Penn Arts & Sciences
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October 25, 2023

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 you or a member of your institution will be in the Philadelphia area and would like to meet with some of our students, Gina Conway, our Graduate Group Coordinator, would be pleased to arrange such interviews. She can be reached by phone 215-898-5691 or email at gnc@sas.upenn.edu.

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,

Iourii Manovskii
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Andrew Shephard
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Graduate Coordinator
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SUMMARY LISTING OF DOCTORAL STUDENTS SEEKING EMPLOYMENT, 2023/2024

Candidate Name	Research Interest	Job Market Paper	Faculty Advisor, Email
Yoshiki Ando yando@sas.upenn.edu	Macroeconomics, Innovation, Firm Dynamics, Financial Frictions	Dynamics of High-Growth Young Firms and the Role of Venture Capitalists	Jeremy Greenwood recommendations@jeremygreenwood.net
Pawel Bednarek pbed@sas.upenn.edu	Financial Innovation, Macroeconomics, Blockchain	Bitcoin's Achilles Heel: Transition from Block Rewards to Fees	Urban Jermann jermann@wharton.upenn.edu
Priyanka Goonetilleke goonep@sas.upenn.edu	Law and Economics, Economics of Crime	Judicial Bias Against Minority and Female Attorneys	Hanming Fang hanming.fang@econ.upenn.edu
Leon Huetsch lhuetsch@sas.upenn.edu	Macroeconomics, Inequality, Technological Change, Institutions and Growth	Technological Change and Unions: An Intergenerational Conflict with Aggregate Impact	Dirk Krueger dkrueger@econ.upenn.edu
Kathleen Hui huikat@sas.upenn.edu	Health, IO	The Impact of a Vape Ban on Cigarette Smoking and Life Expectancy	Aviv Nevo anevo@upenn.edu
Min Kim minkim1@sas.upenn.edu	Macroeconomics, Household Finance, Financial Literacy	General Equilibrium Study of Household Financial Literacy and Portfolio Choice	Dirk Krueger dkrueger@econ.upenn.edu Olivia S. Mitchell mitchelo@wharton.upenn.edu
Artem Kuriksha kuriksha@sas.upenn.edu	Applied Microeconomics, Industrial Organization, Computational Economics	Illegal Drug Use and Government Policy: Evidence from a Darknet Marketplace	Andrew Shephard asheph@sas.upenn.edu
Aaron Mora aaronmor@sas.upenn.edu	Econometrics, Financial Economics, Industrial Organization	Revealed Preference for Green Stocks: An Asset Demand Approach	Francis Diebold fdiebold@econ.upenn.edu Frank Schorfheide schorf@econ.upenn.edu
Rodrigo Morales Mendoza rodmo@sas.upenn.edu	Macroeconomics, Network Economics, and Inequality	The Power of Good Neighbors: An Analysis of International Mobility	Jesus Fernandez-Villaverde jesusfv@econ.upenn.edu
Joao Ritto jritto@sas.upenn.edu	Macroeconomics, Monetary Economics, Macro-labor	Doing Without Nominal Rigidities: Real Effects of Monetary Policy in a Monetary World	Victor Rios-Rull vr0j@econ.upenn.edu
Juan Sagredo sagju@sas.upenn.edu	Applied Theory, Theory, Political Economy	The Visible Hand	Guillermo Ordonez ordonez@econ.upenn.edu
German Sanchez Sanchez germansa@sas.upenn.edu	Macroeconomics, Housing and Mortgage Finance, Financial Intermediation	Mortgage Choice and Credit Guarantees	Guillermo Ordonez ordonez@econ.upenn.edu

Candidate Name	Research Interest	Job Market Paper	Faculty Advisor, Email
Shasha Wang wss@sas.upenn.edu	Machine learning in Economics, Gender, Labor, Health, Education, Marriage Market, and Family Economics	STEMming the Gender Gap in the Applied Fields: Where are the Leaks in the Pipeline?	Petra Todd ptodd@econ.upenn.edu
Zhemin Yuan yzhemin@sas.upenn.edu	Empirical Microeconomics, Health Economics, Labor Economics, Public Economics	The Effects of the ACA on Pharmaceutical Prices, Demand and Innovation	Hanming Fang hanming.fang@econ.upenn.edu

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Birth Year: 1993

Undergraduate Studies:
B.A. in Economics, The University of Tokyo, 2016

Masters Level Work:
M.A. in Economics, The University of Tokyo, 2018

Graduate Studies:
University of Pennsylvania, 2018 to present
Thesis Title: "*Essays in Macroeconomics*"
Expected Completion Date: May 2024

Thesis Committee and References:

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Wharton School, University of Pennsylvania
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ssalgado@wharton.upenn.edu

Teaching and Research Fields:
Primary field: Macroeconomics
Secondary fields: Innovation, Firm Dynamics, Heterogeneous-Agent Models

Teaching Experience:

University of Pennsylvania

2023 Spring	Numerical Methods for Macroeconomists, TA for Prof. Greenwood
2022 Fall	Economics of Family, TA for Prof. Greenwood

University of Tokyo

2017 Fall	Macroeconomics II (graduate level), TA for Prof. Aoki
2017 Spring	Macroeconomics I (graduate level), TA for Prof. Jinnai

Research Experience and Other Employment:

2020-2022	Research Assistant for Prof. Krueger
2021, 2022	Research Assistant (proofreading) for Prof. Greenwood
2022	Research Assistant (proofreading) for Prof. Jermann
2021	Summer Intern at the International Monetary Fund

Professional Activities:

2023	Annual Conference on Macroeconomics Across Time and Space (Poster Presentation)
2023	NBER Innovation Research Boot Camp (Funded Attendee)

Referee Experience:

Young Economists Symposium (2020, 2021, 2022), Macroeconomic Dynamics

Honors, Scholarships, and Fellowships:

2021-2023	Xingmei Graduate Fellow, 2021-2022, 2022-2023
2019	Best Performance in the Preliminary Examination in Macroeconomics
2018-2020	Japan-IMF Scholarship Program
2018	JSPS Research Fellowships for Young Scientists

Research Papers:

"Dynamics of High-Growth Young Firms and the Role of Venture Capitalists" (Job Market Paper)

I examine the role that venture capital (VC) plays in helping promising startups achieve high growth. Three facts are documented from US Census data and proprietary VC datasets: (i) substantial growth of VC-backed firms and their contribution to aggregate growth, (ii) the large upfront investment of VC-backed startups relative to startups using other forms of finance, and (iii) extra equity stakes acquired by venture capitalists relative to Angel investors. Based on the evidence, I develop a firm-dynamics model with endogenous firm productivity and the choice of finance from VC, Angel investors, and banks. The model shows the benefit of VC and Angel finance over bank finance for innovative firms because of their volatile revenue, which increases the likelihood of bankruptcy with bank finance. The model estimates that the value-adding effect of venture capitalists accounts for around one-fourth of the growth of VC-backed firms. Finally, policy experiments predict that subsidies to innovation expenditures or equity investments enhance aggregate output, in contrast to bank loan subsidies.

"One-Sided Limited Commitment and Aggregate Productivity Risk", with Dirk Krueger and Harald Uhlig

In this paper, we study the neoclassical growth model with idiosyncratic income risk and aggregate productivity risk in which risk sharing is endogenously constrained by one-sided limited commitment. Households can trade a full set of contingent claims that pay off depending on both idiosyncratic and aggregate risk, but limited commitment rules out that households sell these assets short. The model results, under suitable restrictions of the parameters of the model, in partial consumption insurance in equilibrium. With log-utility and idiosyncratic income shocks taking two values, one of which is zero (e.g., employment and unemployment), we show that the equilibrium can be characterized in closed form, despite the fact that it features a non-degenerate consumption and wealth distribution. We use the tractability of the model to study, analytically, inequality over the business cycle and asset pricing.

Research Paper in Progress:

"Technifying Ventures", with Emin Dinlersoz, Jeremy Greenwood, and Ruben Piazzesi

The role that venture capital plays in stimulating startups that adopt advanced technologies, such as artificial intelligence and robotics, is examined. Using the Census Bureau's 2018 Annual Business Survey, the relationship between technology adoption, VC-backed status, and firm performance is investigated. There is a disproportionate presence of advanced technology among VC-backed firms. Additionally, among startups that adopt advanced technologies, VC-backed firms outperform non-VC-backed ones, measured in terms of employment and revenue. A general equilibrium model is developed of advanced technology usage and VC finance. Consistent with the data, the model predicts that firms adopting advanced technologies are more likely to raise VC finance. The ex post productivity distribution of advanced technology firms stochastically dominates the productivity distribution of non-advanced technology firms. Additionally, the ex post productivity distribution of VC-backed firms stochastically dominates the productivity distribution of non-VC-backed firms due to both selection and synergy effects.

Research Statement

Yoshiki Ando

University of Pennsylvania

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My research interests lie in macroeconomics, with a particular focus on innovation, firm dynamics, and heterogeneous-agent models with financial frictions. The first two projects study the roles of venture capitalists in (i) helping promising startups achieve high growth and (ii) encouraging the adoption of advanced technologies. Both studies exploit US Census data to understand the characteristics of venture-capital-backed firms in the US economy. A quantitative model is developed to explain micro-level empirical evidence and obtain aggregate implications. The third project is a theoretical study of the neoclassical growth model with a limited commitment constraint. We analyze household inequality and asset pricing in an economy with idiosyncratic and aggregate risk as well as endogenously incomplete markets. The following is a synopsis of the three projects.

"Dynamics of High-Growth Young Firms and the Role of Venture Capitalists" (job market paper). Here, I examine the role that venture capital (VC) plays in helping promising startups achieve high growth. Venture capital is modeled as a financial intermediary that invests in startups in the form of private equity and provides both funding and managerial advice.

I analyze US Census data and proprietary VC datasets and document three facts. First, VC-backed firms have a particularly high chance of achieving high growth compared to non-VC-backed firms. Although only around 0.2% of all firms in the United States raise VC finance, VC-backed firms account for around 10-15% of aggregate growth in employment and payroll. Second, I document that VC-backed startups make large upfront investments relative to startups using other forms of finance. Finally, venture capitalists acquire around 3.3% extra equity stakes relative to Angel investors, conditional on firms' characteristics. I interpret this as compensation for venture capitalists' managerial advice.

Based on these empirical findings, I develop a firm-dynamics model with endogenous firm productivity and the choice of finance from VC, Angel investors, and banks. In the model, firms are born with heterogeneous growth potential and invest in innovation to improve their productivity. Venture capitalists give advice to enhance the probability of successful innovation in exchange for extra ownership stakes. The model shows the benefit of VC and Angel finance over bank finance for innovative firms because of their volatile revenue, which increases the likelihood of bankruptcy with bank finance. Venture capitalists' advice is particularly beneficial to high-potential firms because of the high return of successful innovation. The model is calibrated to match the average employment of all firms over the lifecycle and explains the substantial growth and upfront investment of VC-backed firms as untargeted moments. The model implies that the value-adding effect

of venture capitalists accounts for around one-fourth of the growth of VC-backed firms.

Finally, I conduct counterfactual analyses using the calibrated model. Policy experiments predict that subsidies to innovation expenditures or equity investments enhance aggregate output, as opposed to bank loan subsidies. This happens because the first two subsidies induce high-potential firms to increase innovation expenditures, improve their productivity, and use more labor and capital in the economy.

"Technifying Ventures" (work in progress), joint with Emin Dinlersoz, Jeremy Greenwood, and Ruben Piazzesi, examines the role of venture capital for startups that adopt advanced technologies, such as artificial intelligence and robotics. New firms exploiting the latest technologies may outgrow their competitors and achieve substantial growth. In this project, we exploit the Census Bureau's 2018 Annual Business Survey, a nationally representative survey of over 850,000 firms, and investigate the relationship between technology adoption, VC-backed status, and firm performance. We find a disproportionate presence of advanced technology among VC-backed firms. Additionally, among startups that adopt advanced technologies, VC-backed firms outperform non-VC-backed ones, measured in terms of employment and revenue. We then build a model of advanced technology usage and VC finance in general equilibrium. Consistent with the data, the model predicts that firms adopting advanced technologies are more likely to raise VC finance. The ex post productivity distribution of advanced technology firms stochastically dominates the productivity distribution of non-advanced technology firms. Additionally, the ex post productivity distribution of VC-backed firms stochastically dominates the productivity distribution of non-VC-backed firms as a result of both selection and synergy effects.

"One-Sided Limited Commitment and Aggregate Productivity Risk," joint with Dirk Krueger and Harald Uhlig, examines how households insure themselves against idiosyncratic income risk and aggregate productivity risk. We analyze a neoclassical growth model in which risk sharing is endogenously constrained by one-sided limited commitment, in contrast to the standard incomplete-market model (e.g., Aiyagari, 1994; Krusell and Smith, 1998). Households trade a full set of contingent claims that pay off depending on both idiosyncratic and aggregate risk, but limited commitment prevents households from short-selling these assets. Under suitable restrictions of the parameters, the model results in partial consumption insurance in equilibrium. With log-utility and idiosyncratic income shocks taking two values, one of which is zero (e.g., employment and unemployment), we show that the equilibrium can be characterized in closed form despite the fact that it features a non-degenerate consumption and wealth distribution. We use the tractability of the model to analytically study inequality over the business cycle and asset pricing. In particular, we provide conditions under which the equity premium in the limited-commitment model coincides with that in the standard representative agent model. Furthermore, an extended version of the model with stochastic capital depreciation generates a sizable equity premium, significantly larger than that of the representative agent version of the model and closer to the data.

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Personal Information: Citizenship: Polish, Sex: Male

Undergraduate Studies:

B.Sc. in Mathematics, Operational Research, Statistics and Economics, University of Warwick, 1:1 honors, 2017

Masters Level Work:

M.A. in Economics, University of Pennsylvania, 2020

M.Sc. in Statistical Science, University of Oxford, 2018

Graduate Studies:

University of Pennsylvania, 2018 to present

Thesis Title: *"Financial Paradigms Shifts: Bitcoin's Future and Implications of Passive Investing"*

Expected Completion Date: May 2024

Thesis Committee and References:

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Teaching and Research Fields:

Primary fields: macroeconomics, financial innovation, blockchain

Secondary fields: game theory

Teaching Experience:

Fall, 2023	Microeconomic Theory (graduate), Prof. Steven Matthews
Spring, 2023	Game Theory, Prof. Steven Matthews
Fall, 2022	Microeconomic Theory (graduate), Prof. Steven Matthews
Spring, 2022	Game Theory, Prof. Steven Matthews
Fall, 2021	Microeconomic Theory (graduate), Prof. Steven Matthews
Spring, 2021	Game Theory, Prof. Steven Matthews
Fall, 2020	Game Theory, Prof. Steven Matthews
Spring, 2020	Game Theory, Prof. Steven Matthews
Fall, 2019	Introduction to Microeconomics, Prof. Anne Duchene

Research Experience and Other Employment:

2020	World Bank, Research Assistant for Dr. Clement Joubert
2017	Polish Academy of Science, Research Assistant for Professor Katarzyna Zawalinska
2016	University of Warwick, Research Assistant for Professor Simon Spencer
2016	HM Treasury, Intern Policy Analyst
2015	Chancellery of the Prime Minister of Poland, Economic Research Trainee

Honors, Scholarships, and Fellowships:

2018 - 2024	Ph.D. Fellowship, University of Pennsylvania
2017	Academic Excellence in Statistics Award (top GPA)
2017	The Rohin Modasia Prize for Excellence in Economics (dissertation award)

Research Papers:

"Bitcoin's Achilles Heel: Transition from Block Rewards to Fees" (Job Market Paper)

Abstract:

This article addresses the long-term effects on the Bitcoin network's security and sustainability as it transitions from mining subsidies to transaction fees. The predetermined reductions in the mining rewards, commonly known as halvings, lead to programmed reductions in Bitcoin supply expansion. Mining rewards serve as an incentive to miners to provide hashrate, which is synonymous with network security. Subsequent halvings make miners increasingly more reliant on transaction fees, which raises concerns about whether this will be enough to maintain Bitcoin's security. In an overlapping generations model, the users derive transactional utility and rationally forecast the future resale value of Bitcoin. Users compete for the inclusion of their transactions in the blockchain in an auction setting, and the concept of real hashrate is introduced to estimate the network's security. The blockchain's inherent characteristics and observed network statistics are used to obtain a quantitative perspective. I find that the growth of the user base together with hashrate is almost solely responsible for variation in prices. I project that as Bitcoin undergoes subsequent halvings, the transaction fees will be insufficient to maintain the current levels of network security and Bitcoin price. Continued growth of the user base will positively contribute to both the user welfare and Bitcoin real balances, but mass adoption is expected to decrease both due to the constraints on the number of transactions that can be confirmed on the blockchain. The model also suggests that a simple policy that sets a fixed inflation rate of about 1% would guarantee greater sustainability and higher network value in the long run as opposed to a network entirely dependent on transaction fees.

"Rise of Passive Investing: Effects on Price Level, Market Volatility, and Price Informativeness"

Abstract:
In this paper, I answer growing concerns pertaining to the rapid growth of passive investment strategies over the last two decades. I construct a rational expectations equilibrium model allowing investors to choose different modes of investment (active, passive, and delegated active), introduce agent heterogeneity, and estimate the model using data from 2000 to 2017. The model considers investment fees as exogenous, and variations in these fees influence the shifts in the distribution of investors selecting different investment vehicles. I find that the growth of passive investing did not increase the overall price level, thus contradicting the common ETF bubble hypothesis, which postulated that rapid growth in passive strategies may lead to the detachment of prices of these securities from fundamentals. Furthermore, the model suggests that this shift in investing has contributed to increasing asset price volatility, consistent with empirical findings. I estimate that about 10% of current market volatility can be attributed to the rise of passive investing. It also resulted in diminished price informativeness due to weakened information acquisition. Further reduction in passive management fees will strengthen these effects. Reductions in fees associated with delegated active investing may have an ambiguous effect on the proportion of passive investing but will result in enhanced price volatility and reduced informativeness, akin to the dynamics observed in passive fee reductions.

Languages: English (fluent), Polish (native)

Computer Skills: R, Python, Stata, VBA, MATLAB

RESEARCH STATEMENT

Paweł Bednarek

University of Pennsylvania

My research focuses on the macroeconomic aspects of modern finance. I am particularly passionate about blockchain, fintech, and passive investing. In my work, I try to understand the long-term effects of financial innovation.

We are currently witnessing some of the largest paradigm shifts in finance and economics. We have observed a tremendous rise of cryptocurrencies in the last decade, the effects of which we do not fully understand yet. Similarly, passively managed portfolios started dominating the investing landscape with potentially significant consequences for the markets. These changes along with their long-lasting consequences are at the core of my work and interests.

Implications of Bitcoin's monetary policy

In my paper *'Bitcoin's Achilles Heel: Transition from Block Rewards to Fees'*, I address the long-term effects on the Bitcoin network security and sustainability as it undergoes the transition from mining subsidies to transaction fees. Bitcoin was conceived as a system facilitating transactions between users. The problem of its security was resolved through implementation of block rewards, which serve as an incentive for miners to provide computational power (hashrate). The monetary policy was programmed as an inflation schedule that reduces by 50% every four-year cycle. The received wisdom is that once the block rewards inevitably go to zero, the transaction fees paid to miners will be sufficient to maintain the security of the network. This paper explores whether there is merit in this claim.

