October 19, 2020

Dear Recruiting Chair:

We are pleased to provide the curriculum vitae and research statements/dissertation abstracts of the Penn Economics Ph.D. students who seek employment in this year's job market. Also find below the table, a summary indicating fields of interest and advisors' names.

Full dissertation abstracts and research papers will be supplied directly from the candidates as they apply for positions. Each candidate is also responsible for having confidential letters of recommendation sent upon request.

We encourage you to contact the faculty members who are most familiar with the students’ work (each vita contains a list of faculty references). Also, please feel free to contact either of the placement officers.

If we can help in any way regarding the placement of this year's University of Pennsylvania students, please call or e-mail us.

Sincerely,

Guillermo Ordonez  
Graduate Placement Officer  
ordonez@econ.upenn.edu  
(215) 898-6880

David Dillenberger  
Graduate Placement Officer  
ddill@sas.upenn.edu  
(215) 898-1503
### Placement Coordinator

Guillermo Ordonez  
Associate Professor of Economics  
ordonez@econ.upenn.edu  
215-898-1875

David Dillenberger  
Associate Professor of Economics  
ddill@sas.upenn.edu  
215-898-1503

Gina Conway  
Graduate Coordinator  
Main Department: 215-898-7701

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**SUMMARY LISTING OF DOCTORAL STUDENTS SEEKING EMPLOYMENT, 2020/2021**

<table>
<thead>
<tr>
<th>Candidate Name</th>
<th>Research Interest</th>
<th>Job Market Paper</th>
<th>Faculty Advisor, Email</th>
</tr>
</thead>
</table>
| Gorkem Bostanci         | Macroeconomics (firm dynamics, labor economics, and economics of information)   | Productivity Gains from Labor Outsourcing: The Role of Trade Secrets                                  | Hal Cole  
colehl@sas.upenn.edu  
Guillermo Ordonez  
ordonez@econ.upenn.edu |
| Omer Faruk Koru         | Macroeconomics, labor economics                                                   | Automation and Top Wealth Inequality                                                                  | Hal Cole  
colehl@sas.upenn.edu  
Dirk Krueger  
dkruger@econ.upenn.edu |
| Marc Folch              | Macroeconomics, Labor Economics, Economics of Education, Household Finance        | Go Big or Buy a Home: Student Debt, Career Choices and Wealth Accumulation                            | Jesus Fernandez-Villaverde  
jesusfv@econ.upenn.edu |
| Philippe Goulet Coulombe| Econometrics, Machine Learning, Macroeconomics, Climate                           | The Macroeconomy as a Random Forest                                                                  | Frank Diebold  
fdiebold@econ.upenn.edu  
Frank Schorfheide  
schorf@econ.upenn.edu |
anneo@upenn.edu |
| Youngsoo Heo            | Decision Theory, Microeconomic Theory                                             | The Aversion to Uncertainty about Multiple Issues                                                    | David Dillenberger  
ddill@econ.upenn.edu  
Andy Postlewai  
apostlew@econ.upenn.edu |
hanming.fang@econ.upenn.edu  
Petra Todd  
p todd@sas.upenn.edu |
| Ashwin Kambhampati      | Microeconomic Theory, Industrial Organization, Matching and Market Design         | Robust Performance Evaluation                                                                        | George Mailath  
gmailath@econ.upenn.edu |
| Tomas Larroucau         | Empirical Market design, Matching, Economics of Education, and Labor Economics    | Dynamic College Admissions and the Determinants of Students' College Retention                       | Hanming Fang  
hanming.fang@econ.upenn.edu  
Rakesh Vohra  
rvohra@seas.upenn.edu |
<table>
<thead>
<tr>
<th>Name</th>
<th>Email</th>
<th>Phone</th>
<th>Department</th>
<th>Research Focus</th>
<th>Paper Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanbaek Lee</td>
<td><a href="mailto:hanbaek@sas.upenn.edu">hanbaek@sas.upenn.edu</a></td>
<td>215-827-9213</td>
<td>Macroeconomics, Finance</td>
<td>Striking While the Iron Is Cold: Fragility after a Surge of Lumpy Investments</td>
<td>Jesus Fernandez-Villaverde</td>
<td><a href="jesusfy@econ.upenn.edu">Email</a>, Dirk Krueger <a href="dkruger@econ.upenn.edu">Email</a></td>
</tr>
<tr>
<td>Desen Lin</td>
<td><a href="mailto:desenlin@wharton.upenn.edu">desenlin@wharton.upenn.edu</a></td>
<td>267-905-9192</td>
<td>Urban Economics, Macroeconomics, Household Finance, Real Estate Economics</td>
<td>Housing Search and Rental Market Intermediation</td>
<td>Dirk Krueger <a href="dkruger@econ.upenn.edu">Email</a>, Susan Wachter <a href="wachter@wharton.upenn.edu">Email</a></td>
<td></td>
</tr>
<tr>
<td>Alejandro Sanchez Becerra</td>
<td><a href="mailto:alesan@sas.upenn.edu">alesan@sas.upenn.edu</a></td>
<td>267-908-2105</td>
<td>Applied Econometrics, Networks, Causal Effects</td>
<td>Homophily and Selection: The Network Propensity Score</td>
<td>Xu Cheng <a href="xucheng@econ.upenn.edu">Email</a></td>
<td></td>
</tr>
<tr>
<td>Kris Shaw</td>
<td><a href="mailto:shawkr@sas.upenn.edu">shawkr@sas.upenn.edu</a></td>
<td>613-798-6514</td>
<td>Labour, Public Finance</td>
<td>Progressive Consumption Taxation</td>
<td>Petra Todd <a href="ptodd@sas.upenn.edu">Email</a></td>
<td></td>
</tr>
<tr>
<td>Seung-Ryong Shin</td>
<td><a href="mailto:seushi@sas.upenn.edu">seushi@sas.upenn.edu</a></td>
<td>267-325-4351</td>
<td>Health Economics, Macroeconomics</td>
<td>On Optimal Taxation of Healthy and Unhealthy Goods under the US Health Insurance System</td>
<td>Dirk Krueger <a href="dkruger@econ.upenn.edu">Email</a></td>
<td></td>
</tr>
<tr>
<td>Gabrielle Vasey</td>
<td><a href="mailto:gvasey@sas.upenn.edu">gvasey@sas.upenn.edu</a></td>
<td>215-292-6845</td>
<td>Empirical Microeconomics, Education Economics, Development Economics</td>
<td>How Child Labor Impacts School Enrollment, Student Effort and Achievement in Mexican Middle Schools</td>
<td>Petra Todd <a href="ptodd@sas.upenn.edu">Email</a></td>
<td></td>
</tr>
<tr>
<td>Sergio Villalvazo Martin</td>
<td><a href="mailto:vsergio@sas.upenn.edu">vsergio@sas.upenn.edu</a></td>
<td>267-901-0343</td>
<td>International Economics, Macro-Finance, Public Economics, Macroeconometrics.</td>
<td>Inequality and Asset Prices during Sudden Stops</td>
<td>Enrique Mendoza <a href="egme@econ.upenn.edu">Email</a>, Frank Schorfheide <a href="schorf@econ.upenn.edu">Email</a></td>
<td></td>
</tr>
<tr>
<td>Jianhong Xin</td>
<td><a href="mailto:jxin@sas.upenn.edu">jxin@sas.upenn.edu</a></td>
<td>215-407-9585</td>
<td>Macro and Labor Economics, Empirical Methods Combining Economic Theory with Machine Learning and Cluster Analysis</td>
<td>Measuring the Effects of Co-workers on Wages</td>
<td>Iourii Manovskii <a href="manovski@econ.upenn.edu">Email</a></td>
<td></td>
</tr>
<tr>
<td>Wu Zhu</td>
<td><a href="mailto:zhuwu@sas.upenn.edu">zhuwu@sas.upenn.edu</a></td>
<td>215-285-8924</td>
<td>Macroeconomics, Finance, Machine Learning, and Network Economics</td>
<td>Networks and Business Cycles</td>
<td>Rakesh Vohra <a href="rvohra@seas.upenn.edu">Email</a>, Linda Zhao <a href="lzhao@wharton.upenn.edu">Email</a></td>
<td></td>
</tr>
</tbody>
</table>
UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez
   ORDONEZ@ECON.UPENN.EDU   215-898-1875
Placement Director: David Dillenberger
   DDILL@ECON.UPENN.EDU   215-898-1503
Graduate Student Coordinator: Gina Conway
   GNC@SAS.UPENN.EDU   215-898-5691

Office Contact Information:
The Ronald O. Perelman Center for Political Science and Economics, Room 535
133 South 36th Street
Philadelphia, PA 19104
Phone: 267-432-3452

Personal Information: Male, Turkey (F-1 Visa)

Undergraduate Studies:
   B.S. in Industrial Engineering, Middle East Technical University, Turkey, 2013

Masters Level Work:
   M.A. in Economics, Koc University, Turkey, 2015

Graduate Studies:
   University of Pennsylvania, 2015 to present
   Thesis Title: “Essays on Firm Level Distortions and Aggregate Productivity”
   Expected Completion Date: May 2021

Thesis Committee and References:
   Professor Guillermo Ordonez (Co-Advisor)
   Department of Economics
   University of Pennsylvania
   133 South 36th Street, Suite 505,
   Philadelphia, PA, 19104
   Phone: 215-898-1875
   E-mail: ordonez@econ.upenn.edu

   Professor Harold L. Cole (Co-Advisor)
   Department of Economics
   University of Pennsylvania
   133 South 36th Street, Suite 517,
   Philadelphia, PA, 19104
   Phone: 215-898-7788
   E-mail: colehl@sas.upenn.edu

   Professor Aviv Nevo
   Department of Economics
   University of Pennsylvania
   133 South 36th Street, Suite 617,
   Philadelphia, PA, 19104
   Phone: 215-898-0499
   E-mail: anevo@upenn.edu

Teaching and Research Fields:
   Primary fields: Macroeconomics
   Secondary fields: Firm Dynamics, Labor Economics, Information Economics
**Teaching Experience:**

**University of Pennsylvania**
- **Summer 2017-2020**: Introduction to Econometrics, Instructor (4 semesters)
- **Summer 2018, 2019**: Public Speaking, Debating and Persuasion (High School), Instructor
- **Spring 2020**: Introduction to Econometrics, Recitation Instr. for Prof. John Lazarev
- **Fall 2019**: Labor Economics, Teaching Asst. for Prof. Petra Todd
- **Spring 2017**: Econometrics II (Graduate), Recitation Instr. for Prof. Frank Schorheide
- **Fall 2016**: Macroeconomic Theory, Recitation Instr. for Prof. Guillermo Ordonez

**Koc University**
- **Spring 2015**: Macroeconomics II (Graduate), Koc U, Recitation Instr. for Prof. Sumru Altug
- **Fall 2014**: Global Economics (Graduate), Koc U, TA for Prof. Kamil Yilmaz
- **Fall 2014**: Turkish Economy, Koc U, Teaching Asst. for Prof. Kamil Yilmaz
- **Spring 2014**: Introduction to Economics II, Koc U, Teaching Asst. for Prof. Ozgur Yilmaz
- **Fall 2013**: Introduction to Economics I, Koc U, Teaching Asst. for Prof. Ozgur Yilmaz

**Research Experience and Other Employment:**
- **2019**: Research Assistant for Prof. Jesus Fernandez-Villaverde (MBER)
- **2018**: Research Assistant for Prof. Harold Cole
- **2017-2018**: Research Assistant for Prof. Guillermo Ordonez
- **2016**: Research Assistant for Prof. Philipp Illeditsch
- **2013-2015**: Research Assistant for Prof. Kamil Yilmaz

**Professional Activities:**

**Presentation:**

**Referee:**

**Honors, Scholarships, and Fellowships:**
- **2020**: Federal Reserve Bank of St. Louis Dissertation Internship (Cancelled)
- **2019**: Macro-Financial Modeling (MFM) Dissertation Fellowship (Alfred Sloan P. Found.)
- **2019**: PIER Student Travel Grant x2 (UPenn)
- **2019**: SASgov Travel Grant (UPenn)
- **2019**: GAPSA Research Student Travel Grant (UPenn)
- **2018**: Mack Institute Research Fellowship (Mack Institute for Innovation Management)
- **2018**: SAS Dean’s Travel Subvention (UPenn)
- **2015**: Hiram C. Haney Foundation Fellowship (UPenn)

**Publications:**

“How Connected is the Global Sovereign Credit Risk Network?” *Journal of Banking and Finance 2020 (113-105761)*, (with Kamil Yilmaz)
Research Papers:

“Productivity Gains from Labor Outsourcing: The Role of Trade Secrets” (Job Market Paper)

Producers' demand for workers changes over time and the speed at which workers can move between producers is a key component of aggregate productivity. Labor outsourcing allows producers to make quick adjustments to their workforce, avoiding most hiring and firing costs. However, producers will avoid using outsourced workers in tasks that provide access to sensitive information if courts do not adequately enforce the protection of trade secrets. In this paper, I estimate the impact of trade secret protection on aggregate productivity. First, using event studies and differences-in-differences estimators around the staggered adoption of the Uniform Trade Secrets Act across the states of the U.S., I show that better trade secret protection leads to a higher use of outsourcing. Second, to quantify the resulting gains in aggregate productivity, I build a structural model of outsourcing and industry dynamics and estimate it with data from the U.S. manufacturing sector. I decompose the cross-state differences in labor outsourcing into differences in firing costs, industry compositions, demand fluctuations, and trade secret protection. The estimated differences in trade secret protection can explain one-third of the cross-state dispersion. If all states enforced trade secret law as well as the ‘best state’, the aggregate output would increase by 0.5%.


“Price Informativeness and Business Cycle Misallocation” (with Guillermo Ordonez)

Recessions are characterized by slow input reallocation and increased misallocation across firms. We study the role of information frictions by measuring how the informativeness of the stock prices changes with business cycles. We first build a model where both the information acquisition behavior and the ‘noise’ in prices respond endogenously to changes in economic activity, affecting how well those prices can be used to guide investment over the business cycle. In particular, as stock traders get increasingly worried about liquidity and risk, changes in the stock price become less connected to the actual performance of the firm. Then, we incorporate this module into an RBC model with heterogeneous firms to characterize how the price informativeness and misallocation interact over the cycle. Finally, we introduce a methodology to identify the model parameters and estimate the cyclical properties of price informativeness in more than thirty countries.

Presented at: 14th Macro Finance Society Workshop (2019-Poster Session), MFM Summer Session for Young Scholars (2018-Poster Session)
“Changing Jobs to Fight Inflation: Labor Market Reactions to Inflationary Shocks” (with Omer Koru and Sergio Villalvazo)

Recent empirical work shows a strong positive correlation between job-to-job transition rates and nominal wage growth in the U.S. First, using time series regressions, structural monetary policy shocks, and survey data on search effort we provide evidence that inflationary shocks cause higher job-to-job transitions in the subsequent years. Second, to understand the aggregate implications, we build a structural model with aggregate shocks and competitive on-the-job search in which wages react sluggishly to inflation. In periods with high inflation, the decline in real wages incentivizes the employees to search on-the-job more actively, to negotiate a new contract, but also to be less selective in their search behavior. This creates a fundamental trade-off: increased search effort leads to more job-to-job transitions while being less selective reduces the expected efficiency gain in each transition. Therefore, the effect on output becomes ambiguous. Third, we calibrate the model to the U.S. economy and confirm that the output response to inflation shock is non-monotonic. Importantly, our paper highlights a novel role for inflation: the monetary authority can stimulate productivity with an inflationary shock through job-to-job transitions.

Presented at: Macro Lunch Talk at UPenn (2018, 2019)

“Products and Politics: Comparative Advertising and Competitive Positioning” Submitted (with Jerath, K. and Yildirim, P.)

Comparative advertising promotes a product through a comparison with competitors' products, often highlighting the weaknesses of the latter. We study comparative advertising with a focus on how it impacts product positioning for profit maximizing firms. We find that factors such as the negative spillover of comparative advertising and heterogeneity in consumer tastes are important determinants of how firms position themselves in the market and whether they engage in comparative advertising. In certain settings, the threat of comparative advertising can result in lower positional differentiation along with positive advertising. We derive welfare implications of comparative advertising; for instance, allowing comparative advertising, as the FTC does, may lead to lower innovation by firms and lower consumer welfare, without comparative advertising being actually used in equilibrium. We also study the context of political competition, where a candidate's objective is winning by plurality. We find that, due to this difference in objective (compared to profit-maximizing firms), the equilibrium outcome supports high positional differentiation along with comparative advertising. This can help to explain the often-observed polarization in political campaigns.

Languages: Turkish (Native), English (Fluent)

Computational Skills: R, Matlab, C++, Julia, Python, VBA, GAMS
My research interests are in Macroeconomics, with a particular focus on firm dynamics, labor markets, and the economics of information. A unifying theme of my research is to understand how frictions at the firm and the worker level impact aggregate productivity.

In my job market paper, ‘Productivity Gains from Labor Outsourcing: The Role of Trade Secrets’, I study how an economy may under-utilize its workforce due to the concerns of individual producers over sharing sensitive information with outsiders. In particular, when trade secret laws are not well enforced, producers would be reluctant to use outsourced labor in tasks that provide access to sensitive information. This reluctance, in turn, would keep the outsourcing sector inefficiently small, and hamper the movement of workers across producers, reducing aggregate productivity. To measure the magnitude of this channel I use the staggered adoption of trade secret laws across the U.S. states. First, I document novel facts on the temporal and spatial heterogeneity of labor outsourcing in the U.S. These facts indicate a fundamental heterogeneity in the ‘taste for outsourcing’ that cannot be explained by compositional differences over time or across states. Second, I use event studies and differences-in-differences based estimators around the adoption of trade secret laws and find the adoptions caused a faster growth in outsourcing. Third, to quantify the gains in labor allocation and aggregate productivity, I build a structural model of firm boundaries and industry dynamics and estimate it with data from the U.S. manufacturing sector. I decompose the cross-state heterogeneity in outsourcing levels into differences in industry compositions, firm dynamics, employment protection laws, and trade secret protection. I find that differences in trade secret protection can explain one-third of the cross-state dispersion. Furthermore, if all states had the same level of protection as the the state with the best protection, aggregate output would increase by 0.5%, indicating large potential gains. I recently earned a Special Sworn Status (SSS) at the U.S. Census Bureau as the principal investigator for the project “Causes of the Major Growth of Professional Business Services and Its Macroeconomic Implications”. In the next five years, using the vast micro-data available, I will dig deeper into other channels that contribute to the growing use of outsourcing and how it shapes the U.S. economy. I am also in the process of gaining access to microdata from Statistics Canada on how firms invest in cybersecurity to protect their trade secrets from online threats.

In ‘Price Informativeness and Business Cycle Misallocation’, Guillermo Ordonez and I ask why input reallocation across producers slows down during crises, with a focus on the role played by

*Dept. of Economics, University of Pennsylvania, Website: gorkembostanci.com, Email: bostanci@sas.upenn.edu*
information frictions. We argue that in crises, the real sector has lower quality information about investment opportunities because the stock markets become less informative. In particular, as stock traders get increasingly worried about liquidity and risk, changes in the stock price become less connected to the actual performance of the firm. To understand this channel, we first build a stock market model in which both the information content and the noise in prices respond to changes in economic activity endogenously, affecting how well those prices can be used to guide investments over the business cycle. We then incorporate this module into an RBC model with heterogeneous firms to characterize how price informativeness and input misallocation interact over the cycle. Lastly, we introduce a methodology to identify the model parameters and estimate the cyclical properties of price informativeness in more than thirty countries. While this research is ongoing, its results will help illuminate how the behavior of stock markets can amplify or dampen the magnitude of business cycles.

In ‘Changing Jobs to Fight Inflation: Labor Market Reactions to Inflationary Shocks’, Omer Koru, Sergio Villalvazo, and I study how the allocation of workers across firms responds to changes in monetary policy. We argue that the recently documented high correlation between inflation and the rate of job-to-job transitions reflects how monetary policy reallocates the surplus between the workers and the firms in the presence of nominal rigidities. First, using time series regressions, structural monetary policy shocks, and survey data on search effort we provide evidence that inflationary shocks cause higher job-to-job transitions in the subsequent years. Second, to understand the aggregate implications, we build a structural model with aggregate shocks and competitive on-the-job search in which wages react sluggishly to inflation. In periods with high inflation, real wages decline more rapidly, and the workers’ share of the surplus diminishes. This decline incentivizes the employees to search on-the-job more actively, to negotiate a new contract, but also to be less selective in their search behavior. This creates a fundamental trade-off: increased search effort leads to more job-to-job transitions while being less selective reduces the expected efficiency gain in each transition. Therefore, the effect on output becomes ambiguous. Third, we calibrate the model to the U.S. economy and confirm that the output response to inflation shock is non-monotonic. We determine the threshold level for the inflation shock where the selectivity channel dominates, and the shock leads to an output loss. Importantly, our paper highlights a novel role for inflation: the monetary authority can stimulate productivity with an inflationary shock through job-to-job transitions.
UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez
Placement Director: David Dillenberger
Graduate Student Coordinator: Gina Conway

Office Contact Information
The Ronald O. Perelman Center for Political Science and Economics, Room 535
133 South 36th Street
Philadelphia, PA 19104
Phone: 267-690-1589

Personal Information:
Date of Birth: July 7th, 1990
Citizenship: Turkey (F-1 Visa)

Undergraduate Studies:
B.A. in Economics (with minor in Mathematics), Sabanci University, Turkey, 2013

Masters Level Work:
M.A. in Economics, Sabanci University, Turkey, 2015

Graduate Studies:
University of Pennsylvania, 2015 to present
Thesis Title: “Essays on Automation, Inequality, and Macroeconomic Performance”
Expected Completion Date: May 2021

Thesis Committee and References:
Professor Dirk Krueger (Co-Advisor)  
Department of Economics  
University of Pennsylvania  
133 South 36th Street, Philadelphia, PA, 19104  
Phone: 215-573-1424  
E-mail: dkrueger@econ.upenn.edu

Professor Harold L. Cole (Co-Advisor)  
Department of Economics  
University of Pennsylvania  
133 South 36th Street, Philadelphia, PA, 19104  
Phone: 215-898-7788  
E-mail: colehl@sas.upenn.edu

Professor Guido Menzio  
Department of Economics  
New York University  
19 West 4th Street 10012, New York, NY 10012  
Phone: 773-865-6337  
E-mail: gm1310@nyu.edu

Research Fields:
Macroeconomics, Labor Economics, Inequality, Entrepreneurship
Teaching Experience:

University of Pennsylvania

Fall 2020  Microeconomic Theory (Graduate), TA for Prof. Steven A. Matthews
Fall 2019  International Finance, TA for Prof. Alessandro Dovis
Summer 2019  Intermediate Microeconomics, Instructor
Fall 2018, Spring 2019  Introductory Economics: Macroeconomics, Instructor
Spring 2018, Spring 2019  Introductory Economics: Macroeconomics, TA for Prof. Luca Bossi
Fall 2017  Microeconometrics, TA for Prof. Xu Cheng
Fall 2017  Labor Economics, TA for Prof. Kenneth Burdett
Spring 2017  Macroeconomics Theory II (Graduate), TA for Prof. José Víctor Ríos Rull
Fall 2016  Game Theory, TA for Prof. Deniz Selman

Sabanci University

Fall 2014  Microeconomics 1 (Graduate), TA for Prof. Mehmet Barlo
Summer 2014  Summer Math Camp, Instructor
Fall 2012-'13-'14  Industrial Organization, TA for Prof. Esra Durceylan Kaygusuz
Spring 2014  Games and Strategies, TA for Prof. Mustafa Oğuz Afacan
Spring 2013  Games and Strategies, TA for Prof. Özgür Kıbrıs
Spring 2012  Game Theory, TA for Prof. Mehmet Barlo

Research Experience and Other Employment:

2014-2015  Research Associate, Sabanci University, Turkey

Professional Activities:


Honors, Scholarships, and Fellowships:

2019  SASgov Travel Grant (University of Pennsylvania)
2019  GAPSA Research Student Travel Grant (University of Pennsylvania)
2019  SAS Dean’s Travel Subvention (University of Pennsylvania)
2013-2015  The Scientific and Technological Research Council of Turkey Scholarship
2008-2013  Sabanci University, Merit Scholarship

Computational Skills:  R, Matlab, C++, Stata, VBA

Languages:  Turkish (Native), English (Fluent)
Research Papers:

“Automation and Top Wealth Inequality” (JOB MARKET PAPER)

Over the last 50 years, there has been a substantial increase in top wealth share. This paper analyzes the effects of improvements in automation technology on the rise of the top wealth share. I consider an incomplete market model with entrepreneurs and a financial friction. In the model, automation impacts wealth concentration by two channels. First, it enables entrepreneurs to scale up their production. This decrease in the severity of diseconomies of scale increases the return to entrepreneurial productivity, hence automation leads to a higher income concentration. Since wealth distribution follows the income distribution, it affects the wealth concentration. Second, automation raises the capital demand, which intensifies the tightness of collateral constraint. Since this constraint is more important for highly productive entrepreneurs than low productive ones, the dispersion of the return to capital increases. I calibrate the model to the US economy to quantitatively analyze the impact of improvements in automation. The model generates one-fourth of the observed increase in the top 1% wealth share and explains 10% of the observed increase in the top 0.1%. In consumption equivalence terms, workers' welfare increased by 4% and entrepreneurs' welfare increased by 8%.

“Automation and Top Income Inequality”

This paper analyzes the impact of automation on top income inequality. It is well-known that top income is well approximated by a Pareto distribution. In this paper, we provide a theory that links automation technology to the Pareto tail of the income distribution. We construct a model in which the span of control is defined by the measure of labor used in production. We model this as a convex cost of labor, and that model generates a production function that has decreasing returns to scale. An improvement in automation enables entrepreneurs to substitute labor with capital and decreases the severity of diseconomies of scale. This leads to higher returns on entrepreneurial skills, a decrease in the Pareto parameter, and an increase in top income inequality. We rationalize the convex cost of labor using a theory of efficiency wages. Using cross-industry and cross-country data, we provide evidence that there is a significant correlation between automation and top income inequality.

“Changing Jobs to Fight Inflation: Labor Market Reactions to Inflationary Shocks” (with Görkem Bostancı and Sergio Villalvazo)

Recent empirical work shows a strong positive correlation between job-to-job transition rates and nominal wage growth in the U.S. First, using time series regressions, structural monetary policy shocks, and survey data on search effort we provide evidence that inflationary shocks cause higher job-to-job transitions in the subsequent years. Second, to understand the aggregate implications, we build a structural model with aggregate shocks and competitive on-the-job search in which wages react sluggishly to inflation. In periods with high inflation, the decline in real wages incentivizes the employees to search on-the-job more actively, to negotiate a new contract, but also to be less selective in their search behavior. This creates a fundamental trade-off: increased search effort leads to more job-to-job transitions while being less selective reduces the
expected efficiency gain in each transition. Therefore, the effect on output becomes ambiguous. Third, we calibrate the model to the U.S. economy and confirm that the output response to inflation shock is non-monotonic. Importantly, our paper highlights a novel role for inflation: the monetary authority can stimulate productivity with an inflationary shock through job-to-job transitions.

