Digital Economics

Avi Goldfarb
University of Toronto and NBER
(Based on the *Journal of Economic Literature* article with Catherine Tucker)

The Economics of Digitization: An Agenda for NSF

By Shane Greenstein, Josh Lerner, and Scott Stern

Motivation

Our starting point is the gap between research and recent changes brought about by digitization. The increasing creation, support, use, and consumption of digital representation of information touched a wide breadth of economic activities. In less than a generation digitization has transformed social interactions, facilitated entirely new industries and undermined others, and reshaped the ability of people –consumers, job seekers, managers, government officials, and citizens – to access and leverage information.

Key topics

- Understanding changes in market structure and market conduct
- Rethinking the design of copyright
- Redesigning incentives for innovation and creativity
- The economics of the commons
- The economics of privacy
- Measuring digitization with an eye towards open policy issues
- The absence of analysis untied to stakeholders

Authors, please upload your paper here

NATIONAL BUREAU OF ECONOMICS RESEARCH, INC.

Economics of Digitization

Shane Greenstein, Josh Lerner and Scott Stern, Organizers

February 24 and 25, 2011

SIEPR
Stanford University
Stanford, CA

PRELIMINARY PROGRAM

THURSDAY, FEBRUARY 24:

12:00 n	Lunch
1:00 pm	Introduction
1:20 pm	Jonathan Levin, Stanford University and NBER *Learning from Seller Experiments in Online Markets*
2:10 pm	Break
2:40 pm	Avi Goldfarb, University of Toronto *Privacy Regulation and Online Advertising*
3:40 pm	Break
4:00 pm	Panel: The Role of Copyright Preston McAfee, Yahoo! Research Fernando Laguarda, Time Warner Cable Gil Penchina, Wikia Molly Van Houweling, UC Berkeley
5:00 pm	Adjourn
6:30 pm	Group Dinner Il Fornaio Restaurant, 520 Cowper Street (at the Garden Court Hotel), Palo Alto.

FRIDAY, FEBRUARY 25:

8:30 am	Breakfast
9:00 am	Heidi Williams, MIT and NBER *Intellectual Property Rights and Innovation: Evidence from the Human Genome*
9:50 am	Break
10:10 am	Pam Samuelson, UC Berkeley *The Economics of the Digitization of Books As a Rationale for the Google Books Project and Settlement (and the Implications of Google Books for the Future)*
11:00 am	Break
11:15 pm	Panel: The Future of Digitization and its Governance, Ashlee Vance, Bloomberg Businessweek Hal Varian, Google Danny Goroff, Sloan Foundation
12:15 pm	Lunch and Adjourn

Economics of Digitization Spring 2012

DATE February 24, 2012 **LOCATION** SIEPR at Stanford University

ORGANIZERS Shane Greenstein, Josh Lerner and Scott Stern

The Attention Economy: Measuring the Value of Free Goods on the Internet

AUTHOR(S):

Erik Brynjolfsson, Stanford University and NBER
Joo Hee Oh, Massachusetts Institute of Technology

Copyright, Digitization, and Aggregation

AUTHOR(S):

Lesley Chiou, Occidental College
Catherine Tucker, Massachusetts Institute of Technology and NBER

The Effect of Localization on News Consumption

AUTHOR(S):

Susan Athey, Stanford University and NBER
Markus Mobius, University of Michigan and NBER

Ad Revenue and Content Commercialization: Evidence from Blogs

AUTHOR(S):

Monic Sun, Boston University

Piracy Propagation of Information Goods: Demand and Supply-side Dynamics in P2P Networks

AUTHOR(S):

Joo Hee Oh, Massachusetts Institute of Technology
Il-Horn Hann, University of Maryland

Contents

National Bureau of Economic Research, Inc.