I construct an overlapping generations model, in which users obtain utility from transacting after purchasing Bitcoin and rationally forecast its resale value. I model each instance of the competition for transaction confirmation as a pay-as-bid multi-item auction with heterogeneous agents, and derive the symmetric Bayes-Nash equilibrium. The security of the network plays a crucial role in the agents' expectations as it is synonymous with the probability of the network's survival and subsequent ability to sell Bitcoin. The miner-provided security and real balances are inherently intertwined as the price of Bitcoin affects miners' revenue, and therefore, the hashrate. I obtain the equilibria of the OLG model, both in the inflationary era as well as in the long run when there is no further debasement. I find that as block rewards go down, the transaction fees will be insufficient to maintain the current levels of network security and price, hence showing that the framework of Bitcoin has not been built on sound economic principles. I prove the existence of a unique inflation policy that maximizes the value of the network. Specifically, I conclude that a simple policy that sets a fixed inflation rate of about 1% would guarantee substantially greater sustainability and higher network value in the long run as opposed to a network entirely dependent on transaction fees

Lastly, I incorporate the blockchain data and present a quantitative perspective. I decompose the transaction fees into the competition effect and perceived value of transaction confirmation. I show that the growth of the user base together with hashrate is almost solely responsible for variation in prices. Based on the inflation schedule, I project the evolution of real balances, hashrate, and network security level.

I contribute to the literature in a few ways, through: (a) developing a tractable framework for transaction fee competition with the use of auction theory, (b) obtaining a quantitative perspective allowing for counter-factual statements, and (c) proposing and discussing an economic structure that would provide superior stability and sustainability.

Effects of the rise of passive investing

Another of my papers, *'Rise of Passive Investing: Effects on Price Level, Market Volatility, and Price Informativeness'*, attempts to answer concerns about the shift in investment modes over the last two decades.

I construct a noisy rational expectations equilibrium model building on Grossmann and Stiglitz (1980). Agents are heterogeneous in their cost of information acquisition and they choose different investment vehicles - passive, active, or delegated active (mutual fund). Active investors acquire signals about future asset returns, whereas passive investors, or 'indexers', remain uninformed. The mutual fund acquires information on behalf of those who choose it and uses the management fees for that purpose. Active agents and the mutual fund contribute to the price informativeness, however, the price does not fully reveal the aggregate signal due to the uncertainty in the asset's supply. The cost of information acquisition together with management fees are the drivers determining the proportions of agents selecting different modes of investing.

The analysis of the equilibrium leads me to a conclusion that refutes the common 'ETF bubble hypothesis', according to which passive investing was thought to inflate prices. That being said, I find that it had a detrimental impact on the overall informativeness of the prices. Through making the model dynamic, I study changes in asset price volatility, and the results indicate that passive investing has been amplifying the volatility in the markets. I also obtain a quantitative perspective, which suggests that about 10% of current market volatility can be attributed to passive investing, compared to the counterfactual lack of indexing altogether. Furthermore, I project that further anticipated reductions in management fees will only amplify these effects. My contribution to the study of this issue is the provision of a tractable theoretical framework, which is consistent with empirical findings in the literature.

Future work

I plan on forging on the same path and shedding light on financial innovation through a macro lens. Due to the increasing pace of the changes occurring in the markets, I hope that my research makes a step toward understanding their effects before they manifest themselves. There are a handful of other avenues related to blockchain that I am currently exploring. They include the stability of algorithmic stablecoin and the mechanics of decentralized finance. With respect to portfolio management, the rise of passive investing may soon be accompanied by portfolios managed by large language models (LLMs), and the research into its impact is still in its infancy. I consider it to be another natural aspect that requires further investigation into its effects on the markets.

References

Grossman, S. and Stiglitz, J., 1980. On the Impossibility of Informationally Efficient Markets. *The American Economic Review*, 70(3), pp. 393-408.

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Personal Information:
Citizenship: Australia

Undergraduate Studies:
B.Ec. in Economics (Honours Class I and The University Medal), The University of Sydney, 2011
LLB. (Honours Class I), The University of Sydney, 2011

Graduate Studies:
University of Pennsylvania, 2018 to present
Ph.D. Candidate in Economics
Thesis Title: "Essays in Law and Economics"
Expected Completion Date: May 2024

Thesis Committee and References:

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Professor Juan Pablo Atal
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Professor Aurélie Ouss
Department of Criminology
University of Pennsylvania
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Teaching and Research Fields:

Research fields: Law and Economics, Economics of Crime

Teaching fields: Labor Economics

Teaching Experience:

University of Pennsylvania

Fall, 2023	Labor Economics, Teaching Assistant for Andrew Shephard
Spring, 2023	Introductory Macroeconomics, Head Teaching Assistant for Luca Bossi
Fall, 2022	Introductory Macroeconomics, Head Teaching Assistant for Luca Bossi
Spring, 2022	Introductory Macroeconomics, Head Teaching Assistant for Luca Bossi
Fall, 2021	Introductory Macroeconomics, Head Teaching Assistant for Luca Bossi
Spring, 2020	Introductory Macroeconomics, Teaching Assistant for Luca Bossi
Fall, 2019	Introductory Macroeconomics, Teaching Assistant for Luca Bossi

University of Sydney

Fall, 2012	Intermediate Microeconomics, Teaching Assistant for Russell Toth
Spring, 2012	Introductory Macroeconomics, Teaching Assistant for Luca Bossi
Fall, 2011	Introductory Microeconomics, Teaching Assistant for Andrew Wait
Spring, 2011	Introduction to Economic Statistics, Teaching Assistant for John Goodhew

Research Experience and Other Employment:

2020-2021	Research Assistant for Professor David Abrams
2013-2018	Goldman Sachs, Associate – Interest Rates Trading

Professional Activity:

2023	Economics Graduate Students Conference – Washington University in St Louis
2023	PDRI: Crime and Policing in Comparative Perspective Conference
2022	Journal of Empirical Legal Studies (Referee)
2021	NBER Summer Institute Law and Economics Workshop
2021	NBER Summer Institute Economics of Crime Workshop
2021	Southern Economics Association Conference
2021	Wharton Applied Economics Seminar

Honors, Scholarships, and Fellowships:

2023	Horowitz Foundation Grant for Social Policy
2023	Donald R. Cressey Award
2023	SASGov Small Research Grant
2022	SASGov Large Research Grant
2021	CSERI Graduate Research Grant
2011	The Ian Joye Medal

Publications:

"Police Frisks" with David Abrams and Hanming Fang, AEA Papers and Proceedings, May 2022

"Hydra: Lessons from the World's Largest Darknet Market" with Aleksei Knorre and Artem Kuriksha, Forthcoming Criminology & Public Policy

Job Market Paper:

"*Judicial Bias against Minority and Female Attorneys*"

This paper tests for bias against racial minority and female attorneys by examining its impact on case outcomes. It is motivated by a theoretical model in which bias against marginalized attorneys may affect the weight judges place on their arguments. I account for potential omitted variable bias by exploiting the random assignment of first-appearance hearings in Miami-Dade County to public defenders and judges. Defining a successful outcome as the release of an attorney's client pending trial, as implied by my model, I analyze the differences across judges in the rates at which attorneys of different demographic groups secure a pretrial release. While I do not find evidence of judicial bias in the treatment of female or Hispanic attorneys, I find statistically significant variation in the release rate between Black and White attorneys measured across different judges. Specifically, a defendant with a Black attorney is 2.8 percentage points less likely to be released when assigned a judge in the bottom quartile of a least-favorable to most-favorable-towards Black attorneys ranking, compared with being assigned a judge in the most-favorable quartile. Since Black defendants are more likely to have Black attorneys, these differences suggest that previously measured racial gaps in bail decisions, convictions, and sentencing may be due partly to judicial bias against legal teams. And as case outcomes affect not only defendants' freedom but also attorneys' productivity and wages, judicial bias may also help explain minorities' continued underrepresentation in the law profession, particularly its higher ranks.

Working Papers:

"Do Cops Know Who to Stop? Assessing Optimizing Models of Police Behavior with a Natural Experiment" with David Abrams and Hanming Fang

The standard economic model of police stops implies that the contraband hit rate should rise when the number of stops or searches per officer falls, ceteris paribus. We provide empirical corroboration of such optimizing models of police behavior by examining changes in stops and frisks around two extraordinary events of 2020: the COVID-19 pandemic onset and the nationwide protests following the killing of George Floyd. We find that hit rates from pedestrian and vehicle stops rose as stops and frisks fell dramatically. Using detailed data, we are able to rule out a number of alternative explanations, including changes in street population, crime, police allocation, and policing intensity. We find mixed evidence about the changes in racial disparities, and evidence that police stops do not decrease crime, at least in the short run. The results are robust to a number of different specifications. We also compute the elasticities of policing production functions with respect to the policing intensities for the different combinations stop type and contraband. Our findings provide quantitative estimates that can contribute to the important goals of improving and reforming policing.

"Illegal Drug Use and Government Policy: Evidence from a Darknet Marketplace" with Anastasia Karpova, Artem Kuriksha and Peter Meylakhs

This paper develops a structural model of demand for illegal drug varieties and studies how consumers substitute between different types of drugs in response to government policies. We use a unique longitudinal dataset on prices, quantities, and individual decisions that we obtained by scraping a darknet marketplace that covered the majority of the retail illegal drug trade in Russia. Our estimation procedure exploits a novel set of micro-level moment conditions to identify correlations in preferences for specific drug types and the degree of attachment to them. We find that the median own-price elasticity of demand for illegal drugs is -3.6, and that there is high substitution within two classes of drugs: medium-risk stimulants and cannabis. We validate our estimates using exogenous variation in the price of hashish caused by increased policing. The estimated model is used to evaluate counterfactual drug policies. We find that the legalization of cannabis has the benefit of decreasing the use of riskier drugs while increasing cannabis use. For every 4 additional doses of cannabis consumed, 1 less dose of another drug is consumed. Our estimates show that the recent introduction of a new family of synthetic drugs has increased total drug demand in the country by 40%, suggesting that governments should allocate resources to prevent the introduction of new drug products. Finally, our model helps identify the optimal drugs to target for interdiction, specifically those without close substitutes, such as Alpha-PVP.

Research Statement - Priyanka Goonetilleke

I am an applied microeconomist working on topics in the area of law and economics. My research applies causal inference and structural modeling methods to criminal justice. My research agenda consists of two main strands. The first strand of my research focuses on racial inequality in the criminal justice system. I currently have two papers that focus on contributing to the literature on the role of bias in driving these inequalities. The second strand aims to inform law-enforcement interventions in illegal drug markets.

My job market paper, **"Judicial Bias Against Minority and Female Attorneys,"** extends our understanding of how discrimination manifests during the trial process by looking not only at the judge-defendant relationship, but also at how judicial bias toward public defenders might affect case outcomes. I test for bias against attorneys from traditionally marginalized groups (specifically, Black or Hispanic male attorneys and female attorneys of all races) by examining variations in bail decisions. The existence of an overall racial or gender gap alone is insufficient to confirm the presence of bias due to potential omitted variable bias (OVB). In other words, whether unobservable factors correlated with race or gender can explain differential outcomes across demographic groups, even in the absence of bias. The two key potential sources of OVB are: (1) the selection of cases by attorneys; and (2) differences in the distribution of ability among demographic groups of attorneys.

I address OVB by exploiting institutional features in the context of Miami-Dade County where judges and attorneys are randomly assigned to bail hearings. I define a successful outcome for a public defender as the pre-trial release of their defendant pending trial. Random assignment of cases to attorneys eliminates the potential for case selection to play a confounding role. Random assignment of cases to judges allows me to account for potential group differences in attorney ability. I do this by examining whether there is statistically significant variation *across judges* in pre-trial release rates according to the race or gender of attorneys. Under random assignment, if judges do not vary in their treatment of attorneys based on demographics, then there should not be significant variation in these gaps across judges. Consequently, such variation indicates that certain judges treat attorneys differently based on their demographic group.

My analysis fails to uncover evidence of statistically significant discrimination against Hispanic or female attorneys. However, I find statistically significant variation in the gap between Black and White public defenders' release rates across judges, indicating variation beyond what can be attributed to sampling variability alone. I conclude that this variation constitutes evidence of bias, whereby some judges treat Black attorneys differently than White attorneys. The magnitude of the bias is such that, when ranking judges from most negative to most positive towards Black attorneys, a defendant represented by a Black public defender is 2.8 percentage points less likely to be released if their case is heard by a judge at the 25^{th} percentile of bias relative to a judge at the 75^{th} percentile. As a future project, I am requesting videos of the hearings. After using machine learning to transcribe these videos, I plan to use natural language processing to analyze variation in judge and attorney behavior to see to what extent this may explain the observed bias.

In my paper **"Do Cops Know Who to Stop? Assessing Optimizing Models of Police Behavior with a Natural Experiment,"** co-authored with David Abrams and Hanming Fang, we provide empirical validation of optimizing models of police behavior. These models are not only used throughout the economic literature to test for discrimination but have become the workhorse model for racial discrimination cases against police departments throughout the U.S. (e.g., *Bailey v City of Philadelphia*). A key implication of these models is that there are diminishing returns to police stops: as an individual officer reduces the number

of stops they enact, their probability of finding contraband from a given stop should rise, ceteris paribus.

Our paper is the first to directly test this empirically. Prior research relied on between-officer variation as a proxy for within-officer variation. However, if officers are not equal in their ability to detect contraband, diminishing returns does not necessarily hold *between* officers. We study within-officer variation by utilizing the pandemic response and the onset of the nationwide protests following the killing of George Floyd as natural experiments that led to plausibly exogenous changes in policing. We find that hit rates generally increased as police stops plunged, consistent with the predictions of optimizing models of behavior. As well as verifying a crucial assumption used in tests for racial discrimination in policing, this paper holds additional policy significance by estimating the trade-off between reduced contraband discoveries and fewer stops. We published a related paper, **"Police Frisks,"** in *AEA: Papers and Proceedings* in May 2022.

The second strand of my research seeks to inform drug policy. Research into illegal drug markets has generally been limited by the difficulty of observing these markets. In my research with Artem Kuriksha, we utilize novel datasets from darknet cryptomarkets to gain insight into illegal drug consumption. We currently have two papers utilizing novel datasets from Hydra, a cryptomarket that served several Russian-speaking countries and was, at the time of its closure, the world's largest darknet market. Our first paper, **"Hydra: Lessons from the World's Largest Darknet Market,"** co-authored with Aleksei Knorre, documents the main features of Hydra and, using data scraped from the platform, quantitatively examines the scale and structure of the marketplace. We then employ Hydra as a case study to derive qualitative insights into the impact of Western drug enforcement policies that target illegal cryptomarkets. This paper is forthcoming in *Criminology & Public Policy*.

Our second paper, **"Illegal Drug Use and Government Policy: Evidence from a Darknet Marketplace,"** co-authored with Anastasia Karpova and Peter Meylakhs, utilizes data on drug listings and natural language processing of review data from Hydra to estimate a structural demand model for illicit drugs. We employ this model to answer the question: What are the effects of drug policies when there is substitution between drugs? We assess the implications of the legalization of cannabis on the demand for more dangerous illicit drugs as well as the welfare costs of the introduction of "bath salts" into the illegal drug market. We find that enacting cannabis legalization in a manner that significantly reduces its price can substantially decrease the consumption of more dangerous drugs, although consumption of marijuana and hashish greatly increases, causing an overall increase in total drug consumption. Meanwhile, we find that the introduction of "bath salts" resulted in a 40% increase in overall drug consumption even after factoring in substitution from other drug types.

In addition to these two projects, we plan to use the review data we have from Hydra and other darknet marketplaces to study the development of drug addiction over time. These projects mark the initial steps in an ongoing research agenda leveraging our extensive access to data from darknet markets to gain insights into illegal drug markets.

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Undergraduate Studies:
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Graduate Studies:
University of Pennsylvania, 2018 to present.
Thesis Title: "Technological Change and Unions: An Intergenerational Conflict with Aggregate Impact"
Expected Completion Date: May 2024

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Teaching and Research Fields:

Research fields: Macroeconomics, Inequality, Technological Progress, Labor Economics

Teaching fields: Macroeconomics, Economic Growth

Teaching Experience:

University of Pennsylvania

Spring, 2023	Economic Growth, Teaching Assistant for Professor Hubmer
Fall, 2022	Money and Banking, Teaching Assistant for Professor Ordonez
Spring, 2022	Money and Banking, Teaching Assistant for Professor Ordonez
Fall, 2021	Economic Growth, Teaching Assistant for Professor Hubmer
Fall, 2020	Introduction to Macroeconomics, Teaching Assistant for Professor Bossi
Spring, 2020	Numerical Methods for Macroeconomists, Teaching Assistant for Professor Greenwood
Fall, 2019	Introduction to Microeconomics, Teaching Assistant for Professor Duchene

Goethe University Frankfurt

Summer, 2016	Introduction to Econometrics, Teaching Assistant for Professor Entorf

Research Experience and Other Employment:

2020-2021	University of Pennsylvania, Research Assistant for Professor Landvoigt (Wharton)
2016-2018	Goethe University Frankfurt, Research Assistant for Professor Ludwig

Professional Activities:

2023	NBER Macroeconomics Across Time in Space Conference
2023	Southern Economic Association Conference
2023	International Conference on Computing in Economics and Finance (CEF)
2023	NBER International Seminar on Macroeconomics
2022	ICIR Conference
2020	Princeton Initiative at Bendheim Center for Finance
2020-2021	Macro Lunch Organizer (University of Pennsylvania)

Refereeing:

Journal of Economic Theory (JET), International Economic Review (IER), Young Economist Symposium

Honors, Scholarships, and Fellowships:

2023	Joel Popkin Graduate Student Teaching Price in Economics, University of Pennsylvania
Since 2018	PhD Fellowship, Graduate Division of Arts and Sciences, University of Pennsylvania
2014-2017	Dean′s List Fellowship, Faculty of Economics and Business, Goethe University Frankfurt

Research Papers:

"Technological Change and Unions: An Intergenerational Conflict with Aggregate Impact"
(Job Market Paper)
Technological progress in the form of automation spurs productivity, but temporarily disrupts labor markets through worker displacement and reduced earnings. I study the role of unions in shaping the employment and wages of workers exposed to labor replacement during technological transitions. I document that unionization shifts the transitional costs in the form of wage and employment decline from incumbent to incoming workers, consistent with insider-outsider dynamics. I further document that unions have aggregate implications, accelerating the decline of overall employment among exposed workers, resulting in a more severe employment drop early in the transition and a subsequent slow catch-up of employment decline in less unionized labor markets. To quantify the intergenerational transfer generated by unions, I build a quantitative model of technology adoption and unionization. In the model, the distributional and aggregate effects of unionization result simultaneously from the static and dynamic effects of labor adjustment costs in the context of gradual technology adoption over time. I find that unionization increases the welfare cost of automation for young workers by 2% of permanent consumption along the transition, whereas the cost of automation to incumbent workers falls by 4% of permanent consumption. Unionization further creates spillover effects by suppressing wages in the non-adopting sector early in the transition driven by the accelerated employment decline in the adopting sector and corresponding reallocation of workers.