**Research in Progress:**

“*Robot Tax in an Inefficient Labor Market*”

“*Self-employment Premium Puzzle: Amenities or Negative Selection*”
Chapter 1: Automation and Top Wealth Inequality (Job Market Paper)

Top wealth inequality has been increasing in the US for the last forty years. In this paper, I quantitatively analyze the impact of improvements in automation technology on top wealth shares. I define automation as any labor-replacing technology including information technology as well as robots. To this end, I consider an Aiyagari model with entrepreneurs and a financial friction. I use a task-based production function where entrepreneurs need to complete a set of tasks and choose which tasks to automate. In the model, automation has two effects. First, it increases the income concentration by enabling entrepreneurs to scale up their production. Hence, the market share of highly productive entrepreneurs increases. Since wealth concentration follows income concentration with a lag, it leads to higher top wealth shares. Second, an improvement in automation increases the dispersion in the return to capital. Due to the collateral constraint, entrepreneurs cannot operate their businesses at the efficient level, which causes heterogeneity in capital return. As automation technology advances the demand for capital increases and the collateral constraint becomes tighter. This leads to higher dispersion in the return to capital since this constraint is more severe for highly productive entrepreneurs. By calibrating the model to the US economy, I quantitatively analyze the impact of automation on wealth concentration. The key parameter here is the automation level. One implication of the task-based framework is that the capital share of income is equal to the automation level. For this reason, I use the capital share of income as a measure of the automation level. The model generates one-fourth of the observed increase in wealth share of the top 1% and explains 10% of the observed increase in the top 0.1%. In consumption equivalence terms, workers’ welfare increases by 5%, and entrepreneurs’ welfare increases by 8%.

Chapter 2: Automation and Top Income Inequality

In this paper, I analyze the impact of automation on top income inequality and provide the theoretical background of the first chapter of this dissertation. A well-known fact about top income distribution is that it can be approximated by a Pareto distribution and top income inequality is a function of the shape parameter of this distribution. I provide a theory that links automation
technology to the shape parameter of Pareto distribution of the top income distribution. I con-
struct a model in which the span of control is defined by the measure of labor used in production.
I model this as a convex cost of labor. This convex cost generates a production function that has
decreasing returns to scale. An improvement in automation enables entrepreneurs to substitute
labor with capital and they become less dependent on labor. This reduces the severity of dise-
conomies of scale, therefore the return to entrepreneurial skill increases. Because high-productive
entrepreneurs scale up their production more than low-productive entrepreneurs, the convexity
of profit as a function of productivity increases. This leads to higher returns to entrepreneurial
skills, a decrease in the Pareto parameter, and an increase in top income inequality. I rationalize
the convex cost of labor using a theory of efficiency wages. Using cross-industry and cross-country
data, I show that the data supports the model’s prediction.

Chapter 3: Changing Jobs to Fight Inflation: Labor Market Reactions to Inflationary
Shocks (with Görmem Bostancı, Sergio Villalvazo)

In this paper, we study how the allocation of workers across firms responds to changes in mon-
etary policy. We argue the recently documented high correlation between inflation and the rate
of job-to-job transitions reflects how monetary policy reallocates the surplus between the workers
and the firms in the presence of nominal rigidities. First, using time series regressions, structural
monetary policy shocks, and survey data on search effort we provide evidence that inflationary
shocks cause higher job-to-job transitions in the following years. Second, to understand the aggre-
gate implications, we build a structural model with aggregate shocks and competitive on-the-job
search where wages react sluggishly to inflation. In periods with high inflation, real wages decline
more rapidly, and workers’ share of the surplus diminishes. This decline incentivizes the employ-
ees to search on-the-job more actively, to negotiate a new contract, but also to be less selective
in their search behavior. This creates a fundamental trade-off: increased search effort leads to
more job-to-job transitions while being less selective reduces the expected efficiency gain in each
transition. Therefore, the effect on output becomes ambiguous. Third, we calibrate the model
to the U.S. economy and confirm that the inflation response is non-monotonic. We determine
the threshold level for the inflation shock where the selectivity channel dominates, and the shock
leads to an output loss. Importantly, our paper highlights a novel role for inflation: the monetary
authority can stimulate productivity with an inflationary shock through job-to-job transitions.
UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez  ORDONEZ@ECON.UPENN.EDU  215-898-1875
Placement Director: David Dillenberger  DDILL@ECON.UPENN.EDU  215-898-1503
Graduate Student Coordinator: Gina Conway  GNC@SAS.UPENN.EDU  215-898-5691

Office Contact Information:
Department of Economics
University of Pennsylvania
133 South 36th Street, Office 636
Philadelphia, PA 19104
+34 690-848-687

Personal Information:
Date of Birth: May 19th, 1990
Citizenship: Spanish
Visa: F1

Undergraduate Studies:
B.Sc., Economics, Universitat Pompeu Fabra, 2012

Masters Level Work:
M.Sc., Economics, Barcelona Graduate School of Economics, 2013

Graduate Studies:
University of Pennsylvania, 2016 to present.
Thesis Title: "Essays in the Macroeconomics of Higher Education"
Expected Completion Date: May 2021

Thesis Committee and References:
Jesús Fernández-Villaverde (Advisor)
Office 521, Department of Economics
University of Pennsylvania.
133 South 36th Street
Philadelphia, PA 19104
+1 (215) 573-1504
jesusfv@econ.upenn.edu

Dirk Krueger (Advisor)
Office 520, Department of Economics
University of Pennsylvania
133 South 36th Street
Philadelphia, PA 19104
+1 (215) 573-1424
dkrueger@econ.upenn.edu

Holger Sieg
Office 625, Department of Economics
University of Pennsylvania.
133 South 36th Street
Philadelphia, PA 19104
+1 (215) 898-7194
holgers@econ.upenn.edu

Andrew Hertzberg
Economic Research Department
Federal Reserve Bank of Philadelphia
Ten Independence Mall
Philadelphia, PA 19106
+1 (215) 574-6155
andrew.hertzberg@phil.frb.org
Research Fields:
Macroeconomics, Household Finance, Labor Economics, Economics of Education

Teaching Experience:
Fall 2020  Foundations of Market Economies, Teaching Assistant for Prof. Jesús Fernández-Villaverde and Prof. Fernando Arteaga
Spring 2013  Advanced Macroeconomics II, CETEC, private tutor (2 classes of 30 students) in undergraduate course taught by Prof. Jordi Galí at Universitat Pompeu Fabra

Research Experience and Other Employment:
2018-2020  Federal Reserve Bank of Philadelphia, Graduate Research Analyst
2014-2016  Central Bank of Spain, Monetary Policy Research Division, Research Assistant
2011-2012  Universitat Pompeu Fabra (UPF), Research Assistant for Prof. Luigi Pascali

Professional Activities:
Presentations  2021: Society for Economic Dynamics (scheduled)
                2020: European Winter Meeting of the Econometric Society (ESWM), University of Pennsylvania, Young Economists Symposium (YES), European Economic Association Congress (EEA), 15th Economics Graduate, Students’ Conference of Washington University in St. Louis (EGSC), 20th Annual Trans-Atlantic Doctoral Conference (cancelled)
                2019: University of Pennsylvania
Discussions  2020: Young Economists Symposium (YES)

Honors, Scholarships, and Fellowships:
2018-2021  University Fellowship, University of Pennsylvania
2016-2017  Fellowship for Graduate Studies in the United States, "la Caixa" Foundation
2015  XI Summer School of Public Economics Fellowship, Georgia State University
2013  Scholarship for Masters of Excellence, CatalunyaCaixa - La Pedrera Found.
2012  Top 5 Academic Transcripts in Economics, Universitat Pompeu Fabra
2012  Research Collaboration Scholarship, Universitat Pompeu Fabra

Publications (Prior to PhD):


Research Papers in Progress:

“Go Big or Buy a Home: Student Debt, Career Choices and Wealth Accumulation”
(with Luca Mazzone, Job Market Paper)

Coverage: EEA Congress, LSE Business Review

What is the impact of student loans on post baccalaureate choices? Using within-college variations in financial aid policies, we find that higher levels of debt induce a front loading of earnings, an underinvestment in human capital and an earlier entry into home ownership. We then estimate a life-cycle model using a representative panel of college graduates and analyze the mechanisms behind the interaction between student debt, career choices and housing. Our results indicate that lower net wealth generates a trade-off between career and housing choices for college graduates. Finally, we compare alternative policy proposals. Relative to the baseline 10-year fixed repayment plan, an income-based repayment plan increases human capital accumulation and earnings growth, while postponing entry into home ownership. Importantly, linking repayments to income achieves outcomes that are close to what can be achieved by a more ambitious college for all subsidy plan.

"Upskilling and the Rise in College Inequality"

Using college-level panel data from the College Scorecard project, I present series on dispersion of post-college students' earnings from 2000 to 2014 in the United States. The data indicate that earnings inequality among students attending different colleges has been steadily increasing over this period. I also find an increase in the dispersion of instructional expenditure per student, net tuition revenue per student, and selectivity of students. I then introduce a human capital life-cycle model with a two-tier college system operating under monopolistic competition. In response to the observed rise in the returns to human capital (upskilling), the model predicts an increase in college enrollment, in college quality dispersion, and, in earnings inequality, all consistent with the data. This rising inequality happens as a result of increasing diversity of students (selection effect) and a stronger demand for elite institutions (segregation effect). Finally, I use the model to run policy counterfactuals. Government financial aid programs have relatively small effects on the Gini coefficient compared to policies aimed at decreasing human capital dispersion before college. This result suggests substantial potential for policy improvement and provide additional perspective on why human capital investment at childhood is critical in shaping earnings inequality.

“Household Credit within the Household: The Role of Joint Debt” (with Andrew Hertzberg)

Using a nationally representative panel of US credit reports with detailed information on both individuals’ and households’ debt, we document two facts about the US household credit market: (1) since the early 2000s, there was a significant increase in the share of individual credit for all types of consumer debt (mortgage, credit card and auto loans); and, (2) joint debt reduces credit delinquency significantly. We then use spatial variation to show that changes in marital transitions for young individuals had a strong influence on the decline in joint mortgages and auto loans. These results imply that the US consumer credit market is becoming more vulnerable due to changing in household’s structure and the ensuing decrease in the share of joint credit.

Computational Skills:  MATLAB, Stata, R, LaTeX, Parallel Computing

Languages:  English (Fluent), Spanish (Native), Catalan (Native)
Research Statement
Marc Folch
University of Pennsylvania

My research interests lie at the intersection between macroeconomics, labor economics, and the economics of education. Recently, I have focused on analyzing the interaction between Higher Education and the labor market. Understanding this interaction is becoming an increasingly relevant area of research as rapid technological change and growing skill demand are placing Higher Education at a focal point for competitiveness and economic growth. However, increasing participation in Higher Education has been accompanied by growing income inequality among college graduates in a number of countries. In my dissertation, I explore contributing factors to this growth in graduate income inequality using the context of the United States. Below, I describe the two chapters of my dissertation in more detail.

In my job market paper, "Go Big or Buy a Home: Student Debt, Career Choices and Wealth Accumulation" (joint with Luca Mazzone), we use data from a representative panel of US college graduates (Baccalaureate and Beyond Longitudinal Study) to study how increasing student debt has shaped career, education and housing choices of young Americans, and introduce a theoretical framework to look at their interaction.

In order to estimate how undergraduate borrowing affects post-bachelor choices, we need to overcome the problem that the amount borrowed may be determined by unobserved individual ability, which in turn would affect post graduation choices. We address this problem by introducing an instrument based on variations in colleges’ financial aid. We focus on institutional grants, which are college-specific (funded from private sources and net assets of the institution) and experience significant variations year-by-year. We then use these yearly supply changes in aid to extract variation in borrowing that is not correlated with post-bachelor choices through unobserved characteristics.

We find that undergraduate debt induces graduates to front load earnings: on average, increasing debt balances by 10% has an effect of increasing earnings one year after graduation by 2.9%. Our estimates also indicate that the initial earnings increase is offset by a reduction in subsequent earnings growth by approximately 1% per year. Three channels contribute to this result. First, indebted students make on average different occupational choices. Occupations are classified as steep careers if they are in the top quintile of earnings growth between age 25-30 and age 45-50. As debt balances grow, their likelihood to choose such an occupation decreases. Second, increasing debt balances has a negative and persistent effect on post-bachelor’s degree attendance and completion. Third, more indebted graduates tend to access homeownership relatively earlier, being less likely to switch careers or attend graduate school.
We develop a life-cycle model with endogenous (risky) human capital accumulation enriched by career and housing choices to understand the importance of initial assets in shaping post graduation outcomes. In presence of financial constraints, student debt affects post graduation choices by making further borrowing more difficult. As the relative value of current consumption grows, and workers postpone additional human capital investment, a series of life cycle decisions are consequently affected. We highlight one often overlooked cost of additional investment in human capital, that is the postponing of home-ownership. When this channel is taken into account, the initial impact of financial constraints on human capital accumulation and lifetime earnings is amplified, as the relative value of additional human capital investment decreases throughout the life cycle, due to stronger horizon effects induced by mortgage repayment.

The model highlights three important facts. First, non-monetary returns to investment in housing and education are large, and important in explaining observed behavior: were housing choices not valuable to graduates, the effects of student debt on their career choices would be significantly smaller. Second, we find that as of age 25, differences in initial financial position account for substantial variation in lifetime earnings and wealth. Third, a reform that links student loan payments to income is almost as effective at reducing the impact of debt on inequality as debt forgiveness, but with costs for the taxpayer that are lower by many orders of magnitude.

In the project "Upskilling and the Rise in College Inequality", I analyze the evolving role of the American Higher Education market on earnings inequality. First, using data from the College Scorecard project, I present series on dispersion of students’ earnings across four-year colleges from 2000 to 2014. I show that earnings inequality across students attending different colleges has been steadily increasing over this period. I then look for sources to explain this increasing inequality across colleges and show that dispersion in instructional expenditures per student, net tuition revenues per student, and selectivity of students have also increased.

I then introduce a human capital life-cycle model with a two-tier college system operating under monopolistic competition. In response to the observed rise in the returns to human capital (upskilling), the model predicts an increase in college enrollment, in college quality dispersion, and, in earnings inequality, all consistent with the data. This rising inequality happens as a result of increasing diversity of students (selection effect) and a stronger demand for elite institutions (segregation effect). Finally, I use the model to run policy counterfactuals. Government financial aid programs have relatively small effects on the Gini coefficient compared to policies aimed at decreasing human capital dispersion before college. This result suggests substantial potential for policy improvement and provide additional perspective on why human capital investment at childhood is critical in shaping earnings inequality.

Although my dissertation focuses on the American Higher Education market, my research gives important lessons for Europe and other economies similarly experiencing upskilling in the labor market and growing graduate wage inequality. Hence, an important topic for future research is to study these trends in college inequality in other countries as data become available.
PHILIPPE GOULET COULOMBE
philippegouletcoulombe.com
gouletc@sas.upenn.edu

UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez ORDONEZ@ECON.UPENN.EDU 215-898-1875
Placement Director: David Dillenberger DDILL@ECON.UPENN.EDU 215-898-1503
Graduate Student Coordinator: Gina Conway GNC@SAS.UPENN.EDU 215-898-5691

Office Contact Information
Department of Economics, PCPSE 626
133 South 36th Street, Philadelphia, PA 19104
Cell phone number: (267) 881-6440

Personal Information:
Date of Birth: 1992
Citizenship: Canadian

Undergraduate Studies:
BA, Economics, Université Laval, Québec City, 2014

Masters Level Work:
MA, Economics, Queens University, Kingston, 2015
Essay: A Fractionally Cointegrated VAR Analysis of Price Discovery and Financial Integration
Supervisor: James G. MacKinnon

Graduate Studies:
University of Pennsylvania, 2016 to present
Thesis Title: Machine Learning Econometrics
Expected Completion Date: May 2021

Thesis Committee and References:
Professor Francis X. Diebold (Co-advisor), University of Pennsylvania
Contact: 215-898-1507, fdiebold@econ.upenn.edu

Professor Frank Schorfheide (Co-advisor), University of Pennsylvania
Contact: 215-898-8486, schorf@econ.upenn.edu

Professor Karun Adusumilli, University of Pennsylvania
Contact: akarun@sas.upenn.edu

Professor Dalibor Stevanovic, Université du Québec à Montréal
Contact: 1-514-987-3000 # 8374, dstevanovic.econ@gmail.com

Teaching and Research Fields:
Econometrics, Machine Learning, Macroeconomics, Climate Change

Teaching Experience:
Recitation Instructor for Econ 103 (Statistics for Economists)
Semesters: Fall 2017, Spring 2018, Fall 2018, and Spring 2019
Professors: Karun Adusumilli, Francis DiTraglia, Suleyman Ozmucur
Research Experience and Other Employment:

- Research Assistant for Professor Francis X. Diebold (Penn) 2019-
- Research Assistant for Professor Ioana Marinescu, (Penn) 2018
- Economist, Economic Studies and Policy Analysis, (Department of Finance Canada) 2015-16

Research Papers:

**The Macroeconomy as a Random Forest** (Job Market Paper)

Over the last decades, an impressive amount of non-linearities have been proposed to reconcile reduced-form macroeconomic models with the data. Many of them boil down to have linear regression coefficients evolving through time: threshold/switching/smooth-transition regression; structural breaks and random walk time-varying parameters. While all these schemes are reasonably plausible in isolation, I argue that those are much more in agreement with the data if they are combined. To this end, I propose Macroeconomic Random Forests, which adapts the canonical Machine Learning (ML) algorithm to the problem of flexibly modeling evolving parameters in a linear macro equation. The approach exhibits clear forecasting gains over a wide range of alternatives and successfully predicts the drastic 2008 rise in unemployment. The obtained generalized time-varying parameters (GTVPs) are shown to behave differently compared to random walk coefficients by adapting nicely to the problem at hand, whether it is regime-switching behavior or long-run structural change. By dividing the typical ML interpretation burden into looking at each TVP separately, I find that the resulting forecasts are, in fact, quite interpretable. An application to the US Phillips curve reveals it is probably not flattening the way you think.

**Time-Varying Parameters as Ridge Regressions** (submitted)

Time-varying parameters (TVPs) models are frequently used in economics to model structural change. I show that they are in fact ridge regressions. Instantly, this makes computations, tuning, and implementation much easier than in the state-space paradigm. Among other things, solving the equivalent dual ridge problem is computationally very fast even in high dimensions, and the crucial "amount of time variation" is tuned by cross-validation. Evolving volatility is dealt with using a two-step ridge regression. I consider extensions that incorporate sparsity (the algorithm selects which parameters vary and which do not) and reduced-rank restrictions (variation is tied to a factor model). To demonstrate the usefulness of the approach, I use it to study the evolution of monetary policy in Canada. The application requires the estimation of about 4600 TVPs, a task well within the reach of the new method.

**To Bag is to Prune** (submitted)

It is notoriously hard to build a bad Random Forest (RF). Concurrently, RF is perhaps the only standard ML algorithm that blatantlty overfits in-sample without any consequence out-of-sample. Standard arguments cannot rationalize this paradox. I propose a new explanation: bootstrap aggregation and model perturbation as implemented by RF automatically prune a (latent) true underlying tree. More generally, there is no need to tune the stopping point of a properly randomized ensemble of greedily optimized base learners. Thus, Boosting and MARS are eligible for automatic (implicit) tuning. I empirically demonstrate the property, with simulated and real data, by reporting that these new completely overfitting ensembles yield an out-of-sample performance equivalent to that of their tuned counterparts – or better.

**Arctic Amplification of Anthropogenic Forcing: A Vector Autoregressive Analysis**

(R&R, Journal of Climate), with Maximilian Göbel

Arctic sea ice extent (SIE) in September 2019 ranked second-to-lowest in history and is trending downward. The understanding of how internal variability amplifies the effects of external CO2 forcing is still limited. We propose the VARCTIC, which is a Vector Autoregression (VAR) designed to capture and extrapolate Arctic feedback loops. VARs are dynamic simultaneous systems of equations, routinely
estimated to predict and understand the interactions of multiple macroeconomic time series. Hence, the VARCTIC is a parsimonious compromise between full-blown climate models and purely statistical approaches that usually offer little explanation of the underlying mechanism. Our "business as usual" completely unconditional forecast has SIE hitting 0 in September by the 2060s. Impulse response functions reveal that anthropogenic CO2 emission shocks have a permanent effect on SIE - a property shared by no other shock. Further, we find Albedo- and Thickness-based feedbacks to be the main amplification channels through which CO2 anomalies impact SIE in the short/medium run. Conditional forecast analyses reveal that the future path of SIE crucially depends on the evolution of CO2 emissions, with outcomes ranging from recovering SIE to it reaching 0 in the 2050s. Finally, Albedo and Thickness feedbacks are shown to play an important role in accelerating the speed at which predicted SIE is heading towards 0.

**How is Machine Learning Useful for Macroeconomic Forecasting?** (submitted)
with Maxime Leroux, Dalibor Stevanovic and Stéphane Surprenant

We move beyond "Is Machine Learning Useful for Macroeconomic Forecasting?" by adding the "how". The current forecasting literature has focused on matching specific variables and horizons with a particularly successful algorithm. In contrast, we study the usefulness of the underlying features driving ML gains over standard macroeconometric methods. We distinguish four so-called features (nonlinearities, regularization, cross-validation and alternative loss function) and study their behavior in both the data-rich and data-poor environments. To do so, we design experiments that allow to identify the "treatment" effects of interest. We conclude that (i) nonlinearity is the true game changer for macroeconomic prediction, (ii) the standard factor model remains the best regularization, (iii) K-fold cross-validation is the best practice and (iv) the L2 is preferred to the $\bar{\epsilon}$-insensitive in-sample loss. The forecasting gains of nonlinear techniques are associated with high macroeconomic uncertainty, financial stress and housing bubble bursts. This suggests that Machine Learning is useful for macroeconomic forecasting by mostly capturing important nonlinearities that arise in the context of uncertainty and financial frictions.

**Macroeconomic Data Transformations Matter** (submitted)
with Maxime Leroux, Dalibor Stevanovic and Stéphane Surprenant

From a purely predictive standpoint, rotating the predictors' matrix in a low-dimensional linear regression setup does not alter predictions. However, when the forecasting technology either uses shrinkage or is non-linear, it does. This is precisely the fabric of the machine learning (ML) macroeconomic forecasting environment. Pre-processing of the data translates to an alteration of the regularization -- explicit or implicit -- embedded in ML algorithms. We review old transformations and propose new ones, then empirically evaluate their merits in a substantial pseudo-out-sample exercise. It is found that traditional factors should almost always be included in the feature matrix and moving average rotations of the data can provide important gains for various forecasting targets.

**Optimal Combination of Arctic Sea Ice Extent Measures: A Dynamic Factor Modeling Approach.**
(R&R, International Journal of Forecasting)
with Frank Diebold, Maximilian Göbel, Glenn Rudebusch and Boyuan Zhang

The diminishing extent of Arctic sea ice is a key indicator of climate change as well as an accelerant for future global warming. Since 1978, Arctic sea ice has been measured using satellite-based microwave sensing; however, different measures of Arctic sea ice extent have been made available based on differing algorithmic transformations of the raw satellite data. We propose and estimate a dynamic factor model that combines four of these measures in an optimal way that accounts for their differing volatility and cross-correlations. We then use the Kalman smoother to extract an optimal combined measure of Arctic sea ice extent. It turns out that almost all weight is put on the NSIDC Sea Ice Index, confirming and enhancing confidence in the Sea Ice Index and the NASA Team algorithm on which it is based.
Research Paper(s) in Progress

Identifying VARs with Transmission Mechanism Restrictions, with Maximilian Göbel

The Path to an Ice-Free Arctic: Constrained Projections of Sea Ice Area, Extent, Thickness, and Volume, with Frank Diebold, Glenn Rudebusch, Maximilian Göbel, and Boyuan Zhang

External Conferences/Seminars:
ML, RF, Ridge and VARCTIC refers to which paper above was (or will be) presented.

- American Economic Association (RF) Jan 2021
- International Conference on Financial and Computational Econometrics (RF) Dec 2020
- Bank of Italy and Federal Reserve Board Workshop on "Nontraditional Data & Statistical Learning with Applications to Macroeconomics" Nov 2020
- Washington University Annual Economics Graduate Student Conference (RF) Nov 2020
- Modelling with Big Data and Machine Learning, Bank of England (RF) Nov 2020
- Vienna Workshop on Economic Forecasting (RF) Oct 2020
- Society for Financial Econometrics, PhD Job Market Candidates seminar (RF) Oct 2020
- Aarhus Joint Econometrics-Finance Lunch Seminar (RF) Sept 2020
- Young Economists Symposium (RF) Aug 2020
- Econometric Society World Congress (RF) Aug 2020
- European Geophysical Union, Vienna (VARCTIC) May 2020
- OECD Innovation Lab, Paris (RF) Nov 2019
- Canadian Econometric Study Group, Montreal (ML, and poster Ridge) Oct 2019
- Forecasting at Central Banks Conference, Ottawa, (poster Ridge) Oct 2019
- North American Summer Meeting of the Econometric Society, Seattle (ML) June 2019
- Bank of Canada Brownbag Seminar, Ottawa (Ridge) June 2019
- 10th Nordic Econometric Meeting, Stockholm (Ridge) May 2019
- Workshop on High-Dimensional Time Series in Macro, Vienna (Ridge, ML) May 2019
- Société Canadienne de Sciences Économiques, Québec City (Ridge) May 2019
- Symposium of the Society for Nonlinear Dynamics & Econometrics, Dallas (Ridge) March 2019
- Canadian Economic Association, Montreal (ML) June 2018

Referee:

Honors, Scholarships, and Fellowships:
- Doctoral Scholarship, Canadian Social Sciences and Humanities Research Council (2018-2020)
- Penn Fellowship (2016-2021)
Much of econometrics is based on a tight probabilistic approach to empirical modeling that dates back to Haavelmo (1944). This thesis explores a modern algorithmic view, and by doing so, finds solutions to classic problems while developing new avenues. In *Time-Varying Parameters as Ridge Regressions*, Kalman-filter based computations of random walk coefficients are replaced by a closed-form solution akin to OLS. In *The Macroeconomy as a Random Forest*, evolving coefficients are modeled and forecasted with a powerful machine learning (ML) algorithm instead of the widely-used random-walk process. Conveniently, this generalization of time-varying parameters provides statistical efficiency and interpretability, which off-the-shelf ML algorithms cannot easily offer with macro data. Finally, *To Bag is to Prune* answers the question: why can’t Random Forest (RF) overfit? I show it is a surprising byproduct of randomized “greedy” algorithms – often deployed in the face of computational adversity. Then, I capitalize on the new insight by developing new high-performing non-overfitting algorithms.

**The Macroeconomy as a Random Forest** (Job Market Paper)

Within the modern ML canon, Random Forest (RF) is outstandingly good at predicting $y_t$ because it allows for complex nonlinearities, handles high-dimensional data, bypasses overfitting, and requires little to no tuning. I redirect it to predict $\beta_t$, a vector of meaningful coefficients in a macroeconomic equation. The new algorithm, Macroeconomic Random Forest (MRF), comes with some benefits.

First, it can be interpreted. Its main output, *Generalized Time-Varying Parameters* (GTVPs) is a versatile device nesting many popular nonlinearities (threshold/switching, smooth transition, structural breaks/change). In the end, we simply get a linear equation with time-varying coefficients following a very general law of motion. The latter is powered by a large data set, and an algorithm particularly apt with complex nonlinearities and high-dimensionality.

Second, by striking an appealing balance of efficiency and flexibility, it forecasts better. Most ML algorithms are designed for large cross-sectional data sets, whereas macroeconomics is characterized by short dependent time series. If persistence (or any other linear relationship) is pervasive, important efficiency gains ensue from modeling them directly. As a result, MRF supplants off-the-shelf ML algorithms both in simulated environments and a substantive forecasting exercise. When measured against econometric approaches, MRF again does better, but now by being less rigid about $\beta_t$’s law of motion and avoiding overfitting. Thus, by design, it palliates critical issues plaguing nonlinear methods, such as misspecification and the difficulty to translate in-sample gains into out-of-sample ones.

Here are the key algorithmic modifications putting the M in MRF. First, plain RF is an ensemble of randomized regression trees. The shift from forecasting $y_t$ to $\beta_t$ is operated by fitting small linear models within each leaf of the trees, rather than just intercepts. Second, I provide a regularization scheme better suited for time series which procures a desirable smoother path for GTVPs. Third, I propose Moving Average Factors (MAFs) as a convenient way to compress ex-ante the information contained in the lags of a regressor entering the trees. Fourth, a variant of the Bayesian Bootstrap provides credible regions for GTVPs.

