

Paul Sangrey

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EDUCATION

University of Pennsylvania

PH.D. ECONOMICS

Grove City College

B.S. MATHEMATICS, ECONOMICS

Philadelphia, PA | May 2019

Grove City, PA | May 2013

WORK EXPERIENCE

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

- Produced the Amazon-wide forecast for Prime Early Access Sale 2022. This was a brand-new event without a historical antecedent. However, Paul produced the most accurate forecast for a major event in Amazon US's history and the 2nd most accurate forecast for Europe.
- Proposed and peer led a science effort to build a next generation of short-horizon demand forecasting and seasonality modeling at Amazon. This forecast would drive much of Amazon Amazon Consumer's operations planning such as hiring, transportation contracts, and fulfillment center construction.
 1. Adapted state-of-the-art econometric time series and neural network models to allow for complex daily seasonality that is driven by events such as Prime Day and Black Friday whose timing and intensity vary across time.
 2. Is approximately 20% more accurate than the highly-tuned production forecast before COVID-19 and approximately 40% more accurate afterwards.
 3. Is highly extensible to new granularities. Running the model on a novel data segmentation without any additional tuning substantially reduced average error relative to the production forecast.
 4. Is interpretable and controllable by our stakeholders. For example, we configured how the drivers of the forecast reacted to COVID-19 in less than an hour.
 5. Is scalable (We can simultaneously forecast hundreds of series.)
- Proposed and peer led a team of scientists to develop a reconciliation engine that combines distributional forecasts at different levels of aggregation at scale.
- 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.
- Proposed a system for evaluating forecasts for Amazon's demand at scale for both point and distributional forecasts using both qualitative and quantitative metrics using SQL and Tableau. This was adopted as the standard used to judge all demand forecasts at Topline.
- Served as the science lead on an the first project using a new engineering architecture for science experimentation. Worked closely with senior engineers as they developed a system for science experimentation at scale, serving as voice of the customer and testing the system.
- Proposed and verified that that recent surges in inflation drive customers to be more sensitive to prices. Estimated time variation in the price elasticity of demand using product-level data showing that changes in price sensitivity explain 40% of unpredicted variation in Prime Day demand in just a few days.

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. Received an average student 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.
- Assisted multiple professors in conducting both econometrics and macroeconomics research.

PAPERS

CROSS-SECTIONAL STATE-SPACE FORECASTING WITH PARTIAL POOLING [↗](#)

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

We propose a novel architecture for time series models built upon state-space methods. We jointly estimate many, potentially multivariate, distributions defined using state-space models by partially pooling their parameters across the cross-section. We leverage the explainability of state-space models and the scalability and flexibility of neural networks to build an accurate, interpretable forecast that is not a black box and outperforms both neural networks and univariate methods since Covid-19.

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.

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.

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.

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. Proposed a new definition describing what it means for independently-produced distributions to be coherent. Provided an algorithm that scales to hundreds of thousands of data-points while maintaining optimality and allowing information to be passed both up and down the hierarchy.

SKILLS

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

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

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. Kettler 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), Intrinsic Time in Finance, Amazon Machine Learning Conference (AMLC) Amazon Economics Annual Research Day, Amazon Consumer Science Summit National Associate for Business Economics Tech Economics Conference 2022

Referee Activity International Economics Review, Quantitative Economics, Annals of Applied Statistics

International Journal of Forecasting, Journal of Business and Economic Statistics, Econometric Reviews