"Global Natural Rates in the Long Run: Postwar Macro Trends and the Market-Implied r* in 10 Advanced Economies", *with Davis, Fuenzalida, Mills, and Taylor* ***(under review)***
Benchmark finance and macroeconomic models appear to deliver conflicting estimates of the natural rate and bond risk premia. This natural rate puzzle applies not only in the U.S. but across many advanced economies. We use a unified no-arbitrage macro-finance model with two trend factors to estimate the natural rate r* for 10 advanced economies. We cover a longer and wider sample than previous studies and draw on new sources to construct yield curves and excess returns. The two-trend model improves the explanatory power of yield regressions and return forecasts. Most variation in yields is due to the macro trends r* and π*, and not bond risk premia. Global components of unexpected bond returns are influential, while the local components of natural rates are large. Our r* estimates covary with growth and demographic variables in a manner consistent with theory and previous findings.

"The Medical Expansion, Life-Expectancy, and Endogenous Directed Change", *with Krueger and Ludwig*
We build a quantitative theory of income growth, the increase in life expectancy in the last two centuries, and the emergence and expansion of a modern health sector in the 20th century. To do so, we develop a two-sector overlapping generations model with endogenous and directed technical change in which income growth, life expectancy, and technological progress in the health sector and the final goods sector, as well as the size of the health sector and the quality and price of the goods it produces are jointly deter- mined in general equilibrium. The model interprets the facts as three phases of a dynamic equilibrium in which households are initially poor and the quality-adjusted price of health goods is prohibitively high so that demand for health goods is zero, life is short and life expectancy stagnant. As income grows, fueled by technological progress, households start consuming basic health goods, life expectancy starts to rise, and directed technological progress eventually, with a delay of ca. 100 years, leads to the emergence and expansion of a modern health sector.

"Dynamics of the Wealth Distribution in the Presence of Higher-Order Earnings Risk"
This paper introduces higher-order earnings risk consistent with recent empirical findings into a benchmark heterogeneous-agent model to examine its implications for wealth inequality and welfare. I show that higher-order earnings dynamics in the form of left-skewness and excess kurtosis strengthen the precautionary savings motive, leading to greater consumption inequality and lower wealth inequality. The earnings dynamics are partially passed through to the consumption of poor households who are willing to pay up to 1.7% of permanent consumption to avoid higher-order earnings risk. Methodologically, I develop a new General Polynomial Chaos Expansion approach, a global solution method to solve for the aggregate dynamics of this class of models and demonstrate that it increases efficiency relative to previous methods. I extend the baseline method to allow for time-varying base distributions, which is particularly useful in economic settings in which the cross-sectional household distribution at times moves far away from the ergodic distribution. I then apply the extension by introducing time-varying earnings risk into the benchmark model.

Dissertation Abstract

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My field of research is quantitative macroeconomics, especially the interaction between technological progress and inequality. In the first branch of my work, I explore the consequences of technological change for inequality, in particular focusing on automation adoption and rising earnings risk. The second branch of my research analyzes the origins of technological progress and documents long-run trends across countries. I approach these topics by developing and embedding new theory into quantitative heterogeneous agent frameworks which I discipline using large-scale microdata.

Automation and unions. In my job market paper, **"Technological Change and Unions: An Intergenerational Conflict with Aggregate Impact"**, I study the role of unions in shaping the evolution of employment and wages of workers exposed to labor replacement during technological transitions. I show that unionization, and labor adjustment frictions more broadly, are important to understanding the distributional consequences of technology adoption, but also the evolution of aggregate employment during technological transitions.

Linking micro-data on individual employment from several sources, I document the effect of unionization across local labor markets on the labor market outcomes of routine-maunal workers since 1980, workers who are particularly exposed to automation technologies. First, unionization is associated with a greater fall in wages and employment among young workers entering the labor market, consistent with insider-outsider dynamics. Second, unions also shape the evolution of aggregate employment of exposed workers. Employment decline is greater in high-unionized labor markets early in the transition, and subsequently catches up in less unionized labor markets, thus, unions accelerate the decline of overall employment along the transition but leave the long-run decline unchanged.

I then build a quantitative model of technological change and unionization to quantify the intergenerational transfer that unions create. The model combines a two-sector setup of one automatable and one non-automatable sector with overlapping generations of workers who make occupational choices. Workers in the adopting sector are represented by a monopoly union that endogenously sets wage premia for incumbent workers, deriving its ability to do so from exogenous firing costs that reduce the elasticity of labor demand of firms. The two-sector setup with occupational choice is key as it endogenizes labor supply to the adopting sector. The model shows that the documented distributional and aggregate impacts of unions are jointly driven by labor adjustment costs in the context of gradual technology adoption over time. Firing costs drive a static wedge between the price of incumbent and incoming workers that incentivizes to reduce hiring instead of laying off workers when adopting automation. In the context of gradual automation adoption over time, firing costs also create an intertemporal tradeoff. Firms anticipate future adoption and preemptively reduce their current workforce to avoid adjustment costs along the transition. This anticipatory adjustment channel is strong in the model, giving rise to an accelerated overall employment decline in the high-unionized labor market and exacerbating the insider-outsider conflict.

I calibrate the model to local labor markets in the U.S. in 1980 and study the responses of a high-unionized and a low-unionized economy to an unexpected fall in automation prices that matches the price path of capital goods in the U.S. since 1980. I find that unionization increases the welfare cost of automation for young workers who still enter the adopting sector during the transition by 2% of permanent consumption. By contrast, unionization protects incumbent workers, reducing the welfare cost of automation to them by 4% of permanent consumption

along the transition. The impact of unionization spills over into the non-adopting sector as the accelerated reallocation of labor suppresses wages there. Overall, I find that unionization is beneficial for aggregate welfare up until 2000 driven by the protection of incumbent workers in the adopting sector from costly layoffs. From 2000 onward, unionization is costly for aggregate welfare as it lowers the productivity gains from automation.

Technological progress in the modern health sector and life expectancy. What caused the increase in life expectancy since 1800 and rapid growth of a modern health sector during the 20th century? In work with Krueger and Ludwig, **"The Medical Expansion, Life-Expectancy, and Endogenous Directed Change"**, we study the joint dynamics of income growth, the modern health sector, and the increase in life expectancy over the last two centuries. We document the evolution of life expectancy over the last two centuries and the emergence of the modern health sector in the 20th century in the U.S. We then provide a quantitative theory to jointly explain the documented facts. The theory is built on the insight that the demand for health increases over time as individuals become richer and older, which in turn sparks a reallocation of resources towards the production and innovation of health goods. Households are initially too poor to demand health goods, and life expectancy is stagnant. As income grows, fueled by technological progress, households start consuming basic health goods, life expectancy starts to rise, and directed technological progress eventually, with a delay of 100 years, leads to the emergence of a modern health sector.

Long-run interest rates. Real interest rates provide an important channel through which long-run trends in economies affect inequality, by shaping savings and investment decisions as well as monetary policy. What accounts for the secular decline in long-run rates since the 1980s across countries? In **"Global Natural Rates in the Long Run: Postwar Macro Trends and the Market-Implied r* in 10 Advanced Economies"** (with Davis, Fuenzalida, Mills, and Taylor), we estimate paths for the natural rate of interest across 10 advanced economies for the postwar period, covering more countries and decades than previous studies. We first document that estimates of natural rates and risk premia differ between macro and finance frameworks. To resolve this conflict, we build a unified macro-finance framework that jointly disciplines estimates of the natural rate and risk premia with higher-frequency financial information from the yield curve and lower-frequency secular inflation and growth trends as in macro models. To estimate the model, we construct a new database of zero-coupon yield curves for 10 countries for the postwar era. We find that slowing growth and demographic trends account for 2/3 of the long-run decline in natural rates across countries, and show that global components are important for unexpected bond returns, while the local components are important for natural rates.

Rising earnings risk. How much does rising risk in labor earnings matter for wealth inequality and welfare? In **"Dynamics of the Wealth Distribution in the Presence of Higher-Order Earnings Risk"**, I answer this question by introducing higher-order earnings risk consistent with recent empirical findings into a benchmark heterogeneous-agent model. I show that higher-order earnings dynamics in the form of left-skewness and excess kurtosis strengthen the precautionary savings motive, leading to greater consumption inequality and lower wealth inequality. The earnings dynamics are partially passed through to the consumption of poor households who are willing to pay up to 1.7% of permanent consumption to avoid higher-order earnings risk. Methodologically, I develop a new General Polynomial Chaos Expansion approach, a global solution method to solve for the aggregate dynamics of this class of models, and demonstrate that it increases efficiency relative to previous methods. I extend the baseline method to allow for time-varying base distributions, which is particularly useful in economic settings in which the cross-sectional household distribution at times moves far away from the ergodic distribution. I then apply the extension by introducing time-varying earnings risk into the benchmark model.

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Graduate Studies:

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Thesis Title: "The Impact of a Vape Ban on Cigarette Smoking and Life Expectancy"
Expected Completion Date: May 2024

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Teaching and Research Fields:

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Secondary field: Empirical Industrial Organization

Teaching Experience:

Spring, 2023	Health Economics, Teaching Assistant for Professor Juan Pablo Atal
Fall, 2022	Industrial Organization, Teaching Assistant for Professor Aislinn Bohren
Spring, 2022	Health Economics, Teaching Assistant for Professor Juan Pablo Atal
Fall, 2020	Econometrics, Teaching Assistant for Professor Xu Cheng
Spring, 2020	Econometrics, Teaching Assistant for Professor John Lazarev
Fall, 2019	Introduction to Microeconomics, Teaching Assistant for Professor Anne Duchene
June 2016	Industrial Organization and Public Policy, Guest Lecture for Professor Marquise McGraw
June 2015	Industrial Organization and Public Policy, Guest Lecture for Professor Marquise McGraw

Research Experience and Other Employment:

2020-2021	Research Assistant for Professor Juan Pablo Atal (Penn)
2020-2021	Research Assistant for Professor Jose Miguel Abito (Wharton)
2017-2018	Research Assistant for Professor Thomas Wollmann (Chicago Booth)
2014-2016	NERA Economic Consulting (Antitrust Division), Research Associate

Professional Activities:

Presentations	Tobacco Online Policy Seminar (2023) Economics Graduate Student Conference, Washington University in St Louis (2023) European Winter Meeting of the Econometric Society, Berlin (2022) European Association for Research in Industrial Economics, Vienna (2022)
Referee	Journal of Human Resources, Young Economist Symposium, Wharton Innovation Doctoral Symposium
Workshops	NBER Health Economics Research Boot Camp, Berkeley (2022) Boston University Mentoring Workshop (2021)

Honors, Scholarships, and Fellowships:

2023	Horowitz Foundation for Social Policy Grant for "The Impact of a Vape Ban on Cigarette Smoking and Life Expectancy" ($7,500)
	SAS Travel Subvention ($600)
2022	GAPSA Research Student Winter Travel Grant ($800)
	GAPSA Research Student Fall Travel Grant ($200)
	SAS Travel Subvention ($500)
	SAS Small Grant Award ($400)
2021	SAS Travel Subvention ($500)
2020-2021	PIER RA Stipend Matching Grant Award ($13,608)
2018-2019	PhD Fellowship, Graduate Division of Arts and Sciences

Research Papers:

"The Impact of a Vape Ban on Cigarette Smoking and Life Expectancy" (Job Market Paper)

Bans on the sale of vape products have risen in popularity across the world even as their implication for public health remains highly debated. Vapes are considered a less harmful alternative to traditional cigarettes for existing smokers, but their availability may also encourage young non-smokers to start vaping, become addicted, and potentially transition to smoking. In this paper, I study whether banning vape sales in the US could benefit public health. I explicitly account for the disproportionate harms from persistent smoking and vaping in later stages of life by simulating life cycle smoking and vaping decisions with and without a vape ban, and analyzing the implications for life expectancy. I first document that older vapers transition to smoking more than younger vapers, and vaping appears less persistent than smoking. I then develop and estimate a dynamic panel data model of cigarette and vape demand. The model allows choices to depend on cigarette addiction and vape addiction, age and cohort effects, and unobserved preferences for cigarettes and vapes. I also allow product addictiveness to vary over time to reflect changing nicotine levels. I estimate the model using the Population Assessment of Tobacco and Health (PATH), a longitudinal survey that follows individuals age 12 and up from 2014 to 2019 and contains addiction measures. I find that a vape ban would not be beneficial under a range of reasonable assumptions about vapes' harmfulness to life expectancy relative to cigarettes. Assuming that vapes are 25% as harmful as cigarettes, a vape ban would decrease life by 12 million life-years in the current US population and harm all but the youngest cohort. This is because older vapers are more likely to substitute to cigarettes, vapers who switch to smoking may smoke for longer than they would have vaped, and increased smoking persists into later stages of life when smoking is more harmful. Shorter term analyses that do not account for both the persistence and age of tobacco use could underestimate a vape ban's negative long-term impacts.

"Demand Spillover and Inequality in the WIC Program"

The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) is a large US government program that provides infant formula to low-income households, and serves half of all US infants. In each state, manufacturers bid in auctions for the exclusive right to supply infant formula. These exclusive contracts may unintentionally create higher demand for the WIC supplier's product among consumers *ineligible* for WIC benefits, and may result in pricing responses by other manufacturers. Exploiting household-level data and quasi-experimental variation in the timing of the WIC contracts, we show that winning the contract increases a manufacturer's share among ineligible households by 30 percentage points. Preference for the WIC brand may stem from consumer misperception of the WIC brand as a higher quality product, but also from receiving WIC samples upon a new mother's discharge from the hospital. We then show theoretically that household-level heterogeneity in preference for the WIC brand can lead to vertical differentiation that softens price competition and increases prices of both WIC and non-WIC manufacturers. We estimate a demand model for infant formula and show there is substantial observed and unobserved heterogeneity in preference for the WIC brand. Black and lower income households are more likely to prefer the WIC brand, partially because they are more likely to have received hospital samples of the WIC supplier's formula. We combine the demand model with a pricing model to perform a policy experiment that eliminates spillover preference for the WIC brand by banning hospital samples and correcting quality misperception. We find that eliminating the spillover effect decreases prices of all manufacturers and improves consumer welfare.

Research Papers in Progress:

"Patients' and Providers' Incentives in Out-of-Network Emergency Visits"
with Jorge Ale Chilet and Juan Pablo Atal

We study how patients and providers respond to financial incentives surrounding patient anti-dumping provisions in laws governing emergency care. First, we leverage a discontinuity in reimbursement rates and a payment reform in Chile to show that private hospitals respond to financial incentives by choosing how long to treat publicly insured (out-of-network) patients until they declare the patients stabilized. Second, we show that patients stabilized out-of-network respond to exogenous changes in financial incentives in their decision to request a transfer back to in-

network (public) hospitals. Finally, we combine a demand model, a supply model, and provider quality estimates based on an instrumental-variable design to study how counterfactual incentives for providers and patients affect overall expenditures as well as patients' health outcomes.

"Physician Spatial Allocation and Primary Care Access"

I study the extent to which a geographic reallocation of medical school seats can provide efficient and equitable access to primary care physicians. I document that physicians have location preferences for practicing near their medical school, which are predominately in urban locations, and that in recent years, several new medical schools have opened in areas with low physician to population ratios. I construct a model of primary care physicians' (PCPs) location choices that incorporates their attachment to their medical school. I then simulate a policy that redistributes medical school seats towards underserved counties, and evaluate the impact on the geographical distribution of PCPs.

Languages: English (native), French (fluent)

Computational Skills: R, Stata, Matlab, SAS

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Research Statement

My research agenda focuses on evaluating the effectiveness of health policy when both consumers and firms change their behavior in ways that the policy may not have intended. I primarily study markets for health-related goods, such as tobacco and infant formula. In a second setting, I examine how providers and patients respond to financial incentives. To model behavior, I use an array of tools from industrial organization.

My work in markets for health-related goods includes my **job market paper**, **"The Impact of a Vape Ban on Cigarette Smoking and Life Expectancy"** (draft here). Although a vape ban is intended to prevent young non-smokers from vaping, becoming addicted, and potentially transitioning to cigarettes, both former and never smokers may turn to cigarettes when vapes are unavailable. I study the impact of a vape ban on public health, where the key insight is that health impacts depend not only on the smoking and vaping rate at a given point in time, but also on how long and at what age the products are used. I first document that older vapers transition to smoking more than younger vapers, and vaping appears less persistent than smoking. Thus, despite high rates of youth vaping, youth may not vape for long. I then develop and estimate a dynamic panel data model of cigarette and vape demand to simulate life cycle decisions with and without a vape ban. The model incorporates cigarette and vape addiction, age and cohort effects, and unobserved preferences for the products.

I find that a vape ban would decrease life by 12 million life years in the current population and would harm all but the youngest cohort. The vape ban's ability to improve public health is undermined because older vapers are more likely to substitute to cigarettes, some vapers who switch to smoking smoke for longer than they would have vaped, and persistent smoking tends to occur later in life when smoking is more harmful to life expectancy. Additionally, apparent "gateway" effects from vaping to smoking are predominately due to correlated preferences for vapes and cigarettes, so a vape ban pushes vapers toward smoking rather than preventing both vaping and future smoking. Failing to account for substitution, addiction, unobserved heterogeneity, and age and cohort effects could underestimate a vape ban's negative long-term impacts.

My demand model is appropriate for evaluating the long-term impact of policies beyond vape bans, and will be combined with a supply model to study equilibrium effects of vape regulation and innovation. I plan to evaluate the impact of caps on the level of nicotine in products and a prescription-based model that only allows vape purchases when cigarette addiction exceeds a minimum threshold and the individual chooses to see a doctor. To study taxes and subsidies, I will instrument for prices by linking forthcoming restricted data on individuals' state to state-level taxes. I will also allow consumers to choose between flavors to study flavor bans. On the supply side, a vape ban would decrease competition for cigarette firms, potentially raising prices for cigarettes and deterring vapers from switching to cigarettes, particularly price-sensitive youth. Additionally, Juul's introduction of highly addictive "nicotine salts" may have spurred non-price competition in nicotine levels among manufacturers using less addictive "free-base nicotine." I will study how early prevention of a new addictive good may reduce harm not only from the good itself, but from other goods that become more addictive in order to compete.

I also study how household and manufacturer responses in a nutrition program may inadvertently increase prices and harm disadvantaged families who do not participate. In the working paper **"Demand Spillover and Inequality in the WIC Program"** (older draft here), joint with Jose Miguel Abito, Kosuke Uetake, and Yuval Salant, we study a large federal program called WIC that provides infant formula to low-income families. Manufacturers bid in auctions for the exclusive right to supply WIC in the state. Exploiting the quasi-experimental variation created by changes in the manufacturer that supplies WIC, we find that households *ineligible* for WIC sharply increase purchases of manufacturers' formula when they supply WIC. Preference for the WIC brand may stem from misperceiving the WIC brand as a higher quality product, but also from receiving WIC samples upon a new mother's hospital discharge. We estimate demand for infant formula and find that hospital samples of the WIC product partially drive preferences for the WIC brand, particularly among Black and low-income households just above the eligibility threshold. We then provide a theoretical model that formalizes how different preferences for the WIC brand can increase vertical differentiation and soften price competition. Finally, we combine the demand model with a pricing model to perform a policy experiment that eliminates the WIC preference by banning hospital samples and correcting misperception of the WIC supplier's quality. Eliminating preferences for the WIC brand would decrease prices of all manufacturers including the WIC supplier, and increase consumer welfare.