Empirical results are as follows. An MRF, with a small factor model as the linear part in the leaves, forecasts the 2008 rise in unemployment stunningly well. A crucial component is the contribution of forward-looking variables (e.g., term spreads, housing starts, inventories), which nearly doubles before every recession — including 2008, where the associated coefficient is forecasted to do so out-of-sample. This reinforces the view that financial indicators and other market-based expectations proxies can
rapidly capture downside risks around business cycle turning points. MRF learned that – and applied it to great success.

Overall, the predictive inflation equation is subject to a variety of time variations, which is unlikely to be detected by approaches lacking the generality of MRF. Its persistence has decreased slowly in an exogenous fashion. More novel is the finding that the effect of real activity on the price level depends positively on the strength of well-known leading indicators, especially housing-related. Following this lead, I complete the analysis by looking at a traditional Phillips' curve specification. I report that the inflation/unemployment trade-off coefficient decreased significantly since the 1980s and varies strongly with the business cycle. This suggests a convex (yet still flattening) Phillips curve where inflation can rise from a positive unemployment gap, but much more timidly does it go down from economic slack. In contrast to the slow flattening, this behavior is shown to be easily forecastable.

**Time-Varying Parameters are Ridge Regressions**

Econometric models with reputedly daunting computations are those incorporating classical time-varying parameters (TVPs) – i.e., coefficients follow random walks, or related processes. In *Time-Varying Parameters as Ridge Regressions*, I show that one can trade the filtering machinery for a penalized regression which is second only to OLS in the pantheon of simplicity. This has several implications. For instance, fast computations via the dual Ridge overcome well-known limitations of the usual Bayesian paradigm. Among other things, we can easily estimate models of larger size and tune for the optimal level of coefficients time variation by cross-validation. Evolving volatility is dealt through a weighted least-squares correction, resulting in a two-step ridge regression (2SRR). Simulations show that, for models of smaller size (where traditional Bayesian procedures can also be used), 2SRR recovers the true parameter path as successfully as burdensome Bayesian approaches – and sometimes better.

An application implying a (usually prohibitive) total of 4600 TVPs is considered. I document evolving effects of monetary policy (MP) in Canada using time-varying impulse response functions obtained with local projections. The long-run impact of MP shocks on the price level is found to have increased substantially starting from the onset of inflation targeting in the early 1990s. In contrast, the effects on real activity became milder. This finding is consistent with a flattening Phillips’ curve.

**To Bag is to Prune**

In *To Bag is to Prune*, I take as a lead a frequently overlooked paradox: among classic ML offerings (and all econometric models, for that sake), RF is the only algorithm that completely overfits the training sample with no consequence on its out-of-sample performance. This observation is hard to reconcile with the bias-variance trade-off. Concurrently, RF is an extremely popular algorithm. Why? Because it works so well, on so many data sets. Yet, it is a wonder that a seemingly overfitting algorithm can deliver such robust predictions. In short, this occurs because RF does not overfit where it matters.

I show that RF is miraculously self-regularized on a hold-out sample, and that it is a general feature of randomized greedy algorithms. The crucial insight is that, when recursively constructing the model, a greedy algorithm takes what happened before as given, and treats what happens next as if it will never happen. Building a model in such fashion immunizes the earlier non-overfitting steps from the estimation uncertainty brought upon by subsequent steps. I exploit the finding to develop two new “ensemble” techniques inheriting RF’s desirable properties. They deliver excellent performance on classic prediction tasks with no tuning involved. The innovation is also helpful to macroeconomic forecasting, as typical tuning procedures (like cross-validation) may fail when applied to time series data.
UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez
Placement Director: David Dillenberger
Graduate Student Coordinator: Gina Conway

Office Contact Information
The Ronald O. Perelman Center for
Political Science and Economics
133 South, 36th Street.
Philadelphia, PA, 19104
Room 641.
+1 215 760 5027

Personal Information:
Date of Birth: Jan 9th, 1990
Citizenship: Brazilian
Visa: J1

Undergraduate Studies:
B.A., Economics, Federal University of Rio de Janeiro, 2013

Masters Level Work:
M.A., Economics, Getulio Vargas Foundation/EPGE, 2015
M.A., Economics, University of Pennsylvania, 2019

Graduate Studies:
University of Pennsylvania, 2015 to present
Thesis Title: Essays in Empirical Industrial Organization and Regulation
Expected Completion Date: May 2021

Thesis Committee and References:
Professor Aviv Nevo (Advisor) Professor Katja Seim
University of Pennsylvania Yale University
215-898-0499, anevo@upenn.edu 203-432-5487, katja.seim@yale.edu

Professor Jose Miguel Abito
Wharton School, University of Pennsylvania
215-746-3134, abito@upenn.edu

Fields:
Industrial Organization, Applied Microeconomics, Applied Econometrics

Teaching Experience (instructor/mentor):
Summer 2020 Mentor to graduate summer instructors, University of Pennsylvania
Summer 2019 Mentor to graduate summer instructors, University of Pennsylvania
Summer 2018 Game Theory, University of Pennsylvania
Summer 2017 Game Theory, University of Pennsylvania

Teaching Experience (teaching assistant):
Fall 2020 Empirical Industrial Organization (Graduate), University of
Pennsylvania, Professor Aviv Nevo

Fall 2019  Empirical Industrial Organization (Graduate), University of Pennsylvania, Professor Aviv Nevo
Spring 2019  Microeconometrics (Undergraduate), University of Pennsylvania, Professor Petra Todd
Fall 2018  Empirical Industrial Organization (Graduate), University of Pennsylvania, Professor Aviv Nevo
Spring 2018  Game Theory (Undergraduate), University of Pennsylvania, Professor Steven Matthews
Fall 2017  Microeconomic Theory I (Graduate), University of Pennsylvania, Professors Steven Matthews and Andrew Postlewaite
Spring 2017  Game Theory (Undergraduate), University of Pennsylvania, Professor Steven Matthews
Fall 2016  Microeconomic Theory I (Graduate), University of Pennsylvania, Professors Steven Matthews and Andrew Postlewaite
Spring 2014  Real Analysis II (Graduate), Getulio Vargas Foundation/EPGE, Professor Humberto Moreira
Fall 2011  Econometrics (Undergraduate), Federal University of Rio de Janeiro, Professor Armando Castelar
Spring 2011  Econometrics (Undergraduate), Federal University of Rio de Janeiro, Professor Armando Castelar
Spring 2010  Macroeconomic Theory I, Federal University of Rio de Janeiro, Professor Carlos Eduardo Young

Research Experience and Other Employment:

2019, 2020  Research Assistant, Wharton Competition and Policy Initiative

Professional Activities
Referee for: RAND Journal of Economics

Honors, Scholarships, and Fellowships:

2018  Hiram C. Haney Fellowship Award in Economics (best 3rd year paper in the Department of Economics)
2015-2016  University Fellowship, University of Pennsylvania
2013-2014  CAPES Fellowship for Master's Studies in Economics

Research Papers:

“Regulation and Service Provision in Oligopoly: Evidence from Mobile Telecommunications” (Job Market Paper)

Concerns regarding service underprovision, especially in disadvantaged areas, have motivated regulatory oversight or intervention in several markets. However, little is known about the effectiveness and relative desirability of alternative policies. In this paper, I study coverage requirements, a common regulation in mobile telecommunications markets that intends to accelerate the introduction of new mobile telecommunications technologies to disadvantaged areas. A coverage requirement tasks a single firm with introducing a new technology in a predetermined area by a date set by the regulator. I argue that coverage requirements engender entry deterrence effects that may lead to delays in the introduction of new technologies and that the asymmetric way it treats firms renders it less cost-effective than alternative policies. To quantify the policy's effect on the introduction of new technologies and the cost of such introduction, I build a dynamic game of entry and technology upgrade that features coverage requirements explicitly. I estimate the model using panel data on mobile technology availability at the municipality level in Brazil. In counterfactual simulations, I find that coverage requirements accelerate the introduction of 3G technology by one year, on average, and reduce firms' profits by about 2 billion dollars. I find the entry deterrence effects to be small. Moreover, I show that an alternative subsidization
policy attains slightly better speedups and that it leads to just over 1.9 billion dollars in cost savings.

“Retailers’ Product Portfolios and Negotiated Wholesale Prices” (Winner of the Hiram C. Haney Fellowship Award in Economics)

Product portfolios have a direct effect on prices via optimal pricing decisions and also an indirect effect because they influence retailers’ bargaining positions, and thus the wholesale prices retailers are able to procure. I study the effects of characteristics of retailers’ product portfolios, in particular their offerings of store-brand products, on the retail prices of national brands. I propose a Nash-in-Nash model of wholesale and retail price determination, which I estimate using IRI scanner data. I use the estimated model to simulate a counterfactual in which I eliminate store-brand products and to quantify the welfare effect of double marginalization. I find that the presence of store-brand products decreases the prices of national brands by about 1%, and that the elimination of double marginalization leads to substantial consumer welfare gains.

Research Paper(s) in Progress:

“Scheduling Competition and Efficiency in Passenger Transportation Markets: Evidence from the Long Distance Bus Market in Brazil”

“On Identification in Infinitely Repeated Games” (with Jose Miguel Abito, Cuicui Chen, and Arkadiusz Szydlowski)

“Access to Mobile Communications Technologies and Educational Achievement” (with Raphael Bruce)

Computational Skills: R, C++, Matlab, SQL.

Languages: English (Fluent), Portuguese (Native), Spanish (Intermediate).
Research Statement

João Granja

I am an Empirical Industrial Organization economist. My research focuses on non-price dimensions of oligopolistic competition, particularly on firms’ choices of what products to offer in the market, and how those choices are affected by regulation. I am particularly interested in the design of regulation to overcome market inefficiencies in product and service provision.

Concerns regarding service underprovision, especially in disadvantaged areas, have motivated regulatory oversight or intervention in several markets, such as health care, consumer goods, airlines, and communications. Regulators have used different policies in these markets, and little is known about their efficacy and relative desirability.

In my job market paper, Regulation and Service Provision in Oligopoly: Evidence from Mobile Telecommunications, I study the effect of regulation on the provision of mobile telecommunications services and the introduction of new mobile telecommunications technologies. In telecommunications markets, a regulatory tool commonly used to ensure the broad and timely diffusion of new technologies is coverage requirements. A coverage requirement tasks a firm with offering a specific technology in a particular location by a date set by the regulator.

I argue that coverage requirements can engender equilibrium effects that can, in theory, generate delays in the introduction of new mobile telecommunications technologies, an outcome opposite to that desired by regulators. Moreover, I contend that the asymmetric way in which the policy treats firms makes coverage requirements less cost-efficient than an alternative regulation that treats firms symmetrically.

Motivated by these observations, I set out to measure the effect of coverage requirements on the diffusion of 3G and 4G technology, and how coverage requirements fare against alternative interventions. To this end, I build a dynamic game of entry and technology upgrade that features coverage requirements explicitly and estimate this model using panel data on mobile technology availability at the municipality level in Brazil. I use the estimated model to measure the effect of coverage requirements on how fast 3G and 4G technology are introduced, by simulating firm behavior under coverage requirements and without regulation. I find that coverage requirements accelerate the introduction of 3G technology by about one year, on average, and that the role of the equilibrium effects mentioned above is limited. I also use the model to simulate an alternative policy that subsidizes the first firm to offer 3G technology or better. I set the magnitude of the subsidy so that the firms themselves would be willing to finance it. This policy attains a

*University of Pennsylvania, Department of Economics, joaog@sas.upenn.edu.
speed-up in the introduction of 3G that is only marginally better than that achieved by coverage requirements. However, I show that this policy generates substantial cost savings due to its symmetric treatment of firms. These findings have immediate implications for universal service regulation in the telecommunications industry.

In a second project titled “Retailers’ Product Portfolios and Negotiated Wholesale Prices”, I zoom in on the interaction between firms’ product offerings and prices. In particular, I study the effect of the size of retailers’ product portfolios, the number of different brands they offer, and their private label offerings on national brands’ prices. Product portfolios have a direct effect on prices via optimal pricing decisions and also an indirect effect because they influence retailers’ bargaining positions, and thus the wholesale prices retailers are able to procure. I propose an empirical bargaining model of wholesale and retail price setting which accounts for both effects. I estimate the model using IRI scanner data. Among other results, I find that private label products are responsible for a 1% decrease in national brands’ prices.

I intend to work on other projects that broaden my research on non-price competition and its welfare effects. I have obtained from the Brazilian ground transportation regulator ticket-level data on the long-distance bus market. I intend to use these data to study firms’ scheduling decisions, a dimension of competition that has not been explored by the existing literature on passenger transportation markets. The Hotelling-like nature of competition that arises is prone to inefficiencies in product provision, which I intend to quantify empirically. I also plan to use these data to study the trade-off between consumer protection and product availability, manifested in this setting by price controls in specific segments of the market, which have resulted, anecdotally, in reduced service in these segments. Finally, I am involved in a project to collect detailed data on the access to telecommunications technologies of a sample of high school students in Brazil. These data will be paired with administrative data on students’ scores in the Brazilian national college admissions exam, to further our understanding of the relationship between access to telecommunications technologies and educational achievement.

In summary, my work focuses on non-price dimensions of oligopolistic competition, particularly on firms’ choices of what products to offer, the effects of those choices on consumer well-being, and how regulators can best design policies to overcome market inefficiencies in the provision of goods and services. I intend to deepen that research agenda by further exploring the empirical settings described above and others where service underprovision is a salient concern, such as broadband, food deserts, and health care.
UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez
Placement Director: David Dillenberger
Graduate Student Coordinator: Gina Conway

Office Contact Information
University of Pennsylvania
The Ronald O. Perelman Center for
Political Science and Economics
133 South 36th Street Office 526
Philadelphia, PA 19104
215-807-9647

Personal Information: Citizenship: South Korea (US Permanent Resident), Gender: Male

Undergraduate Studies:
B.A./B.S., Economics/Mathematical Sciences, Seoul National University, 2012

Masters Level Work:
M.A., Economics, Seoul National University, 2014

Graduate Studies:
University of Pennsylvania, 2014 to present
Thesis Title: “Essays on Uncertainty Aversion and Signaling”
Expected Completion Date: May 2021

Thesis Committee and References:
Professor David Dillenberger (Co-advisor)
University of Pennsylvania
The Ronald O. Perelman Center for
Political Science and Economics
133 South 36th Street Office 619
Philadelphia, PA 19104
ddill@econ.upenn.edu

Professor Andrew Postlewaite (Co-advisor)
University of Pennsylvania
The Ronald O. Perelman Center for
Political Science and Economics
133 South 36th Street Office 515
Philadelphia, PA 19104
apostlew@econ.upenn.edu

Professor Annie Liang
University of Pennsylvania
The Ronald O. Perelman Center for
Political Science and Economics
133 South 36th Street Office 501
Philadelphia, PA 19104
anliang@upenn.edu
**Research Fields:**
Decision Theory, Microeconomic Theory

**Teaching Experience:**
- **Spring 2017**  Introduction to Macroeconomics, Teaching Assistant for Professor Luca Bossi
- **Fall 2016**  Microeconomic Theory I (graduate), Teaching Assistant for Professor Steven Matthews and Professor Andrew Postlewaite
- **Spring 2016**  Intermediate Macroeconomics, Teaching Assistant for Guillermo Ordonez
- **Fall 2015**  Microeconomic Theory I (graduate), Teaching Assistant for Professor Steven Matthews and Professor Andrew Postlewaite

**Research Experience:**
- **2018-2020**  Research Assistant for Professor Andrew Postlewaite and Professor George Mailath

**Honors and Fellowships:**
- **2018-2019**  PIER RA Stipend Matching Grant, Penn Institute for Economic Research
- **2017-2018**  Sidney Weintraub Memorial Fellowship in Economics, University of Pennsylvania
- **2014-2018**  Scholarship, Kwanjeong Educational Foundation
- **2014-2019**  University Fellowship, University of Pennsylvania
- **2013**  Social Sciences Korea Research Scholarship, National Research Foundation of Korea
- **2012, 2013**  Brain Korea 21 Research Scholarship, National Research Foundation of Korea

**Research Paper:**
*“The Aversion to Uncertainty about Multiple Issues” (Job Market Paper)*
We study a decision problem under uncertainty about multiple issues by explicitly imposing a product structure on the set of states in the Anscombe-Aumann framework. In this environment, a decision maker may exhibit a tendency to avoid uncertain acts that depend on many issues since it can be harder to form a belief about multiple issues jointly than about individual issues separately. We provide a novel behavioral property, *Multi-issue Aversion*, which captures this idea. The property blends two concepts of aversion to uncertainty. First, it requires that when there are pairwise indifferent acts that depend on distinct issues, a mixture of them must be less preferred to each individual act since the mixture demands multi-issue considerations. Second, the property imposes the Uncertainty Aversion axiom of Gilboa and Schmeidler (1989) among the alternatives that depend on a single issue. We characterize the set of utility functions consistent with Multi-issue Aversion within the broad class of invariant biseparable preferences. We show that exhibiting Multi-issue Aversion is equivalent to having a belief satisfying two conditions: richness of the core of the (joint) belief and superadditivity of the marginal beliefs. The richness condition provides a novel way of comparing a decision maker’s confidence levels about different sets of issues. If a belief has a rich core, it can be interpreted as the decision maker being more confident about individual issues in isolation than about the entire set of issues.

**Research in Progress:**
*“Signaling with Multiple Senders”*
We develop a signaling model to examine the idea that when there is more than one sender, a receiver may evaluate their signaling choices relatively. This idea is related to the question of whether students
will choose their education levels competitively based on what others choose even if there is no explicit competition between them. Our model extends Spence’s (1973) job market signaling game so that there are two workers (senders) and each worker has a two-dimensional type consisting of her ability and her cost of education, of which the second component is positively correlated across workers. The primary question of this paper is whether a firm (receiver) bases its wage offer to a worker on both workers’ education choices in an equilibrium. Even though workers do not have incentives to send a signal about the second component of their types, a worker's education choice may unwittingly convey to the firm some information about it. Since the second components are correlated across workers, this can complicate the firm’s inference problem of assessing each worker’s ability from their education choices. In particular, one worker’s education choice gives nontrivial information about the other worker’s ability. The main results of this paper are the following. First, it is shown that a worker's wage necessarily depends on the other worker's education level in any non-babbling equilibrium if the second components are strictly positively correlated. Second, we show that there always exists an equilibrium in which a worker's wage is decreasing in the other's education level, which suggests competitive behavior in signaling.

“Understanding Pessimism with Choquet Expected Utility Models”
We provide novel axiomatizations of Choquet Expected Utility (CEU) functions with convex capacities and disjointly superadditive capacities, respectively. We first show that the two properties can be characterized in alternative ways by using the rank-dependent probabilities associated with a capacity. These new characterizations elucidate the tight connections between the properties and a decision maker’s pessimism. Based on the alternative characterization of convexity, we provide a behavioral axiom called Pessimism. A decision maker satisfying this axiom behaves as if she assigns a higher likelihood to an event when the act being considered delivers relatively worse outcomes on the event. In the CEU model, this axiom is shown to be equivalent to the convexity of a capacity. Then, we present a parallel result regarding disjoint superadditivity which has been less explored in the literature. We find the equivalence between a weaker axiom, Weak Pessimism, and the disjoint superadditivity of a capacity. In addition, we discuss the relationship between two axioms, Pessimism and Uncertainty Aversion of Schmeidler (1989). It is shown that once transitivity and Comonotonic Independence are assumed, Uncertainty Aversion implies Pessimism.

“Decision Making under Unawareness”
We propose a utility function that reflects a decision maker’s awareness of her unawareness and provide an axiomatic foundation of it. The utility function is a combination of two parts. The first part is a standard expected utility which is based on the decision maker’s evaluation of the specified part of an act. The second part is a function of the set of outcomes that can be delivered by the act on specified events, and captures her speculation on what would happen on possibly unspecified events. Her final utility from the act is a convex combination of the two parts. The uniquely identified weight she assigns on the first part is interpreted as her confidence in her awareness. The axiomatization includes weakening of two axioms, Reversal of Order and Dominance that are proposed by Anscombe and Aumann (1963) in their axiomatization of Subjective Expected Utility (SEU). These axioms are weakened so that they hold only between the acts that share the same set of outcomes on specified events. If two acts do not share the set, the decision maker’s speculation about the possibly unspecified part of each act may differ, which causes deviation from the standard SEU preferences.
Dissertation Abstract

Youngsoo Heo

In my job market paper titled “The Aversion to Uncertainty about Multiple Issues”, I study a decision problem under uncertainty about multiple issues. When multiple issues are involved, it can be harder to form a belief about them altogether than about individual issues separately since the correlation across issues must be considered. In light of this, many issues being involved may mean a higher degree of uncertainty, and a decision maker averse to such uncertainty may exhibit a tendency to choose alternatives that depend only a small number of issues. This suggests that in a multiple-issue environment a decision maker’s aversion to uncertainty may be manifested by a specific behavioral pattern that cannot be captured by existing notions in the literature, including the Uncertainty Aversion axiom of Schmeidler (1989) and Gilboa and Schmeidler (1989).

The primary goal of this paper is to formalize this idea of aversion to uncertainty in a multiple-issue environment by providing a behavioral definition of it, and to characterize the set of utility functions that are consistent with the new concept. In order to do so, I model uncertainty with multiple issues by adopting the Anscombe-Aumann framework and explicitly imposing a product structure on the set of states so that each component of a state encodes the description of all relevant consequences regarding an individual issue which is a part of the entire uncertainty.

I start by defining a behavioral property, called Multi-issue Aversion. This blends two concepts of aversion to uncertainty. First, the property requires that a decision maker prefer alternatives that depend on a single issue to those that depend on multiple issues. To be more precise, when there are pairwise indifferent acts that depend on distinct issues, a mixture of them must be less preferred to each individual act since the mixture demands multi-issue considerations. Second, the property imposes the Uncertainty Aversion axiom among the alternatives that depend on a single issue. Given this, Multi-issue Aversion can be viewed as an extension of the Uncertainty Aversion axiom into a model with multi-dimensional states.

Then, I characterize the set of utility functions consistent with Multi-issue Aversion within the broad class of invariant biseparable preferences. These preferences can be represented by utility functions under which a decision maker’s preference over lotteries and belief over the states can be separated. Thus, my characterization of utility functions works by imposing conditions on the belief part, which captures the decision maker’s uncertainty attitude rather than her risk attitude. I show that exhibiting Multi-issue Aversion is equivalent to having a belief that satisfies two conditions: Richness of the core of a belief and superadditivity of marginal beliefs. The latter condition is directly achieved from imposing the Uncertainty Aversion axiom on individual issues. The former is a novel condition that reflects the aversion to alternatives that depend on multiple issues. The richness condition requires that the core of a (joint) belief be sufficiently large relative to the cores of marginal beliefs, being interpreted as a decision maker being more confident about individual issues in isolation than about the entire set of issues.
In the paper titled “Signaling with Multiple Senders”, I develop a signaling model to examine the idea that when there is more than one sender, a receiver may evaluate their signaling choices relatively. This idea is related to the question of whether students will choose their education levels competitively based on what others choose even if there is no explicit competition between them. My model extends Spence’s (1973) job market signaling game so that there are two workers (senders) and each worker has a two-dimensional type consisting of her ability and her cost of education, of which the second component is positively correlated across workers.

The primary question of this paper is whether a firm (receiver) bases its wage offer to a worker on both workers’ education choices in an equilibrium. Even though workers do not have incentives to send a signal about the second component of their types, a worker's education choice may unwittingly convey to the firm some information about it. Since the second components are correlated across workers, this can complicate the firm’s inference problem of assessing each worker’s ability from their education choices. In particular, one worker’s education choice gives nontrivial information about the other worker’s ability.

The main results of this paper are the following. First, it is shown that a worker's wage necessarily depends on the other worker's education level in any non-babbling equilibrium if the second components are strictly positively correlated. Second, I show that there always exists an equilibrium in which a worker's wage is decreasing in the other's education level, which suggests competitive behavior in signaling.

In the paper titled “Understanding Pessimism with Choquet Expected Utility Models”, I provide a novel axiomatization of Choquet Expected Utility (CEU) functions with convex capacities and disjointly superadditive capacities, respectively, demonstrating the close relationships between those properties and pessimistic behavior. A capacity $v$ is said to be convex if $v(A \cup B) + v(A \cap B) \geq v(A) + v(B)$ for any events $A$ and $B$. Disjoint Superadditivity is a weaker condition that requires the inequality hold only when the two events are disjoint. The connection between these properties and pessimism is illustrated by providing an alternative characterization of them using rank-dependent probabilities associated with a capacity.

A CEU maximizer behaves as if she assigns different likelihoods to an event when she considers different acts. Given an act, the likelihood of a particular event is determined by the ranking of the event in terms of how preferable the outcomes delivered on the event are. I show that the likelihood assigned to the event under a convex capacity is decreasing in the ranking of the event. That is, the better the outcomes, the smaller the likelihood. This can immediately be understood as pessimism. Using this characterization, I provide a novel axiom called Pessimism. In the CEU model, this axiom is proved to be equivalent to the convexity of a capacity. I provide parallel results about disjoint superadditivity, too, which is less explored in the literature. It is characterized by a similar but weaker property, and I establish an equivalence between a weaker axiom, called Weak Pessimism, and disjoint superadditivity. In addition, I discuss the relationship between the two axioms, Pessimism and Uncertainty Aversion of Schmeidler (1989) which is known to be equivalent to convexity. It is shown that once transitivity and Comonotonic Independence are imposed, Uncertainty Aversion implies Pessimism.
Office Contact Information
Department of Economics
University of Pennsylvania
133 South 36th Street, Office 528
Philadelphia, PA 19104
+1 (267) 570-7570

Personal Information:
Date of Birth: March 5th, 1988
Citizenship: Israeli

Undergraduate Studies:

Master Level Work:
M.A., Economics, Hebrew University of Jerusalem, 2015
M.A., Economics, University of Pennsylvania, 2017

Graduate Studies:
University of Pennsylvania, 2015 to present
Thesis Title: “Essays on Firm, Worker and Consumer Decision-making in On-Demand and Health Care Markets”
Expected Completion Date: June 2020

Thesis Committee and References:
Hanming Fang (Co-advisor) Petra Todd (Co-advisor)
Office 605, Department of Economics Office 606, Department of Economics
University of Pennsylvania University of Pennsylvania
133 South 36th Street, Office 605 133 South 36th Street
Philadelphia, PA 19104 Philadelphia, PA 19104
+1 (215) 898-7767 +1(215) 898-4084
hanming.fang@econ.upenn.edu ptodd@econ.upenn.edu

Iwan Barakay
Office 2201, The Wharton School
University of Pennsylvania
3620 Locust Walk
Philadelphia, PA 19104
+1 (215) 898-6372
barakay@wharton.upenn.edu
**Research Fields:**

**Teaching Experience:**
- 2017, 2018, 2019: Advanced Micro Econometrics (Graduate), University of Pennsylvania, Teaching Assistant for Prof. Petra Todd
- 2018, 2019 Spring, 2020: Health Economics, University of Pennsylvania, Teaching Assistant for Prof. Juan Pablo Atal
- Fall 2017: Political Economy, University of Pennsylvania, Teaching Assistant for Prof. Sarah Moshary
- Spring 2016: Introductory Economics: Macroeconomics, University of Pennsylvania, Instructor
- Fall 2016: Introductory Economics: Macroeconomics, University of Pennsylvania, Recitation Instructor for Prof. Luca Bossi
- 2015: Public Economics, Hebrew University of Jerusalem, Teaching Assistant for Prof. Ity Shurtz
- Fall 2014: Mathematics for Economist, Hebrew University of Jerusalem, Teaching Assistant for Dr. Jonathan Stupp

**Research Experience:**
- 2019-2020: Research Assistant for Professor Peter Cappelli and Professor Liat Eldor, The Wharton School, University of Pennsylvania
- 2013-2015: Research Assistant for Professor Victor Lavy, Hebrew University of Jerusalem, University of Warwick, and NBER
- 2012-2013: Research Assistant for Professor Avraham Ebenstein, Hebrew University of Jerusalem

**Professional Activities:**
- **Presentations**
  - 2020: Cedefop, Eurofound and IZA Conference on Workplace and Management Practices (Virtual); Applied Economics Seminar (University of Pennsylvania)
  - 2019: H2D2 Research Day (University of Michigan); Young Economists Symposium (Columbia University); Applied Economics Seminar (University of Pennsylvania)
  - 2018: Applied Economics Seminar (University of Pennsylvania)
- **Refereeing**
  - 2018: Young Economist Symposium (NYU)
  - 2019: Young Economist Symposium (Columbia University)

**Honors, Scholarships, and Fellowships:**
- 2018, 2019: SAS Dean’s Travel Subvention, University of Pennsylvania
- 2015-2020: University Fellowship, University of Pennsylvania
- 2012, 2013: Dean’s List, Faculty of Social Science, Hebrew University of Jerusalem, Israel
- 2010-2011: Undergraduate Fellowship for Outstanding Records, Hebrew University of Jerusalem, Israel
Research Papers:

“Gig Workers and Performance Pay: A Dynamic Equilibrium Analysis of an On-Demand Industry”
(Job Market Paper)

In many online product markets, firms manufacture and supply products almost immediately after receiving orders. Thus, firms need to ensure that their workers satisfy product demand, which can vary over time, in a cost-effective way. This paper develops and estimates a dynamic equilibrium model of firm and worker behavior in an ‘on-demand’ production context. The firm solves a dynamic discrete choice cost minimization model in which it faces uncertainty about future product demand and workers' productive capacity. The firm chooses to employ two types of workers – gig workers and permanent workers – and it sets parameters of a compensation scheme that is a mix of salary and performance-based incentives to elicit worker effort. Heterogeneous workers solve a daily effort choice problem given the compensation scheme offered by the firm. I estimate the model and perform an out-of-sample validation of the model using panel data from an online, global manufacturer that produces customized items. The data include detailed measures of workers' output and output quality under varying compensation schemes. I find that gig workers and permanent workers exhibit different production patterns and that gig workers are much more responsive to incentive pay. I embed the workers' optimal effort decisions into the firm's dynamic cost minimization problem and use simulation methods to derive optimal labor force composition and compensation schemes. I show that varying the compensation scheme over time and using a mix of gig and permanent workers provides the flexibility that the firm needs to effectively operate in an on-demand customized production environment.

