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2015 (Oral): Industrial Organization
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Dissertation Title: *Research Productivity and the Dynamic Allocation of NIH Grants*

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M.Phil., Economics, Yale University, 2015
M.A., Economics, Yale University, 2015
M.Sc., Econometrics and Mathematical Economics (Research), London School of Economics, 2011 (with distinction)
B.A., Economics and Statistics, University of California, Berkeley, 2010 (with honors)

Fellowships, Honors and Awards:

University Dissertation Fellowship, Yale University, 2017
Cowles Foundation Fellowship, Yale University, 2013-2016
Yale University Doctoral Fellowship, 2013-2017

Teaching Experience:

Teaching Fellow, Yale University
Economic Models of New Technology, Fall 2017
(undergraduate, instructor: Prof. Evangelia Chalioti)
The Economics of Innovation, Spring 2017
(undergraduate, instructor: Prof. Mitsuru Igami)
Firms, Markets and Competition, Fall 2016
(undergraduate, instructor: Prof. Evangelia Chalioti)
Econometrics III: Econometric Theory, Spring 2016
(graduate, instructors: Prof. Donald Andrews, Prof. Xiaohong Chen)
Econometrics IV: Time Series Econometrics, Fall 2015
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Research and Work Experience:

Research Consultant to Prof. Bruce Weinberg and Prof. Julia Lane,
the Ohio State University and the New York University, 2018 - present
Research Assistant to Prof. Xiaohong Chen,
Yale University, 2014-2015
Research Assistant to Prof. Susan Athey,
Microsoft Research New England, 2011-2013

Publications:

"Methods for Nonparametric and Semiparametric Estimation with Endogeneity: A Gentle Guide," (September 2016) with Prof. Xiaohong Chen, *Annual Review of Economics,* 8, 259-290.

Working Papers:

"Matthew Effect, Research Productivity, and the Dynamic Allocation of NIH Grants", (September 2018), *Job Market Paper*

Work in Progress:

"Reputation and Matching with Risk Choice: Theory and Estimation of Venture Capital Market" with Jin-Wook Chang, and Olav Sorenson, (Semptember 2018)

"The Scientific Production Function" with Adam Dearing, and Bruce Weinberg, (Semptember 2018)

"Competition and the Prolonged Duration of Postdoctoral Training in Life Sciences" with Donghyuk Kim, and Masayuki Sawada, (Semptember 2018)

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Dissertation Abstract

Chapter 1: Matthew Effect, Research Productivity, and the Dynamic Allocation of NIH Grants [Job Market Paper]

How should the government allocate research funding? This paper studies the impact of funding allocation policies on research output in the context of academic cancer research, which is heavily reliant on public funding from the National Institutes of Health (NIH). A myopically optimal allocation rule would fund the current "best" researchers. Because experience is likely an important input to researcher productivity, such a rule would tend to favor veteran researchers. Experience, however, can only be accumulated by doing research, which requires funding. Therefore, underfunding of young researchers would jeopardize the future of scientific advancement. This can be seen as a form of Merton's (1968) "Matthew Effect:" the more the researchers already have, the more they will be given. The NIH is well aware of the challenge and has implemented a series of policies to support novice researchers. How to allocate funds between veterans and novices depends on how funding affects current and future research output.

In this paper, I provide an empirical framework to examine the optimal funding allocation between veteran and young researchers and its effect on research output. I begin by estimating a research production function that incorporates funding and experience as inputs, recognizing that researchers also have unobserved productivities. To address the endogeneity of funding and experience, I exploit variation in the aggregate NIH budget as an instrument, combining this with frontier techniques in the literature (e.g., Ackerberg et al., 2015), which utilize the dynamic panel structure, on estimation of production functions. Using panel data constructed from NIH cancer research grant archives and publication data associated with these grants, my estimates reveal that funding increases not only immediate research output but also future output through the experience channel. In addition, the estimates show that unobserved total factor productivity (TFP) at the researcher level is persistent.

Using these estimates, I develop a funding allocation model in which the planner (the NIH) maximizes the discounted sum of research output by choosing an allocation from a pool of researchers with different characteristics to fund subject to a budget constraint. Due to

long-term impacts of funding, the planner needs to consider the effect of funding on experience and the persistence of TFP when deciding whom to fund. The funding allocation problem can be formulated as a dynamic programming problem where each state variable is the number of available researchers with a particular characteristic. My model has over 1000 state variables representing researcher characteristics, which makes the problem computationally intractable. I overcome this curse of dimensionality by adopting approximate dynamic programming techniques from the operations research literature (also known as reinforcement learning in the computer science literature).

The simulation results provide three main policy implications. First, a forward-looking policy with a discount factor of 0.9 produces 1% less current research output in the first five years but 5% more research output per year thereafter as compared to the myopic policy. Second, the actual funding behavior of the NIH appears to account for the intertemporal tradeoffs, although it may still underfund novice researchers: the discount factor rationalizing observed NIH funding decisions is about 0.75. Lastly, a temporary funding cut, similar to the one proposed by the current administration, would have a long-lasting effect on overall research output.

Chapter 2: Reputation and Matching with Risk Choice: Theory and Estimation of Venture Capital Market with Jin-Wook Chang and Olav Sorenson

Why do successful venture capital (VC) firms invest in safer start-ups? This paper studies the role of VC firms' reputations on investment choices. We define a VC firm's reputation as its perceived quality, determined by its investment performance. We first develop a theoretical model in which a VC firm decides which start-up to invest, where start-ups are differentiated by quality and risk level. We show that a higher reputation VC firm matches with a higher quality start-up, and is more likely to invest in safer start-ups. We then develop an empirical framework to quantify the importance of reputation in the VC market. We utilize the VentureXpert database, which contains the entire investment histories of nearly all VC firms and the outcome of the investments measured by the start-up's exit outcomes based on initial public offering or trade sale from 1961 to 2006. We use a dynamic discrete choice model for VC firms' investment decisions. Empirical results are work in progress.