

Application for NBER Economics of Digitization Tutorial

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Course of Study

With software and cloud-based technologies increasingly replacing hardware, many high-tech firms are finding that human capital has become their most important input for production. As a 5th year graduate student in Economics at Stanford University interested in the organizational and personnel economics of innovation and entrepreneurship, I have designed my course of study to better understand how firms producing digital products find, motivate, and incentivize highly skilled workers and engineers.

My interest in the incentives for workers on digital products began during a course taught by Petra Moser. Through her seminar, I learned about previous studies measuring the impact of intellectual property and licensing on subsequent innovation. Building on this previous literature, I researched and wrote a paper examining the empirical evidence regarding how the license choice of open source software products correlated with the subsequent usage and popularity of that software package.

In order to enhance my understanding of the incentives for workers on digital products, I enrolled in courses that would provide me with frameworks for analyzing the motivations of highly skilled workers in this market. I participated in a seminar on Personnel Economics taught by Eddie Lazear, Paul Oyer, and Kathryn Shaw, as well as a course on Contract Theory from Ilya Segal. In all of these courses, I sought out connections between the general frameworks presented and the specific nuances for digital producers. For example, through a course on Labor Economics taught by Nick Bloom I applied the classic ideas from Waldman (1984) regarding worker retention and public skill signaling to the decision of firms regarding whether to condoned or even incentivized participation in open source software projects.

As the popularity and adoption of software products often follows classic patterns of information diffusion, I also studied methods geared towards understanding social and economic network analysis. Under the guidance of Matthew Jackson, I learned about methods for modeling and investigating the factors that impact the pace of digital products being adopted as well as how open source contributors chose which repositories to give their time and attention.

Throughout my time at Stanford, I have found opportunities to work on project utilizing big data from online sources. As a research assistant for Jon Levin and Liran Einav, we analyze seven years of credit and debit card transaction data provided by Visa Inc. The goal of this project emphasizes both my interest in organizational economics as well as my interest in digitization. One of our projects asks to what extent have the benefits of online retail stores been through the increased availability of brands to areas without brick-and-mortar stores versus the convenience from time savings. Using time variation in the availability of brick-and-mortar stores versus the inception of corresponding online stores, we are able to study this nexus.

Finally, I have sought out teaching in the field of digitization. This past quarter, I served as a Teaching Assistant for Susan Athey's course, Management Economics 513: Platform Competition in Digital Markets. In addition, as a Teaching Assistant for a Business Strategy class I had the opportunity to teach about two-sided market economics and dynamics commonly found amongst online marketplaces.

Current Research

Increasingly, for-profit companies rely on open-source software, code that is posted online for anyone to freely use. While some of that code is posted by individual programmers, a large amount of open-source software and libraries are developed and maintained by companies. Thus, when one firm uses open-source software distributed by another firm, a tremendous amount of value is transferred that has not been analyzed or quantified by traditional economic metrics.

The primary focus of my current research is to estimate the value of open source packages sponsored by one company and freely used by another. In order to assess the value transferred, I have collected a large amount of data on the authors of open source contributions. In particular, I have linked open source contributors to their digital resumes. This enables me to track where a contributor worked during the time when they developed and uploaded source code. By tracking the employer of the contributors and companies that used the uploaded code, I am able to see the flows of valuable code across companies. Using Glassdoor salary data at the level of a job title, I quantify these transfers into monetary valuations.

Currently, I am asking a number of questions of this dataset that I constructed. First, who derives the benefits of open source contributions? Are the software packages that are most widely used coming from large or small firms? Do the majority of the benefits flow from contributions made by large, high wage firms to smaller, low wage firms and start-ups? In addition, using the resumes of open source contributors, I would like to ask the counterfactual question: in the absence of open source contributions from other firms, which software packages would firms have paid to recreate independently?

A second avenue of research analyzes the usage of open source contributions as signals of coders' potential productivity in the labor market for software engineers. Using data on open source contributions, I am able to discern coders' knowledge of various programming languages. I combine this data with information self-reported on digital resumes. What I have found thus far is that female coders underreport their knowledge of programming languages by self-reporting fewer of their known languages than their male counterparts. While the difference between male and female coders is small, this could have a large impact on the labor market outcomes for these workers.

As Professors Greenstein and Nagle estimated in their recent paper, billions of dollars of value are created by open source software. Furthermore, the sharing of these software packages between firms creates a digital infrastructure that is often overlooked. Simultaneously, open source contributions have become important signals used by employers and job seekers in the labor market for highly skilled engineers. Understanding these digital products and the incentives for workers to contribute to them is tremendously important for maintaining our digital infrastructure and creating innovations in the future.