“Family Information Spillovers: Evidence from the RAND Health Insurance Experiment”
R&R at the Journal of Health Economics

I study how family information spillovers shape health care consumption through two main sources: a learning channel whereby family members share information about the health insurance plan, and a behavioral channel whereby risk perception and habits are shared and transmitted. I exploit two types of sudden health shocks to separately identify a causal effect operating through each channel. I incorporate these shocks into an event-study and a synthetic control event study frameworks to quantify the effect of spillovers on health care consumption of a non-injured adult family member. I find a significant behavioral spillover effect of an increase of more than 70% in medical spending of preventive care over a two-year horizon. Moreover, I find a strong and persistent spillover effect associated with learning that amounts to an average increase in medical spending of more than 100% relative to prior to the health shock. While the first result is in line with previous findings in the literature, the second is novel. I demonstrate that learning about health plan cost structure and coverage benefits are means in which the learning-spillover channel operates, and that acquired knowledge promotes consumption of preventive treatments.

“Sitting Habits and Productivity: Evidence from a Randomized Field Experiment”

Modern life has made us sedentary and our health suffers in consequence. Although the obvious direct costs of a sedentary lifestyle are health care expenses, there is an additional crucial path of indirect costs associated with the decline of workers’ productivity, as worse health can lead to performance decrement and more work absences. I conduct a randomized control field experiment in a workplace with sedentary jobs to shed light on this indirect path. I supply workers with a “smart pillow”, a new technological device that provides real-time biofeedback on sitting posture and aims to improve workstation ergonomics. By combining workers’ subjective and objective job performance measures with their detailed sitting records over time, I study the link between workers’ health and productivity, as well as the sitting habit-forming process. More generally, the implications of this study concern workers’ health in a modern work lifestyle both in the short run, as a result of an immediate improvement in sitting habits and adoption of a dynamic working environment, as well as the long run, after the treatment is removed.
Never Too Much? The Nonlinear Effect of Psychological Safety on Business Performance (with Peter Cappelli and Liat Eldor) Under Review

Psychological safety is widely seen as having a positive relationship with work performance. Could there be a downside, however? Drawing on the theoretical principle of a “too-much-of-a-good-thing” effect, we propose that high levels of psychological safety can actually harm business performance. We also propose that perceptions of accountability and shared ultimate goals can moderate this too-much-of-a-good-thing, based on cognitive representation theory. We test our hypotheses using data on employee attitudes as well as business performance outcomes over four years and across 257 branches of a retail chain store. We find that moderate levels of psychological safety have strong and positive effect on business outcomes whereas at the highest levels, the relationship reverses and becomes negative. Perceptions of accountability and shared ultimate goals moderate the negative effect. The results extend research on psychological safety to the organization level, specifically real business outcomes, and have important implications for research and practice.

Research Papers in Progress

“Anchoring Worker’s Pay Expectations: Evidence from the Gig Economy”

“Gifts Forming Social Exchange Relationship” [working title] (with Peter Cappelli and Liat Eldor)

“Internal or External Hiring?” [working title] (with Peter Cappelli and Liat Eldor)

Languages: Hebrew (Native), English (Fluent)

Computational Skills: Matlab, Stata, R
RESEARCH STATEMENT

MICHAL HODOR

Email: mhodor@sas.upenn.edu  Website: www.michalhodor.com

My areas of study include labor economics, health economics, personnel economics, and applied econometrics. In my research, I strive to enrich standard economic models, use them to challenge traditional views and address empirical questions relevant to new market conditions and social policy implications.

In my job market paper, “Gig Workers and Performance Pay: A Dynamic Equilibrium Analysis of an On-Demand Industry,” I address questions pertinent to firm and worker behavior in an on-demand manufacturing environment. On-demand manufacturing is an adjustable process that aims to produce customized items based on real-time data under tight production times and thus must respond quickly to changing product demand. Traditionally, manufacturing firms operated assembly lines that produced large quantities of products that were kept in storage until delivery; however, with on-demand customized items, this demand-smoothing practice is not feasible. My research analyzes how a firm optimally operates a customized on-demand production system. I develop a dynamic equilibrium model of firm and worker behavior in an on-demand production context and empirically implement the model based on a rich data set I obtained from an online manufacturer that produces customized items. The firm, facing uncertainty about future product demand and worker productive capacity, chooses to employ two types of workers, gig workers and permanent workers, and sets parameters of a compensation scheme that is a mix of salary and performance-based incentives to elicit worker effort. Gig and permanent workers differ in their total factor productivity, intrinsic motivation, and effort cost, and choose effort levels that affect both the total productivity and the quality of output. The major challenge in determining the optimal labor force composition (composed of both gig and permanent workers) and compensation pay structure (flat wage or performance incentive pay) in response to changing demand conditions is that worker productivity responds endogenously to the firm’s pay structure. Therefore, the equilibrium framework is constructed such that workers’ optimal production decisions, job experience, and on-the-job learning processes are integrated into the firm’s problem through an incentive compatibility constraint.

I estimate the model and perform an out-of-sample model validation using data from years 2015 and 2018. I find that whereas permanent workers produce close-to-constant amounts over various levels of job experience, gig workers exhibit an increasing production pattern over time spent in the firm. Furthermore, gig workers exhibit statistically and economically significant responses to incentives that amount to 12% productivity gains on average, but permanent workers’ average production response to incentives is not statistically different from zero for almost all job experience levels. Through the structural model estimation, I explore the origins of these differences and find that gig workers’ personal motivation and total factor productivity are more than twice as large as those of permanent workers. I further find that varying the compensation scheme over time and using a mix of gig and permanent workers provides flexibility the firm needs to effectively operate in an on-demand production environment. Lastly, providing gig workers’ with a base wage while implementing the incentive pay structure is a key component that maintains workers’ utility.

My paper “Family Information Spillovers: Evidence from the RAND Health Insurance Experi-
ment,” (currently R&R at the *Journal of Health Economics*) investigates how the flow and sharing of information among family members following health events can impact health care consumption. Although the family unit has been shown to significantly influence various individual and economic outcomes, little is known on its role in shaping health care consumption decisions. I study how family information spillovers shape health care consumption through two main sources: a learning channel whereby family members share information regarding their health insurance plan, and a behavioral channel whereby risk perception and habits are shared and transmitted. I exploit two types of sudden health shocks to separately identify a causal effect operating through each channel: a spouse’s non-fatal heart attack or stroke and a severe injury to a child. I incorporate these shocks into an event-study and a synthetic control event-study frameworks to quantify the effect of spillovers on health care consumption of a non-injured adult family member. I find a significant behavioral spillover effect of a more than 70% increase in medical spending of preventive care over a two-year horizon. Moreover, I find a strong and persistent spillover effect associated with the family learning about their health insurance plan that amounts to an average increase in medical spending of more than 100% relative to prior to the health shock. While the first result is in line with previous findings in the literature, the second is novel. I demonstrate that learning about health plan cost structure and coverage benefits are means in which the learning-spillover channel operates and that acquired knowledge promotes consumption of preventive treatments.

My work in progress, “Sitting Habits and Productivity: Evidence from a Randomized Field Experiment,” intersects health and labor economics and addresses labor issues in modern working environments. Modern life has made us sedentary and our health suffers in consequence. Although the obvious direct costs of a sedentary lifestyle are health care expenses, there is an additional crucial path of indirect costs associated with the decline of workers’ productivity, as worse health can lead to performance decrement and more work absences. I conduct a randomized control field experiment in a workplace with sedentary jobs to shed light on this indirect path. I supply workers with a “smart pillow”, a new technological device that provides real-time biofeedback on sitting posture and aims to improve workstation ergonomics. By combining workers’ subjective and objective job performance measures with their detailed sitting records over time, I study the link between workers’ health and productivity, as well as the sitting habit-forming process. More generally, the implications of this study concern workers’ health in a modern work lifestyle both in the short run, as a result of an immediate improvement in sitting habits and adoption of a dynamic working environment, as well as the long run, after the treatment is removed.

Other projects in progress relate to the topic of labor management practices in non-traditional workplaces of the developing on-demand industry. In the study “Anchoring Worker’s Pay Expectations: Evidence from the Gig Economy,” I explore gig workers’ pay expectations under a dynamic pay structure. In jobs that use both flat wage pay and incentive pay at various times, workers may develop a behavioral-conditioning effect in which they need an incentive to produce more than the lowest productivity level required. In particular, the incentive structure echoes the fact that production above the expected lower bound requires an uncompensated effort. In other projects with Peter Cappelli and Liat Eldor, we empirically investigate the influence of the now-common practice of giving employees gift cards for celebrating special occasions on job performance, and the tradeoffs between internal and external hiring in a high-turnover workplace.
UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez
Placement Director: David Dillenberger
Graduate Student Coordinator: Gina Conway

Contact Information
Department of Economics
University of Pennsylvania
133 South 36th Street, Office 548
Philadelphia, PA 19104
908-461-5681

Personal Information:
Citizenship: United States
Language: English (native)

Undergraduate Studies:
B.A., Economics (High Honors) and Mathematics, Oberlin College, 2014

Masters Level Work:
A.M., Economics, University of Pennsylvania, 2018

Graduate Studies:
University of Pennsylvania, 2014-2015 and 2016-present
Thesis Title: Incentives and Information for Teams
Expected Completion Date: May 2021

Thesis Committee and References:
Professor George J. Mailath (Advisor)
Department of Economics
University of Pennsylvania
113 South 36th Street, Office 522
Philadelphia, PA 19104
215-898-7908
gmailath@econ.upenn.edu

Professor J. Aislinn Bohren
Department of Economics
University of Pennsylvania
113 South 36th Street, Office 502
Philadelphia, PA 19104
215-573-6233
abohren@sas.upenn.edu

Professor Steven A. Matthews
Department of Economics
University of Pennsylvania
113 South 36th Street, Office 618
Philadelphia, PA 19104
215-898-7749
stevenma@econ.upenn.edu

Professor Juuso Toikka
Wharton Business Economics and Public Policy Department and Department of Economics
University of Pennsylvania
3733 Spruce Street, 330 Vance Hall
Philadelphia, PA 19104
215-898-8920
toikka@wharton.upenn.edu
**Fields:** Microeconomic Theory, Industrial Organization, Matching and Market Design

**Teaching:**

- **Sole Instructor**
  - Fall 2017  ECON 101: Intermediate Microeconomics, University of Pennsylvania
    Avg. Evaluation: 3.25 on a 0-4 scale.

- **TA (Graduate)**
  - Spring 2020  ECON 682: Game Theory, University of Pennsylvania
    Instructor: J. Aislinn Bohren  Avg. Evaluation: 3.54 on a 0-4 scale.

- **TA (Undergraduate)**
  - Fall 2019  ECON 013: Strategic Reasoning, University of Pennsylvania
    Instructor: David Dillenberger  Avg. Evaluation: 3.29 on a 0-4 scale.
  - Spring 2018  ECON 235: Industrial Organization, University of Pennsylvania
  - Spring 2017  ECON 211: Social Choice, University of Pennsylvania
    Instructor: SangMok Lee  Avg. Evaluation: 3.79 on a 0-4 scale.
  - Fall 2016  ECON 001: Intro Microeconomics, University of Pennsylvania
    Instructor: Rebecca Stein  Avg. Evaluation: 2.16 on a 0-4 scale.
  - Fall 2012/2013  ECON 255: Intro Econometrics, Oberlin College
    Instructor: Barbara Craig

**Teaching Awards and Training:**

- Spring 2018  Joel Popkin Graduate Student Teaching Prize in Economics
- Fall 2017  Center for Teaching and Learning (CTL) Teaching Certificate

**Research Assistance:**

- 2020-present  University of Pennsylvania, George J. Mailath and Rakesh V. Vohra
- Spring 2019  University of Pennsylvania, Rohit Lamba
- 2018-2019  University of Pennsylvania, George J. Mailath and Andrew Postlewaite
- Summer 2017  University of Pennsylvania, Camilo Garcia-Jimeno
- Summer 2013  Boston University, Laurence J. Kotlikoff
- Spring 2012  Oberlin College, Ron Cheung

**Other Employment:**

- Summer 2018  Copy Editor for “Modeling Strategic Behavior” by George J. Mailath
- 2013-2014  Oberlin College, Academic Ambassador (Peer Advisor)
- Spring 2013  White House Council of Economic Advisers, Intern
- Summer 2012  United States Department of Justice, Antitrust Division, Intern

**External Presentations**

- 2021  6th World Congress of the Game Theory Society (scheduled)
- 2020  12th World Congress of the Econometric Society
- 2018  29th Stony Brook International Conference on Game Theory
- 2018  Pennsylvania Economic Theory Conference (poster)
- 2017  28th Jerusalem School in Economic Theory (poster)

**Scholarships and Honorary Societies:**

- 2014-2019  University Fellowship, University of Pennsylvania
- 2014  Phi Beta Kappa, Oberlin College
- 2014  Omicron Delta Epsilon, Oberlin College

October 11, 2020
Research Papers:

Robust Performance Evaluation (Job Market Paper)

Can team-based incentive pay be justified in the absence of task interdependency or correlation in individual performances? My paper answers: Yes, if robustness is a concern. In a moral hazard in teams model in which a principal knows that the agents she compensates are identical and technologically independent, but does not know all of the common actions they can take, I show that any worst-case optimal contract is nonlinear with respect to total output and exhibits joint performance evaluation. This result establishes a fundamentally new channel leading to the optimality of joint performance evaluation and formalizes a longstanding idea that interdependent incentive schemes are advantageous due to their flexibility. It contrasts with the recent literature on robust contracting with unbounded uncertainty, which finds linear incentive schemes to be worst-case optimal, and with the classical theory of incentives, which finds independent performance evaluation to be Bayesian optimal.

The Optimal Assortativity of Teams Inside the Firm (with Carlos Segura-Rodriguez)

How does a profit-maximizing manager form teams and compensate workers in the presence of both adverse selection and moral hazard? Under complete information, it is well known that any complementarity in characteristics implies that positive assortative matching is productively efficient. But, under asymmetric information, we uncover the problem of disassortative incentives: incentive costs may increase in assortativity. Profit maximization thus prescribes either random or negative assortative matching, both productively inefficient, when complementarities are weak and effort costs are high enough. When this is the case, the manager may instead prefer to delegate matching, allowing workers to sort themselves into teams. Our results shed light on recent empirical work documenting patterns of non-assortative matching inside of firms.

Matching to Produce Information: A Model of Self-Organized Research Teams (with Carlos Segura-Rodriguez and Peng Shao)

In recent decades, research organizations have brought the “market inside the firm” by allowing workers to sort themselves into teams. How do research teams form absent a central authority? We introduce a model of team formation in which workers first match and then non-cooperatively produce correlated signals about an unknown state. We uncover a novel form of moral hazard: an efficient team of workers producing complementary signals may be disrupted if one of its members can form an inefficient team in which she exerts less effort. This inefficiency rationalizes targeted management interventions which designate specific workers as “project leaders” with more assumed responsibilities.

Payoff Continuity in Games of Incomplete Information: An Equivalence Result

Monderer and Samet (1996) and Kajii and Morris (1998) define notions of proximity for countable, common prior information structures that preserve equilibrium payoff continuity. Monderer and Samet (1996) fix a common prior and perturb lists of partitions, while Kajii and Morris (1998) fix a type space and perturb common priors. Due to these differences, the precise relationship between the two papers has remained an open question. We establish an equivalence between them by mapping pairs of partition lists to pairs of common priors, and vice-versa. The key condition of the mapping ensures that belief types are changed independently of payoff types in the Kajii and Morris (1998) perturbation.

Research Papers in Progress:

Search Committees with Disparate Costs (with S. Nageeb Ali and J. Aislinn Bohren)
RESEARCH STATEMENT

Ashwin Kambhampati
Department of Economics, University of Pennsylvania
Website: https://sites.google.com/sas.upenn.edu/ashwinkambhampati
E-mail: akambh@sas.upenn.edu

Teams are central to the functioning of the modern firm. A key determinant of firm productivity, therefore, is the effectiveness of their management. My dissertation comprises three papers that explore the optimal provision of incentives in firms that employ teams. The first considers the robust design of incentives when a Principal does not fully understand her workers’ production technology; the second simultaneously considers how to optimally match workers into teams and provide incentives for effort; and the third investigates how information complementarities interact with team incentives when team formation is decentralized. Together, this research offers empirical researchers in the fields of industrial organization, labor, and development both novel frameworks for thinking about firm productivity, and empirically testable predictions. I first discuss each paper and its applications, then outline work in progress.

My job market paper, “Robust Performance Evaluation”, addresses a fundamental question in incentive theory: How should a Principal compensate identical agents whom complete tasks independently when she cannot observe the actions they take, but can observe their individual performance? If individual performances are uncorrelated and the Principal has a complete understanding of the agents’ environment, then the Informativeness Principle dictates that the Principal optimally compensates each agent according to her own performance alone. But what if the Principal does not know all of the actions the agents can take and so optimizes against worst-case scenarios? In stark contrast to the Bayesian setting, I show that any worst-case optimal contract involves nonlinear joint performance evaluation; each agent’s wage is nonlinear in total output and increases in the performance of another agent. This result is driven by a rent-extraction benefit of joint incentives that emerges in the presence of robustness considerations. It thereby generates the novel prediction that interdependent, team-based incentive schemes can arise in the absence task interdependence or correlation in individual performances; they will also arise when the Principal does not have a complete understanding of the agents’ environment.

In “The Optimal Assortativity of Teams Inside the Firm”, with Carlos Segura-Rodriguez, we conduct a unified analysis of optimal team composition and incentives in the presence of both adverse selection and moral hazard. We consider a Beckerian matching setting in
which positive assortative matching is full-information optimal. Under asymmetric information, we show that a novel rent-efficiency tradeoff arises: When complementarities are weak and effort costs are high, expected wage payments increase in the assortativity of the matching the manager implements, i.e. if the most productive workers are matched with one another as often as possible, then expected wage payments are maximized. As a result, either random or negative assortative matching can be profit-maximizing. This sheds light on recent empirical work documenting patterns of non-assortative matching inside of firms, even when there are productive complementarities.

As self-organizing teams are playing an increasingly important role in economic activity, a key related question is whether management should assign workers to teams or delegate the sorting problem to workers themselves. In “The Optimal Assortativity of Teams Inside the Firm”, we show that if the moral hazard in teams problem is not too severe and talent is scarce, then delegation outperforms centralized assignment because workers can exploit private information about one another’s characteristics to sort efficiently.

In “Matching to Produce Information: A Model of Self-Organized Research Teams”, with Carlos Segura-Rodriguez and Peng Shao, we consider a different framework with rich informational complementarities in which decentralized matching is not, in fact, efficient. In this model, each worker can produce multiple signals about an unknown state. The signals that each worker produces are correlated with those of other workers in the firm, thereby affecting the incentives of workers to form teams with one another. In this setting, we uncover a novel source of moral hazard: An efficient team of workers producing complementary signals may be disrupted if one of its members can form an inefficient team in which she exerts less effort. This inefficiency rationalizes targeted management interventions which designate specific workers as “project leaders” with more assumed responsibilities.

In on-going research, I continue to explore topics related to strategic robustness and the internal structure of organizations. In “Payoff Continuity in Games of Incomplete Information: An Equivalence Result”, I establish an equivalence between two well-known notions of proximity for information structures in games of incomplete information. These notions possess the robustness property that two information structures are close if and only if they imply similar strategic predictions across all games the players might be playing. In “Search Committees with Disparate Costs”, with Nageeb Ali and Aislinn Bohren, we study how heterogeneity in hiring search costs distorts the quality of hired candidates and the welfare of the committee.
TOMAS LARROUCAU
https://tlarroucau.github.io/
tomasl@sas.upenn.edu

UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez
Placement Director: David Dillenberger
Graduate Student Coordinator: Gina Conway

Office Contact Information
Department of Economics
University of Pennsylvania
133 South 36th Street, Office 546
Philadelphia, PA 19104
+1 (215) 900-6743

Home Contact Information
4247 Locust street, apt 825
Philadelphia, PA 19104

Personal Information:
Date of Birth: June 9th, 1988
Citizenship: Chilean
Visa: J1

Undergraduate Studies:
Undergraduate Degree, Industrial Engineering, University of Chile, Highest Distinction, 2013
B., Engineering Science in Industrial Engineering, University of Chile, Highest Distinction, 2011

Masters Level Work:
M. A., Economics, University of Pennsylvania, 2018
M., Public Policies, University of Chile, Highest Distinction, 2013

Graduate Studies:
University of Pennsylvania, 2015 to present
Thesis Title: “Essays on Empirical Market Design in Higher Education”
Expected Completion Date: May 2021

Thesis Committee and References:
Hanming Fang (Advisor)
Office 605
Department of Economics
University of Pennsylvania
133 South 36th Street
Philadelphia, PA 19104
215-898-7767
hanming.fang@econ.upenn.edu

Rakesh Vohra (Advisor)
Office 523
Department of Economics
University of Pennsylvania
133 South 36th Street
Philadelphia, PA 19104
215-898-6777
rvohra@seas.upenn.edu

Eduardo Azevedo
Business Economics and Public Policy Department
Wharton School
3733 Spruce Street
Vance Hall 329
Philadelphia, PA 19104
215-573-9984
eazevedo@wharton.upenn.edu

Margaux Luflade
Department of Economics
International Bldg., Room 253A, Princeton, NJ, 08544
984-260-1547
mluflade@sas.upenn.edu

Christopher Neilson
Department of Economics
Princeton University
609-258-6957
cneilson@princeton.edu
Teaching and Research Fields:

Teaching Experience:
Fall, 2016, Introduction to Economics, University of Pennsylvania, Teaching Assistant for Professor Anne Duchene
Spring, 2017, Introduction to Economics, University of Pennsylvania, Teaching Assistant for Professor Rebecca Stein
Fall, 2018, Intermediate level Microeconomics, University of Pennsylvania, Teaching Assistant for Professor Rakesh Vohra
Spring, 2020, Industrial Organization, University of Pennsylvania, Teaching Assistant for Professor John Lazarev

Research Experience and Other Employment:
2017 University of Pennsylvania, R.A. for Professors Hanming Fang and Andrew Shephard
2018 University of Pennsylvania, R.A. for Professors Hanming Fang and Andrew Shephard
2018 University of Pennsylvania, R.A. for Professor Rakesh Vohra
2019 University of Pennsylvania, R.A. for Professors Juan Pablo Atal and Rakesh Vohra

Professional Activities
Presentations: University of Chile, Santiago, Chile (2020)
North American Summer Meeting / Econometric Society, Seattle, USA (2019)
Professional: Startup - Consultancy Company, TwoMatch Consulting (Design of matching algorithms)
2014-2015: Chilean College Board

Honors, Scholarships, and Fellowships:
2020-2021 Maloof Family - Dissertation Fellowship in Economics
2018-2019 Rodin Graduate Fellowship
2017 Joel Popkin Award, Graduate Student Teaching Prize in Economics, Department of Economics, University of Pennsylvania
2015-2020 University of Pennsylvania Fellowship Department of Economics, University of Pennsylvania
2014 Eugenio Lahera Prize: Best Thesis in Public Policies, University of Chile

Publications:
“Hunter-gatherers maintain assortativity in cooperation despite high-levels of residential change and mixing”, with K. Smith, I. Mabulla, C. Apicella, in Current Biology 28 (19), 3152-3157, 2018


Research Papers:
Job Market Paper:
“Dynamic College Admissions and the Determinants of Students’ College Retention” (with I. Rios)
We analyze the determinants of students’ college retention in the context of dynamic centralized assignment mechanisms, where students can learn about their preferences and abilities over time and can re-apply to the system. We show that the most common assignment mechanism, the Deferred Acceptance (DA) algorithm, can result in significant inefficiencies as it fails to elicit the intensity of students’ preferences. Using data from Chile, we document these inefficiencies, and we show that not being assigned to ones’ top-reported preference has a positive causal effect on the probability of (i) reapplying to the centralized system, (ii) switching one’s major/college, and (iii) delaying college graduation. Moreover, we find that a significant fraction of students change their preferences over time, which increases switchings and delay graduations, and we also observe that these switchings
and dropout decisions vary depending on students' characteristics including gender and level of income. Based on these facts, we build and estimate a structural model of students' college progression in the presence of a centralized admission system, allowing students to learn their match-quality over time. We use the estimated model to disentangle how much of students' switching behavior is due to initial mismatches as opposed to learning, and we also analyze the impact of changing the assignment mechanism and the re-application rules on the efficiency of the college admissions' system. Our counterfactual results show that policies that provide score bonuses which elicit the intensity on students' preferences can significantly decrease switchings, dropouts, and increase the overall welfare of students.

"Improving the Chilean College Admissions System" (with R. Cominetti, I. Rios and G. Parra), in Operations Research (R & R Minor revisions). First place, Doing Good with Good OR - Student Paper Competition (2018)

In this paper we present the design and implementation of a new system to solve the Chilean college admissions problem. We develop an algorithm that obtains all stable allocations when preferences are not strict and when all tied students in the last seat of a program (if any) must be allocated, and we used this algorithm to determine which mechanism was used to perform the allocation. In addition, we propose a new method to incorporate the affirmative action that is part of the system and correct the inefficiencies that arise from having double-assigned students. By unifying the regular admission with the affirmative action, we have improved the allocation of approximately 3% of students every year since 2016. From a theoretical standpoint, we introduce a new concept of stability and we show that some desired properties, such as strategy-proofness and monotonicity, cannot be guaranteed under flexible quotas. Nevertheless, we show that the mechanism is strategy-proof in the large, and therefore truthful reporting is approximately optimal.

