SPACE FORECASTING AT AMAZON SCALE**

WITH MIKE BEDARD (AMAZON) AND MATT JOHNSON (AMAZON)

We propose a novel architecture for time series models built upon state-space methods. In particular, we propose joint estimation of many, potentially multivariate, distributions defined using states-space models with linear propagation of shocks. These joint distributions define a novel recurrent neural network. This lets us specify almost arbitrary state-space models using interpretable structural parameters and then pool information across dozens of multivariate series to estimate these parameters.

## WHATCOM: CONSTRAINED FORECAST RECONCILIATION AT SCALE

IN PROGRESS

WITH MATT JOHNSON (AMAZON)

Forecasts are easiest to develop when the scientist can focus on solving one customer problem at a time. However, teams must provide non-contradictory forecasts. In real-world examples with large time and cross-sectional dimensions, state-of-the-art reconciliation procedures become impossible to compute. We provide a novel algorithm that can scale to hundreds of thousands of data-points while maintaining optimality and allowing information to be passed both up and down the hierarchy.

## JUMPS, REALIZED DENSITIES, AND NEWS PREMIA [↗](#)

Announcements and other news continuously barrage financial markets, causing asset prices to jump hundreds of times each day. I derive a tractable nonparametric continuous-time representation for the price jumps, derive an implied sufficient statistic for their dynamics, and show how to consistently estimate this statistic from high-frequency data.

## FEASIBLE MULTIVARIATE DENSITY ESTIMATION USING RANDOM COMPRESSION [↗](#)

WITH MINSU CHANG (GEORGETOWN UNIVERSITY)

Nonparametric density estimators typically converge slowly when the number of series is large. We extend ideas from the random compression literature to nonparametric density estimation and construct an estimator that, with high probability, converges at almost parametric rates even when applied to a large, fixed number of series.

## IDENTIFICATION ROBUST INFERENCE FOR RISK PRICES IN STRUCTURAL STOCHASTIC VOLATILITY MODELS [↗](#)

WITH XU CHENG (UNIVERSITY OF PENNSYLVANIA) AND ERIC RENAULT (UNIVERSITY OF WARWICK)

In structural stochastic volatility asset pricing models, changes in volatility affect risk premia through two channels: the market return risk price and the volatility risk price. We provide uniformly valid confidence intervals for these risk prices regardless of the magnitude of the correlation between volatility and returns.

## SKILLS

**Languages:** Python, SQL, C++, R, MATLAB, Bash,  $\LaTeX$

**Technology:** Git, Tableau, AWS (Batch, ECR, EC2, S3, Glue), OpenMP

## HONORS AND FELLOWSHIPS

2018 University of Pennsylvania, SAS Dissertation Completion Fellowship

2013 Institute for Humane Studies, Humane Studies Fellowship

2013 Grove City College, Franklin C. Ketler Mathematics Prize

## PROFESSIONAL ACTIVITIES

**Presentations** UCSD (Rady), UBC (Sauder) Tillburg, AQR, Penn (Wharton), Penn (Econ), Chicago (SoFie Summer School)  
Stanford (NBER-NSF SBIES Seminar), George Washington University (Student Research Conference)  
Yale (Young Economics Symposium)

**Referee Activity** International Economics Review, Quantitative Economics, Annals of Applied Statistics  
International Journal of Forecasting