We plan to quantify the impact of the various mechanisms that change a manufacturer's perceived value when they supply WIC. In addition to the hospital channel, retailers may allocate more and better shelf space to the WIC supplier's product to attract WIC beneficiaries. We will quantify the effect of this mechanism on non-beneficiaries using data on online sales where shelf space is not a constraint. We will then simulate policy experiments that circumvent retailers by providing WIC formula directly to beneficiaries.

The second setting in my research agenda centers on provider and patient response to financial incentives. In **"Patients' and Providers' Incentives in Out-of-Network Emergency Visits,"** a work in progress with Jorge Alé-Chilet and Juan Pablo Atal, we study how patients and providers respond to financial incentives surrounding patient anti-dumping provisions in laws for emergency care. First, we leverage a discontinuity in reimbursement rates and a payment reform in Chile to show that private hospitals respond to financial incentives by choosing how long to treat publicly insured (out-of-network) patients until they declare the patients stabilized. Second, we show that patients stabilized out-of-network respond to exogenous changes in financial incentives in their decision to request a transfer back to in-network (public) hospitals. Finally, we combine a demand model, a supply model, and provider quality estimates based on an instrumental-variable design to study how counterfactual incentives for providers and patients affect overall expenditures as well as patients' health outcomes.

In work in progress titled **"Physician Spatial Allocation and Primary Care Access,"** I study the extent to which a geographic reallocation of medical school seats can provide efficient and equitable access to primary care physicians. I document that physicians have location preferences for practicing near their medical school, which are predominately in urban locations, and that in recent years, several new medical schools have opened in areas with low physician to population ratios. I construct a model of primary care physicians' (PCPs) location choices that incorporates their attachment to their medical school. I then simulate a policy that redistributes medical school seats towards underserved counties, and evaluate the impact on the geographical distribution of PCPs. In future work, I will use data on the composition of provider types at each practice to evaluate the extent that complementarity with and substitution between different providers affect provider location decisions.

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Undergraduate Studies:

B.A., Mathematics-Economics (with Honors), Brown University, 2016
A.A., Economics (with Honors), Bergen Community College, 2013

Graduate Studies:

University of Pennsylvania, 2018 to present
Thesis Title: *"Essays on Macroeconomics and Household Finance"*
Expected Completion Date: May 2024

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Research Fields:

Macroeconomics, Household Finance, Financial Literacy

Research Experience and Other Employment:

2023	*Summer Dissertation Fellow*, Federal Reserve Bank of St. Louis
2022	*AEA Summer Economics Fellow,* Federal Reserve Board
2016-2018	*Research Assistant* to Profs. Fernando Ferreira and Benjamin Keys, Wharton School
2015-2016	*Research Assistant* to Prof. Emily Oster, Brown University
2014	*Summer Intern,* Economics Section, Embassy of the Republic of Korea in the USA

Teaching Experience:

Graduate TA (Penn)	*Consumer Financial Decision Making* for Prof. Olivia S. Mitchell (Fall 2023) *International Trade* for Prof. Iourii Manovskii (Spring 2020, 2021, 2022, 2023) *International Finance* for Prof. Alessandro Dovis (Fall 2020, 2022) *Introduction to Economics for Business* for Prof. Gizem Saka (Fall 2021) *Introduction to Microeconomics* for Prof. Anne Duchene (Fall 2019)
Undergraduate TA (Brown)	*Introduction to Econometrics* for Prof. Brian Knight (Spring 2016) *Economics for Public Policy* for Profs. John Friedman and Emily Oster (Summer 2015)

Professional Activities:

Presentations	2023: Federal Reserve Bank of Philadelphia (poster presentation), Federal Reserve Bank of St. Louis, University of Pennsylvania 2022: Federal Reserve Board, International Pension Research Association Doctoral Tutorial
Workshops	NBER Behavioral Macroeconomics Boot Camp (2022), Boston University PhD Women's Workshop (2021)
Organizer	University of Pennsylvania Macro Lunch (2021)

Honors, Scholarships, and Fellowships:

2022-2023	*Quartet Pilot Research Project Competition Award,* Boettner Center, Wharton School
2018-2023	*University Doctoral Fellowship,* University of Pennsylvania
2015	*Chase Manhattan Research Assistantship,* Brown University
2015-2016	*Karen T. Romer Undergraduate Teaching and Research Award,* Brown University

Job Market Paper:

"Financial Literacy, Portfolio Choice, and Wealth Inequality: A General Equilibrium Approach"
[Paper] [Summary Slides]

Abstract: I develop a general equilibrium model in which households allocate their wealth to safe and risky assets ("bonds'" and "stocks") and accumulate financial literacy to raise their risk-adjusted stock returns. Calibrated to match financial literacy and stock market participation rate of U.S. households, the model demonstrates that a policy subsidizing financial literacy acquisition increases short-run stock investments. In equilibrium, however, the resulting aggregate capital growth lowers the average equity premium, thereby moderating the subsidy's impact. Nevertheless, the policy mitigates wealth inequality by inducing heterogeneous portfolio adjustments across the wealth distribution. With the subsidy, the middle wealth quartiles acquire more financial literacy and shift their portfolios toward stocks. The top quartile attains its maximum literacy level prior to the subsidy and shifts toward bonds to compensate for lower stock returns. Consequently, the ratio of total wealth held by the top quartile versus the rest of the population decreases.

Research Paper in Progress:

"Financial Constraints and Sources of Liquidity: Micro and Macro Implications" (with Sara Casella and Agustin Diaz Casanueva)

Research Statement

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My research interest spans topics in macroeconomics and household finance with a focus on the economic well-being of households. The core theme of my research agenda is to examine the redistributive effects of mitigating financial and knowledge barriers that economic agents face. In my works, I integrate empirical motivation from micro data–heterogeneity in household financial conditions and sophistication–with quantitative macroeconomic frameworks. My structural analyses examine the aggregate and redistributive implications of households' limited capacity to make sound economic decisions. My studies further inform the vital policy discussions on achieving financial education parity and bridging the wealth gap.

My job market paper, "***Financial Literacy, Portfolio Choice, and Wealth Inequality: A General Equilibrium Approach***" (Draft Here) analyzes to what extent policies subsidizing households' financial literacy can augment aggregate capital and mitigate wealth inequality. This paper contributes to the literature at the intersection of macroeconomics and household finance by incorporating household portfolio choices and financial literacy accumulation into a heterogeneous-agent incomplete market model. The model posits that households' accumulation of financial literacy raises their risk-adjusted returns. Disciplined to match financial literacy and stock market participation rate of U.S. households in the Survey of Consumer Finances (SCF), the model features the competing aggregate implications of financial literacy subsidies: on one hand, making financial literacy more affordable increases stock demand, while on the other hand, greater capital investment reduces the rental rate of capital, in turn lowering equity premium on average. Nevertheless, the policy interventions mitigate wealth inequality by generating heterogeneous portfolio rebalancing: the wealthiest group shifts toward bonds to compensate for lower stock returns, while the middle wealth group accumulates more financial literacy and increases stock holding. In what follows, I elaborate on the framework, quantitative analyses, and future avenue of my job market paper.

Framework: In my general equilibrium model, households allocate their wealth into safe and risky assets ("bonds" and "stocks"), and they select their level of investment in financial literacy. By accumulating financial literacy, households can increase their risk-adjusted stock returns. The household choices are constrained by a stock market participation cost, a financial literacy investment cost, and depreciation of financial literacy over time. The government issues a risk-free bond and a representative firm rents capital competitively. In equilibrium, productive capital is supplied by households' stock investments, and the aggregate capital income is distributed across households according to their financial literacy levels. The equilibrium effects of raising financial literacy are twofold: first, it increases aggregate capital and hence lowers marginal product of capital; and second, it decreases the equilibrium stock market *participation* premium, or the expected stock return for stock investors with minimum financial literacy. These equilibrium channels reduce the equity premium, which has an overall effect on wealth inequality.

Quantitative and policy analyses: I calibrate the model to match financial literacy and stock market participation rate of U.S. households, taking key data moments from the Survey of Consumer Finances (SCF). Recent waves of the Survey provide a measure of financial literacy, determined by survey respondents' understanding of fundamental economic concepts (namely, inflation, interest rates, and risk diversifica-

tion).[1] The paper then considers the impact of a policy intervention that subsidizes 75 percent of the household's financial literacy investment cost, financed by a tax on capital income. The model predicts that the subsidy is likely to boost average financial literacy by 10.1 percent, while increasing the aggregate participation rate only by 0.2 percentage point. This small policy effect arises from downward pressures on the average equity premium due to: (1) an increase in aggregate capital followed by the decline in capital input price, and (2) an increase in the capital income tax rate. Calculating the policy effects without accounting for either channel (i.e., using a partial equilibrium model) leads to a predicted 1.9 percentage point increase in the participation rate, whereas accounting only for the price adjustment channel generates a 0.8 parentage points increase.

I further show that the financial literacy subsidy has heterogeneous effects on equity premia and portfolio choices of different wealth groups. The middle wealth quartiles, accumulate more financial literacy and raise their risky portfolio share by 1.8 percent. The top quartile attains its maximum literacy level prior to the subsidy and decreases their risky share by 0.7 percent to compensate for lower equity premium. The bottom quartile remains out of the stock market due to participation costs and still does not acquire literacy even when it is subsidized. As a result, wealth inequality, measured as a ratio of total wealth held by the top quartile versus the rest of the population, decreases by 1.9 percent. In alternative policy experiments, I find that subsidizing both stock market participation and financial literacy investment for the younger population can substantially promote the overall stock market participation.

Future works: I plan to further develop a separate project which examines the normative facets of financial literacy by characterizing a constrained-efficient allocation of household wealth and literacy. This project aims to compare the effect of financial literacy on capital allocation and TFP growth ("productivity externality") to its negative "pecuniary externality" on the equity premium. The role of financial literacy can be further linked to various other factors contributing to the sustainability of household balance sheets and their economic well-being, such as student loans, mortgage choices, and pension savings.

I am also interested in the aggregate ramifications of liquidity constraints, another factor making it difficult for households to smooth consumption. In a paper underway, "***Financial Constraints and Sources of Liquidity: Micro and Macro Implications***," (with Sara Casella and Agustin Diaz), we use a novel empirical approach to identify hand-to-mouth households using a micro-level survey in Chile, Encuesta de Protección Social (EPS), and the U.S. Survey of Consumer Finances (SCF). We exploit the survey questionnaire to characterize various sources of potential emergency funding that households can utilize when confronted with negative income shocks. The reported sources include accessing debt markets, insurance markets, defaulting on payments, and borrowing from family and friends. We find that the primary source of borrowing for 80% of households with low liquid assets is family and friends, while only 25% of households with high liquid assets resort to that channel. We use the Chilean household survey with administrative labor income consumption history. This allows us to analyze variation in marginal propensity to consume across households with different levels of liquidity and emergency funding sources. We study how the existence of such alternative insurance channels interacts with household decisions to hold liquid assets and their impact on macro policies which stabilize aggregate output.

[1] Data from the 2016-2019 SCF shows that only 44.2% of the U.S. households between age 26 and 80 can answer all three financial literacy questions, which is less than the aggregate stock market participation rate, 54.1%.

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Undergraduate Studies:
B.Sc. in Mathematics, National Research University Higher School of Economics, 2015

Masters Level Work:
M.A. in Economics, New Economic School, *cum laude*, 2017

Graduate Studies:
University of Pennsylvania, 2018 to present
Thesis Title: *"Modeling Drug Use and Bounded Rationality*"
Expected Completion Date: May 2024

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Research Fields:
Primary fields: Applied Microeconomics, Industrial Organization
Secondary fields: Computational Economics

Teaching Experience:

Instructor:

Summer, 2021	Economics and Wharton Ph.D. Math Camp, UPenn
Summer, 2020	Econometrics, UPenn

Teaching Assistant:

Fall, 2023	Economics of Education, UPenn, for Professor Francesco Agostinelli
Summer, 2021	Continuous-Time Methods in Macroeconomics, Oxford University, for Professor Jesus Fernandez-Villaverde
Spring, 2021	Money and Banking, UPenn, for Professor Guillermo Ordonez
Fall, 2020	Health Economics, UPenn, for Professor Juan Pablo Atal
Spring, 2020	History of Economic Thought, UPenn, for Fernando Arteaga
Fall, 2019	Economics of Education, UPenn, for Professor Francesco Agostinelli
Spring, 2017	Macroeconomics, NES, for Professor Konstantin Styrin
Fall, 2016	Macroeconomics, NES, for Professor Valery Charnavoki
Spring, 2015	Higher Algebra, HSE, for Professor Valentina Kiritchenko
Fall, 2014	Topology, HSE, for Yuri Burman

Research Experience and Other Employment:

2021-2023	Research Assistant for Professor Jesus Fernandez-Villaverde, UPenn
2022	Applied Scientist PhD Intern, Uber
2019-2020	Research Assistant for Professor Santosh Anagol, The Wharton School
2017-2018	Data Scientist, Yandex Taxi

Professional Activities:

Presentations	Annual Meeting of the Southern Economic Association (scheduled), Economics Graduate Student Conference at Washington University in St. Louis (2023), New Economic School (2023), International Conference on Computing in Economics and Finance (2022), Young Economist Symposium (2022)
Organizer	Empirical Micro Lunch, UPenn, 2020 – 2021
Refereeing	Young Economist Symposium
M.A. Thesis Examiner	New Economic School

Honors, Scholarships, and Fellowships:

2023	Dean's Travel Subvention ($600)
2023	SASGov Large Research Grant ($2000)
2022	Dean's Travel Subvention ($500)
2018-2023	University Fellowship, University of Pennsylvania
2016-2017	Petr Aven Scholarship, New Economic School

Publications:

"Hydra: Lessons from the World's Largest Darknet Market"
with Priyanka Goonetilleke and Alex Knorre, forthcoming at *Criminology & Public Policy*

JOB MARKET PAPER:

"*Illegal Drug Use and Government Policy: Evidence from a Darknet Marketplace*"
with Priyanka Goonetilleke, Anastasia Karpova, and Peter Meylakhs

This paper develops a structural model of demand for illegal drug varieties and studies how consumers substitute between different types of drugs in response to government policies. We use a unique longitudinal dataset on prices, quantities, and individual decisions that we obtained by scraping a darknet marketplace that covered the majority of the retail illegal drug trade in Russia. Our estimation procedure exploits a novel set of micro-level moment conditions to identify correlations in preferences for specific drug types and the degree of attachment to them. We find that the median own-price elasticity of demand for illegal drugs is -3.6, and that there is high substitution within two classes of drugs: medium-risk stimulants and cannabis. We validate our estimates using exogenous variation in the price of hashish caused by increased policing. The estimated model is used to evaluate counterfactual drug policies. We find that the legalization of cannabis has the benefit of decreasing the use of riskier drugs while increasing cannabis use. For every 4 additional doses of cannabis consumed, 1 less dose of another drug is consumed. Our estimates show that the recent introduction of a new family of synthetic drugs has increased total drug demand in the country by 40%, suggesting that governments should allocate resources to prevent the introduction of new drug products. Finally, our model helps identify the optimal drugs to target for interdiction, specifically those without close substitutes, such as α-PVP.

Research Papers:

"*An Economy of Neural Networks: Learning from Heterogeneous Experiences*"
PIER Working Paper No. 21-027

This paper proposes a new way to model behavioral agents in dynamic macro-financial environments. Agents are described as neural networks and learn policies from idiosyncratic past experiences. I investigate the feedback between irrationality and past outcomes in an economy with heterogeneous shocks similar to Aiyagari (1994). In the model, the rational expectations assumption is seriously violated because learning of a decision rule for savings is unstable. Agents who fall into learning traps save either excessively or save nothing, which provides a candidate explanation for several empirical puzzles about wealth distribution. Neural network agents have a higher average MPC and exhibit excess sensitivity of consumption. Learning can negatively affect intergenerational mobility.

Research Statement

Artem Kuriksha

My research interests lie in applied microeconomics and empirical industrial organization. Methodologically, my research uses and advances computational methods, particularly ones involving modern machine learning techniques.

My job market paper, *"Illegal Drug Use and Government Policy: Evidence from a Darknet Marketplace,"* joint with Priyanka Goonetilleke, Anastasia Karpova, and Peter Meylakhs, studies the effects of supply-side drug policies such as interdiction and legalization. To analyze how these policies affect drug consumption, it is necessary to understand how consumers make consumption decisions allowing for possible substitution between different types of drugs. For example, interdictions targeting a specific drug decrease its consumption but may inadvertently increase the consumption of other drug types that serve as substitutes. Conversely, the legalization of cannabis can increase the consumption of cannabis but reduce the use of more dangerous drugs.

To address these questions, we develop a model of consumer demand for illegal drug varieties. We study drug user preferences using a unique dataset we collected by scraping Hydra, the largest darknet marketplace ever. Our dataset covers a large share of the retail market for drugs in Russia and allows us to observe consumption and prices in specific locations. Crucially, our data enable us to infer the consumption patterns of individual consumers. We document several facts about preference heterogeneity for drugs. First, consumers typically choose the same drug in different time periods. Second, the average degree of intertemporal attachment differs for different drug types. For instance, consumers of cocaine display much stronger attachment compared to consumers of MDMA. Third, substitution between drug types is most active within two particular classes of drugs: medium-risk stimulants, such as amphetamine and MDMA, and cannabis.

We develop a demand model that can fit the consumption patterns observed in the data. Because the number of parameters pertaining to preference heterogeneity is large, estimation using aggregate data alone is difficult. We circumvent this problem using a novel set of micro moments that describe consumer reviewing behavior. Our approach facilitates the estimation of the mixed logit model and can be applied in other studies that use data from online marketplaces for demand estimation. We find that demand for drugs is elastic, with a median own-price elasticity of -3.6. Our estimates indicate that preference heterogeneity has considerable implications for predictions about substitution: for instance, there is five times more substitution from amphetamine to MDMA than to cocaine. We validate our demand model estimates by comparing predicted and observed consumer responses to an increase in hashish prices caused by a policing campaign started in the sample period.

The estimated model is used to evaluate the effects of important supply-side policies that have been introduced in some countries. First, we consider the implications of legalizing of cannabis. We find that for every 4.5 additional doses of cannabis consumed, approximately one less non-cannabis dose would be consumed. A substantial fraction of the substitution occurs from drugs associated with large risks. Second, we use our model to evaluate the effects of the introduction of new drugs. We simulate consumer choices without the popular family of synthetic drugs that emerged recently and find that its introduction led to a 40% increase in total drug demand. This dramatic effect suggests the importance of policies preventing the discovery and adoption of new substances. Third, we study the impact of targeted interdictions. If the government's goal is to reduce total drug use, drug types that should be prioritized for enforcement are ones that have few substitutes, such as $\alpha-$PVP (a synthetic stimulant associated with high risks).

My paper *"Hydra: Lessons from the World's Largest Darknet Market,"* co-authored with Priyanka Goonetilleke and Alex Knorre, analyzes another drug policy, shutdowns of darknet marketplaces. The case of Hydra shows what would occur if drug marketplaces were allowed to exist for an extended period and dominate the market. We examine the Hydra marketplace to understand and describe how shut-down policies trade off the potential increase in consumption against the possible decrease in harm per unit of consumption. The paper is forthcoming in *Criminology & Public Policy*. In an early-stage project with Priyanka Goonetilleke, we utilize our marketplace review data to explore the dynamics of drug consumption. We study the so-called stepping-stone effect, the hypothesis that the frequency of drug consumption and riskiness of the consumed drugs increase over time.