"Do “Short-List” Students Report Truthfully? Strategic Behavior in the Chilean College Admissions Problem" (with I. Rios)

We analyze the application process in the Chilean College Admissions problem. Students can submit up to 10 preferences, but most students do not fill their entire application list ("short-list"). Even though students face no incentives to misreport, we find evidence of strategic behavior as students tend to omit programs for which their admission probabilities are too low. To rationalize this behavior, we construct a portfolio problem where students maximize their expected utility given their preferences and beliefs over admission probabilities. We adapt the estimation procedure proposed by Agarwal and Somaini (2018) to solve a large portfolio problem. To simplify this task, we show that it is sufficient to compare a ROL with only a subset of ROLs ("one-shot swaps") to ensure its optimality without running into the curse of dimensionality. To better identify the model, we exploit a unique exogenous variation on the admission weights over time. We find that assuming truth-telling leads to biased results. Specifically, when students only include programs if it is strictly profitable to do so, assuming truth-telling underestimates how preferred selective programs are and overstates the value of being unassigned and the degree of preference heterogeneity in the system. Ignoring the constraint on the length of the list can also result in biased estimates, even if the proportion of constrained ROLs is relatively small. Our estimation results strongly suggest that "short-list" students should not be interpreted as truth-tellers, even in a seemingly strategy-proof environment. Finally, we apply our estimation method to estimate students' preferences for programs and majors in Chile and find strong differences in preferences regarding students' gender and scores.

"College Admissions Problem with Ties and Flexible Quotas" (with R. Cominetti, I. Ríos and G. Parra)

We study an extension of the classical college admission problem where applicants have strict preferences, but careers may include ties in their preference lists. We present an algorithm which enables us to find stable assignments without breaking ties rules but considering flexible quotas. We investigate the properties of this algorithm -- stability, optimality -- and we show that the resulting algorithm is neither monotone nor strategy-proof. The mechanism is used to solve real instances of the Chilean college admission problem. Among our results, we show that the welfare of students is increased if flexible quotas and a student-optimal assignment are combined. Finally, we argue why such assignment may be desirable in the Chilean context.

**Research Paper(s) in Progress**

"The effects of Automation on the U.S Labor Market, under the Affordable Care Act" (with H. Fang and A. Shephard)

"Hybrid Dutch auctions and Toxic bonds", (with T. Mylovanov, and R. Vohra)

"Mistakes in College Admissions” (with M. Martinez, C. Neilson, and I. Rios)

**Languages:** Spanish (Native) and English (Fluent)

**Computational Skills:** R, Repp, C++, Python, SQL, and Stata
RESEARCH STATEMENT
Tomas Larroucau
Department of Economics, University of Pennsylvania

My research interests are at the intersection of Empirical Market Design, Labor Economics, and Education. The core of my research is understanding the role of centralized assignment mechanisms in the provision of education, and how different market-designs can affect the efficiency and equity of the system, especially when agents face strategic incentives, learn about their match-qualities over time, and can have repeated interactions with the mechanism over time.

Centralized assignment mechanisms are widely used and present in many markets, including admission to Higher Education, school choice, and kidney exchanges, among others. The empirical evaluation of these markets is an important and challenging task. For instance, in the Higher Education context, depending on the mechanism used, students may face strategic incentives when reporting their preferences, making it difficult for researchers to identify their true preferences and evaluate policy changes. Also, even if we have access to students’ preferences, it is still unclear how students would behave if we introduce strategic incentives in the mechanism or application rules. Moreover, we do not know the effects of different market-designs on students’ outcomes beyond their initial assignments, especially when students can have repeated interactions with the assignment mechanism over time and learn over time about their preferences and match-qualities. In my dissertation, I answer some of these questions, combining administrative data on the Chilean college admissions process with unique data sets I constructed from survey information about students’ preferences and beliefs on admission probabilities and massive records on students’ college grades.

In my Job Market Paper: “Dynamic College Admissions and the Determinants of Students’ College Retention, with I. Rios”, we analyze the determinants of students’ college retention in the context of dynamic centralized assignment mechanisms, where students can learn about their preferences and abilities over time and can re-apply to the system. We show that the most common assignment mechanism, the Deferred Acceptance (DA) algorithm, can result in significant inefficiencies as it fails to elicit the intensity of students’ preferences. Using data from Chile, we document these inefficiencies, and we show that not being assigned to ones’ top-reported preference has a positive causal effect on the probability of (i) reapplying to the centralized system, (ii) switching one’s major/college, and (iii) delaying college graduation. Moreover, we find that a significant fraction of students change their preferences over time, which increases switchings and delay graduations, and we also observe that these switching and dropout decisions vary depending on students characteristics including gender and level of income. Based on these facts, we build and estimate a structural model of students’ college progression in the presence of a centralized admission system, allowing students to learn their match-quality over time. We use the estimated model to disentangle how much
of students’ switching behavior is due to initial mismatches as opposed to learning, and we also analyze the impact of changing the assignment mechanism and the re-application rules on the efficiency of the college admissions’ system. Our counterfactual results show that policies that provide score bonuses which elicit the intensity on students’ preferences can significantly decrease switchings, dropouts, and increase the overall welfare of students.

In my paper “Do “short-list” students report truthfully? Strategic behavior in the Chilean college admissions problem” with I. Rios (2019), we document strong evidence of strategic behavior in students’ applications, even though students face no incentives to misreport their preferences. Thus, their reported preferences need not coincide with their actual preferences. Taking this empirical fact into account, we build a new methodology that recovers students’ preferences from observed application lists, even when students face a large number of choices and do not report truthfully. Our paper provides a significant theoretical and methodological contribution that can be applied to other settings where individuals need to choose a subset of alternatives from a large set of possible choices. We use the proposed methodology to estimate preferences in the Chilean college admissions system and find substantial differences in majors’ preferences relative to students’ gender and scores.

The two projects mentioned above were motivated by my close collaboration with the Chilean college board over the years, which included the re-design of the admissions’ system (“Improving the Chilean College Admissions System” with I. Rios, et al., in Operations Research (R & R)), the evaluation of affirmative action policies (“Effect of Including High-School Grades Rank in the Admission Process to Chilean Universities” with A. Mizala and I. Ríos, in Pensamiento Educativo, 52 (1), 95–118, 2015), and analyzing the prevalence of strategic mistakes in students’ applications (with M. Martinez, C. Neilson, and I. Rios).

Although an essential part of my research is related to Higher Education, I am also interested in Empirical Microeconomics, Market Design, and Labor economics. I am currently analyzing the incentives that firms face to adopt automation technologies in the presence of labor market regulations, such as the ACA (with H. Fang and A. Shephard), the labor market effects of licensing physicians in Chile (with J. Atal), and how to use auctions to sell toxic bonds in the presence of insiders in Ukraine (with R. Vohra and T. Mylovanov). Regarding my core research, I have several directions for future work. We still do not understand why students make strategic mistakes when applying to college and how effective are information policies to lower these mistakes’ prevalence. Moreover, we have made significant progress in understanding the inefficiencies that initial mismatches could generate in dynamic college admissions systems. However, there is very little work in understanding the right learning environment for students and the optimal time for specializing in their college education. These answers could be key to improve the efficiency and equity of Higher Education systems across the world.
UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez  
Placement Director: David Dillenberger  
Graduate Student Coordinator: Gina Conway

Office Contact Information
Department of Economics  
University of Pennsylvania  
133 South 36th Street, Office 636  
Philadelphia, PA 19104  
+1 (215) 827-9213

Personal Information
Date of Birth: August 4th, 1988  
Citizenship: South Korean  
Visa: F1

Undergraduate Studies:
B.B.A., Business Administration, Korea University, 2014  
B.S., Mathematics, Korea University, 2014

Masters Level Work:
M.S., Finance, University of Illinois at Urbana-Champaign, 2016

Graduate Studies:
University of Pennsylvania, 2016 to present.  
Thesis Title: “Essays on Heterogeneity in Macroeconomics”  
Expected Completion Date: May 2021

Thesis Committee and References:
Jesús Fernández-Villaverde (Advisor)  
Dirk Krueger (Advisor)
Office 521, Department of Economics  
Office 520, Department of Economics  
University of Pennsylvania  
University of Pennsylvania  
133 South 36th Street  
133 South 36th Street  
Philadelphia, PA 19104  
Philadelphia, PA 19104  
+1 (215) 573-1504  
+1 (215) 573-1424  
jesusfv@econ.upenn.edu  
dkrueger@econ.upenn.edu

Frank Schorfheide  
Andrew Abel
Office 621, Department of Economics  
Office 2315, Department of Finance  
University of Pennsylvania  
The Wharton School  
133 South 36th Street  
University of Pennsylvania  
3620 Locust Walk  
Philadelphia, PA 19104  
Philadelphia, PA 19104  
+1 (215) 573-1424  
+1 (215) 898-4801  
schorf@econ.upenn.edu  
abel@wharton.upenn.edu
Research Fields:
Macroeconomics, Finance

Teaching Experience:
Summer, 2019 - 2020 University of Pennsylvania, an instructor of the Math Camp for the first-year Ph.D.
Spring, 2018 University of Pennsylvania, Intermediate Macroeconomics, Teaching Assistant for Professor Dirk Krueger
Fall, 2017 University of Pennsylvania, Econometrics I: Fundamentals for the first-year Ph.D. core course, Teaching Assistant for Professor Xu Cheng
Spring, 2013 Korea University, Investments, Teaching Assistant for Professor Baeho Kim

Research Experience and Other Employment:
2018-2020 University of Pennsylvania, Research Assistant for Professor Jesús Fernández-Villaverde
2019 Summer FRB San Francisco Thomas J. Sargent Dissertation Fellow
2018 Summer Princeton Initiative Summer Program
2014-2016 University of Illinois at Urbana-Champaign, Research Assistant for Professor Dana Kiku and Professor Jaewon Choi
2013-2014 Korea University, Research Assistant for Professor Jong-Wha Lee and Professor Baeho Kim
2013-2014 Asiatic Research Institute (ARI) at Korea University, Assistant Researcher

Professional Activities:
Presentations 2021: AEA/ASSA (Virtual), SED Annual Meeting; 2020: KER International Conference (Virtual), WEAI Annual Meeting (Virtual), MEA Annual Meeting (cancelled), University of Pennsylvania; 2019: San Francisco FRB, University of Pennsylvania
Referee International Economic Review, Games and Economic Behavior, Macroeconomic Dynamics

Honors, Scholarships, and Fellowships:
2020 Hiram C. Haney Fellowship Award in Economics for Best Third Year Research Paper
2019 FRB San Francisco Thomas J. Sargent Dissertation Fellowship
2016-2020 University of Pennsylvania Doctoral Fellowship
2016-2020 Kwanjeong Educational Foundation Fellowship
2015 American Finance Association (AFA) Doctoral Student Travel Grant Award
2014 Zwisler Fellowship (merit-based), University of Illinois at Urbana-Champaign
2014-2015 University of Illinois at Urbana-Champaign Doctoral Fellowship

Research Paper:
"Striking While the Iron Is Cold: Fragility after a Surge of Lumpy Investments"
(JOB MARKET PAPER)

In this paper I argue that synchronized large-scale investments of large firms can significantly amplify productivity-driven aggregate fluctuations, and lead to investment cycles even in the absence of aggregate shocks. Using U.S. Compustat data, I show that years preceding recessions display investment surges among large firms. Furthermore, after the investment surges, large firms become inelastic to interest rates and display persistent inaction duration. I then develop a heterogeneous-firm
real business cycle model in which a firm needs to process multiple investment stages for large investments and can accelerate it at a cost. In the model, following a TFP shock the synchronized timings of lumpy investments are persistently synchronized. And TFP-induced recessions are especially severe after the surge of large firms’ lumpy investments. In support of this prediction, I present evidence for the investment cycle in post-shock period in macro-level data on nonresidential fixed investment.

**Research Papers in Progress:**

“Top Income Inequality and the Business Cycle”

This paper studies how the pass-through businesses of top income earners affect aggregate fluctuations in the U.S. economy. I develop a heterogenous-household real business cycle model with endogenous labor supply and occupation choice. In the model, heterogenous labor demand sensitivities to TFP shocks between pass-through businesses and C corporations build the core of the aggregate dynamics. Using the model, I argue that the recent trend of top income inequality being driven by pass-through businesses has substantially changed the aggregate fluctuations. In particular, unemployment responds significantly more strongly to a negative TFP shock under top income inequality driven by pass-through businesses than under top income inequality driven by factor income. The model prediction is empirically supported by heterogenous labor adjustment patterns between pass-through businesses and C corporations in the midst of the dot-com bubble crash.

“Aggregate Uncertainty and Repeated Transition Method”

In this paper, I develop and test a novel algorithm that solves heterogenous agent models with aggregate uncertainty. The algorithm repeatedly updates agents' expectation on the future path of aggregate states from the transition dynamics on a single path of simulated shocks until the expected path converges to the simulated path. The nonlinear dynamic stochastic general equilibrium could be computed with a high degree of accuracy by this method; the market clearing prices and the expected aggregate states are directly computed at each point on the path without relying on the parametric law of motions. Using the algorithm, I analyze a heterogenous-firm business cycle model where firms are subject to external financing cost and hoard cash as a buffer stock up to a target level. Based on the model, I discuss the business cycle implications of the corporate cash holdings.

“Rising Concentrated Intangibles” with Jesús Fernández-Villaverde

“Rising Intangible and Fading Listed” with Sara Casella and Sergio Villalvazo

**Languages:** English (fluent), Korean (native)

**Computational Skills:** MATLAB, Julia, R, Stata, SAS
Dissertation Abstract

Hanbaek Lee†

University of Pennsylvania

My research interests are in macroeconomics and finance, with a particular focus on the business cycle implications of micro-level heterogeneity. In my job market paper, I study how interest-inelastic lumpy investments at firm level amplify aggregate productivity shocks; in my second project, I study how rising importance of pass-through businesses in labor market increases employment sensitivity during the recession; and my third research project develops a novel computational method that solves the nonlinear dynamic stochastic general equilibrium with heterogenous agents. The key components of my research are modeling cross-sectional heterogeneity based on the empirical facts and quantitatively analyzing the model with aggregate uncertainty.

In my job market paper, “Striking while the Iron is Cold: Fragility after a Surge of Lumpy Investments,” I argue that synchronized large-scale investments of large firms can significantly amplify productivity-driven aggregate fluctuations, and lead to investment cycles even in the absence of aggregate shocks. Using U.S. Compustat data, I show that years preceding recessions display investment surges among large firms. Furthermore, after the investment surges, large firms become inelastic to interest rates and display persistent inaction duration. I then develop a heterogeneous-firm real business cycle model in which a firm needs to process multiple investment stages for large-scale investments and can accelerate it at a cost. In the model, following a TFP shock the synchronized timings of lumpy investments are persistently synchronized. This synchronized investment timings result in endogenous nonlinear fluctuations in the aggregate investment which I call as an echo effect. And TFP-induced recessions are especially severe after the surge of large firms’ lumpy investments. This is because the lowered interest rate during the recession does not motivate large firms to make another round of large-scale investment. This channel amplifies the TFP shock effect up to 15%, and a negative TFP shock has a 29% greater impact on aggregate investment after a surge of lumpy investments. In support of this prediction, I present evidence for the

†University of Pennsylvania. Email: hanbaek@sas.upenn.edu
investment cycle in post-shock period in macro-level data on nonresidential fixed investment.

In “Top Income Inequality and the Business Cycle,” I study how the observed trend of rising top income inequality driven by pass-through business income affects the business cycle. Pass-through business is a highly illiquid asset due to the nature of closed ownership. Therefore, if a productivity shock hits a pass-through business, a great portion of the shock effect is loaded on the labor demand because the other input factor, capital stock, is hardly adjustable. To quantitatively analyze how the rising pass-through business affects the business cycle, I develop a heterogenous-household real business cycle model with endogenous labor supply and occupation choice. In the model, heterogenous labor demand sensitivities to TFP shocks between pass-through businesses and C corporations build the core of the aggregate dynamics. Using the model, I argue that the recent trend of top income inequality being driven by pass-through businesses has substantially changed the aggregate fluctuations. In particular, unemployment responds significantly more strongly to a negative TFP shock under top income inequality driven by pass-through businesses than under top income inequality driven by factor income. The model prediction is empirically supported by heterogenous labor adjustment patterns between C corporations and pass-through businesses in the midst of the dot-com bubble crash.

Finally, in “Aggregate Uncertainty and Repeated Transition Method,” I develop and test a novel algorithm that solves heterogenous agent models with aggregate uncertainty. My job market paper and the second paper above use this algorithm to solve the nonlinear dynamic stochastic general equilibrium. The algorithm repeatedly updates agents’ expectation on the future path of aggregate states from the transition dynamics on a single path of simulated shocks until the expected path converges to the simulated path. The nonlinear dynamic stochastic general equilibrium could be computed with a high degree of accuracy by this method; the market clearing prices and the expected aggregate states are directly computed at each point on the path without relying on the parametric law of motions. Using the algorithm, I analyze a heterogenous-firm business cycle model where firms are subject to external financing cost and hoard cash as a buffer stock up to a target level. Based on the model, I discuss the business cycle implications of the corporate cash holdings.
UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez
Placement Director: David Dillenberger
Graduate Student Coordinator: Gina Conway

Office Contact Information
Office 535, Department of Economics
University of Pennsylvania
133 South 36th Street
Philadelphia, PA, 19104
+1 (267) 905-9192

Personal Information: Male, China (F-1 visa)

Undergraduate Studies:
B.A., Mathematical Economics, Fudan University, 2013

Master Level Works:
M.A., Economics, University of Pennsylvania, 2020
M.A., Economics, University of California, Santa Barbara, 2015

Graduate Studies:
University of Pennsylvania, 2015 to present
Thesis Title: “Essays on Housing Markets and Mortgage Finance”
Expected Completion Date: May 2021

Thesis Committee and References:
Dirk Krueger (Advisor)
Office 520, Department of Economics
University of Pennsylvania
PCPSE, 133 South 36th Street
Philadelphia, PA 19104
+1 (215) 573-1424
dkrueger@econ.upenn.edu

Susan Wachter (Advisor)
Office 422, Department of Real Estate
The Wharton School, University of Pennsylvania
Vance Hall, 3733 Spruce Street
Philadelphia, PA 19104
+1 (215) 898-6355
wachter@wharton.upenn.edu

Guillermo Ordonez
Office 505, Department of Economics
University of Pennsylvania
PCPSE, 133 South 36th Street
Philadelphia, PA 19104
+1 (215) 898-1875
ordonez@econ.upenn.edu

Joachim Hubmer
Office 504, Department of Economics
University of Pennsylvania
PCPSE, 133 South 36th Street
Philadelphia, PA 19104
+1 (215) 898-8761
jhubmer@sas.upenn.edu

Research Fields:
Urban Economics, Macroeconomics, Household Finance, Real Estate Economics
Teaching Experience:
Fall, 2020  Public Finance, Penn, TA for Prof. Hanming Fang
Spring, 2018- Spring, 2020  Urban Real Estate Economics (Undergraduate/MBA), the Wharton School, TA for Prof. Susan Wachter
Spring, 2019- Spring, 2020  International Housing Comparisons (Undergraduate/MBA), the Wharton School, TA for Prof. Susan Wachter
Fall, 2016- Intermediate Microeconomics, Penn, TA for Prof. Rakesh Vohra and Kenneth Burdett
Spring, 2015  Intermediate Microeconomics, UC Santa Barbara, TA for Prof. Kelly Bedard
Fall, 2014- Microeconomic Theory I & II (Graduate), UC Santa Barbara, TA for Prof. Zach Grossman and Cheng-Zhong Qin
Winter, 2015  Principle of Microeconomics, UC Santa Barbara, TA for Prof. Javier Birchenall
Fall, 2013- Spring, 2014  Principle of Microeconomics, UC Santa Barbara, TA for Prof. Jon Sonstelie
Winter, 2014

Research Experience and Other Employment:
2019-present  Penn Institute of Urban Research, Affiliated PhD Student
2017-present  The Wharton School, RA for Prof. Susan Wachter
2017-present  Penn Wharton GIS Lab, Graduate Research Assistant
2014  UC Santa Barbara, RA for Prof. Ted Bergstrom
2012  UCLA, Cross-disciplinary Scholars in Science and Technology (CSST) Summer Research Program

Professional Activities:
Presentation
2017-2018  46th AREUEA National Conference, DC
Discussant  “Why Are Housing Cost Rising?” by C. Makridis, 2020 AREUEA-ASSA Conference, San Diego
“Land Use Controls Do Not Reduce the Elasticity of Housing Supply in the Standard Urban Model” by D. Broxterman and Y. Liu, 14th Meeting of Urban Economics Association, Philadelphia
Co-organizer  Financial Intermediation and Markets (FIM) Reading Group (jointly held by Wharton finance and economics department)

Honors, Scholarships, and Fellowships:
2015-2020  University Fellowship, Penn
2020  Mack Institute PhD Research Fellowship, the Wharton School
2019-2020  GAPSA Research Travel Grant, Penn
2018-2020  SASgov Travel Grant, Penn (x2)
2019 Doctoral Travel Grant, AREUEA
2017-2019 SAS Dean’s Travel Subvention, Penn (x2)
2017-2019 Xinmei Zhang Fellow, Penn
2014-2015 Thormahlen Family Fellowship in Economics, UC Santa Barbara
2013-2014 Graduate USAP Fellowship, UC Santa Barbara

Research Papers:

“Housing Search and Rental Market Intermediation” (Job Market Paper)
Rental brokers as the matchmakers between tenants and landlords contribute 80% of the rental listings in certain markets, but how they smooth the search friction and transmit policy impacts is not well understood. This paper is the first to use a listing-agent matched data set from an online platform to show the heterogeneous impact of the listing capacity of a broker, i.e. the agent size, on the rental market outcomes. I document that brokers with greater listing capacity are related to lower rent and shorter listing duration. The dispersion cannot be fully explained by the amenity difference of rentals and points to a sizable agent impact that a broker with greater capacity lists a rental at a lower rent. I develop a search model that features a search-and-matching process in which the capacity constraints of heterogeneous brokers interact with the tenant coordination friction. The capacity constraints differentiate brokers’ ability to coordinate tenant search. The lower rent premium for listings by larger brokers reflects the capacity benefit that greater listing capacity allows brokers to coordinate tenant search better. An endogenous agent distribution of the listing capacity, which summarizes how frictional the rental market is, arises in the model. I evaluate the counterfactual effects of two rental market policies. First, I show that expanding the brokerage sector will not benefit tenants in the search process. As the mean agent size decreases, the rental market becomes more frictional. Second, I evaluate the impact of shifting the commission liability from tenants to landlords, which is central to the New York rental market reform. As the equilibrium rent increase cannot fully compensate the commission cost on landlords, the policy decreases rental supply and makes searching tenants worse off. I characterize the optimal allocation of the broker’s fee and show that brokers with greater listing capacity should list more rentals with the fee paid by landlords.

“Land Use Regulation, Regulatory Spillover and Housing Prices” (with Susan Wachter) Under Review
We estimate the effect of city land use regulation on housing prices in the presence of regulatory spillover. The total effect of regulation is decomposed into a direct effect in which regulation lowers housing productivity and an indirect effect in which household location choice mitigates the price effects of regulatory restrictions. Using housing sales data from California, we structurally estimate a closed-form housing price equation based on a housing model with spatial arbitrage. We find that the total price effect of a one standard deviation increase in city restrictiveness is 9.3% on average, ranging from 4.1% to 14.4% across cities. The spillover effect is economically significant, with the size of the indirect effect equal to 21% of the direct effect for an average city, ranging from 0 to 47%. We point to the importance of identifying direct and indirect effects by controlling for regulation in surrounding locations. For jurisdictions with the power to impose regulation on a larger number of locations, regulation has a stronger price impact due to limits on regulatory spillover.

How did pricing for mortgage credit risk change during the years prior to the 2008 financial crisis? Using a database from a major American bank that served as trustee for private-label mortgage-backed securitized (PLS) loans, this paper identifies a decline in credit spreads on mortgages conditioned on loan and borrower characteristics. We show that observable risk factors, FICO score and loan-to-value ratio, had less of an impact on mortgage pricing over time. As the volume of PLS mortgages expanded and lending terms eased, risk premiums failed to price the increase in risk.

Fifty years after the adoption of the 1968 Fair Housing Act that prohibits discrimination in the housing market, homeownership rates have not increased for Black or Hispanic households. The current homeownership rate for Black households is 42 percent, identical to the 1970 census reported level, and 48 percent for Hispanic households, lower than that in 1970. Using data from the 1989, 2005, and 2013 American Housing Surveys, we identify the extent to which group differences in household endowments account for persistently low minority homeownership levels.

“Housing Boom, Mortgage Default and Agency Friction”

The housing prices and the mortgage credit witnessed faster growth than GDP in the run-up of the Great Recession. I document a mortgage market puzzle during the boom period: (1) the mortgage risk measured by the *ex post* delinquency increased, but (2) the mortgage spread decreased. The default risk premium alone cannot explain the decreasing mortgage spread in the boom episode. I develop a dynamic general equilibrium model of the housing and the mortgage markets with borrowers, depositors, and intermediaries to explain the empirical fact. The model features the tightness of the lending condition and the mortgage risk as the aggregate shocks, which generate the time-varying liquidity and default premiums in the mortgage spread. I quantify the contribution of the aggregate risks to the boom-bust dynamics before and after the Great Recession. A plausible size of the income shock alone is insufficient to generate the observed movement in the mortgage spread. The model shows that lending relaxation that eases the leverage constraint of an intermediary leads to the increasing mortgage credit and the decreasing mortgage spread in the boom period. The lending condition shock generates pro-cyclical leverage of intermediaries that amplifies the aggregate shocks in the boom-bust dynamics.

**Research Papers in Progress:**

“Nonbank Mortgage Lending, Regulation and Macroeconomic Transmission”

“Yes, in My Backyard: Sharing Economy and Neighborhood Impact in New York City” (with Betty Wang)

“The Amenity Value of Green Space: Evidence from Philadelphia” (with Shane Jensen and Susan Wachter)

“The Distributional Impact of QM Patch and DTI Relaxation” (with Susan Wachter)

**Book Chapters**


**Languages:** Chinese (Native), English (Fluent)

**Computational Skills:** Matlab, R, Stata, LaTeX, ArcGIS
Dissertation Abstract

Desen Lin
University of Pennsylvania

Housing Search and Rental Market Intermediation (Job Market Paper)

Rental brokers as the matchmakers between tenants and landlords contribute 80% of the rental listings in certain markets, but how they smooth the search friction and transmit policy impacts is not well understood. This paper is the first to use a listing-agent matched data set from an online platform to show the heterogeneous impact of the listing capacity of a broker, i.e. the agent size, on the rental market outcomes. I document that brokers with greater listing capacity are related to lower rent and shorter listing duration. The dispersion cannot be fully explained by the amenity difference of rentals and points to a sizable agent impact that a broker with greater capacity lists a rental at a lower rent. I develop a search model that features a search-and-matching process in which the capacity constraints of heterogeneous brokers interact with the tenant coordination friction. The capacity constraints differentiate brokers' ability to coordinate tenant search. The lower rent premium for listings by larger brokers reflects the capacity benefit that greater listing capacity allows brokers to coordinate tenant search better. An endogenous agent distribution of the listing capacity, which summarizes how frictional the rental market is, arises in the model. I evaluate the counterfactual effects of two rental market policies. First, I show that expanding the brokerage sector will not benefit tenants in the search process. As the mean agent size decreases, the rental market becomes more frictional. Second, I evaluate the impact of shifting the commission liability from tenants to landlords, which is central to the New York rental market reform. As the equilibrium rent increase cannot fully compensate the commission cost on landlords, the policy decreases rental supply and makes searching tenants worse off. I characterize the optimal allocation of the broker's fee and show that brokers with greater listing capacity should list more rentals with the fee paid by landlords.

Land Use Regulation, Regulatory Spillover and Housing Prices (with Susan Wachter)

We estimate the effect of city land use regulation on housing prices in the presence of regulatory spillover. The total effect of regulation is decomposed into a direct effect in which regulation lowers housing productivity and an indirect effect in which household location choice mitigates the price effects of regulatory restrictions. Using housing sales data from California, westructurally estimate a closed-form housing price equation based on a housing model with spatial arbitrage. We find that the total price effect of a one standard deviation increase in city restrictiveness is 9.3% on average, ranging from 4.1% to 14.4% across cities. The spillover effect is economically significant, with the size of the indirect effect equal to 21% of the direct effect for an average city, ranging from 0 to 47%. We point to the importance of identifying direct and indirect effects by controlling for regulation in surrounding locations. For jurisdictions with the power to impose regulation on a larger number of locations, regulation has a stronger price impact due to limits on regulatory spillover.
**Mortgage risk premiums during the housing bubble** (with Adam Levitin and Susan Wachter)

How did pricing for mortgage credit risk change during the years prior to the 2008 financial crisis? Using a database from a major American bank that served as trustee for private-label mortgage-backed securitized (PLS) loans, this paper identifies a decline in credit spreads on mortgages conditioned on loan and borrower characteristics. We show that observable risk factors, FICO score and loan-to-value ratio, had less of an impact on mortgage pricing over time. As the volume of PLS mortgages expanded and lending terms eased, risk premiums failed to price the increase in risk.

**Endowments and Minority Homeownership** (with Arthur Acolin and Susan Wachter)

Fifty years after the adoption of the 1968 Fair Housing Act that prohibits discrimination in the housing market, homeownership rates have not increased for Black or Hispanic households. The current homeownership rate for Black households is 42 percent, identical to the 1970 census reported level, and 48 percent for Hispanic households, lower than that in 1970. Using data from the 1989, 2005, and 2013 American Housing Surveys, we identify the extent to which group differences in household endowments account for persistently low minority homeownership levels.

**Housing Boom, Mortgage Default and Agency Friction**

The housing prices and the mortgage credit witnessed faster growth than GDP in the run-up of the Great Recession. I document a mortgage market puzzle during the boom period: (1) the mortgage risk measured by the *ex post* delinquency increased, but (2) the mortgage spread decreased. The default risk premium alone cannot explain the decreasing mortgage spread in the boom episode. I develop a dynamic general equilibrium model of the housing and the mortgage markets with borrowers, depositors, and intermediaries to explain the empirical fact. The model features the tightness of the lending condition and the mortgage risk as the aggregate shocks, which generate the time-varying liquidity and default premiums in the mortgage spread. I quantify the contribution of the aggregate risks to the boom-bust dynamics before and after the Great Recession. A plausible size of the income shock alone is insufficient to generate the observed movement in the mortgage spread. The model shows that lending relaxation which eases the leverage constraint of an intermediary leads to the increasing mortgage credit and the decreasing mortgage spread in the boom period. The lending condition shock generates pro-cyclical leverage of intermediaries that amplifies the aggregate shocks in the boom-bust dynamics.
UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez  
Placement Director: David Dillenberger  
Graduate Student Coordinator: Gina Conway

Office Contact Information
133 South 36th St.  
Philadelphia, PA 19103

Home Contact Information
2011 Spruce St, Apt 3R  
Philadelphia, PA 19103  
Phone number: +1 267 9082105

Personal Information:
Date of birth: September 24, 1990  
Sex: Male  
Citizenship: Colombia, US Permanent Resident  
Languages: English (native level), Spanish (native), French (Fluent: 7 years), German (Beginner: 1 year)

Undergraduate Studies:
B.A., Business Administration, Universidad de los Andes (Colombia), cum laude, 2013.

Masters Level Work:
M.A., Economics, Universidad de los Andes (Colombia), 2015.

Graduate Studies:
University of Pennsylvania, 2015 to present  
Thesis Title: “Essays on Peer Effects and Network Econometrics”  
Expected Completion Date: May 2020.

Thesis Committee and References:
Professor Xu Cheng (Primary Advisor)  
Professor Francis J DiTraglia  
University of Pennsylvania  
University of Oxford  
133 South 36th St., PCPSE 620  
Manor Road, Oxford OX1 3UQ  
215-898-6775  
518 300 1330  
xucheng@econ.upenn.edu  
francis.ditraglia@economics.ox.ac.uk

Professor Petra Todd  
University of Pennsylvania  
133 South 36th St., PCPSE 606  
215-898-4084  
ptodd@econ.upenn.edu

Teaching and Research Fields:
Primary fields: Econometrics, Development Economics, Applied Microeconomics.  

Teaching Experience:
As primary instructor:
2017-2019  
Summer Math Camp for incoming Economics Ph.D. Students, UPenn
Fall 2015  
Stata Workshop, UniAndes
Spring 2014  
Stata Workshop, UniAndes
Teaching Assistant (TA) at University of Pennsylvania:
Spring 2020  Polit. Econ. of Early British America, TA for Jesus Fernandez-Villaverde.
Fall 2019  Foundations of Market Economics, TA for Jesus Fernandez-Villaverde.
Spring 2019  Topics in Development, TA for Jesus Fernandez-Villaverde.
Fall 2018  Statist. Learning and Causal Inference in Econ., TA for Francis J. DiTraglia.
Spring 2018  Econometric Theory II (Ph.D. course), TA for Frank Diebold.
Fall 2017  Econometric Theory I (Ph.D. course), TA for Xu Cheng and Frank Schorfheide.
Spring 2017  Intermediate Macroeconomics, TA for Alessandro Dovis.
Fall 2016  Econometric Theory I (Ph.D. course), TA for Xu Cheng and Frank Schorfheide.

Teaching Assistant (TA) at Universidad de los Andes:
Spring 2015  Advanced Econometrics (Masters), TA for Raquel Bernal.
Fall 2014  Advanced Econometrics (Masters), TA for Raquel Bernal.
Spring 2012  Colombia and its Institutions (Undergraduate), TA. For Nathalia Franco.

Research Experience and Other Employment:
2019  UPenn, Research Assistant for Jere Behrman and Irma Elo.
2018  UPenn, Research Assistant for David Abrams.
2017  UPenn, Research Assistant for Hans-Peter Kohler.
2016-2017  UPenn, Research Assistant for Francis J. DiTraglia and Camilo García-Jimeno.

Professional Activities:
Referee  Journal of Econometrics.

Honors, Scholarships, and Fellowships:
2020  School of Arts and Sciences Dissertation Completion Fellowship, UPenn.
2018  Joel Popkins Award, for best teaching by a graduate student, UPenn.
2016  Award for best preliminary examination in Econometrics, UPenn.
2015  University Fellowship for five years of Ph.D. Studies, UPenn.

Research Papers:
(1) Spillovers, Homophily and Selection into Treatment: The Network Propensity Score
(Job Market Paper)
Propensity score matching is a well-known method to estimate treatments when there is selection on observables, but it can fail to identify causal effects in settings with spillovers. I propose a novel network propensity score matching (NPS) approach that identifies both treatment effects and spillovers. I show that in settings with selection on observables, a bilateral network formation process, and exchangeability, there exists a three-dimensional vector of probabilities - the NPS - that balances the pre-treatment covariates of individuals with different treatment status and different number of treated friends. I then show that the NPS can be used for causal comparisons in much the same way as the propensity score, and propose estimators that are consistent and asymptotically normal for settings with multiple large networks. I evaluate my methodology on an information intervention to increase microfinance adoption in Southern India, where selection and homophily are particularly salient. In the extensions I show how to conduct robustness checks, extend the NPS to settings with relationships intensity, and interpret the NPS in stratified multi-stage experiments.
(2) Identifying Causal Effects in Experiments with Social Interactions and Non-compliance
(with Frank DiTraglia, Camilo Garcia and Rossa O'Keeffe-O'Donovan)
This paper shows how to use a randomized saturation experimental design to identify and estimate causal effects in the presence of social interactions—one person’s treatment may affect another’s outcome—and one-sided non-compliance—subjects can only be offered treatment, not compelled to take it up. Two distinct causal effects are of interest in this setting: direct effects quantify how a person’s own treatment changes her outcome, while indirect effects quantify how her peers’ treatments change her outcome. We consider the case in which social interactions occur only within known groups, and take-up decisions do not depend on peers’ offers. In this setting we point out that one person’s treatment effects, both direct and indirect, in a flexible random coefficients model that allows for both heterogeneous treatment effects and endogenous selection into treatment.

(3) High-Dimensional Minimum Distance Estimation with Graphical Lasso Weighting
(with Xu Cheng and Andrew Shephard)
Following the seminal paper by Altonji and Segal (1996), many researchers who estimate structural models through moment matching apply a diagonal weighting matrix. The diagonal structure plays a crucial role in reducing the estimation bias caused by the correlation between the weighting matrix and the moment conditions. We argue that the diagonal design is a simple yet extreme way to impose sparsity, i.e., many zeros on the weighting matrix. This paper proposes to replace it with a new weighting matrix based on the graphical lasso estimator, a machine learning method for estimating high-dimensional covariance matrix and its inverse. This alternative weighting matrix uses data to determine the position of a small number of non-zero off-diagonal elements and provides more effective bias and variance trade-off in practice. Furthermore, we show that the ideal and infeasible weighting matrix exhibits a sparse pattern in many economic settings, including the models for earning dynamics that we study in detail. In this case, this graphical-lasso-based weighting matrix provides the same level of efficiency as the ideal and infeasible weighting matrix in a many-moments asymptotic setting. Finally, we illustrate the improved finite-sample performance in a simulation study from the earnings dynamics literature.

(4) Politico-financial crises: New Evidence (with Samuel W. Malone)
Using a wide sample of countries during the period 1974-2004, we instrument leader exits and financial crises to assess the causal effect each has on the other. We find that leader exits due to scheduled elections and term limits raise the probability of a banking crisis in the same year by 9% and that of a twin crisis by 7.6%. These effects are highly significant statistically, robust, and confined primarily to presidential regimes. In contrast, for financial crises instrumented with determinants from early warning models, only sovereign defaults appear to induce the exit of national leaders.

Research in Progress
(5) Enrollment, Math Performance and Wages: A Coordination Model in Mexican Middle Schools (with Gabrielle Vasey and Petra Todd)
We estimate a structural model of students’ enrollment decisions, and the joint effort decisions of students and teachers for those that do enroll in school. Class composition and effort choices are determined endogenously via a strategic game, which takes into consideration peer effects within the classroom. We combine administrative data on test performance with surveys for teachers, students and parents. We incorporate spatial data on child wages to evaluate the outside option from dropping out of school. Our model allows for heterogeneous endowments and teacher ability. With this model, we can evaluate the impact of a conditional cash transfer on not only beneficiary enrollment choices and achievement, but also on their classmates.

(6) Own and Parents’ Schooling as Predictors of Cognitive and Physical Health at Older Ages: Findings from the Longitudinal Chilean Social Protection Survey (with Irma Elo, Jere Behrman, David Bravo and Sneha Mani)
I work in the areas of econometrics, causal inference, and network analysis. My current research agenda is dedicated to developing new program evaluation tools that incorporate network data and measure spillover effects. A common theme of my work is a focus on the role of social interactions. I also work on empirical applications with a substantive econometric component, primarily in applied microeconomics.

In my job market paper “Spillovers, Homophily and Selection into Treatment: The Network Propensity Score,” I explore ways of measuring treatment effects and spillover effects using social networks data in observational settings. For example, individuals targeted by an advertisement about a product might be more likely to purchase it (a treatment effect) and might also tell their friends about it (a spillover effect). Measuring spillovers is important for cost-benefit calculations (whether we can impact more people with a lower investment) and welfare (whether one person’s benefit comes at the expense of another’s). I show that propensity score matching, a well-known technique for estimating treatment effects when there is selection on observables, can fail to identify any meaningful causal effects in the presence of spillovers. People’s choice of friends generates a second form of selection because only a subset of people might have a treated friend. This is due to homophily, the tendency to befriend similar people, which has been widely documented in real networks.

My job market paper proposes a novel network propensity score (NPS) approach that identifies both treatment effects and spillover effects. I show that the NPS inherits the desirable properties of the propensity score for a setting with spillovers among friends, selection on observables, and homophily on observables. I prove that a three-dimensional vector of probabilities (the NPS) can be used to identify causal effects, by comparing individuals with similar characteristics. I then propose estimators that are consistent and asymptotically normal in settings with multiple large networks. I evaluate my methodology on an information intervention intended to increase microfinance adoption in Southern India, where selection and homophily are particularly salient. In the extensions I show how to conduct robustness checks, extend the NPS to settings with relationships intensity, and interpret the NPS in stratified multi-stage experiments.

Spillovers can also be identified using experiments. In our paper “Identifying Causal Effects in Experiments with Social Interactions and Non-compliance” Francis J. DiTraglia, Camilo García-Jimeno, Rossa O’Keeffe-O’Donovan, and I propose novel instrumental variables to estimate spillovers in experiments with non-compliance. We apply our method to reevaluate a job placement program in France. In this context, spillovers arise from job displacement effects between job seekers that received assistance and those that did not when there are a limited
number of vacancies. Our empirical example, following a growing literature, uses an experimental design that randomizes treatment probabilities across clusters (classrooms, neighborhoods or cities) in order to generate exogenous variation in the fraction of treated individuals. However, empirical researchers are often faced with a situation where individuals are offered treatment but are not compelled to comply. This is considered another form of selection into treatment. In our empirical example only 30% take-up treatment, which raises concerns regarding the validity of intent-to-treat effects. We use the design as a source of exogenous variation to construct novel instrumental variables, at the group level and the individual level, that identify treatment effects and spillover effects. We find that the share of compliers in each cluster is a key source of first-stage heterogeneity, because individuals’ take-up decisions are correlated with perceptions of quality about the program.

In a third econometrics paper, “High-Dimensional Minimum Distance Estimation with Graphical Lasso Weighting”, Xu Cheng, Andrew Shephard and I propose a novel way of estimating two-step minimum distance estimators. We use the graphical lasso – a high-dimensional technique – to estimate the first-stage weighting matrix and find large efficiency gains in examples from the earning dynamics literature. Our method improves upon commonly used diagonal weighting strategies in empirical work, by obtaining lower mean squared error in finite sample and achieving large sample efficiency with the optimal weighting matrix under sparsity. Our method is fast and easy to implement for a variety of settings.

In a second area of research, I have three empirical papers in development economics and political economy. In ongoing work “Enrollment, Math Performance and Wages: A Coordination Model in Mexican Middle Schools”, Petra Todd, Gabrielle Vasey and I estimate a structural model of strategic interactions between teachers and student using administrative data from Mexican middle schools. We design a structural model with classroom spillovers that allows us to understand the key economic trade-offs in students’ decisions to work outside of school, exert effort in their studies, and interact with their classmates. In order to identify these effects, we combine test score data, geo-coded information on child wages and surveys with teachers, parents and students.

In our paper, “Politico-financial crises: New Evidence” Samuel Malone and I propose an instrumental-variables fixed effects design to study the causal relationship between financial crises and political turnover using a panel of country indicators. We find that leadership transitions, due to scheduled elections and term limits increase the likelihood of financial crises. These effects are highly significant statistically, robust, and confined primarily to presidential regimes. In contrast, for financial crises instrumented with determinants from early warning models, only sovereign defaults appear to induce the exit of national leaders.

Finally, in ongoing work, “Own and Parents’ Schooling as Predictors of Cognitive and Physical Health at Older Ages: Findings from the Longitudinal Chilean Social Protection Survey”, Jere Behrman, Irma Elo, Sneha Mani, and David Bravo I study the determinants of cognitive decline of the elderly in Chile using longitudinal data. We examine the role of early childhood experiences, including parental education, in later life outcomes.
UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez
Placement Director: David Dillenberger
Assistant Director: Gina Conway

Office Contact Information
133 South 36th Street
Philadelphia, PA 19104
215-898-7701

Home Contact Information
12 Glen Avenue Apt 2
Ottawa, ON K1S 2Z7
613-798-6514

Personal Information: Citizenship: Canada. Languages: English (native), French.

Undergraduate Studies:
BA, Economics, University of Winnipeg, 2007

Masters Level Work:
MA, Economics, Queen’s University, 2009

Graduate Studies:
University of Pennsylvania, 2011-Present (on family medical leave 2017-2019)
Thesis Title: “Are Consumption Taxes Really Better Than Labour Income Taxes? Theoretical and Quantitative Implications of the Choice of Tax Base”
Expected Completion Date: May 2021

Thesis Committee and References:
Professor Petra Todd (Advisor)                                  Professor Dirk Krueger
University of Pennsylvania                                      University of Pennsylvania
ptodd@econ.upenn.edu                                            dkrueger@econ.upenn.edu

Professor Andrew Shephard
University of Pennsylvania
asheph@econ.upenn.edu
215-898-7408

Fields of Interest:

Fields: Labour Economics, Public Economics, Applied Microeconomics

Teaching Experience:

Instructor

University of Pennsylvania
Fall 2014  ECON 033 – Labour Economics
Research Papers:

“Are Consumption Taxes Really Better Than Labour Income Taxes? Theoretical and Quantitative Implications of the Choice of Tax Base” (Job Market Paper)

In many standard economic models, taxes on labour earnings and taxes on consumption are outcome-equivalent. However, this is not the case when taxes are non-linear and households face uninsurable wage risk, which is the case considered in this paper. I study the differences between the two tax regimes in a two-period framework and show that the theoretical advantages of consumption taxation are twofold. First, it eliminates an intertemporal distortion on labour supply. Second, earnings are a noisier signal of lifetime resources, which matters for redistribution and insurance. To assess the quantitative implications of the choice of tax base, I construct a standard overlapping generations model with incomplete markets. After calibrating the model to the U.S. economy, I study a tax reform where a progressive labour income tax is replaced by a progressive consumption tax. This reform leads to non-trivial long-run welfare gains, most of which stem from improvements in labour productivity that follow from the mitigation of distortions on work decisions.
Work in Progress:

“Asset Liquidity and Intertemporal Preferences”

In this paper, I construct a dynamic model of savings behavior, where agents have access to two types of assets—a liquid asset (e.g. cash) and an illiquid asset (e.g. retirement funds). The presence of two savings options allows for a cleaner distinction between precautionary motives and life-cycle motives. Households build buffer stocks of liquid savings in order to self-insure against income fluctuations but save for retirement with illiquid savings in order to exploit higher long-run rates of return. Illiquid savings are not desirable for self-insurance against shocks because early withdrawals are penalized. Without this feature of the model, it is difficult to separately identify patience from risk aversion. In order to solve the model with feasible computational expense, I develop an extension of the endogenous grid method for models with two continuous state variables. Estimation using data from the NLSY (National Longitudinal Survey of Youth) is pending.
Tax system design has two core problems. One concerns the rate of taxation: should rates vary between individuals or across time? And if so, how? An even more fundamental question concerns the choice of tax base. What should be taxed? After all, fiscal instruments must be selected before they can be calibrated.

This thesis focuses on the choice between the taxation of labour income and the taxation of consumption. In many standard economic models these two types of taxes are outcome-equivalent and therefore mutually redundant. Any allocation that can be implemented with one can also be implemented with the other. But this is not true when taxes are non-linear and households are heterogenous with respect to wages, which is the case considered here.

I examine the choice between labour taxation and consumption taxation by analyzing two versions of the overlapping generations model. The model economies are populated by finitely-lived agents with different wage paths who make endogenous labour supply and savings decisions. In both versions, the government’s tax design problem is formulated as a Ramsey-style optimal taxation problem in which the government selects a tax-and-transfer scheme from a given parametric class. Importantly, the government chooses whether to levy its progressive tax on labour income or consumption.

I begin the analysis with a simple life-cycle framework. In this model, a continuum of new agents is born in each period, each of whom draws an idiosyncratic productivity profile from some distribution. They supply labour elastically in every period and can transfer

resources across time without constraint. Because all uncertainty is resolved at the moment of economic birth, each household acts with full knowledge of its future.

I use this framework to illustrate several important features of progressive consumption taxation. Fixing the degree of progressivity, I show that lifetime hours are lower but lifetime earnings are higher under a consumption tax compared with a labour income tax. By breaking the link between when income is earned and when tax is assessed, a consumption-based tax system mitigates the distorting effects of progressive taxation, leading to more efficient work decisions. I also show that a period-by-period tax on consumption is equivalent to a tax on lifetime earnings. Because lifetime earnings are the ultimate target of redistribution, a consumption tax can provide better \textit{ex ante} insurance to agents. Finally, I provide a sufficient (but not necessary) condition on the distribution of wages under which it is optimal to tax consumption rather than earnings.

To assess the quantitative implications of the choice of tax base, I then construct a richer and more realistic but less tractable version of the model. As in the first model, agents have heterogeneous wage profiles. But now they also face persistent and transitory productivity shocks, against which they can only self-insure. This opens another channel for consumption taxation to outperform labour income taxation. A progressive labour income tax dampens the worker’s response to unanticipated fluctuations in earning power while a consumption tax does not. The logic is the same as with predictable patterns of wage growth.

After calibrating the model to the U.S. economy, I study a tax reform where a progressive labour income tax is replaced by a progressive consumption tax. Because a newly imposed consumption tax mimics a tax on existing wealth, I only apply the new tax policy to newborn generations. Existing taxpayers continue to operate under the original labour tax policy. I also fix the capital income tax rate at its initial value so that the choice between consumption taxation and labour income taxation can be studied independently of any direct changes to savings and investment incentives. Accounting for macroeconomic effects along the transition, I find that such a reform leads to non-trivial long-run welfare gains. Most of the reform’s benefits stem from improvements in labour efficiency that follow from the mitigation of distortions on work decisions. Notably, most of the gains are due to amplified sensitivity to wage shocks, especially transitory ones.

The first tax experiment imagines a change in the tax base, holding progressivity fixed. Because the baseline progressivity may not be optimal for either tax base, I also numerically characterize the optimal tax for both regimes and then compare optimally calibrated tax systems. The principal quantitative results from this best-on-best comparison are broadly unchanged from the simple reform. Finally, I conduct a series of sensitivity analyses to gauge the importance of key modeling and parametric assumptions.
SEUNG-RYONG SHIN  
https://sites.google.com/view/seung-ryong-shin  
seushi@sas.upenn.edu

UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez  
ORDONEZ@ECON.UPENN.EDU  215-898-1875
Placement Director: David Dillenberger  
DDILL@ECON.UPENN.EDU  215-898-1503
Graduate Student Coordinator: Gina Conway  
GNC@SAS.UPENN.EDU  215-898-5691

Office Contact Information:
Department of Economics  
University of Pennsylvania  
133 South 36th Street, Suite 150  
Philadelphia, PA 19104  
+1 (267) 325-4351

Personal Information:
DOB: 05/13/1988  
Gender: Male  
Citizenship: South Korea

Undergraduate Studies:
B.A., Economics, Seoul National University, South Korea, 2013

Masters Level Work:
Completed, Economics, Seoul National University, South Korea, 2013-2015

Graduate Studies:
University of Pennsylvania, 2015 to the present  
Thesis Title: “Essays on the Economics of Health and Optimal Taxation”  
Expected Completion Date: May 2021

Thesis Committee and References:  
Professor Dirk Krueger (Advisor)  
133 South 36th Street, Office 520  
Philadelphia, PA 19104  
215-573-1424  
dkrueger@econ.upenn.edu

Professor Harold L. Cole  
133 South 36th Street, Office 517  
Philadelphia, PA 19104  
215-898-7788  
colehl@sas.upenn.edu

Professor Andrew Shephard  
133 South 36th Street, Office 601  
Philadelphia, PA 19104  
215-898-7408  
asheph@econ.upenn.edu

Teaching and Research Fields:  
Macroeconomics, Health Economics, Public Policies

Teaching Experience:  
Fall, 2020  Introduction to Microeconomics, UPENN, Recitation Instructor for Professor Anne Duchene
Spring, 2020  Intermediate Macroeconomics, UPENN, Recitation Instructor for Professor Guillermo Ordonez
Fall, 2019  Statistics for Public Policy, UPENN, Recitation Instructor for Professor Matthew Levendusky
Fall, 2019  Public Economics, UPENN, Recitation Instructor for Professor Lauren Russell
Spring, 2019  Intermediate Macroeconomics, UPENN, Recitation Instructor for Professor Dirk Krueger
Honors, Scholarships, and Fellowships:

2016 Certificate of Distinctive Performance in the Preliminary Examination in Microeconomics, Department of Economics, University of Pennsylvania

Publications:


Research Papers(s) in Progress:

“On Optimal Taxation and Subsidization of Health Goods” (Job Market Paper)

In the current US health insurance system in which the households directly sponsor small part (10%) of the high health care cost they incur (17.7% of GDP), optimal taxation and subsidization on health goods show large scope for welfare improvement. If households do not fully pay for the medical expenditure, they generate externalities by not internalizing the full effects of their own health behaviors on medical expenditure and, in turn, on health insurance premiums or tax burdens for governmental health care subsidies. Using an overlapping generations framework of working age that models these externalities, this paper compares the welfare effects of optimal taxation of alcohol and cigarette to those of optimal subsidization of complementary goods to physical activity. Nation-wide sports goods subsidization policies, as opposed to the extant health excise taxes on alcohol and cigarette, have received less attention despite the numerous evidences of their potentials to internalize the externalities. The welfare gain from optimal subsidization of sports goods, however, is $146.08 per household every year, about 16 times higher than that from optimal taxation on alcohol and cigarette. The former decreases the aggregate medical expenditure by 3.2%, while the latter only by 0.2%.

“On Age-dependent Health Investment Motive against Idiosyncratic Health Risk”

While the macroeconomic literature has seen a large progress in understanding the saving motive to self-insure against various idiosyncratic shocks, little is understood on the health investment motive to self-insure against idiosyncratic health shocks. Towards deepening our knowledge about health capital as part of asset portfolio, this paper studies the importance of incorporating age-dependent health components in evaluating the role of health investment in self-insuring against idiosyncratic health shocks and the welfare effects. We construct a life cycle model in which higher medical expenditure increases the future health capital, which in turn increases the future wage. In making the optimal health investment decisions, the households also consider the effects of health capital on the co-insurance rate and the distribution of health shocks. Depending on the existence of age-dependence in the health production function and in its effects on co-insurance rate and health shock density, the welfare cost of health risk could differ by 2.1 percentage points (12.1% for age-dependent and 10.0% for age-invariant model).

Computational Skills:

MATLAB, R, Stata, Julia
Research Statement

Seung-Ryong Shin
University of Pennsylvania

My research focuses on health macroeconomic welfare analyses. I am particularly interested in assessing the role of health production function in the social welfare. The first health production function of households’ choices in economics was developed by Grossman (1972), but the health macroeconomic literature has only recently started to incorporate such health endogeneity in its models. Two of my papers contribute to this trend. The first paper uses a health production function of alcohol, cigarette, and exercise to compare the welfare effect of optimal taxation on alcohol and cigarette with that of optimal subsidization of sports goods. The second paper investigates the importance of incorporating age-dependent health production function in assessing its welfare gain from self-insuring against idiosyncratic health shocks. While the first paper emphasizes the negative role of health production function in generating externalities, the second paper focuses on the positive role of health production function as an investment tool.

Paper 1: “On Optimal Taxation and Subsidization of Health Goods” (Job Market Paper)

In the current US health insurance system in which the households directly sponsor small part (10%) of the high health care cost they incur (17.7% of GDP), optimal taxation and subsidization on health goods show large scope for welfare improvement. If households do not fully pay for the medical expenditure, they generate externalities by not internalizing the full effects of their own health behaviors on medical expenditure and, in turn, on health insurance premiums or tax burdens for governmental health care subsidies. Using an overlapping generations framework of working age that models these externalities, this paper compares the welfare effects of optimal taxation of alcohol and cigarette to those of optimal subsidization of complementary goods to physical activity. Nation-wide sports goods subsidization policies, as opposed to the extant health excise taxes on alcohol and cigarette, have received less attention despite the numerous evidences of their potentials to internalize the externalities. The welfare gain from optimal subsidization of sports goods, however, is
$146.08 per household every year, about 16 times higher than that from optimal taxation on alcohol and cigarette. The former decreases the aggregate medical expenditure by 3.2%, while the latter only by 0.2%.