My job market paper uses machine learning to derive proxies for product quality from review data. I also utilize machine learning in my research in the field of computational economics. My paper *"An Economy of Neural Networks: Learning from Heterogeneous Experiences"* applies ideas from deep reinforcement learning to develop a dynamic model of bounded rationality. In the model, agents improve their decision rules over time, guided by the utility flow they derived from past decisions. This model has the property that agents with different personal experiences make different choices in identical states, which aligns with empirical studies on consumption and investment behavior. The approach I develop can be used to relax the assumption of rational expectations in a large set of DSGE models. I apply it to the canonical framework of Aiyagari (1994). Consumers in the model learn to make saving decisions when their income is subject to idiosyncratic fluctuations. I find that the assumption of rational expectations is substantially violated in simulations because the learning process is unstable. Agents who fall into learning traps save either excessively or save nothing. The model enables me to explain several empirical puzzles, particularly the high share of the population with no savings and the excess sensitivity of consumption to predictable changes in income. Heterogeneity in learning outcomes may partially explain high wealth inequality in the economy. In an extension of the model, I show that learning can lead to low intergenerational mobility.

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Undergraduate Studies:

B. A., Economics, Universidad de Costa Rica, summa cum laude, 2013
B. Sc., Actuarial Science, Universidad de Costa Rica, 2014
B. Sc., Pure Mathematics, Universidad de Costa Rica, 2017

Masters Level Work:

Master, Economic Theory and Econometrics, Toulouse School of Economics, first-class honors, 2016
Diplome Europeen d'Economie Quantitative Approfondie (DEEQA), Toulouse School of Economics, 2018
Master of Arts, Economics, University of Pennsylvania, 2021

Graduate Studies:

University of Pennsylvania, 2018 to present
Ph.D. Candidate in Economics
Thesis Title: "Essays in Financial Econometrics" Expected Completion Date: May 2024

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Teaching and Research Fields:

Primary fields: Econometrics, Financial Economics

Secondary fields: Industrial Organization, Machine Learning, Climate Economics

Teaching Experience:

University of Pennsylvania

Spring 2021	Introduction to Econometrics, TA for Professor John Lazarev
Spring 2020	Introduction to Macroeconomics, TA for Professor Luca Bossi
Fall 2019, Fall 2020	Introduction to Microeconomics, TA for Professor Anne Duchene

Universidad de Costa Rica

Spring 2016	Macroeconomic Theory II, TA for Professor Randall Romero
Spring 2015	Calculus II, Lecturer for the Mathematics Department
Spring 2014 to Spring 2015	Introduction to Economics, Lecturer for the Economics Department
Spring 2014 to Spring 2015	Microeconomic Theory I, TA for Professor Edgar Robles

Research Experience and Other Employment:

Research Assistant

2021-2024	University of Pennsylvania, RA for Prof. Francis X. Diebold
Spring, Summer 2021	University of Pennsylvania, RA for Profs. Juan Camilo Castillo and Amit Gandhi
Summer 2020	University of Pennsylvania, RA for Prof. Karun Adusumilli

Research Employment

2016-2017	Junior Researcher, Economic Research Department, Central Bank of Costa Rica

Other Employment

Aug-Nov 2014	Actuarial Science Intern at Ernst & Young, Costa Rica
Mar-Aug 2013	Junior Inspector at Comptroller General of the Republic, Costa Rica

Professional Activities:

External Conferences and Seminars

2023	-33rd Annual Meeting of the Midwest Econometrics Group, Federal Reserve Bank of Cleveland -International Assoc. for Applied Econometrics Annual Conference, BI Norwegian Business School.
2022	-17th Economics Graduate Students′ Conference, Washington University in St. Louis. -3rd Rising Scholars Conference, Chicago University Booth School of Business -2da Conferencia Economistas CR (Econ CR 2022), Universidad de Costa Rica.
2021	-1ra Conferencia Economistas CR (Econ CR 2021), Universidad de Costa Rica.

Referee

International Economics Review

Honors, Scholarships, and Fellowships:

2023	Best Student Paper Award, 33rd Annual Meeting of the Midwest Econometrics Group
2022, 2023	School of Arts and Sciences Dean's Travel Award
2022	Hiran C. Haney Fellowship Award in Economics (*best third-year research paper*)
2019-2024	Ph.D. Fellowship, School of Arts and Science, University of Pennsylvania
2017-2019	Research Fellowship, Central Bank of Costa Rica
2015	Masters Fellowship, Toulouse School of Economics
2011, 2014	Honors Scholarships, Universidad de Costa Rica

Publications:

2020 Information rigidities and rationality on inflation expectations of Costa Rican agents. (*with* Alonso Alfaro) in *Inflation Expectations, Their Measurement and the Estimate of Their Degree of Anchoring* edited by A. Guarín, L. Melo and E. González, Center for Latin American Monetary Studies (CEMLA)'s Joint Research Program

Research Papers:

"Revealed Preference for Green Stocks: An Asset Demand Approach" (Job Market Paper)

Winner of the Best Student Paper Award of the 33rd Annual Meeting of the Midwest Econometrics Group, 2023

This paper combines a traditional portfolio construction problem with demand estimation techniques to estimate the demand for green stocks of US institutional investors. The methodology presented builds upon recent influential work on asset demand estimation in at least two dimensions. First, in addition to investor heterogeneity through differential beliefs about future returns, our framework allows for investors to care about the characteristics of the portfolio they are forming beyond those related directly to an expected return-versus-risk trade off. Second, by using a mixed logit demand specification, we can estimate asset demands that deliver more realistic substitution patterns across assets. Using data on the environmental performance of firms and quarterly stock holdings data from institutional investors, we estimate the demand for green stocks while controlling for return-related stock characteristics. We find that taste for green stocks fluctuates over time and by investor's assets under management. In a counterfactual exercise we study the equity price effects of a ban on green investing for pension funds; we find that a portfolio with the top brown stocks is estimated to have capital gains of 5.9% due to the policy, while a portfolio with the top green stocks is estimated to have capital losses of 7.3%.

"Exchange Rate Supervised Topic Extraction"

Winner of the Hiran C. Haney Fellowship Award in Economics, University of Pennsylvania, 2022

This paper shows how to use a hybrid of supervised and unsupervised learning models to go from text from news articles to an FX news index that can be used to enhance traditional models from the FX literature. To do so we rely on Supervised Latent Dirichlet Allocation (sLDA) which combines information about a supervising variable with topic extraction over a corpus of text in a single-stage estimation. Although this estimation can be done in two stages, we document with a Monte Carlo simulation that there are efficiency gains from a single-stage approach. The empirical application is centered around the Monex Market, the main Costa Rican platform for FX trade; accordingly, news articles are gathered from the main Costa Rican newspapers. The exchange rate of interest is the Costa Rican Colón (CRC), the local currency, and the United States dollar (USD). Using the CRC/USD exchange rate as the supervising variable, we suggest using sLDA to extract the topics from the news article corpus that are relevant as covariates for the exchange rate over short frequencies.

"On Robust Inference in Time Series Regression" (with Richard T. Baillie, Francis X. Diebold, George Kapetanios and Kun Ho Kim)

Least squares regression with heteroskedasticity and autocorrelation consistent (HAC) standard errors has proved very useful in cross section environments. However, several major difficulties, which are generally overlooked, must be confronted when transferring the HAC estimation technology to time series environments. First, in plausible time-series environments involving failure of strong exogeneity, OLS parameter estimates can be inconsistent, so that HAC inference fails even asymptotically. Second, most economic time series have strong autocorrelation, which renders HAC regression parameter estimates highly inefficient. Third, strong autocorrelation similarly renders HAC conditional predictions highly inefficient. Finally, the structure of popular HAC estimators is ill-suited for capturing the autoregressive autocorrelation typically present in economic time series, which produces large size distortions and reduced power in HAC based hypothesis testing, in all but the largest samples. We show that all four problems are largely avoided using a simple dynamic regression procedure, which is easily implemented. We demonstrate the advantages of dynamic regression with detailed simulations covering a range of practical issues.

"Order Flow, Market Making and Exchange Rates: Costa Rica's Monex Market"

The cornerstone result of the market microstructure literature in FX markets is that the order flow, the difference between buyer-initiated and seller-initiated transactions, is a key determinant of the exchange rate short-run dynamics. This paper advocates studying the short-term dynamics of the Costa Rican Colón to United States Dollar exchange rate generated in the Monex market by employing market microstructure tools. Using transaction level data for 729 trading days we gather evidence that the order flow has explanatory power on the short-term dynamics of exchange rate returns, even after accounting for a feedback effect. Additionally, we show evidence suggesting that the informational content of the order flow has persistent effects. Finally, when characterizing the role of the interventions by the monetary authority on the market, data shows that interventions affect the informational content of the order flow, and that the monetary authority acts as a liquidity provider and a market maker in the Monex platform.

Languages:

Spanish (native), English (fluent), French (proficient)

Computational Skills:

Python, R, Matlab, Julia, TensorFlow, Mathematica, Visual Basic, HTML, JavaScript, Stata, Eviews

Research Statement

Aaron Mora
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I am an applied econometrician with interests in applications in asset pricing and industrial organization. My research combines and adapts methodologies from different literatures into new approaches to study various questions in financial economics. The first of these questions has to do with why investors exhibit great variation in the portfolios they construct, and the consequences for asset prices and holdings. In another research question, I use non-traditional text data and machine learning techniques to study the short-term dynamics of exchange rates.

In my job market paper, "*Revealed Preference for Green Stocks: An Asset Demand Approach*" I combine a traditional portfolio construction problem with demand estimation techniques to estimate the demand for green stocks of US institutional investors. This paper presents two methodological contributions with respect to recent influential work on asset demand estimation. First, in addition to investor heterogeneity through differential beliefs about future returns, this framework allows investors to care about the characteristics of the portfolio they are forming beyond those related directly to an expected return-versus-risk trade off. Second, by using a mixed logit demand specification, I can estimate asset demands that deliver more realistic substitution patterns across assets, and improve upon the restrictive elasticities of the logit demand specification commonly used in the literature. In a logit specification the price elastiticities are proportional to the portfolio holdings; this restricts the substitution patterns between two stocks such that they only depend on the portfolio weights and ignore whether the stocks have similar fundamentals or belong to different industries.

Using data on the environmental performance of firms and quarterly stock holdings data for institutional investors, I estimate the demand for green stocks while controlling for return-related stock characteristics. While it is not possible to distinguish whether each characteristic is included in the demand due to belief or taste heterogeneity using only holdings data, survey evidence supports the interpretation of environmental aspects as a taste characteristic. Giglio et al. (2023) examine a survey of retail investors on the motives for Enviromental Social and Governance (ESG) investing and find that generally investors expect ESG investments to underperform the market and that only 7% of investors in ESG assets were motivated by return expectations.

I find that taste for green stocks fluctuates over time. That is, estimates show periods where on the aggregate investors have a positive taste for green stocks while in other periods there is a distaste for green stocks. Notably, after the Great Recession (2017-Q1 to 2009-Q2) the estimates show the biggest change, from a positive to a negative taste for green stocks. This suggests that after periods of economic downturn, investors care relatively more about the return-related characteristics of the stocks and relatively less about

the environmental performance of the companies underlying the stocks.

In a counterfactual exercise I study the equity price effects of a ban on green investing for pension funds. This counterfacutal is based on current policy discussions surrounding green investing; on March 1st 2023, the US Senate passed a bill to prevent pension fund managers from basing investment decisions on factors like climate change. This bill was vetoed 19 days later by President Biden, but various US State Legislatures have approved similar initiatives. In the counterfactual exercise this policy is implemented by making the demand for stocks of pension funds inelastic to the environmental performance of the stocks. For these investors only return-related characteristics are taken into account in their demand for stocks. This counterfactual shows that stock with the lowest environmental performance, brown stocks, will benefit the most in terms of counterfactual pricing. A portfolio with the top brown stocks is estimated to have capital gains of 5.9% due to the policy, while a portfolio with the top green stocks is estimated to have capital losses of 7.3%.

In the paper "*Exchange Rate Supervised Topic Extraction*" I show how to use a hybrid of supervised and unsupervised learning models to go from text from news articles to an FX news index that can be used to enhance traditional models from the FX literature. The paper uses Supervised Latent Dirichlet Allocation, a topic model that combines information about a supervising variable with topic extraction over a corpus of text in a single-stage estimation. Although this estimation can be done in two stages, I use a Monte Carlo simulation to document that there are efficiency gains from the single-stage approach. The empirical application is centered around the Monex Market, the main Costa Rican platform for FX trade; accordingly, news articles are gathered from the main Costa Rican newspapers. The exchange rate of interest is the Costa Rican Colón (CRC), the local currency, and the United States dollar (USD). Using the CRC/USD exchange rate as the supervising variable, I extract the topics from the news article corpus that are relevant as covariates for the exchange rate over short frequencies.

The work with with Richard T. Baillie, Francis X. Diebold, George Kapetanios, and Kun Ho Kim titled "*On Robust Inference in Time Series Regression*" revisits a fundamental problem in time-series regression and offers a new solution. This paper proposes a simple dynamic regression procedure, which is easily implemented, to conduct inference robust to serial correlation. The alternative of least squares regression with heteroskedasticity and autocorrelation consistent (HAC) standard errors has proved very useful in cross section environments. However, in time series environments with strong autocorrelation it suffers from major difficulties. First, in plausible time-series environments involving failure of strong exogeneity, OLS parameter estimates can be inconsistent, so that HAC inference fails even asymptotically. Second, most economic time series have strong autocorrelation, which renders HAC regression parameter estimates highly inefficient. Finally, the structure of popular HAC estimators is ill-suited for capturing the autoregressive autocorrelation typically present in economic time series, which produces large size distortions and reduced power in HAC based hypothesis testing, in all but the largest samples. This paper shows that these problems are largely avoided using a simple dynamic regression procedure, which is easily implemented. We demonstrate the advantages of dynamic regression with detailed simulations covering a range of practical issues.

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Personal Information:
Citizenship: Mexican, F-1 visa.

Undergraduate Studies:
BA in Applied Mathematics, Instituto Tecnológico Autónomo de México, graduated with honors, 2016.
BA in Economics, Instituto Tecnológico Autónomo de México, graduated with honors, 2016.

Graduate Studies:
M.A. in Economics, University of Pennsylvania, 2022
Ph. D. in Economics, University of Pennsylvania, 2018 to present
Thesis Title: "The power of good neighbors. An analysis of intergenerational mobility"
Expected Completion Date: May 2024.

Thesis Committee and References:

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Research Fields:

Macroeconomics, Inequality, Network Economics.

Teaching Experience:

Fall 2023	Foundations of Market Economies, TA for Jesús Fernández-Villaverde
Spring 2023	History of Economic Thought, TA for Fernando Arteaga
Spring 2023	Pricing Strategies, TA for John Zhang (Wharton)
Fall 2022	Foundations of Market Economies, TA for Jesús Fernández-Villaverde
Summer 2022	Managerial Economics, TA for Kent Smetters (Wharton)
Summer 2022	Statistics I, Main instructor, Rio Grande College
Spring 2022	Political Economics of Early Americas, TA for Fernando Arteaga
Fall 2021	Foundations of Market Economies, TA for Jesús Fernández-Villaverde
Spring 2021	Political Economics of Early Americas, TA for Jesús Fernández-Villaverde
Fall 2020	Foundations of Market Economies, TA for Jesús Fernández-Villaverde
Summer 2020	Microeconomic Theory, Course instructor, Sichuan University
Spring 2020	Political Economics of Early Americas, TA for Jesús Fernández-Villaverde
Fall 2019	Economics 2 (Macroeconomics), TA for Luca Bossi
Summer 2019	Penn Summer Prep. What is Mathematics? Course Instructor (UPENN)

Research Experience and Other Employment:

Summer 2021	Harvard Business School, Research Assistant, Prof. Laura Alfaro
Summer 2021	World Bank: Doing Business, Research Assistant
2016-2018	Banco de Mexico, Economist

Refereeing

Review of World Economics

Honors. Scholarships. and Fellowships:

2018-2023	University of Pennsylvania Fellowship
2022-2023	Collegium Institute Graduate Fellowship, UPENN
Spring 2023	SASgov Research Grant, UPENN

Research Paper:

"*The power of good neighbors. An analysis of intergenerational mobility*" (Job Market Paper)

Abstract:

This paper provides a theoretical and quantitative analysis of the role of good neighbors (i.e., neighbors with better information signals about the current state of the economy) for saving and human capital formation outcomes. It proposes a framework that links the spillover effects of optimal neighborhood selection with inequality and network analysis and estimation. This research contributes to the growing literature on intergenerational mobility. Theoretically, it introduces a novel network-based model of information cluster formation, incorporating endogenous neighborhood selection. Living in neighborhoods with high connectivity produces information spillovers, so that better financial choices result from those connections and are ultimately reflected in savings decisions and wealth accumulation. Similarly, the spillover affects the choice of parents on their children's education, further enhancing wealth accumulation over time. A network

is more homogeneous (heterogeneous) when the agents are more (less) connected at the same information level. The study characterizes the unobservable parameter values, returns of investment and precision signal of the agents, for which there is a stable homogeneous outcome that does not maximize the sum of expected returns of all the agents. The unobserved parameters are estimated with data from the Opportunity Atlas. Quantitatively, the compensating value in welfare for a low-information household (an agent with a less precise signal) of living in a neighborhood with 25% of high-information neighbors, instead of none, is estimated to be roughly 16% of the median saving. Furthermore, the simulation based on the estimated parameters in the network structure predicts a ten-percent decrease in Economic Connectedness – the fraction of high-informed friends among low-informed individuals – for the next generation, compared to the benchmark of a random network.

Research Statement

Rodrigo A. Morales Mendoza
University of Pennsylvania
Email: rodmo@sas.upenn.edu Website: moralesmendozar.com

My research interests focus on intergenerational mobility, growth, network analysis and machine learning applications in Macroeconomics. Growth and innovation are often considered to be at odds with fairness and equality. I am interested in addressing to what extent that is the case.

The information sharing is not uniformly distributed. Families with more knowledge and access to data sources can provide better opportunities for their community. The effect of this on inequality and growth is largely understudied and is critical for tackling issues like the sharp decline in intergenerational mobility of the past four decades and the substantial wealth transfer induced by demographic transitions over the decades to come. Examples of information flows include reading the news and providing financial advice. Understanding how these flows impact intergenerational transfers is essential to address the disparities that may arise.