Paper 2: “On Age-dependent Health Investment Motive against Idiosyncratic Health Risk”

While the macroeconomic literature has seen a large progress in understanding the saving motive to self-insure against various idiosyncratic shocks, little is understood on the health investment motive to self-insure against idiosyncratic health shocks. Towards deepening our knowledge about health capital as part of asset portfolio, this paper studies the importance of incorporating age-dependent health factors in evaluating the role of health investment in self-insuring against idiosyncratic health shocks and the welfare effects. We construct a life cycle model in which higher medical expenditure increases the future health capital, which in turn increases the future wage. In making the optimal health investment decisions, the households also consider the effects of health capital on the co-insurance rate and the distribution of health shocks. Depending on the existence of age-dependence in the health production function and in its effects on co-insurance rate and health shock density, the welfare cost of health risk could differ by 2.1 percentage points (12.1% for age-dependent and 10.0% for age-invariant model).

In the future, I plan to research into how the new normal after the outbreak of COVID-19 could change the long-term environment of health. As we are still in the transition stage, however, the insufficient household panel data after the outbreak makes it hard to predict long-term health variables in the new world, but I am trying to sustain my interest in the COVID-19 issue by participating in projects on its macroeconomic effects. For example, “The role of global connectedness and market power in crises: Firm-level evidence from the COVID-19 pandemic” written with Jay Hyun and Daisoon Kim and published in Covid Economics, Vetted and Real-Time Papers, 2020, 49(4), 148–171 shows that firms with higher global connectedness (via supply chains and exports) and market power (measured by markups) were more resilient to the COVID-19 pandemic shock, using weekly global stock market data.
UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez
Placement Director: David Dillenberger
Graduate Student Coordinator: Gina Conway

Office Contact Information
Department of Economics
Room 528, PCPSE
133 South 36th Street
Philadelphia, PA 19104-6297
215 292-6845

Personal Information
Citizenship: Canada
Languages: English (native)
French (advanced)
Gender: Female

Graduate Studies:
University of Pennsylvania, 2015 to present
Thesis Title: “Enrollment, Labor, and Effort: Analyzing the Educational Choices of Middle School Students in Mexico”
Expected Completion Date: May 2021

Thesis Committee and References:
Professor Petra Todd (Advisor)
Department of Economics
University of Pennsylvania
133 South 36th Street, Suite 606
Philadelphia, PA, 19104
ptodd@econ.upenn.edu
215-898-4084

Professor Jere Behrman
Department of Economics
University of Pennsylvania
133 South 36th Street, Suite 616
Philadelphia, PA, 19104
jbehrman@econ.upenn.edu
215-898-7704

Professor Holger Sieg
Department of Economics
University of Pennsylvania
133 South 36th Street, Suite 615
Philadelphia, PA, 19104
holgers@econ.upenn.edu
215-898-4084

Professor Arthur van Benthem
Wharton Business Economics and Public Policy
University of Pennsylvania
3733 Spruce Street, 372 Vance Hall
Philadelphia, PA, 19104
arthurv@wharton.upenn.edu
215-898-3013

Fields: Empirical Microeconomics, Education Economics, Development Economics
Teaching Experience:

- **Summer, 2018**: Introduction to Microeconomics, UPenn, Instructor
- **Fall, 2017**: Introduction to Microeconomics, UPenn, Instructor
- **Spring, 2020**: Advanced Econometric Techniques and Applications, UPenn, TA for Prof. Petra Todd
- **Spring, 2019**: Integrative Studies: Poverty: History and Economics, UPenn, TA for Prof. Petra Todd
- **Spring, 2019**: Statistics for Economists, UPenn, TA for Prof. Karun Adusumilli
- **Fall, 2018**: Statistics for Economists, UPenn, TA for Prof. Frank DiTraglia
- **Spring, 2018**: Statistics for Economists, UPenn, TA for Prof. Frank DiTraglia
- **Spring, 2017**: Industrial Organization, UPenn, TA for Prof. Frank DiTraglia
- **Fall, 2016**: Introduction to Microeconomics, UPenn, TA for Prof. Anne Duchene

Research Experience and Other Employment:

- **2019 – 2020**: University of Pennsylvania, RA for Petra Todd and Jere Behrman
- **2017 – 2019**: Wharton BEPP, RA for Mike Abito and Arthur van Benthem
- **2017**: Multilateral Investment Guarantee Agency (MIGA), Summer Intern

Professional Activities:

**Presentations:**
- 2020: PLAC UPenn, University of Pennsylvania
- 2019: LACEA (Puebla), University of Pennsylvania
- 2018: University of Pennsylvania

Honors, Scholarships, and Fellowships:

- **2019**: Penn Institute for Economic Research (PIER) RA Matching Grant
- **2018**: Kleinman Center for Energy Policy Grant, University of Pennsylvania
- **2017**: Ibrahim Family Fellow of the Penn Wharton Public Policy Initiative
- **2017**: Edwin Mansfield Teaching Prize in Economics, University of Pennsylvania
- **2015**: University Fellowship, University of Pennsylvania

Research Papers:

**School Enrollment, Time Allocation and Achievement: the Role of Child Labor** (Job Market Paper)

When school-age children work, their education must compete for their time and effort, which may lead to lower educational attainment and academic achievement. This paper develops and estimates a model of student achievement in Mexico, in which students choose whether to attend school, work or to combine school and work, what type of school to attend taking into account locally available options, and how much effort to apply to their studies. All of these decisions can affect their academic achievement in math and Spanish, which is modeled using a value-added framework. The model is a random utility model over discrete school-work alternatives, where study effort is determined as the outcome of an optimization problem under each of these alternatives. The model is estimated using a large administrative test score database on Mexican 6th grade students combined with survey data on students, parents and schools, geocode data on school locations, and wage data from the Mexican census. I find that if students are not able to work while in school, over 10% of those who would like to work drop out. For the students who remain in school, their study effort increases by almost 5% on average, which results in an increase in their math and Spanish test scores of 8.9% and 3.8%. Conditional cash transfers encourage beneficiaries to attend school, however ensuring school access to students in rural areas is crucial to their effectiveness. The distance education schools in Mexico, Telesecondaries, are a cost-effective policy tool for the government to encourage school enrollment of students in rural areas.
Research in Progress:

The Marginal Returns of Distance Education on Achievement: Analyzing Mexico’s Telesecondarys with Emilio Borghesan

We estimate the marginal effects of attending Mexican Telesecondary schools on 7th grade Math and Spanish scores. We find positive treatment effects of Telesecondaries on achievement, but these estimates mask considerable heterogeneity. We use nonparametric estimates of the Marginal Treatment Effect to analyze several counterfactual policies, including a school-building program and an expansion of the conditional cash transfer program.

Designing More Cost-Effective Trading Markets for Renewable Energy with Mike Abito, Felipe Flores-Golfin, and Arthur van Benthem

We study the cost-effectiveness of a crucially important solar policy: solar energy portfolio standards. These policies, which require that a certain percentage of power be generated from solar, are often written as targets that increase year-on-year and greatly vary in stringency across states. We estimate supply curves for solar energy in different U.S. states to quantify the gains from linking the currently separate state-specific markets that do not allow for geographic trading, and to study how intermediate temporal target setting may harm the cost-effectiveness of these policies. Preliminary results suggest large gains from market integration and potentially significant cost increases from ramping up the intermediate targets too quickly.

Enrollment, Math Performances and Wages: A Coordination Model in Mexican Middle Schools with Alejandro Sanchez and Petra Todd

This paper estimates a structural model of students enrollment decisions, and the joint effort decisions of students and teachers for those that do enroll in school. Class composition and effort choices are determined endogenously via a strategic game, which takes into consideration peer effects within the classroom. Test scores are a function of student characteristics, as well as student, teacher, and classmate effort. We combine administrative data on test performance with surveys for teachers, students and parents. We incorporate spatial data on child wages to evaluate the outside option from dropping out of school. Our model allows for heterogeneous endowments and teacher ability. With this model, we can evaluate the impact of a conditional cash transfer on not only beneficiary enrollment choices and achievement, but also on their classmates.

Publications (Prior to PhD):

Additional navigational strategies can augment odor-gated rheotaxis for navigation under conditions of variable flow (with Ryan Lukeman and Russell C. Wyeth), Integrative and Comparative Biology 2015, 55.3: 447-460
Research Statement
Gabrielle Vasey
Department of Economics, University of Pennsylvania
Website: www.gabriellevasey.com E-mail: gvasey@sas.upenn.edu

My research interests lie in applied micro and my dissertation focuses on development and education economics. I use behavioral models in conjunction with rich administrative and survey data to estimate the potential effects of public policies. My research focuses on the school choice and time allocation decisions of students, particularly in developing countries. I extend existing frameworks to incorporate elements that are important to a developing country setting, such as child labor, to accurately evaluate the impact of policies that incentivize enrollment and increase school access. I have also done research in energy economics as described below.

In my job market paper, School Enrollment, Time Allocation and Achievement: the Role of Child Labor, I consider the school and labor choices that children make as they move from primary to middle school. When school-age children work, their education must compete for their time and effort, which may lead to lower educational attainment and academic achievement. I develop and estimate a model of student achievement in Mexico, in which students make decisions on school enrollment, study effort and labor supply, taking into account locally available schooling options and wages. These decisions affect their academic achievement in math and Spanish, which is modeled using a value-added framework. The model is a random utility model over discrete school-work alternatives, where study effort is determined as the outcome of an optimization problem under each of these alternatives. I estimate the model using a large administrative test score database on Mexican 6th grade students combined with survey data on students, parents and schools, geocode data on school locations, and wage data from the Mexican census. I find that if students were prohibited from working while in school, over 10% of those who would like to work drop out. The students who remain in school increase their study effort by 5% on average, which increases their math and Spanish test scores by 8.9% and 3.8%. Conditional cash transfers encourage beneficiaries to enroll, however ensuring school access to students in rural areas is crucial to their effectiveness. The distance
education schools in Mexico, Telesecondaries, are a cost-effective policy tool for the government to encourage school enrollment of students in rural areas.

In the paper *The Marginal Returns of Distance Education on Achievement: Analyzing Mexico’s Telesecondaries* (joint with Emilio Borghesan) we analyze the effectiveness of the Telesecondary schools. We estimate the marginal effects of attending Mexican Telesecondary schools on 7th grade math and Spanish scores, using the relative distance between the nearest Telesecondary school and the nearest traditional school as our exclusion restriction. We find positive average treatment effects of Telesecondaries on achievement, with considerable heterogeneity. We use nonparametric estimates of the marginal treatment effect to analyze several counterfactual policies, including a school-building program and an expansion of the conditional cash transfer program.

Outside of the education and development fields, in the paper *Designing More Cost-Effective Trading Markets for Renewable Energy* (joint with Mike Abito, Felipe Flores-Golfin, and Arthur van Benthem), I study the cost-effectiveness of a crucially important solar policy: solar energy portfolio standards. These policies, which require that a certain percentage of power be generated from solar, are often written as targets that increase year-on-year and greatly vary in stringency across states. We estimate supply curves for solar energy in different U.S. states to quantify the gains from linking the currently separate state-specific markets that do not allow for geographic trading, and to study how intermediate temporal target setting may harm the cost-effectiveness of these policies. Preliminary results suggest large gains from market integration and potentially significant cost increases from ramping up the intermediate targets too quickly.

Finally, in other ongoing work, I am incorporating peer effects in a model of student study effort choices. In *Enrollment, Math Performances and Wages: A Coordination Model in Mexican Middle Schools* (with Alejandro Sanchez and Petra Todd) I develop a structural model of students’ enrollment decisions, and the joint effort decisions of students and teachers for those that do enroll in school. Class composition and effort choices are determined endogenously via a strategic game, which takes into consideration peer effects within the classroom.
UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez  ORDONEZ@ECON.UPENN.EDU  215-898-1875
Placement Director: David Dillenberger  DDILL@ECON.UPENN.EDU  215-898-1503
Graduate Student Coordinator: Gina Conway  GNC@SAS.UPENN.EDU  215-898-5691

Office Contact Information
Department of Economics
University of Pennsylvania
133 South 36th Street, Office 535
Philadelphia, PA 19104
+1 (267) 901-0343

Personal Information:
Date of Birth: August 17, 1988
Citizenship: Mexican
Visa: F1

Undergraduate Studies:
B.A., Economics, ITAM, Highest Honors, 2011

Masters Level Work:
M.A., Economics, University of Pennsylvania, 2017

Graduate Studies:
University of Pennsylvania, 2015 to present
Thesis Title: “Essays on Financial Crises”
Expected Completion Date: May 2021

Thesis Committee and References:
Professor Enrique G. Mendoza (Co-Advisor)  Professor Frank Schorfheide (Co-Advisor)
Department of Economics  Department of Economics
University of Pennsylvania  University of Pennsylvania
133 South 36th Street, Office 538  133 South 36th Street, Office 621
Philadelphia, PA 19104  Philadelphia, PA 19104
+1 (215) 573-4664  +1 (215) 898-8486
egme@econ.upenn.edu  schorf@econ.upenn.edu

Professor Dirk Krueger  Professor Alessandro Dovis
Department of Economics  Department of Economics
University of Pennsylvania  University of Pennsylvania
133 South 36th Street, Office 520  133 South 36th Street, Office 537
Philadelphia, PA 19104  Philadelphia, PA 19104
+1 (215) 573-1424  +1 (215) 898-5421
dkrueger@econ.upenn.edu  adovis@econ.upenn.edu
Teaching and Research Fields:
International Economics, Macro-Finance, Public Economics, Macroeconometrics.

Teaching Experience:
Fall, 2020  Econometrics (undergraduate), UPenn, teaching assistant for Professor Xu Cheng
Fall, 2018  International Finance (undergraduate), UPenn, teaching assistant for Professor Enrique G. Mendoza
Spring, 2017 Macroeconomics (graduate), UPenn, teaching assistant for Professor Jeremy Greenwood
Fall, 2016  Microeconomics (undergraduate), UPenn, teaching assistant for Professor Rakesh Vohra

Research Experience and Other Employment:
2017 to present  University of Pennsylvania and Becker Friedman Institute, Research Assistant for Professor Frank Schorfheide
Summer 2020  Dissertation Scholar. Federal Reserve Bank of Atlanta, Research Department
Summer 2019  Quantitative Researcher, Citadel, Global Fixed Income
2018 - 2019 University of Pennsylvania, Research Assistant for Professor Enrique G. Mendoza
Summer 2018  NBER, Research Assistant for Professor Dirk Krueger
2012 - 2015  Economist, Central Bank of Mexico, Economic Research Division

Honors, Scholarships, and Fellowships:
2019  UPenn RA Stipend Matching Grant Awarded
2018  UPenn The President Gutmann Leadership Award
2018  UPenn SAS Dean’s Travel Grant
2015-2021 UPenn University Fellowship

Publications:

Abstract: We propose a simple and fast fixed-point iteration algorithm (FiPIt) to obtain the global, non-linear solution of macro models with two endogenous state variables and occasionally binding constraints. This method uses fixed-point iteration on Euler equations to avoid solving two simultaneous non-linear equations (as with the time iteration method) or creating modified state variables requiring irregular interpolation (as with the endogenous grids method). In the small-open-economy RBC and Sudden Stops models provided as examples, FiPIt is much faster than time iteration and various hybrid methods.


“Decomposition of financial crises in Mexico”, Gaceta de Economía, 2015, No. 34, ITAM. Pre-PhD
Research Papers:

“Inequality and Asset Prices during Sudden Stops”.

(Job Market Paper)


Abstract: This paper studies the cross-sectional dimension of Fisher's debt-deflation mechanism that triggers financial crises of the Sudden Stop type - i.e., episodes with large reversals in the current account. Analyzing micro-data from Mexico for the 2009 crisis, we show that this mechanism's cross-sectional dimension has macroeconomic implications that operate via two opposing effects. First, an amplifying effect by which households with high leverage fire-sale their assets during a crisis, increasing downward pressure on asset prices. Second, a dampening effect by which wealthy households with low leverage buy depressed assets, relieving downward pressure on asset prices. As a result, the role of inequality during crises is ambiguous. We conduct a quantitative analysis using a calibrated small-open-economy asset-pricing model with heterogeneous-agents to measure the effects of inequality on the frequency and severity of financial crises. As in representative-agent models of Sudden Stops, the model features a loan-to-value collateral constraint that triggers Sudden Stops as endogenous responses to aggregate shocks. Households face non-insurable idiosyncratic labor and dividend income shocks. In a version of the model calibrated to an emerging economy that can explain Sudden Stops' key stylized facts, the dampening effect dominates, and Sudden Stop episodes are less severe in heterogeneous-agents economies. Consumption drops one-third and asset prices drop one-tenth of the drop obtained in the representative-agent (RA) version of the model. In contrast to the RA framework, the model produces an empirically plausible leverage ratio distribution and generates persistent current account reversals. Moreover, calibrating the model to an advanced economy where the dividend risk is 50% of the benchmark emerging-markets model, larger debt positions are supported and Sudden Stop crises are less severe, as observed in the data.

“FDI and Sudden Stops in Small Open Economies”.


Abstract: Sudden Stops of capital inflows are not a phenomenon exclusive to emerging economies. However, the underlying factors are not necessarily the same across countries. While advanced economies invest and receive investments from abroad, most emerging economies only receive foreign investments. These differences motivate the study of the components of capital flows in both types of economies to understand better why the probability of having a Sudden Stop in an emerging economy is larger than in advanced economies. Decomposing the Financial Account uncovers important differences between advanced and emerging economies in their FDI account. First, advanced economies have, on average, zero net FDI flows as a percentage of GDP, and second, advanced economies have sufficient FDI outflows that act as buffer savings during Sudden Stops. To quantify the effect of the FDI channel on the probability of a Sudden Stop, we propose a small-open-economy model with an endogenous occasionally-binding constraint with foreign investment subject to expropriation risk in emerging economies. We calibrate the model using data for a large sample of advanced and emerging economies and find that the FDI channel has a large impact on the probability of a Sudden Stop. In particular, the model predicts that, on average, an emerging economy that increases their capital to GDP ratio and eliminates the expropriation risk would reduce the probability of a Sudden Stop from 2.9 to 1.3 percent and would increase its debt-to-income ratio from 35 to 51 percent.

“Piecewise Linear Approximations and Filtering for DSGE Models with Occasionally-Binding Constraints”.

R&R at Review of Economic Dynamics. (with Boragan Aruoba, Pablo Cuba-Borda, Kenji Higa-Flores and Frank Schorfheide)

Abstract: We develop an algorithm to construct approximate decision rules that are piecewise-linear and continuous for DSGE models with an occasionally binding constraint. The functional form of the decision rules allows us to derive a conditionally optimal particle filter (COPF) for the evaluation of the likelihood function that exploits the structure of the solution. We document the accuracy of the likelihood approximation and embed it into a particle Markov chain Monte Carlo algorithm to conduct Bayesian estimation. Compared with a standard bootstrap particle filter, the COPF significantly reduces the persistence of the Markov chain, improves the accuracy of Monte Carlo approximations of posterior moments, and drastically speeds up computations. We use the techniques to estimate a small-scale DSGE model to assess the effects of the government spending portion of the American Recovery and Reinvestment Act in 2009 when interest rates reached the zero lower bound.
“SVARs with Occasionally-Binding Constraints”, R&R at Journal of Econometrics. (with Boragan Aruoba and Frank Schorfheide)

Abstract: We develop a structural VAR in which an occasionally-binding constraint generates censoring of one of the dependent variables. Once the censoring mechanism is triggered, we allow some of the coefficients for the remaining variables to change. By imposing that the regression functions are continuous at the censoring point, we can show that under some mild parameter restrictions delivers a unique reduced form. In our application the occasionally-binding constraint is the effective lower bound (ELB) on nominal interest rates. According to our estimates based on U.S. data, once the ELB becomes binding, in addition to the censoring of the nominal interest rate, the coefficients in the inflation equation change. This coefficient switch translates into a change of the inflation responses to (unconventional) monetary policy shocks and demand shocks. Our results suggest that the presence of the ELB is indeed empirically relevant for the propagation of shocks.

“Optimal Taxes on Capital in the OLG Model with Uninsurable Idiosyncratic Income Risk”, R&R at Journal of Public Economics. (with Dirk Krueger and Alexander Ludwig)

Abstract: We characterize the optimal linear tax on capital in an Overlapping Generations model with two period lived households facing uninsurable idiosyncratic labor income risk. The Ramsey government internalizes the general equilibrium effects of private precautionary saving on factor prices. For logarithmic utility a complete analytical solution of the Ramsey problem exhibits an optimal aggregate saving rate that is independent of income risk, whereas the optimal time-invariant tax on capital implementing this saving rate is increasing in income risk. The optimal saving rate is constant along the transition and its sign depends on the magnitude of risk and on the Pareto weight of future generations. If the Ramsey tax rate that maximizes steady state utility is positive, then implementing this tax rate permanently induces a Pareto-improving transition even if the initial equilibrium is dynamically efficient. For general Epstein-Zin-Weil utility we show that the optimal steady state saving rate is increasing in income risk if and only if the intertemporal elasticity of substitution is smaller than 1.

Research Paper(s) in Progress:
“Changing Jobs to Fight Inflation: Labor Market Reactions to Inflationary Shocks”. (with Gorkem Bostanci and Omer Koru)

“Rising Intangibles and Fading Listed”. (with Sara Casella and Hanbaek Lee)

Languages:
Spanish (native), English (fluent), French (basic).

Computational Skills:
Advanced: Julia, Matlab, Stata, R. Intermediate: Python, C++.
DISSERTATION ABSTRACT

Sergio Villalvazo
Department of Economics, University of Pennsylvania
Website: sergiovillalvazo.com E-mail: vsergio@sas.upenn.edu

This dissertation studies financial crises of the Sudden Stop type where large reversals in the current account are triggered by a deflation mechanism that tightens the borrowing capacity of individuals and amplifies the effects of negative shocks. These episodes are characterized by large drops in consumption and domestic asset prices. In Chapter I, I argue that inequality in wealth and leverage across households plays an important role in determining the aggregate effects of a crisis. Next, in Chapter II, I study the role that foreign direct investment flows have on the different frequency of crises observed in advanced and emerging economies. Finally, Chapter III develops a new algorithm that allows solving DSGE models with occasionally-binding constraints much faster than existing methods.

Chapter I: “Inequality and Asset Prices during Sudden Stops”. (Job Market Paper)

This paper studies the cross-sectional dimension of Fisher’s debt-deflation mechanism. Such a mechanism triggers financial crises and works as follows: after a negative shock, financially constrained agents sell their collateralizable assets putting downward pressure on asset prices. As prices drop, possibly more constrained agents have to sell more assets, which causes feedback that puts additional downward pressure on asset prices, and this, in turn, further tightens aggregate financial conditions.

Analyzing micro-data from Mexico for the 2009 crisis, we show that the mechanism’s cross-sectional dimension operates via two opposing effects. First, an amplifying effect by which households with high leverage fire-sale their assets during a crisis, increasing downward pressure on asset prices. Second, a dampening effect by which wealthy households with low leverage buy depressed assets, relieving downward pressure on asset prices. Hence, studying only aggregate dynamics with representative-agent models misses the fact that since the households’ leverage distribution is time-varying, crises do not affect all households in the same way and inequality has aggregate implications.

I conduct a quantitative analysis using a calibrated small-open-economy asset-pricing model with heterogeneous-agents to measure the effects of inequality on the frequency and severity of financial crises. As in representative-agent models of Sudden Stops, the model features a loan-to-value (LtV) collateral constraint that triggers Sudden Stops as endogenous responses to aggregate shocks. Households face non-insurable idiosyncratic labor and dividend income shocks. In a version of the model calibrated to an emerging economy that can explain Sudden Stops’ key stylized facts, the dampening effect dominates, and Sudden Stop episodes are less severe in heterogeneous-agents economies. Consumption drops one-third, and asset prices drop one-tenth of the drop obtained in the representative-agent (RA) version of the model. In contrast to the RA framework, the model produces an empirically plausible leverage ratio distribution and generates persistent current account reversals. Moreover, calibrating the model
to an advanced economy where the dividend risk is 50% of the benchmark emerging-markets model, the average net foreign debt position is twice as large, consumption drops 0.8 percentage points less, and asset prices drop 0.4 percentage points less. Hence, the model predicts that in economies with lower dividend return risk, larger debt positions are supported, as observed in the data, and Sudden Stop crises are less severe. The analysis also shows that a 50% tax on dividend returns, a rate observed in some OECD economies, generates more frequent but less severe crises.

Chapter II: “FDI and Sudden Stops in Small Open Economies”.

Sudden Stops of capital inflows are not a phenomenon exclusive to emerging economies. However, the underlying factors are not necessarily the same across countries. While advanced economies invest and receive investments from abroad, most emerging economies only receive foreign investments. These differences motivate the study of the components of capital flows in both types of economies to understand better why the probability of having a Sudden Stop in an emerging economy is larger than in advanced economies. Decomposing the Financial Account uncovers important differences between advanced and emerging economies in their FDI account. First, advanced economies have, on average, zero net FDI flows as a percentage of GDP, and second, advanced economies have sufficient FDI outflows that act as buffer savings during Sudden Stops. To quantify the effect of the FDI channel on the probability of a Sudden Stop, I propose a small-open-economy model with an endogenous occasionally-binding constraint with foreign investment subject to expropriation risk in emerging economies. I calibrate the model using data for a large sample of advanced and emerging economies and find that the FDI channel has a large impact on the probability of a Sudden Stop. In particular, the model predicts that, on average, an emerging economy that increases their capital to GDP ratio and eliminates the expropriation risk would reduce the probability of a Sudden Stop from 2.9 to 1.3 percent and would increase its debt-to-income ratio from 35 to 51 percent.


We propose a simple and fast fixed-point iteration algorithm (FiPIt) to obtain the global, non-linear solution of macro models with two endogenous state variables and occasionally binding constraints. The algorithm applies fixed-point iteration on the Euler equations, and by doing so, avoids solving the Euler equations as a non-linear system, as with the standard time-iteration method, and does not require interpolation of decision rules over irregular grids, as with the endogenous grids method. Analytic solutions are obtained for recursive equilibrium functions in each iteration of the algorithm, and standard bi-linear interpolation for obtaining these analytic solutions remains applicable. In the small-open-economy Real Business Cycles and Sudden Stops models provided as examples, FiPIt is much faster than time-iteration and various hybrid methods.
UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez  
ORDONEZ@ECON.UPENN.EDU  
215-898-1875
Placement Director: David Dillenberger  
DDILL@ECON.UPENN.EDU  
215-898-1503
Graduate Student Coordinator: Gina Conway  
GNC@SAS.UPENN.EDU  
215-898-5691

Office Contact Information
The Ronald O. Perelman Center for Political Science and Economics, Room 628
133 South 36th Street
Philadelphia, PA 19104
Phone number: 215-407-9585

Personal Information: Male, China (F-1 Visa)

Undergraduate Studies:
B.S. in Physics, Fudan University, China, 2012

Masters Level Work:
M.S. in System Engineering, University of Pennsylvania, 2014

Graduate Studies:
University of Pennsylvania, 2014 to present
Thesis Title: “Essays on Machine Learning and the Labor Market”
Expected Completion Date: May 2021

Thesis Committee and References:
Professor Iourii Manovskii (Advisor)  
Department of Economics  
University of Pennsylvania  
133 South 36th Street, Room 518  
Philadelphia, PA, 19104  
Phone: 215-898-6880  
Email: manovski@econ.upenn.edu

Professor Marcus Hagedorn  
Department of Economics  
P.O. Box 1095 Blindern  
N-0317 Oslo, Norway  
Phone: (+47)-228-5576  
Email: marcus.hagedorn@econ.uio.no

Professor Dirk Krueger  
Department of Economics  
University of Pennsylvania  
133 South 36th Street, Room 520  
Philadelphia, PA, 19104  
Phone: 215-573-1424  
Email: dkrueger@econ.upenn.edu
Research Fields:

Teaching Experience:
Spring 2018 Intermediate Macroeconomics, Recitation Instructor for Prof. D. Kreuger.
Fall 2017 Introduction to Macroeconomics, Recitation Instructor for Prof. L. Bossi.
Spring 2017 Intermediate Macroeconomics, Recitation Instructor for Prof. A. Dovis.
Summer 2016 Monetary Economics, Teaching Assistant for Prof. T. Shabbir.
Spring 2016, Fall 2016 Intermediate Macroeconomics, Recitation Instructor for Prof. G. Ordonez.
Fall 2015 Intermediate Microeconomics, Recitation Instructor for Prof. R. Vohra.

Research Experience and Other Employment:
2018 - 2019 Research Assistant for Professor Marcus Hagedorn.
2016 - 2018 Research Assistant for Professor Iourii Manovskii.

Professional Activities:
Presentations University of Pennsylvania (2020, 2019, 2018),
Joint Statistical Meetings (2020).
Referee Macroeconomic Dynamics,
International Economic Review.

Honors, Scholarships, and Fellowships:
2014-2017 Graduate Fellowship, University of Pennsylvania.

Research Papers:
“Measuring the Effects of Coworkers on Wages”
(Job Market Paper)
Abstract: The fast-growing literature studying the impact of co-workers on individual’s wages has recently made significant progress by developing techniques that allowed it to move from small and idiosyncratic case studies to more generalizable studies based on large labor markets. However, I show that the empirical methodology underlying this shift delivers a large positive or negative bias in measured co-worker effects in realistic settings. I combine insights from the assortative matching theory with recent computer science advances in graph embedding techniques to develop a machine learning method that allows researchers to obtain efficient and unbiased estimates in those settings. The proposed method allows to non-parametrically measure the potentially heterogeneous impact of different co-workers on individuals’ wages. I am currently using the proposed method to measure co-worker effects in the matched employer-employee panel data covering the entire population of Denmark. The paper contributes to several strands of the literature. The first contribution is to the empirical studies on peer effects using matched-employer-employee dataset with parsimonious machine-learning-based approach that enables reliable and testable results. Second, the paper contributes to the literature of identifying sorting based on unobserved heterogeneity. Complementary to the existing random-effect-based approach, my method delivers precise counterfactual predictions for any individual worker if allocated to any firm conditional on the set of coworkers. Finally, the paper speaks to search frictions and assortative matching literature, providing empirical evidence of the coworker spillovers and worker-firms complementarities in wages.
“Machine Learning the Labor Market”
(with Iourii Manovskii and Marcus Hagedorn)

Abstract: Compensation for workers' productive attributes, not captured by the characteristics that can be directly observed in the data, and sorting between workers and firms based on these attributes, are key for understanding why different workers are paid different wages, why productivity differs across firms, and how government policies affect worker reallocation and economic performance. Using economic theory, we propose a method that allows to identify unobserved firm and worker characteristics in the data. Building on cutting-edge advances in computer science, we develop an original machine learning algorithm that allows implementing this identification strategy in large matched employer-employee datasets. This allows us to measure the consequences for wages, output, and productivity from moving any individual worker to any individual firm in the economy. This enables promising answers to questions such as: Does the market allocate workers to the right jobs for them? Can this allocation be improved? Do large employers pay higher wages because they employ better workers? What are the sources of large wage differences across industries, occupations, or regions? Being able to answer such questions has the potential to substantially impact the design and evaluation of public policies. The proposed methods will be applied to national-level administrative datasets.

Research Papers in Progress:
“Industry Heterogeneity, Production Networks, and Monetary Policy”
(with Zhesheng Qiu and Le Xu)

Languages:
English (fluent), Chinese (native), Japanese (working).

Computational Skills:
Python, MATLAB, Stata, R, SQL, Parallel Computation.

Certificate:
Machine Learning Scientist with Python (DataCamp),
My research interest lies in macro and labor economics, with a special focus on developing innovative empirical methods combining economic theory with machine learning to identify unobserved heterogeneities of workers and firms in the labor market.

My first contribution to this research agenda is “Machine Learning the Labor Market” with Marcus Hagedorn and Iourii Manovskii. We find that most standard assortative matching models in the literature feature one common property: similar workers with similar employment histories must receive similar wages when working in similar firms. We developed a novel hierarchical bi-clustering algorithm to identify the groups of similar workers and groups of similar firms and the membership of individual workers and firms in those groups. This allows us to measure the consequences for wages, output, and productivity from moving any individual worker to any individual firm in the economy: we can predict the counterfactual wages of an individual worker in a firm she never worked at based on what other workers in her cluster have earned in the same firm. As wages can be inverted for output for these models, we can also predict output and productivity. We are now applying the proposed methods to administrative matched employer-employee data from the United States and Denmark. To accommodate the demand for computational efficiency, we integrate our hierarchical clustering method with modern graph embedding based on graph convetional neural networks.

My job market paper “Measuring the Effects of Coworkers on Wages” investigates how the wage of a worker depends on her coworkers. Estimating the coworker spillover for the scale of a local labor market has important implications on optimal assignment of workers into firms. Yet, until recently, the research on peer effects has been limited to small and idiosyncratic case studies and found mixed results. The paper speaks to the growing interest in the literature moving beyond these case studies to more generalizable research based on large labor markets. I show that the leading empirical methodology underlying this shift cannot correctly account for the well-known “selection problem” in realistic settings. The selection problem arises when coworkers are not sorted into firms at random. As suggested by numerous empirical studies, high-productivity workers are more likely to work for high-productivity firms with other high-productivity coworkers. However, identifying in the data the endogenous selection induced by the complementarity between worker and firm is challenging, for the selection may be based on unobserved
productive attributes of both workers and firms. Current research frontier methods to
disentangle sorting and peer effect by including an additively separable firm and worker
fixed effects will induce a sizable misspecification bias in the measured coworker effects,
because they do not allow for the the complementarities between workers and firms. I
show that the bias can be large, with its sign being either positive or negative, depending
on the strength and sign of the complementarity.

I combine insights from the assortative matching theory with recent computer science
advances in graph embedding techniques to develop a machine learning method that en-
ables researchers to obtain efficient and unbiased estimates in this setting. My approach
allows for the potential worker-firm complementarities and heterogeneous peer effects.
The identification has two stages. In the “clustering” stage, I identify workers with sim-
ilar latent productivity using a hierarchical clustering method that is similar to the first
paper, but now more challenging because by allowing for peer effects, wages can be af-
fected by the evolving sets of coworkers. The idea is based economic theory that two
coworkers of similar latent characteristics, conditional on the same working history, must
make comparable wages in the same firm with the identical cohort of coworkers. These
restrictions allow me to identify subgroups of workers with similar productivity levels
by comparing wages between coworkers pairwisely for each point in time. In the “esti-
mation” stage, I non-parametrically estimate the spillover effects for workers clustered at
each productivity level. The identification utilizes the response of the focal worker’s wages
to an exogenous variation of within-firm coworker productivity distribution, conditional
on the worker and firm’s productivity in the match. My job market paper contributes
to multiple strands of the literature. The first contribution is to the empirical studies
on peer effects using large matched-employer-employee data by developing a parsimo-
nious machine-learning-based approach that enables reliable and testable results. Second,
the paper contributes to the literature of identifying sorting based on unobserved heter-
egeneity. Complementary to the existing random-effect-based method, my approach
delivers precise counterfactual predictions for any individual worker if allocated to any
firm conditional on the set of coworkers. Finally, the paper speaks to search frictions and
assortative matching literature, providing empirical evidence of the coworker spillovers
and worker-firms complementarities in wages.

The empirical methods I developed in these papers can be used to provide substantive
answers to a wide range of classic macro and labor research questions that has the potential
to substantially impact the design and evaluation of public policies. For example, they
allow me to asses why wages differ across firms of different sizes or exporting status,
across industries or geographic regions. They also enable me to assess the efficiency of the
observed allocation of workers to jobs and groups of co-workers. Addressing these issues
will represent the immediate next steps in my research agenda.
Wu Zhu
https://zhuwu2012.github.io/
zhuwu@sas.upenn.edu

UNIVERSITY OF PENNSYLVANIA

Placement Director: Guillermo Ordonez  ORDONZE@ECON.UPENN.EDU  215-898-1875
Placement Director: David Dillenberger  DDILL@ECON.UPENN.EDU  215-898-1503
Graduate Student Coordinator: Gina Conway  GNC@SAS.UPENN.EDU  215-898-5691

Office Contact Information
656 Ronald Perelman Center for Political Science
and Economics, 133 South 36th St,
Philadelphia, PA 19104

Home Contact Information
#1906 3737 Chestnut St.,
Philadelphia, PA, 19104
+1 215-285-8924

Education:
Ph.D., Economics, University of Pennsylvania, 2016 – 2021
   Fields: Network Economics, Macro, Finance, and Machine Learning
   Thesis Title: “Networks in Macroeconomics, Finance, and Machine Learning”
Master, Statistics, Department of Statistics, Wharton, Expected in 2021
M.A in Economics, CCER, Peking University, 2016
B.S in Materials Physics, University of Science and Technology, Beijing, 2009

THESIS COMMITTEE AND REFERENCES:
Professor Frank Schorfheide
Department of Economics, University Of Pennsylvania, Philadelphia, PA
215-898-8486
schorf@ssc.upenn.edu

Professor Rakesh Vohra (Primary advisor)
University Professor, Department of
Economics and Electrical and Systems
Engineer, University of Pennsylvania
215-898-6777, rvohra@sas.upenn.edu

Professor Linda Zhao (Co-advisor)
Department of Statistics, Wharton,
University of Pennsylvania, Philadelphia, PA,
215-898-8228, lzhao@wharton.upenn.edu

Research Fields:
Primary Fields: Network Economics
Secondary Fields: Macroeconomics, Finance, and Machine Learning

Relevant Position:
Jun2018- Sep2018   IMF (International Monetary Fund), Machine Learning, Behavior Bias and
Credit Market Crashes (IMF Summer Funding Internship Program for Ph.D.)

Conference and Seminar Talk (* talk by coauthor):
Joint Statistical Meetings (Aug2021,American Statistical Association), American Finance
Association Annual Conference (Jan2021 AFA), NBER Chinese Economy Meeting (Dec2020)*,
Winter Meeting for Econometric Society (Dec 2020), NSF 6th Annual Conference for Networks
Economics(x4,Chicago,Booth), Financial Management Association Annual (Nov2020,NYC),
MFA(x2, Mar2020), American Economic Association Annual (Jan 2020,Sandiego), Summer
Meeting Econometric Society (NA, July2019), IMF (Apr2019)*, Jane Street PhD Symposium
(Jan2019), Asian Meeting of Econometric Society (Jun2019, Xiamen), Bank of Finland (Jul 2019)*,
Penn-Wharton-GSM (June2019), Penn Econ (Macro Lunch, 2019), Penn Econ (Micro Theory
Lunch,2019), Penn Econ (Micro Lunch,2019), PKU (June 2018), Penn Econ (Econometric Lunch,
April 2018), IMF (April 2018)*, Wharton (Oct 2017, MBA Talk), American Economic Association

Teaching Experience:
- Spring 2017  Economics 102, Professor Rakesh Vohra
- Fall 2017  Economics 201, Professor Jose-Victor Rios-Rull
- Spring 2021  Modern Data Mining, Professor Linda Zhao

Relevant Honors and Awards:

Programming and Skills:
Python (High Proficiency), R (Proficiency), Stata (High Proficiency), and SQL.

Research Statement:
My research spans several fields: Macroeconomics, Finance, Machine Learning, Network Theory, and the Chinese Economy. However, it shares a common theme - the use of big data (firm-level) to emphasize the role of networks in investor behavior, business cycles, asset pricing, and systemic risk. Under this common theme, my work can be divided into three groups: Innovation Networks, Machine Learning, and Equity-holding Networks.

Papers under Review:
Note: These two papers are part of the project on equity-holding networks.

1. **The Network Effects of Agency Conflicts** (with Rakesh Vohra (Penn Econ and ESE) and Yiqing Xing (JHU), Under Review) (Winter Meeting of Econometric Society (2020Dec), NSF 6th Annual Conference in Network Economics (U Chicago Booth))
   It is customary to focus on the network of interdependencies between firms to understand how and whether a shock to one firm will propagate to others. This paper argues that agency conflicts at the firm-level and not just the network structure, play a crucial role in amplifying or muting the propagation of exogenous shocks. If firms can take investment decisions in response to an exogenous shock, whether their choices amplify or mute the propagation of the shock will depend on the nature of the agency conflict. When agents in our model are subject to default costs or limited liability, they make investment choices that serve to mitigate the spread of an initial shock. Under some conditions, the aggregate effect of an idiosyncratic shock via propagation does not diminish. This suggests a potentially important role that corporate governance plays in macro fluctuations.

   Using business registry data from China, we show that internal capital markets in business groups can play the role of financial intermediary and propagate corporate shareholders’ credit supply shocks to their subsidiaries. An average of 16.7% local bank credit growth where corporate shareholders are located would increase subsidiaries investment by 1% of their tangible
fixed asset value, which accounts for 71% (7%) of the median (average) investment rate among these firms. We argue that equity exchanges is one channel through which corporate shareholders transmit bank credit supply shocks to the subsidiaries and provide evidence to support the channel.

Papers on Innovation Networks:
Overview: In this project, I constructed most comprehensive patent datasets of U.S. traced back to 1911, combined with various other datasets on analyst’s coverage, news reports, institutional investors, business linkages, and equity-holding etc. I matched these datasets with CRSP/CompStat. Using the final datasets (roughly 50GB), I conducted several researches on business cycles and asset pricing.

3. **Networks and Business Cycles.**
   *(Job Market Paper, with Yucheng Yang) (Talk: UPenn, Princeton)*
   The speed at which the US economy has recovered from recessions ranges from months to years. We propose a model incorporating innovation network, production network, and cross-sectional shock and show that their interactions jointly explain the large variations in the recovery speed across recessions in the US. Besides the production linkages, firms learn insights on production from each other through the innovation network. Using the eigenvalue decomposition, we show that the shock's sectoral distribution plays a crucial role in its amplification and persistence when the innovation network takes a low-rank structure.
   We estimate a state-space model of the cross-sectional technology shock and document a set of new stylized facts on the structure of the innovation network and sectoral distribution of the shock for the US. We show that the specific low-rank network structure and the time-varying sectoral distribution of the shock can well explain the large variation in the recovery speed across recessions in the US. Finally, to emphasize the prevalence of the channel, we explore the application of the theory in asset pricing.

4. **Innovation Networks, Linking Complexity, and Cross Predictability**
   *(Nominee for the Best Paper in Investment (Financial Management Association Annual, Oct 2020))*
   This paper provides evidence that network complexity limits investors’ ability to process non-local information, through the lens of return cross predictability. Using firm-to-firm citation networks, we find that the non-local indirectly linked firms can well predict the return of the focal firm, while the predictability of the local directly linked firms is weak. A long-short strategy using the indirect links yields a risk-adjusted monthly alpha of 198 (164) basis points with equal (value) weights. We further find that (i) the indirect citation links are much more complex than direct ones, (ii) the magnitude of cross predictability increases with the degree of link complexity, (iii) institutional investors don't adjust their positions in a stock with complex links, but in one with simple links immediately, (iv) firms with more complex links receive more public attention, are much larger in size, and exhibit less idiosyncratic volatility than those with simple links.

5. **Networks, Long-Run Risk, and Asset Pricing**
   *(Draft is available once requested; This is part of my job market work)*
   This paper proposes a networked economy incorporating innovation network, production network, and cross-sectional technology shock with E-Z preference. We, theoretically and empirically, argue that the low-rank structure of the innovation network and the sectoral distribution of the technology shock provide a channel to yield a small but persistent component in the expected consumption growth – the long run risk in the consumption growth. This endogenized persistent component yields a very large time-varying variation in the stochastic discount factor and can well explain several puzzles of the financial market – equity premium puzzle, the risk-free rate, and the market return volatility. Besides the explanation of the theory on the puzzles at the aggregate level, we further explore the cross-sectional asset pricing implications of the networked economy.

Papers on Equity-holding Networks:
Overview: This project constructed several proprietary big datasets covering all firms registered in China (roughly 200GB and 90 million firms). These datasets recorded detail information on corporate shareholders and historical updates. Leveraging these, I wrote several papers, including two papers under review, several well-polished papers, and papers in pipeline, to understand the implications of equity-holding networks on firm investment, systemic risk, and monetary policy.

The finance–growth nexus has been a central question in understanding the unprecedented success of the Chinese economy. With unique data on all the registered firms in China, we build extensive ownership networks, reflecting firm-to-firm equity investment relationships, and show that these networks have been expanding rapidly since the 2000s, with more than five million firms in at least one network by 2017. Entering a network and increasing network centrality, both globally and locally, are associated with higher future firm growth rates. Such positive network effects tend to be more pronounced for high productivity firms and privately-owned firms. The positive effects of equity investments of the networks, however, were crowded out by the RMB 4 trillion stimulus, launched by the Chinese government in November 2008 in response to the global financial crisis. Taken together, our analysis suggests that equity ownership networks and bank credit tend to act as substitutes for state-owned enterprises, but as complements for privately owned firms in promoting growth.

7. **State-Owned Enterprises in China Revised** (with Junhui Cai, Xian Gu, and Linda Zhao, draft available)

This paper revisits the state sector and its role in Chinese economy. We propose a revised measure of Chinese SOEs (and partial SOEs) based on the firm-to-firm equity investment relationships. We are the first to provide identifiers of all SOEs among over 40 millions of all Chinese firms. Our revised measure captures a significant larger number of SOEs than the existing measure. It shows parallel trends of decentralization (authoritarian hierarchy) and indirect control (ownership hierarchy) over time. Using the revised measure, we find mixed ownership is associated with higher firm growth and performance; while hierarchical distance to governments is associated with better firm performance but lower growth. Conclusions drawn from a stark distinction between SOEs and POEs could lead to misperceptions of the role of state ownership in Chinese economy.

**Papers on Machine Learning, Investment, and Networks:**
Overview: Understanding how investors collect and process information has been a central topic in economics and finance. In this project, we leverage the machine learning to identify latent network structure and boost prediction, especially incorporate behavior constraints on investment behaviors.

8. **Semi-supervised Learning in Networks** (Daft available, with Junhui Cai (Wharton Stats), Haipeng Shen (HKU), Dan Yang (HKU), Linda Zhao (Wharton Stats)) (JSM 2021, American Statistical Association)
- Model: A predictive model with unobservable networks
- Estimate: L2 norm to boost the unobservable network and the parameters in predictive model,
- Theoretical results: Asymptotic distribution of parameters on predictive model and network.
- Simulation results: Significant boost the parameter estimation and the network structure.
- Real Application: Equity-holding networks, Stock Market Return Prediction (in Progress)

9. **Deep Learning in Dynamic Networks and Foresting** (with Junhui Cai, and Linda Zhao)

In reality, firms are usually linked through various relationship – customer-suppliers, geographical overlapping, technology flow, equity-holding, business overlapping etc. There are two things worth mentioning. First, the links usually dynamically change. Second, the links are usually partially observable either due to the high collection cost or sizable measurement errors. In this paper, we model the latent networks as state variable which evolves over time, each period the state variables will be updated based on its value of the last periods, the latest partially observable counterparts, and the stock returns. We incorporate this process into a Reinforcement Learning with super high dimension of state variables, and significant boost the cross-predictability.

10. **Identifying Underlying Links and Cross Predictability**, (with Junhui Cai (Wharton Stats), Linda Zhao (Wharton Stats), in progress)

**Quantitative Courses Taken (all PhD Level):**
Networks and Business Cycles

Abstract

The speed at which the US economy has recovered from different recessions varies greatly, ranging from months to years. An important question is what drives this slow recovery process. Put differently, what links the short-term business cycles and the long-term growth trend? In this paper, we argue, theoretically and empirically, that the underlying network of knowledge flow on technology and its interactions with production networks and cross-sectional shocks explains the large variations in the speed of recovery across recessions in U.S.

Theoretically, we develop a dynamic general equilibrium incorporating two networks – production network where firms are linked through input-output, and innovation network where firms are linked through technology. We examine how cross-sectional shocks interact with these networks. In general, we show that these interactions allow us to decompose the effects of shocks, even idiosyncratic shocks, on future growth into several components. Each component includes its persistence and amplification. The persistence can be fully captured by the eigenvalue distribution of the adjacency matrix for the innovation network. When the innovation network is low rank (i.e., the leading eigenvalue is much larger than the rest), the direction of the current cross-sectional shock will reveal useful information on the economy’s future recovery process. Furthermore, when the leading eigenvalue is large enough, the impact of the shock would become extremely persistent.

The amplification can be fully captured by two sufficient statistics - the correlation between the centrality in innovation network and shocks, and the correlation between centralities in innovation and production networks. The slow recovery occurs when the amplification on the persistent component increases sharply.

To evaluate the importance of the channel, we construct a new and comprehensive patent dataset of U.S back to 1911 – patent issuance, transaction, and citation, and the production network back to 1950. We first document a set of new stylized facts in U.S. First, the innovation network is very stable and takes a low rank structure; Second, the structure of the innovation network is special such that the effect of the shock becomes very persistent and significantly amplified when sectors in the center of the innovation network are severely hit. Finally, there is a large variation in the sectors’ exposure to adversarial shocks across recessions in U.S.
Research Statement

Wu Zhu

My goal is to understand both theoretically and empirically how the links between firms, financial, physical and technological, affect the business cycle, systemic risk, investor behaviors, and asset pricing.

My work to date can be divided into three parts. The first, focuses on the links by which technological innovation spreads between firms and its implication for the business cycle, asset pricing, and investor behavior. The second focuses on the financial links created by equity-holding relationships and their implications for systemic risk, corporate finance, governance, and monetary policy. The third, uses machine learning techniques to identify 'hidden links' between firms or agents, contracting frictions in the formation of networks, and network effects. These projects span several fields linked to Network Economics – Macroeconomics, Finance, Machine Learning, Theory, and the Chinese Economy.

Project on innovation networks

The speed at which the US economy has recovered from different recessions varies greatly, ranging from months to years. An important question is what drives this slow recovery process. Put differently, what links the short-term business cycles and the long-term growth trend? In my job market paper, “Networks and Business Cycles”, we argue, theoretically and empirically, that the underlying network of knowledge flow on technology and its interactions with production networks and cross-sectional shocks explains the large variations in the speed of recovery across recessions in US.

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such that the effect of the shock becomes very persistent and significantly amplified when sectors in the center of the innovation network are severely hit. Third, the interactions between the innovation and production network are strong and stable over time. Finally, there is a large variation in the sectors’ exposure to adversarial shocks across recessions in U.S.

To explain the risk-premium puzzles in financial market. The long-run risk literature assumes that there is a very persistent component in the consumption growth. My job market paper rationalizes a time-varying persistent component in the consumption growth from the perspective of networks. An importance question is that whether the networking economy can explain the risk-premium puzzle and several related puzzles in financial markets. Besides, the networked economy allows us to directly examine the cross-sectional implications of the long-run risk. In the progressing paper, “Networks, Long Run Risk, and Asset Pricing”, I explore this possibility.

Understanding how agents impound information from their environments is the essential question in economics, closely related to the three power horses in decision making – information, preference, and choice set. The technology links between firms provide us a good chance to study how investors (professional investors like hedge fund managers) incorporate information in decision making. In the working paper, “Networks, Link Complexity, and Cross-Predictability”, I provide evidence to show that link complexity significantly hinders investors impounding fundamentally-relevant information, leading to a significant cross-predictability. A long-short strategy based on the link-complexity yields a risk-adjusted monthly alpha of 270 basis points.

**Project on equity-holding networks**
Equity crossholdings are another way in which firms are dependent upon each other. My goal here is to understand how such networks affects firms’ decision making, propagation of shocks, firm growth, and monetary policy.

In a joint theoretical work with Rakesh Vohra and Yiqing Xing, “The Network Effects of Agency Conflicts”, we develop a flexible model incorporating various types of frictions – default costs, limited liability, interest conflicts and moral hazards between managers and shareholder – to systematically examine the role of firm-level frictions in amplifying and propagating the shocks. This paper argues the within firm agency conflicts and not just the network structure, play a crucial role in amplifying or muting the propagation of the shock. Under some conditions, the aggregate effect of an idiosyncratic shock via propagation does not diminish when the agency conflicts within firms are non-negligible. This suggests a potentially important role that corporate governance plays in macro fluctuations.

On the empirical side, I construct a proprietary and dynamic updated dataset covering the universal firms registered in China till 2020 (70 million firms). This comprehensive dataset records detailed information on firm shareholders, outside investment, and historical update. Using the information on the historical shareholders, I construct the dynamic equity-holding networks that can be traced back to 1990.

In a joint work with Yu Shi and Robert Townsend, “Tiered Intermediation in Business Groups”, we show that internal capital market in business groups can play the role of financial intermediary
and propagate the corporate shareholders’ credit supply shocks to the corporate subsidiaries. This intermediation explains a large variation in firms’ physical investment. We argue that equity exchange is one channel through which corporate shareholders transmit bank credit supply shocks to the subsidiaries and provide evidence to support the channel.

Firms in the equity-holding network not only benefit from the positive exposure to their parent companies, but also benefit from the network effect either due to relationship financing or equity-financing. In a joint work with Franklin Allen, Junhui Cai, Xian Gu, Jun Qian, and Linda Zhao, “Ownership networks and Firm Growth: What Do Forty Million Companies Tell About Chinese Economy”, we examine the effect of firms’ position in the equity-holding on firm growth. This work partially decoding the long-standing puzzle of the Chinese Economy – unprecedented economic growth and sluggish developed financial systems.

A significant feature of the Chinese economy is the dominance of State-Owned Enterprises (SOEs). Besides the traditional industrial policies – targeted tax or subsidies, Chinese government leverages the SOEs to implement its policies. Important questions are what motivates SOEs to hold other firms? How does the government control the economy via leveraging the SOEs and what is the impact of such controls on economic efficiency? In our recent work “State-Owned Enterprises in China Revised”, we revise the definition of SOEs based on the controlling rights and cash-flow rights using the equity-holding networks and document several important facts. For example, the Chinese government has been shifted from direct control to indirect control. On the one hand, the shift leads to a significant rise in controlling rights over the whole economy, on the other hand, it promotes the efficient allocation of resources.

To understand the formation of the equity-holding networks, one interesting observation is that the equity-holding link is bilateral that the investor-investee relationship forges if and only if both parties benefit from the link. When the bargaining cost is high, the equity-holding link may not be forged even if the total payoff is positive. One important question is whether the bilateral link can be efficiently formed and where the bargaining cost comes from.

**Project on machine learning**

In many cases, networking data is costly to collect and there is large measurement errors on the links between agents or firms. Therefore, I am interested in using machine learning techniques to recover the underlying links between firms or agents to study prediction, portfolio management, and information acquisition in a networked world. In recent work with Junhui Cai, Linda Zhao, and Dan Yang, “Semi-supervised Learning with Network Data” (Invited talk in American Statistical Association, 2021), we develop a model to combine both the information in the observed but noisy links, and the information in the predictive model to boost the estimates of parameters and the network structure.

In a networked economy, firms are linked by various types of links – technology links, equity-holding links, geographical links, supply-customer links etc. How do investors learn information in a networked economy is an important but unexplored question. Can investors efficiently extract information about one company from their linked counterparties? How investors learn in a complicated and dynamically changing networked work? We handle these questions in the progressing work.