My job market paper, '*The power of good neighbors. An analysis of intergenerational mobility*', studies the relationship between spillover effects of neighborhood selection, inequality and networks, by quantifying the importance of having good neighbors for better saving outcomes and human capital choices. The key mechanism of the model is this: better-connected agents (i.e., have access to better-informed neighbors) get better returns on their real assets, because they obtain more informative signals about the true state of the economy and this allows them to make better investments, as well as education. There are two investment subperiods. In the first one, agents make choices with only their private information. In the second one, they learn from their neighbors' actions as to what their signals are. In general, agents with high-information neighbors (i.e., a neighbor who is better informed about the fundamentals) choose to delay their investment choices one period to gain certainty about the economy, which is at odds with the premium of early investment. The equilibrium concept is based on the standard stability of outcome from the network literature: no agent can make an offer that makes them both better off, thus stealing the node. The main contribution is twofold:

it adds an endogenous decision of the players on their neighbors to a theoretical framework based on the herding literature with saving technology for intergenerational mobility, and it provides a method of estimating network economies. This results in both theoretical and quantitative contributions to the growing literature on intergenerational mobility.

Theoretically, the comparative statics exercise computes the marginal benefit of each quarter of better-informed neighbors through the compensating variation of a high-information neighbor. A network is more homogeneous (heterogeneous) when the agents are more (less) connected at the same information level. The study characterizes the unobservable parameter values, returns of investment and precision signal (precision in terms of variance) of the agents, for which there is a stable homogeneous outcome that does not maximize the sum of expected returns of all the agents.

The paper uses data from the Opportunity Atlas to estimate the value of each marginal quarter of high-information neighbors for low and high-information agents, where the information level is proxied by college degree. Quantitatively, the compensating value in welfare for a low-information household (an agent with a less precise signal) of living in a neighborhood with 25% of high-information neighbors, instead of none, is estimated to be roughly 16% of the median saving. To get to this number, first the non-observed parameters of the model are estimated with a generalized method of moments, using the predicted equations of the models, and the transformations of the variables to match it, minimizing the square error of the corresponding objective functions. The network structure is fundamental for the estimation. An algorithm was disciplined to perform ecological inference over the agents, whose connectedness is only known at the county level. Furthermore, the simulation based on the estimated parameters in the network structure predicts a ten-percent decrease in Economic Connectedness – the fraction of high-informed friends among low-informed individuals – for the next generation, compared to the benchmark of a random network.

Through my research, I seek to develop and enhance mathematical models that can provide valuable insights into complex economic issues. Ultimately, my goal is to make a meaningful contribution to the field of economics and to help address pressing societal challenges related to income inequality, economic growth, and social welfare. More precisely, I seek to extend the current environment into an overlapping-generations framework with a large or infinite horizon and study the steady-state distribution.

Research Statement

Rodrigo A. Morales Mendoza
University of Pennsylvania
Email: rodmo@sas.upenn.edu Website: moralesmendozar.com

My research interests focus on intergenerational mobility, growth, network analysis and machine learning applications in Macroeconomics. Growth and innovation are often considered to be at odds with fairness and equality. I am interested in addressing to what extent that is the case.

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My job market paper, '*The power of good neighbors. An analysis of intergenerational mobility*', studies the relationship between spillover effects of neighborhood selection, inequality and networks, by quantifying the importance of having good neighbors for better saving outcomes and human capital choices. The key mechanism of the model is this: are better-connected agents (i.e., have access to better-informed neighbors) get better returns on their real assets, because they obtain more informative signals about the true state of the economy and this allows them to make better investments, as well as education. There are two investment subperiods. In the first one, agents make choices with only their private information. In the second one, they learn from their neighbors' actions as to what their signals are. In general, agents with high-information neighbors (i.e., a neighbor who is better informed about the fundamentals) choose to delay their investment choices one period to gain certainty about the economy, which is at odds with the premium of early investment. The equilibrium concept is based on the standard stability of outcome from the network literature: no agent can make an offer that makes them both better off, thus stealing the node. The main contribution is twofold:

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The paper uses data from the Opportunity Atlas to estimate the value of each marginal quarter of high-information neighbors for low and high-information agents, where the information level is proxied by college degree. Quantitatively, the compensating value in welfare for a low-information household (an agent with a less precise signal) of living in a neighborhood with 25% of high-information neighbors, instead of none, is estimated to be roughly 16% of the median saving. To get to this number, first the non-observed parameters of the model are estimated with a generalized method of moments, using the predicted equations of the models, and the transformations of the variables to match it, minimizing the square error of the corresponding objective functions. The network structure is fundamental for the estimation. An algorithm was disciplined to perform ecological inference over the agents, whose connectedness is only known at the county level. Furthermore, the simulation based on the estimated parameters in the network structure predicts a ten-percent decrease in Economic Connectedness – the fraction of high-informed friends among low-informed individuals – for the next generation, compared to the benchmark of a random network.

Through my research, I seek to develop and enhance mathematical models that can provide valuable insights into complex economic issues. Ultimately, my goal is to make a meaningful contribution to the field of economics and to help address pressing societal challenges related to income inequality, economic growth, and social welfare. More precisely, I seek to extend the current environment into an overlapping-generations framework with a large or infinite horizon and study the steady-state distribution.

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Personal Information:
Date of Birth: August 23, 1992
Citizenship: Portuguese

Undergraduate Studies:
B.Sc., Economics, Nova School of Business and Economics, 2013

Masters Studies:
M.Sc., Economics, Nova School of Business and Economics, 2015
M.Sc., Economics, Maastricht University, 2015

Graduate Studies:
University of Pennsylvania, 2018 to present
Thesis Title: "Essays in Monetary Economics"
Expected Completion Date: May 2024

Thesis Committee and References:

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Professor Harold L. Cole
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Teaching and Research Fields:

Primary fields: Macroeconomics
Secondary fields: Monetary Economics, Labor Economics

Teaching Experience:

Fall, 2023	Introductory Microeconomics, TA for Professor Anne Duchene
Spring, 2023	Introductory Macroeconomics, TA for Professor Luca Bossi
Fall, 2022	Introductory Macroeconomics, TA for Professor Luca Bossi
Spring, 2022	The Digital Economy, TA for Professor Juan Camilo Castillo
Fall, 2021	Intermediate Microeconomics, TA for Professor Rakesh Vohra
Spring, 2021	Intermediate Microeconomics, TA for Professor George Mailath
Fall, 2020	Intermediate Microeconomics, TA for Professor Rakesh Vohra
Spring, 2020	Microeconomics II (graduate), TA for Professor George Mailath
Fall, 2019	Intermediate Microeconomics, TA for Professor Rakesh Vohra

Research Experience and Other Employment:

2021	Research Assistant for Professor Harold Cole
2020	Federal Reserve Bank of Philadelphia, Intern
2015-2018	Banco de Portugal, Economist
2015	Research Assistant for Professor Pedro Portugal

Professional Activities:

Referee	Young Economist Symposium (2021, 2022)
Presentations	UPenn Macro Lunch Seminar (2021, 2022), Meeting of the Portuguese Economic Journal (2023), Macroeconomics Across Time and Space Poster Session (2023), UPenn Money-Macro Seminar (2023)

Honors, Scholarships, and Fellowships:

2023	Consultaccount award, 16th Meeting of the Portuguese Economic Journal
2019	Lawrence Robbins Prize, University of Pennsylvania

Publications:

"The neutrality of nominal rates: how long is the long run?", with João Valle e Azevedo and Pedro Teles, *International Economic Review, 2022, Volume 63, Issue 4, pages 1745-1777*

Research Papers:

"Doing Without Nominal Rigidities: Real Effects of Monetary Policy in a Monetary World" (Job Market Paper)

I develop a quantitative model of money as a medium of exchange, built on search frictions in the product and labor markets, which provides an alternative theory for the real effects of monetary policy. Due to matching uncertainty, firms operate below full capacity, and households carry money that ends up unused. A reduction in the nominal interest rate decreases the opportunity cost of holding money, pushing up households′ money demand. The increased liquidity carried by households results in a decrease in money velocity but an increase in capacity utilization, as it becomes easier for firms to match households with money to purchase their goods. This delivers an increase in output and employment. I estimate the model to match the impulse response functions to a stimulative monetary policy shock in a vector autoregression and compare it to a model of nominal rigidities. The search-based model's response to the shock displays positive persistent effects on consumption, investment, and employment. As in the data, the labor share is countercyclical, something the New Keynesian model is unable to deliver.

"Informality, Inflation, and Fiscal Progressivity in Developing Countries", with Daniel Jaar

Developing economies have large informal sectors comprising small firms that avoid taxation and rely predominantly on cash. In addition, poorer households purchase a larger proportion of their consumption bundle from informal firms. We develop a general equilibrium model with a formality decision by firms and a consumption bundle decision by households that jointly rationalizes these facts and calibrate it to evaluate the implications of different revenue-equivalent choices of consumption taxes and inflation for aggregate output, the size of the informal sector, and fiscal progressivity.

Research Paper(s) in Progress:

"The Heterogeneous Effects of Monetary Policy: Profits vs Employment"

Vector autoregressions show that reductions in the effective funds rate lead to increased profits and employment. Because most households do not hold stocks, increased profits benefit households at the top of the wealth distribution. On the other hand, poor unemployed households are the major beneficiaries of the effects of monetary policy on job-finding rates. This paper develops a heterogeneous agent monetary search model with endogenous unemployment and procyclical profits to quantify the distributional effects of monetary policy through these two channels.

Research Statement

João Ritto*

I am a **quantitative macroeconomist** focusing on **monetary** and **labor** economics. I am working on the role played by frictions in both product and labor markets in shaping the aggregate response to shocks and their impact on heterogeneous households.

My job market paper, **"Doing Without Nominal Rigidities: Real Effects of Monetary Policy in a Monetary World"**, proposes an alternative theory for the real effects of monetary policy founded on product market search frictions and money's role as a medium of exchange. Due to matching uncertainty, firms operate below full capacity, and households carry money that ends up unused. A reduction in the nominal interest rate decreases the opportunity cost of holding money, pushing up households' money demand. The increased liquidity carried by households results in a decrease in money velocity but an increase in capacity utilization, as it becomes easier for firms to match households with money to purchase their goods. This delivers an increase in output. I build on this theory by developing a quantitative model that also includes labor market search frictions, a portfolio adjustment cost that makes the response to monetary policy shocks hump-shaped, and investment adjustment costs and variable capital utilization, ingredients typically used in the New Keynesian literature. I evaluate the model using indirect inference methods: I estimate it to match the impulse response functions to a monetary policy shock in a vector autoregression and compare it to the New Keynesian model. The search-based model's response to a reduction in the nominal interest rate displays positive, persistent effects on output, employment, consumption, and investment. On top of this, the model is better able to match the procyclical response of labor productivity and the countercyclical response of the labor share than the New Keynesian model. My findings challenge the conventional belief that nominal rigidities are the sole friction that can rationalize the effects of monetary policy found in the data, opening the door for a more comprehensive analysis of the different channels at play.

In follow-up work in progress, **"The Heterogeneous Effects of Monetary Policy: Profits vs Employment"**, I build a model to analyze the role played by two dimensions

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of heterogeneity on the effects of stimulative monetary policy across the household wealth distribution. In the data, following monetary policy shocks, both profits and employment display procyclical responses. These are two competing forces for the distributional effects of monetary policy: on the one hand, a majority of households hold a large portion of their portfolio in liquid assets with negative real returns and do not benefit from the impact of monetary policy on profits; on the other hand, poor unemployed households are major beneficiaries of the effects of monetary policy on job finding rates. This trade-off cannot be analyzed in the canonical Heterogeneous Agent New Keynesian model where profits are countercyclical, and the rate of unemployment is exogenous to monetary policy (it is determined by idiosyncratic shocks).

As part of my interest in monetary economics, I have also conducted some empirical research. In **"The Neutrality of Nominal Rates: How Long is the Long Run?"**, coauthored with Joao Valle e Azevedo and Pedro Teles, published in the International Economic Review, we scrutinize data on nominal interest rates and inflation across various countries and time periods to investigate their relationship. Long-run neutrality determines that in the long-run higher nominal interest rates must be associated with higher inflation rates. We find this relationship to be well-established in the data. Estimating a statistical model that distinguishes temporary and permanent monetary policy shocks, we find that positive, permanent shocks to the nominal interest rate result in an increase in inflation, even in the short run.

A different strand of my research focuses on the relevance of money for tax evasion and its fiscal implications in developing economies. In the research paper in progress **"Informality, Inflation, and Fiscal Progressivity in Developing Countries"**, with Daniel Jaar, we construct a model that jointly rationalizes the positive correlation between firm size and formality status, and the negative correlation between household income and the proportion of consumption purchased in the informal economy. The theory emphasizes the role of cash and tax evasion to explain these two empirical facts. We calibrate the model and use it to evaluate the implications of different revenue-equivalent choices of consumption taxes and inflation for aggregate output, the size of the informal sector, and fiscal progressivity.

JUAN SAGREDO
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Previous Studies:
B.A., Mathematics and Economics (double major), Cornell University, 2010
Ph.D., Operations Research and Financial Engineering, Princeton University, 2016
- Advisor: Patrick Cheridito
- Thesis Title: "Existence Results in General Equilibrium Theory"

Current Studies:
University of Pennsylvania, 2017 to present
Thesis Title: "Essays on Information"
Expected Completion Date: May 2023

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Research and Teaching Fields:
Applied Theory, Mathematical Economics, Financial Engineering, Political Economy, Econometrics.

Teaching Experience:

2010-2016:	Optimal Learning, Introduction to Financial Mathematics, Fundamentals of Statistics
2017-2023:	Game Theory, Introductory Econometrics, Introductory Time Series, Introductory Economics, International Trade.

Research Experience and Other Employment:

2016 - 2017	ETH Zurich, Postdoctoral Researcher for Professor Patrick Cheridito.

Professional Activities:

Referee	Journal of Economic Theory, International Economic Review, Journal on Financial Mathematics.
Seminar Presentations	2020 Stanford GSB Rising Scholars Conference, 2023 International Industrial Organization Conference

Honors, Scholarships, and Fellowships:

2010 – 2016	Princeton University Presidential Fellowship
2017 - 2023	University of Pennsylvania Fellowship

Research Papers:

"*The Visible Hand*" (Job Market Paper)

Technological innovations have allowed some sellers to collect detailed information about buyers. We study the effects of changes in the precision of sellers' preference information, a characteristic that we refer to as the seller's *expertise*, paying special attention to expertise heterogeneity. Expertise plays a central role in the pursuit of profits through sales (trade) versus markups (rents), thus impacting total surplus and its distribution. When sellers face buyers with more dispersed or left-skewed valuations and operate production technologies with less convex costs they are more prone to pursue inefficient large markup strategies under imprecise information, and expertise relaxes this motive, but in alternate settings, imprecisely informed sellers pursue efficient large sale strategies, and expertise can weaken this motive. Buyers, particularly those with a low willingness to pay, benefit from expertise to the degree that it promotes trade, whereas sellers who obtain expertise always benefit, but peers who do not can become more or less profitable. The higher the level of competition and the less expert the seller who upskills, the worse the profit externalities; nevertheless, in a range of settings, these externalities are positive, and all sellers become more profitable. Lastly, we find a novel channel through which competition exacerbates the gap in usage of information technologies between laggards and leaders.

"*The Political Economy of Pandemics*"
With G. L. Ordoñez and H. Herrera.

The COVID-19 pandemic presented an unprecedented challenge. Policymakers had to manage a crisis with little information but under high public scrutiny, particularly via cross-regional comparisons. We show how comparisons induce herding of policymakers with popularity concerns and discuss its extent under different scenarios. Policy contagion is stronger when shocks are sequential, more correlated, and popularity concerns are larger. Ex ante, it improves welfare, by disciplining biased policy agendas, but ex post, it can decrease welfare, by incentivizing acquiescing to a biased public consensus.

Research Paper(s) in Progress:

"*Expertise Appropriability*"

"*The Cost of Discipline*," With G. L. Ordoñez and H. Herrera.

Languages:

Spanish (native), English (native)

Computational Skills:
Proficient in Python, C++, R, MATLAB, and SQL; knowledgeable in Julia and Excel.

Dissertation Abstract

Juan Sagredo

1 Research Interests

I am an applied theorist broadly interested in information economics. My work has focused on two developments where the nature of information greatly affected business and policy: (1) the boom of data-intensive practices among firms and (2) the highly visible but sparsely informed management of the COVID-19 pandemic. For my job market paper, I study the implications of this analytics boom on competition and welfare in a theoretical model motivated by the retail sector, where firms now broadly but heterogeneously leverage customer preference data to tailor offers. Particular attention is paid to the heterogeneous precision of firms' information in a general setting, where it shapes both prices and product design, and contracts have a flexible form. In a second paper, I team up with Guillermo Ordoñez and Helios Herrera to analyze the implications of public policy comparisons on policymaking, motivated by the COVID-19 pandemic where scarce information about an unprecedented shock gave only tenuous guidance and popularity repercussions were amplified. These papers are the initial steps of a broader research agenda in the fields of information design, information markets, and the economics of social data.

2 Paper 1: *The Visible Hand*

Amazon's well-documented harvesting and leveraging of consumer data exemplifies a sweeping transformation in how contemporary firms operate. A surge in the availability of data and in the power of analytical methods that uncover its insights now helps firms better discern consumer preferences and tailor offers. These methods have spread across industries, but their diffusion within each has been heterogeneous. And yet, despite the importance of this pipeline, its impact on markets is not well understood.

There are several natural questions about this technological change. First, whether it benefits us in aggregate and consumers in particular is of immediate importance, and policymakers have both raised concerns about potential detrimental effects on competition (FTC (2012, 2013, 2014), CEA (2015)) and proactively moved towards containing them with wide-ranging measures, such as the EU's General Data Protection Regulation (European Commission (2012)). Second, how do firms benefit from investments in data expertise? The growing analytics gap between Amazons of the world and more traditional businesses suggests that investment is profitable, but in the right context. So, what is that context? And how does this type of investment affect competitors? To address these questions, we leverage a standard search-theoretic framework of imperfect competition, featuring buyers with heterogeneous private valuations for quality, and introduce sellers with buyer valuation signals of heterogeneous precision. In particular, sellers are differentiated by an ex ante characteristic, which we refer to as a seller's (data) *expertise*, and expertise increases signal precision. We characterize equilibria analytically, linking properties of information with properties of offers, and study the comparative statics of both expertise and market structure, documenting their effect on the nature of competition and social surplus, in aggregate terms, as well as its distribution between and within buyers and sellers.

Expertise fundamentally impacts a seller's trade-off between profiting through more sales (trade) versus higher markups (rents). On the one hand, it allows them to rent-seek when it is least damaging to trade.

On the other hand, it makes rent-seeking more profitable. The former channel increases trade efficiency and, by extension, aggregate surplus, while the latter decreases these. Sellers facing buyers with more dispersed or left-skewed valuations and operating quality production technologies with flatter costs are more prone to pursue inefficient large markup strategies when their information is imprecise, and expertise relaxes this motive, but in the alternate settings, imprecisely informed sellers are predisposed to pursue efficient large sale strategies, and expertise can weaken this motive. Expertise is also inherently redistributive, shifting not only the share of surplus between buyers and sellers but also its distribution within each side of the market. On the demand side, high valuation buyers - the principal victims of rent-seeking - broadly suffer from expertise, whereas low valuation buyers - the principal victims of rationed trade - broadly benefit from it. On the supply side, expertise makes sellers who obtain it more profitable, but its impact on other sellers who do not can be positive or negative. More expert competitors are more likely to offer more (less) competitive low (high) prices to low (high) valuation buyers; in this sense, expertise tends to decrease (increase) the profitability of peers' trade with low (high) valuation buyers. How much expertise impacts the profitability of trade with each type of buyer determines the sign of its profit externality. The larger the average number of sellers per match and the lower the expertise of sellers who upskill, the more (less) that expertise promotes (relaxes) competition in low (high) matches, and the worse its profit externalities; nevertheless, these can be positive and create opportunities for all sellers to benefit, despite the privacy of signals and actions. Counterintuitively, the latter settings, where all sellers benefit from additional expertise, include cases where laggard sellers fall further behind and where they catch up to leaders.

We confirm the classical effects of competition but also find a new - concerning - one. Competition weakens sellers' incentive to rent-seek, resulting in more efficient trade and a larger share of surplus for buyers. However, competition also lowers the returns of expertise, and when expertise is heterogeneous, this affects sellers unequally. In particular, competition and imprecision both decrease the sensitivity of sellers' offers to their signals, eventually becoming information-insensitive (invariant in the seller's signal). In this sense, amateurs are particularly vulnerable to not being able to use, nor have the incentive to improve, their expertise. Although we do not model entry and exit, this suggests the existence of a novel strategic equilibrium force behind the documented disparity in firm usage of these information technologies, and that competition exacerbates it.

3 Paper 2: *The Political Economy of Pandemics*

While the transformation of firms' operations teaches us about some of the principal strategic interactions that arise when information is plentiful, the COVID-19 pandemic taught us what happens at the other end - when information is scarce. Policymakers faced with an unprecedented shock were forced to take immediate action under intense scrutiny. There were multiple sources of public information, but among these, cross-regional comparisons became prominent. The combination of imprecise information and acute career repercussions created a potentially problematic variation of the three channels that traditionally shape policymakers' decisions: (1) doing what is best for the public, (2) doing what is best for their agenda, and (3) doing what is best for their popularity. The pandemic raised a pressing question, present in many principal-agent settings, mainly: what is the effect of public comparisons on the efficiency of policymaking?

We study this question by constructing a model in which policymakers choose actions based on their expected public welfare outcomes, their biases toward particular policies, and their concern for public opinion. When a common shock hits, we show that the prospect of comparisons induces excessive herding on policies. The discipline that herding induces improves ex ante welfare, as personal bias becomes less influential, but the homogeneity that it induces can reduce ex post welfare, as acquiescing to collective bias - in search of popularity - can be worse than a policymakers' personally biased best judgment.

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Masters Level Work
M.A. Economic Theory, ITAM (México City), 2017.

Graduate Studies:
University of Pennsylvania, 2017 to present.
Thesis Title: Essay in Mortgages and Macroeconomics.
Expected Completion Date: May 2024.

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Teaching and Research Fields:

Primary fields: Macroeconomics, Housing and Mortgage Finance.
Secondary fields: Role of Financial Intermediaries, Fiscal and Monetary Policy.

Teaching Experience:

University of Pennsylvania:

Summer 2020	Introductory Macroeconomics (Undergraduate), Instructor
Fall 2019	Economics of the Family (Undergraduate), Teaching Assistant for Jeremy Greenwood
Spring 2019	Intermediate Macroeconomics (Undergraduate), Instructor
Fall 2018	Intermediate Macroeconomics (Undergraduate), Teaching Assistant for Luca Bossi

ITAM:

2008-2009	Intermediate Macroeconomics (Undergraduate), Teaching Assistant for Martina Copelman

Research Experience and Other Employment:

University of Pennsylvania:

2021 – 2023	Research Assistant to Guillermo Ordóñez and Harold Cole, University of Pennsylvania
2019 – Present	Research Assistant to Tim Landvoigt and William Diamond, University of Pennsylvania

ITAM, Mexico:

2016 – 2017	Research Assistant to Felipe Meza Goiz, ITAM, Economic Research Center (CIE, for its acronym in Spanish)

Central Bank of Mexico:

2013 – 2015	Research Assistant to Lorenza Martínez Trigueros, Central Bank of Mexico, Payment Systems Division

Ministry of Economics, Mexico:

2011 – 2012	Research Assistant to Lorenza Martínez Trigueros, Ministry of Economics, Undersecretariat of Industry and Commerce

Professional Activities

Conferences and Seminars:

* Presented by co-authors.

UPenn Macroeconomics Seminars (2021, 2022, 2023), UPenn Macroeconomics Student Talk Seminar (Various), ASSA Meeting* (2022), UBC Winter Finance* (2023), SFS Cavalcade* (2023), Cowles Conference GE* (2023).

Referee Experience:

Journal of Economic Theory, 2020
Young Economist Symposium

Honors, Scholarships, and Fellowships:

Honors:

2022	Honorable Mention, Marshall Blume Prizes in Financial Research, for "Printing Away the Mortgages: Fiscal Inflation and the Post-Covid Housing Boom" with Tim Landvoigt and William Diamond
2020	Nominated for Best 3rd Year Paper for "Restricted Mortgage Offering in the Great Recession" with Dick Oosthuizen

Fellowships:

2022-2023	School of Arts and Sciences Graduate Division Fellowship Award, University of Pennsylvania
2018-2022	Graduate Fellowship, University of Pennsylvania

2017 Ph.D. Fellowship, Central Bank of México
2015-2017 M.A. Fellowship, ITAM

Research Papers:

"Mortgage Choice and the Credit Guarantee" (Job Market Paper)

I analyze the general equilibrium effects of government-sponsored enterprises' credit guarantees for fixed-rate mortgages. I develop a macroeconomic model where borrowers choose between fixed-rate mortgages (FRMs) and adjustable-rate mortgages (ARMs) provided by a constrained financial intermediary. Relative to FRMs, ARMs typically have lower required payments during recessions generating lower and less cyclical default rates. Since the intermediary prices the exposure to credit risk, borrowers choose 60% of ARMs in an economy without credit guarantees. This outcome aligns with some European economies where ARMs are prevalent, and intermediaries maintain unhedged balance sheets against credit risk. With existing guarantees, the intermediary does not bear FRMs′ credit risk, resulting in a high insensitivity of the FRM rate to borrower′s leverage. As observed in the US, this leads to a 70% FRM share. Compared to the economy without guarantees, mortgage default rates are higher, while intermediary equity, borrower consumption and house price volatility increase. The difference in the general equilibrium impact of guarantees crucially relies on my model's novel feature of endogenizing the mortgage choice.

"Printing Away the Mortgages: Fiscal Inflation and the Post-Covid Housing Boom", with Tim Landvoigt and William Diamond.

We theoretically and quantitatively analyze the impact of fiscal and monetary stimulus during and after the 2020 Covid recession on output, inflation, and house prices. Our theoretical analysis clarifies that fiscal stimulus increases consumption demand in a recession by providing liquidity, by redistributing from savers to borrowers, and by lowering the return on saving if it causes future inflation. Future inflation only occurs if taxes after the recession do not increase to pay for the stimulus. In our quantitative analysis, we study a temporary shift to passive monetary policy with low responsiveness to inflation. Fiscally-driven inflation enabled by this passive monetary policy reduces the real value of both mortgages and government debt, so it increases the spending capacity and housing demand of credit-constrained homeowners. Together with transfer payments and large fiscal deficits during the Covid recession, this policy greatly reduces the recession's severity and causes high house prices and inflation similar to the data.

"Restricted Mortgage Offering in the Great Recession", with Dick Oosthuizen.

The literature has studied the ex-ante consequences of introducing teaser-rate mortgages (TRMs) on the housing and mortgage markets. We study how the ex-post restricted access to TRMs during the Great Recession amplified the housing bust. TRMs start with a low initial rate, with the expectation of a rate hike in the future. Empirically, we show that lower-income and younger households chose TRMs during the housing boom. At the onset of the crisis, the government-sponsored enterprises tightened restrictions on their purchases of TRMs, which induced intermediaries to increase their lending standards. To evaluate the impact of eliminating TRMs during the crisis, we use a dynamic general equilibrium housing model with long-term mortgages and a contract choice between fixed-rate mortgages (FRMs) and TRMs. The restricted contract choice amplifies the house price drop by 1 percentage point. Without the availability of TRMs, low-income and younger households are excluded from the mortgage market, leading to a decrease in housing demand that triggers a downward spiral effect on house prices. Without the restricted supply, the share of TRMs would nearly have doubled during the crisis.

Work in Progress:

"Flippers and the Business Cycle", with Agustín Díaz Casanueva and Sean McCrary

Skills:

Programming: MATLAB, Julia, R, STATA, Latex
Languages: Spanish, English

Research Statement

Germán Sánchez Sánchez*
University of Pennsylvania

My research interests lie at the intersection of macroeconomics, finance, and real estate. The core of my work consists of developing quantitative models for the housing and mortgage markets. I am particularly interested in understanding the consequences of policy interventions on the mortgage market and their effects on financial stability and welfare. To address these questions, I employ a combination of complex computational techniques and empirical analysis.

In my job market paper, titled **"Mortgage Choice and the Credit Guarantee"**, I propose that the mortgage credit guarantee provided on agency mortgage-backed securities, such as those issued by Fannie Mae, Freddie Mac, and Ginnie Mae, plays a significant role in explaining the prevalence of fixed-rate mortgages in the United States. In light of the housing finance reform proposals that have followed the 2008 financial crisis, which suggest eliminating (at least partially) the credit guarantee, I argue that it is essential to consider the endogeneity of mortgage choice when assessing the credit guarantee's impact on financial stability and the overall welfare of the economy. To address these questions, I develop a general equilibrium model in which borrowers choose between fixed-rate mortgages (FRMs) and adjustable-rate mortgages (ARMs) provided by a constrained financial intermediary. The government provides credit guarantees for fixed-rate mortgages in exchange for a premium payment, commonly known as the guarantee fee, paid by the financial intermediary.

The financial intermediary offers borrowers separate menus for FRMs and ARMs. The risk-taking capacity of the intermediary determines the risk-premium for default exposure. The resulting menus of mortgage interest rates price the mortgage default rates, which are endogenously solved by the borrowers. Mortgages are modelled as long-term contracts, such that the intermediary prices the entire repayment structure of each contract ex-ante at the moment of origination. Relative to FRMs, ARMs typically have lower required payments during recessions, thereby generating less cyclical and lower default rates. Reducing the cyclicality of default rates for FRMs is possible only when refinancing is frictionless, which is not the case. In an economy without credit guarantees the convexity of the mortgage interest rate for FRMs, as a function of the borrower's leverage, is larger compared to that of the ARMs contract. For borrowers with low loan-to-value ratios, mortgage rates for FRMs are approximately 30 bps higher than those for ARMs; this difference expands to 90 bps for highly-leveraged borrowers. As a result, borrowers choose 60% of ARMs due to the intermediary's pricing of credit risk exposure. ARMs and FRMs coexist because the default probability of a mortgage type increases with the quantity of that mortgage supplied.

When I calibrate my model to the US economy with the credit guarantee on FRMs, I observe a radical

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change in the menu of contracts offered by the intermediary. First, the guarantee lowers the interest rates for both mortgage contracts. However, since FRMs' credit risk is no longer priced, FRM rates become insensitive to borrower leverage. For highly-leveraged borrowers, the interest rate on ARMs is now around 120 bps higher than that of FRMs. Two results stand out: i) Around 70% of the outstanding mortgage balance consists of FRMs, as opposed to 40% in the model without the credit guarantee; and ii) the government insurance results in larger and riskier mortgage originations. Financial stability improves without guarantees. Compared to the economy without guarantees, mortgage default rates are higher, while intermediary equity, borrower consumption and house price volatility increase. These results align with observations derived from data in European economies without guarantees, where ARMs dominate as the primary mortgage product.

My research agenda on mortgage choice extends beyond my job market paper. While the literature has extensively studied the ex-ante consequences of introducing teaser-rate mortgages on the housing and mortgage markets, in my paper **"Restricted Mortgage Offering in the Great Recession"**, co-authored with Dick Oosthuizen, we focus on the ex-post consequences of limiting access to teaser-rate mortgages. Nontraditional mortgages with back-loaded payment structures gained popularity at the beginning of the housing boom in the early 2000s. Our paper uniquely focuses on teaser-rate mortgages, which are characterized by low initial interest rates followed by expected rate hikes. Firstly, we show that the share of teaser-rate mortgage originations increased from 14 percent in 2002 to 37 percent in 2004-2005, highlighting the relevance of these mortgages during the housing boom. We further demonstrate that primarily younger, lower-income households opted for teaser-rate mortgages during the same period.

The primary objective of the paper is to demonstrate that restricting mortgage choice during the Great Recession exacerbated the housing crisis. To achieve this, we developed a life-cycle general equilibrium model that incorporates housing, long-term mortgages, and the choice between fixed-rate mortgages and teaser-rate mortgages. In this paper, I emphasize borrower heterogeneity in mortgage choice, abstracting from the role of a constrained intermediary, as in my job market paper. Our findings indicate that restricted contract choices amplified the decline in house prices by approximately 1 percentage point and significantly increased foreclosure rates. We identify two primary channels contributing to these outcomes. First, constrained buyers face difficulties accessing the mortgage market due to restrictions on mortgages with back-loaded payment structures. Second, existing teaser-rate mortgage holders are unable to refinance into new mortgages. The restricted mortgage offering triggers a downward spiral effect on house prices because the demand for housing declines, not just due to borrowing constraints but also in response to the drop in house prices itself. Had there been no supply restrictions, the share of teaser-rate mortgages would have almost doubled during the crisis.

My third project, **"Printing Away the Mortgages: Fiscal Inflation and the Post-Covid Housing Boom"**, co-authored with Tim Landvoigt and William Diamond, addresses the impact of fiscal and monetary policy on the housing and mortgage markets. Our goal is to theoretically and quantitatively analyze the impact of fiscal and monetary stimulus during and after the 2020 Covid recession on output, inflation, and house prices. In our theoretical model, we identify three distinct channels by which fiscal stimulus can reduce unemployment in a recession, only one of which causes inflation. The first two are well-studied and widely recognized: liquidity enhancement and redistribution. The third channel, which is the most novel and rel-

evant channel on our paper, is that a fiscal stimulus causes future inflation after a recession only if future taxes are not raised enough to pay for the stimulus. This regime, known as the passive monetary policy regime, is characterized by a monetary authority that does not respond strongly to inflation, and a fiscal authority that does not respond strongly to government debt. This lack of future taxation requires debt to be inflated away instead. This inflation reduces the real value of outstanding mortgage debt, resulting in additional redistribution from savers to borrowers that causes a boom in house prices.

In our quantitative model, we study a realistic temporary shift to a passive monetary policy regime with low responsiveness to inflation. One unique feature of our model is that when the government inflates away its debt after the Covid recession, a boom in house prices occurs too. Private sector mortgage debt is inflated away as well, and constrained borrowers are allowed to afford more housing. Like the post-recession inflation in our model, this house price boom is transitory and reverts when the central bank raises rates enough to control inflation. In a counterfactual experiment we show that, without this specific policy response, the Covid recession would have featured a massive drop in consumption, deflation, a wave of mortgage defaults, and a drop in house prices which is counterfactual to the data. Hence our paper highlights the role that the government's loose policy had on consumption, inflation, and the housing sector in general, by printing away mortgage debt together with government debt.

My future work will expand on the importance of the housing and mortgage market in financial crises. For instance, I am also currently working on a project titled **"Flippers and the Business Cycle"**, co-authored with Agustín Díaz Casanueva and Sean McCrary. In this ongoing project, we investigate the impact of house flippers (`mom and pop' type investors) on financial crises. On one hand, these flippers provide a benefit to the economy by alleviating some of the search friction in the housing market through liquidity provision. On the other hand, when the bust arrives flippers have `no skin in the game' and default at higher-than-average rates. We are currently developing a general equilibrium search model with financial frictions which incorporates three key features from the empirical finance literature: (i) the measure of "flippers" is endogenous and procyclical, (ii) the marginal quality of flippers in terms of buy/sell spreads decreases during expansions, and (iii) the availability of credit determines the profitability of flipping. As a first goal, we plan to use the model to quantify the extent to which flippers propagate cyclical housing prices.

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Pronoun: She/Her/Hers
Computer Skills: MATLAB, STATA, R, Python

Undergraduate Studies:
B.A., Economics, Guanghua School of Management, Peking University, 2011

Masters Level Work:
Khenmo, Tibetan Buddhist Philosophy (summa cum laude), Larung Gar Five Sciences Buddhist Academy, Tibet, 2017

Graduate Studies:
University of Pennsylvania, 2018 to present
Ph.D. Candidate in Economics
Thesis Title: Understanding the Sources of Gender Disparities in STEM and in Marriage Markets
Expected Completion Date: May 2024

Thesis Committee and References:

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Research and Teaching Fields:
Primary Fields: Labor Economics, Economics of Education, Economics of Health
Secondary Fields: Machine learning and structural modeling applied to economics, especially in the topics of gender, labor, health, education, marriage market, and family economics

Teaching Experience:

At the University of Pennsylvania

2022 – 2024	Intermediate Microeconomics, teaching assistant
2019 – 2021	Introduction to Microeconomics & Macroeconomics, teaching assistant
Spring, 2021	Political Economy, teaching assistant

Research Experience and Other Employment:

08/2020 - 12/2022	Econometrician [Short-Term Consultant], World Bank
05/2020 - 07/2020	Research Assistant, Professor Toni Whited, University of Michigan
09/2017 - 04/2018	Visiting Researcher, China Center for Health Economic Research, Peking University, Beijing
02/2013 - 04/2017	Lecturer & Translator of Tibetan Buddhist Philosophy, Larung Gar Five Sciences Buddhist Academy, Tibet

Honors, Scholarships, and Fellowships:

01/2023	Travel grant from the Graduate Student Government of the School of Arts and Sciences at the University of Pennsylvania
11/2022	Travel grant from the Graduate Student Government of the School of Arts and Sciences at the University of Pennsylvania
07/2022	Travel grant from the Graduate Student Government of the School of Arts and Sciences at the University of Pennsylvania
2022-2023	Pilot grant ($18k) from the Population Aging Research Center at the University of Pennsylvania
2018-2024	Fellowship from the University of Pennsylvania
2013-2017	Outstanding Academic Scholarship from Larung Gar Five Sciences Buddhist Academy

Conferences & Seminars:

03/2023	Society for Benefit-Cost Analysis, Washington D.C.
01/2023	American Economic Association, New Orleans, Louisiana
11/2022	Southern Economic Association, Fort Lauderdale, Florida
07/2022	Western Economic Association International, Portland, Oregon

Research Papers:

"STEMming the Gender Gap in the Applied Fields: Where are the Leaks in the Pipeline?" **(Job Market Paper)**

In pure STEM fields, women are no longer a minority, but in applied STEM fields like computer science and engineering, their representation remains persistently low for nearly half a century. To understand where the leaks are in the pipeline, I develop and estimate a dynamic model spanning from high school to early career to examine four sources of female under-representation: initial skill gaps, preference differences, wage disparities in STEM sectors, and aversion to male-dominated occupations. In the National Longitudinal Survey of Youth - 1979 Cohort, males show a higher interest in STEM coursework and better STEM skills by 10th grade, primarily in mechanical skills, leading to wider skill disparities. Simulation results show that mechanical skills are more important than math skills in explaining women's low participation in applied-STEM fields and have contrasting effects on college enrollment and the selection of applied-STEM majors and occupations. Closing gender skill gaps upon exiting high school reduces female under-representation by 67% in applied STEM majors and 31% in applied STEM occupations. Removing the preference for female-dominated workplaces reduces female under-representation by 29% in applied-STEM majors and 85% in applied-STEM occupations. Equalizing wage offers in STEM sectors has a smaller effect (3% in majors and 10% in occupations). Mandating more high school STEM courses increases overall STEM participation but doesn't address the gender gap.

Award

2022-2023 Pilot grant ($18k) from the Population Aging Research Center at the University of Pennsylvania

Presentation

11/2023 Southern Economic Association, New Orleans, LA

"How Early Skill Gaps Contribute to Gender Differences in STEM Major and Occupation Choices: A Random Forest Approach," with Petra Todd, submitted

In the US, women go to college at higher rates than men, but they are less likely to choose applied-STEM college majors or occupations. Using the NLSY79 and 97 datasets, this paper assesses the importance of adolescent skill profiles and high school course-taking in explaining gender disparities in four-year college completion, college major, and occupational choices. It considers five cognitive skill measures (math, verbal, science, administrative, and mechanical) and one non-cognitive measure and examines gender skill convergence over a twenty-year time span. Results show that high-school-aged women in the NLSY97 cohort reached parity with men, on average, in mathematics skills and exceed men in verbal and noncognitive skills, but they lag behind in mechanical and, to a lesser extent, science skills. To identify the skill sets, course-taking, and family background characteristics that best predict entry into STEM majors and occupations, we estimate logistic and nonparametric random forest models. The estimates reveal that a combination of mathematics and mechanical skills along with intensive high school exposure to science and math courses are key predictors of choosing STEM majors and careers. A nonparametric decomposition approach is developed and used to quantify how eliminating gender skill disparities would affect entry into STEM fields.

Award

2022-2023 Pilot grant ($18k) from the Population Aging Research Center at the University of Pennsylvania

Presentation

03/2023 Society for Benefit-Cost Analysis, Washington D.C.
01/2023 American Economic Association, New Orleans, Louisiana
11/2022 Southern Economic Association, Fort Lauderdale, Florida

Work in Progress:

"Unraveling the Female Thinness Premium: Marriage and Employment"

This paper studies two mechanisms that jointly contribute to thinness premium in the marriage market: the economic mechanism and the non-economic mechanism. My empirical findings from the Panel Study of Income Dynamics (PSID) reveal that all else being equal, thinner females are more likely to marry richer males. A one-unit increase in BMI (Body Mass Index), roughly equivalent to a six-pound increase for a 5'6" figure, is associated with a 3.9% decrease in the husband's annual labor income for noncollege wives and a 4.3% decrease for college-educated wives. Using the Simulated Method of Moments to estimate a two-stage static matching equilibrium model, this paper determines whether the observed preference for thinner female partners in the marriage market is a result of assortative mating due to the thinness premium in the labor market or is driven by non-economic factors such as a preference for smaller body sizes or other traits associated with smaller body sizes, such as self-discipline, active social interactions, and positive social image. The estimation results indicate that the positive correlation between a husband's income and his wife's thinness is primarily attributed to a male preference for thinner spouses. Women with a BMI below 25 only earn 4% more income than those with a BMI above 25 (assuming all other factors are equal), but having a wife with a BMI below 25 significantly enhances a husband's utility, akin to a 1.15 times

increase in his consumption.

Presentation

11/2022	Southern Economic Association, Fort Lauderdale, Florida
07/2022	Western Economic Association International, Portland, Oregon

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Research Statement

I am an applied microeconomist with research in the areas of education, labor, marriage and health. My job market paper applies descriptive analysis and structural modeling techniques to better understand the sources of gender disparities in four skill domains (i.e., math, science, mechanical, verbal) and in STEM major/career choices. Another research paper uses machine learning methods to identify the key predictors of STEM education and career choices and develops and implements a dynamic sequential decomposition approach to quantity the relative contribution of different factors in explaining gender gaps. A third paper analyzes how men's and women's health investments relate to labor and marriage markets. A general focus on my research is on understanding gender disparities and disentangling the impact of different contributing factors.

My main job market paper, titled ***STEMming the Gender Gap in the Applied Fields: Where are the Leaks in the Pipeline***, examines how early-life skills shape education, college major, and occupation decisions, and how the gender skill gaps, along with other factors, contribute to differences in human capital accumulation, post-secondary education choices, college major selection, and occupation sector choices. My research aims to illuminate key contributing factors in explaining STEM-related education and career choices and evaluate their relative importance and study the effectiveness of potential policy interventions.

I use descriptive analysis and a discrete choice dynamic programming model to analyze individuals' decision-making processes related to high school course selection, college enrollment, choice of college major, and preferred occupational sector. Within this model, I establish four channels that contribute to gender disparities: initial 10th-grade skill gaps, choice-specific preference differences, wage offer disparities, and aversions to working in male-dominated occupations. Furthermore, it investigates how multi-dimensional skill profiles evolve and influence individual's decisions regarding education and career paths. My analysis shows that upon exiting high school, a higher level of mechanical skills alone makes the noncollege option more attractive, but combined with a higher level of math skills, it increases one's likelihood of choosing four-year college applied-STEM majors and subsequently applied-STEM occupations. Simulation results show that closing the gender skill gap in mechanical skills upon exiting high school lowers the percentage of women choosing four-year colleges by 8.8%, while increasing the percentage of women choosing applied-STEM majors by 2.5% and applied-STEM occupations by 1.4%. Mechanical skills are more important than math skills in explaining women's under-representation in applied-STEM college majors and occupations. Lower wage offers for women in applied-STEM occupations and an estimated strong distaste for working in predominantly male occupations also play important roles. Mandating more high school STEM coursework is effective in increasing overall STEM participation but has little effect on closing the gender gap. Equalizing wage offers across genders in STEM sectors reduces female under-representation only by 2% in applied-STEM majors and by 9% in

applied-STEM occupations.

Another of my research projects on the topic of gender disparities in the STEM pipeline, titled ***How Early Skill Gaps Contribute to Gender Differences in STEM Major and Occupation Choices: A Random Forest Approach*** (with Petra Todd), discovers that while math skills are the most important contributing factor in deciding how likely one is to choose a four-year college education, mechanical skills are the most important in deciding how likely one is to choose a four-year college applied-STEM major. We use the NLSY79 and NLSY97 datasets to assess the importance of adolescent skill profiles and high school course-taking in explaining gender disparities in four-year college completion, college major, and occupational choices. We perform a Principal Component Analysis (PCA) to examine the correlation structure among the ten ASVAB test items (i.e., *general science, arithmetic reasoning, word knowledge, paragraph comprehension, numerical operations, coding speed, auto and shop information, mathematics knowledge, mechanical comprehension*, and *electronics information*) and as a guide in constructing a lower-dimensional set of skill composites. Ultimately we consider five cognitive skill measures (math, verbal, science, administrative, and mechanical) and one non-cognitive measure and examine gender skill convergence over a twenty-year time span. Results show that high-school-aged women in the NLSY97 cohort reached parity with men, on average, in mathematics skills and exceed men in verbal and noncognitive skills, but they lag behind in mechanical and, to a lesser extent, science skills. The estimates reveal that a combination of mathematics and mechanical skills along with intensive high school exposure to science and math courses are key predictors of choosing STEM majors and careers. A nonparametric dynamic sequential decomposition approach is developed and used to quantify how eliminating gender skill disparities would affect entry into STEM fields and, thus, the gender composition therein.

My third paper, titled ***Understanding the Female Thinness Myth: Marriage and Employment***, is motivated by the observation that, all else being equal, thinner females are more likely to marry richer males. The empirical findings from the Panel Study of Income Dynamics reveal that a one-unit increase in Body Mass Index, roughly equivalent to a six-pound increase for a 5′6" figure, is associated with a 3.9% decrease in the husband's annual labor income for noncollege wives and a 4.3% decrease for college-educated wives. Using the Simulated Method of Moments to estimate a two-stage static matching equilibrium model, this study aims to determine whether the observed preference for thinner female partners in the marriage market is a result of assortative mating due to the thinness premium in the labor market or is driven by non-economic factors such as a preference for smaller body sizes or other traits associated with smaller body sizes, such as self-discipline, active social interactions, and positive social image. The structural estimation results indicate that the positive correlation between a husband's income and his wife's thinness is primarily attributed to a male preference for thinner spouses. Women with a BMI below 25 only earn 4% more income than those with a BMI above 25 (assuming all other factors are equal), but having a wife with a BMI below 25 significantly enhances a husband's utility, akin to a 1.15 times increase in his consumption.

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Undergraduate Studies:
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Graduate Studies:
University of Pennsylvania, 2017 to present
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Teaching and Research Fields:
Microeconomics, Health Economics, Labor Economics, Public Economics

Teaching Experience:

University of Pennsylvania **Philadelphia, PA**

Spring, 2023	Managerial Economics, Teaching Assistant for Ulrich Doraszelski
Fall, 2022	Introduction to Economics for Business, Teaching Assistant for Gizem Saka
Spring, 2022	Managerial Economics, Teaching Assistant for Ulrich Doraszelski
Fall, 2021	Introductory Macroeconomics, Teaching Assistant for Luca Bossi
Spring, 2021	Digital Economy, Teaching Assistant for Juan Castillo
Fall, 2020	Introduction to Microeconomics, Teaching Assistant for Anne Duchene
Spring, 2020	Health Economics, Teaching Assistant for Juan Pablo Atal
Fall, 2019	Intermediate Macroeconomics, Teaching Assistant for Dirk Krueger
Spring, 2019	Urban Fiscal Policy, Teaching Assistant for Holger Sieg
Fall, 2018	Intermediary Macroeconomics, Teaching Assistant for Alessandro Dovis

Research Experience and Other Employment:

2015-2016	Research Assistant for Michael Waugh, New York University, Stern School of Business

Professional Activities:

2023	Penn LDI Conference: A Prescription for the Future of Drug Pricing
2023	Empirical Micro Seminar, Department of Economics, University of Pennsylvania
2021-23	Empirical Micro Lunch, Department of Economics, University of Pennsylvania
2019	RSF Summer Institute in Social Science Genomics, Santa Barbara
2018	Philadelphia Workshop on Macroeconomics and Economic Policy, Philadelphia Fed & IER
2018	ASSA annual meeting, Philadelphia
2017	Philadelphia Search and Matching Conference, Federal Reserve Bank of Philadelphia

Honors and Scholarships:

2020-2021	Xingmei Zhang & Dai Yongge Graduate Fellowship, University of Pennsylvania
2018-2023	University Fellowship, University of Pennsylvania
2017	Best in Economics Panel Presentation Award, NYU undergraduate Research Conference
2017	Beta Gamma Sigma Honor Society, New York University, Stern School of Business

Research Papers:

"The Effects of the Affordable Care Act on Pharmaceutical Prices, Demand and Innovation" (Job Market Paper)

How do pharmaceutical firms and consumers respond to large-scale health insurance expansions? This paper hypothesizes and tests that the ACA demand shock mainly affects medicines targeting conditions that are prevalent in the working age population. Exploiting plausibly exogenous variation across medical conditions in their exposure to the ACA, this paper studies the causal effect of the ACA-driven demand shock on pharmaceutical prices, demand and R&D initiations. I find that the ACA demand shock increases preclinical R&D on conditions that are prevalent in older workers. Because higher quality medicines improve workers' health, one might expect labor productivity to go up in the long run. Conditional on lagged preclinical developments, I find no evidence that the ACA affects clinical R&D. In addition, I identify the existence of a pre-ACA price discount for medical conditions that are prevalent among younger workers. The insurance expansion of the ACA led pharmaceutical companies to increase prices of drugs consumed by younger workers and eliminated this price discount. I find no evidence that the ACA affects prescriptions per person.

Computational Skills: Stata, MATLAB, R, Latex

Languages: English (proficient), Mandarin (native), Cantonese (native)

Research Statement

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I am an applied microeconomist with research interests in health economics, labor economics and public economics. My job market paper, *"The Effects of the Affordable Care Act on Pharmaceutical Prices, Demand and Innovation,"* studies how pharmaceutical firms and consumers respond to large-scale health insurance expansions through the lens of the Patient Protection and Affordable Care Act (ACA).

The ACA initiated a large and unanticipated demand shock to the pharmaceutical industry mainly through insurance expansion to the working age population aged 19 to 64, whose average uninsurance rate declined from roughly 18% to 10% after the ACA. The elderly and individuals under the age of 18 are less affected by the ACA, because the former is nearly universally covered by the Medicare and the latter is generously covered under the pre-ACA Medicaid eligibility criteria. Because changes in insurance coverage imply changes in future profits, I hypothesize and test that the ACA demand shock mainly affects medicines targeting conditions that are prevalent in the working age group. Exploiting plausibly exogenous variation across medical conditions in their exposure to the ACA, I estimate the causal effect of the ACA-driven demand shock on pharmaceutical prices, demand and R&D initiations. An important empirical finding is that the ACA led pharmaceutical companies to increase prices of drugs consumed by younger workers.

Following previous literature on healthcare reform evaluation, I identify the exposure to the ACA demand shock using pre-reform market shares of medicines consumed by the policy-susceptible group in the 2006-2009 Medical Expenditure Panel Survey (MEPS). Under the assumption that disease prevalence and age group composition stay roughly constant around the reform, pre-reform market shares are valid proxy for the ACA demand shock. I control for time trends in disease prevalence and age demographics with condition and time fixed effect in my empirical specification. I define a medical condition j's "Target Market Share" in age group g ($TMS_{j,g}$) as the fraction of total prescriptions filled by individuals in age group g with condition j, before the reform. Disease conditions are at 3-digit ICD-9 level to assist mapping to the R&D dataset. For each condition, I construct $TMS_{j,g}$ for 3 different age groups g: 0-18, 19-64, 65+. $TMS_{j,19\text{-}64}$ is the proposed measure of the ACA demand shock. I use the 2 placebo market shares $TMS_{j,0\text{-}18}$ and $TMS_{j,65+}$ to validate $TMS_{j,19\text{-}64}$ as the correct measure of the ACA demand shock. Under the assumption that conditions with high and low $TMS_{j,19\text{-}64}$ follow parallel trend, a difference-in-differences specification with treatment intensity measures the causal effect of the ACA-driven demand shock on outcome variables of interests. I perform a causality test with the corresponding event study model.

The diff-in-diffs coefficients on $TMS_{j,0\text{-}18}$ and $TMS_{j,65+}$ are negative and insignificant across all outcome variables of interests, confirming the hypothesis that the ACA-driven demand shock mainly affects medicines targeting the working age group. Consistent with the standard effect of insurance, $TMS_{j,19\text{-}64}$ has a positive diff-in-diffs coefficient on price per prescription, which is statistically significant at the 10% level. A 1 percentage point increase in $TMS_{j,19\text{-}64}$ raises price per prescription by about 0.19%. The $TMS_{j,19\text{-}64}$ ranges between 0.00% and 9.15%, with mean at around 0.14%. This estimate translates to a 0.026% increase in price per prescription for a condition with average exposure to the ACA. This estimate reveals that the working age group becomes less price elastic after the ACA, allowing firms to charge higher prices for conditions that are more prevalent in this age group. In addition, I find that patients consume roughly the same number of prescriptions per person before and after the ACA, which suggests that the working age patients tend to follow physicians' instruction for prescription consumption. The corresponding event study on price per prescription reveals a potential violation of parallel trend assumption, with pre-form coefficients being negative and statistically significant at the 10% level. Post-reform coefficients are mostly

positive and statistically insignificant. These estimates suggest that conditions with larger $TMS_{j,19\text{-}64}$ are more cheaply priced before the reform, because they are less likely to be covered by insurance. The insurance expansion of the ACA has eliminated this price discount as the working age group becomes less price elastic.

To study the effect of the ACA on R&D, I construct quarterly entries of preclinical and clinical trials from the *Cortellis Investigational Intelligence database* (Cortellis). Using the "Cortellis-Indication-ICD9-Crosswalk" from Dranove et al. (2020), I classify targeted diseases in this proprietary dataset to their respective 3-digit ICD-9 categories and merge with $TMS_{j,g}$ variables from MEPS. For preclinical R&D, the diff-in-diffs coefficient on $TMS_{j,19\text{-}64}$ is positive and significant at the 1% level, with a 1 percentage point increase in $TMS_{j,19\text{-}64}$ boosting quarterly entries of preclinical trials by roughly 1.22 trials. The coefficient implies that a condition with average exposure to the ACA has roughly 0.17 more quarterly trials, which is about 5% of mean total quarterly entries at around 3.37. These estimates suggest that the ACA demand shock incentivizes firms to direct innovation towards conditions that are prevalent in the working age population. Because higher quality medicines improve the health of the working age population, one might expect labor productivity to go up in the long run. I find that the ACA-driven demand shock has no effect on *clinical* R&D, after controlling for lagged *preclinical* developments on the same condition. The corresponding event study on preclinical initiations finds support for the parallel trend assumption, with pre-reform coefficients being small and statistically insignificant at the 5% level. Post-reform coefficients are mostly positive and significant, with effect sizes decreasing slightly after 2014. Because the average duration from preclinical testing to Phase I clinical trial ranges from 31.2 to 52.0 months in the literature, this reduction in effect sizes suggests that some pharmaceutical firms with successful preclinical projects from 2010 might redirect their resources to clinical developments after 2014.

To investigate the ACA's heterogenous effects within the working age group, I subdivide individuals aged 19 to 64 into three roughly 15-year age groups and construct three corresponding $TMS_{j,g}$. For preclinical R&D, the diff-in-diffs coefficients on $TMS_{j,19\text{-}35}$ and $TMS_{j,36\text{-}50}$ are statistically insignificant. These estimates suggest that pharmaceutical firms do not anticipate large change in future profits from conditions prevalent in younger working age groups. This is reasonable because the younger workers, despite experiencing larger increase in insurance rate than older workers, tend to spend less per person due to better health status. The diff-in-diffs coefficient on $TMS_{j,51\text{-}64}$ is positive and significant at the 10% level, with a 1 percentage point increase in $TMS_{j,51\text{-}64}$ raising quarterly entries of preclinical trials by roughly 2.31 trials. The $TMS_{j,51\text{-}64}$ ranges between 0.00% and 6.15%, with mean at around 0.08%. This coefficient implies that a condition with average $TMS_{j,51\text{-}64}$ has about 0.19 more quarterly trials, which is about 5% of mean total quarterly entries at around 3.37. These estimates suggest that the ACA demand shock only stimulates pharmaceutical R&D on conditions targeting the oldest segment of the working age population. This more focused R&D effort improves labor productivity more effectively because older workers, compared with their younger counterparts, are more in need of health-enhancing medicines. The event study coefficients on $TMS_{j,51\text{-}64}$ exhibit a pattern similar to that of $TMS_{j,19\text{-}64}$'s coefficients, with effect sizes declining slightly after 2014. For price per prescription, all event study coefficients on $TMS_{j,g}$ are statistically insignificant, confirming the event study results from $TMS_{j,19\text{-}64}$ that there is no price difference between conditions with high and low $TMS_{j,19\text{-}64}$ after the reform. Nevertheless, the event study coefficients on $TMS_{j,19\text{-}35}$ reveal a pattern of pre-post coefficients similar to that of $TMS_{j,19\text{-}64}$'s coefficients, indicating a pre-reform price discount for conditions with larger $TMS_{j,19\text{-}35}$.