To organize and support research on the economics of digitization

7 grants since the beginning

AMOUNT
$667,316

CITY
Cambridge, MA

INVESTIGATOR
Shane Greenstein

INITIATIVE
Economic Analysis of Science and Technology (EAS

Funds from this grant provide three years of support
National Bureau of Economic Research for expenses
with the continued operation of the Economics of Di
Working Group. Led by Shane Greenstein of Northw
Lerner of Harvard, and Scott Stern of MIT, the Econc
Digitization working group brings together a diverse
economists to examine issues related to the digital r

GRANTEE	AMOUNT	CITY	YEAR
National Bureau of Economic Research, Inc.	$724,000	Cambridge, MA	2017

To organize and support innovative research on the economics of digitization

PROGRAM
Research

SUB-PROGRAM
Economic Institutions, Behavior, & Performance

INVESTIGATOR
Shane Greenstein

Digitization changes everything. The rapid decline in marginal costs for information storage, processing, and networking, for example, challenges many basic assumptions of textbook economics. Traditional concepts and analytical tools provide limited help understanding recent phenomena such as on-demand labor markets, zero-cost reproduction of copyrighted material, or exclusively ad-supported consumption goods. This grant provides three years of continued support to the Economics of Digitization Working Group at the National Bureau of Economic Research. Under the leadership of Professors Shane Greenstein and Josh Lerner from Harvard and Scott Stern from MIT, the working group brings together top scholars to address issues such as digital markets for books, music, and the news; online privacy and piracy; government regulation of the internet; the economic implications of artificial intelligence; and the economics of two-sided markets. Grant funds will support two meetings of the working group per year, an annual student tutorial, a small grant program to support new work on the economics of digitization, and outreach and support to the growing community of researchers interested in working on these and related issues.

2021

The following is an overview of the activities of the NBER Digitization program

Digitization Tutorial: We hold a "tutorial" every year in conjunction with the Winter Meetings for about 50 PhD students interested in working on digitization-related topics in their research. PhD students come from diverse fields including Economics, Strategy, Marketing, IS and related fields. See below for the program on all of the past tutorials:

- **2015:** http://conference.nber.org/confer/2015/DTs15/DTs15prg.html
- **2016:** http://conference.nber.org/confer/2016/DTs16/DTs16prg.html
- **2017:** http://conference.nber.org/confer/2017/DTs17/DTs17prg.html
- **2018:** http://conference.nber.org/sched/DTs18
- **2019:** http://conference.nber.org/sched/DTs19
- **2020:** http://conference.nber.org/sched/DTs20

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Digitization Tutorial

Shane Greenstein, Organizer

March 5, 2015

SIEPR
366 Galvez Street
Room 130
Stanford University
Stanford, CA

SCHEDULE

8:30 am	Continental Breakfast
9:00 am	Introduction
9:10 am	First session (reading list) Erik Brynjolfsson, Massachusetts Institute of Technology and NBER
11:15 am	Second session (reading list) Susan Athey, Stanford University and NBER
12:45 pm	Lunch
1:45 pm	Third session (reading list) Heidi Williams, Massachusetts Institute of Technology and NBER
3:45 pm	Fourth session (reading list) (slides) Shane Greenstein, Northwestern University and NBER
6:00 pm	Group Dinner: MacArthur Park Restaurant 27 University Avenue Palo Alto, Ca 94301

Winter Meetings: We meet in the February / March every year at Stanford University to present and discuss latest research in the field in a 1-day conference. About 80-100 people participate every year. See below for programs from the past versions of these meetings.

- **2011:** http://conference.nber.org/confer/2011/EoDs11/program.html
- **2012:** http://conference.nber.org/confer/2012/EoDs12/program.htm
- **2013:** http://conference.nber.org/confer/2013/EoDs13/program.html
- **2014:** http://conference.nber.org/confer/2014/EoDs14/eods14prg.html
- **2015:** http://conference.nber.org/confer/2015/EoDs15/EoDs15prg.html
- **2016:** http://conference.nber.org/confer/2016/EoDs16/EoDs16prg.html
- **2017:** http://conference.nber.org/confer/2017/EoDs17/EoDs17prg.html
- **2018:** http://conference.nber.org/sched/EoDs18
- **2019:** http://conference.nber.org/sched/EoDs19
- **2020:** http://conference.nber.org/sched/EoDs20

Summer Meetings: We meet every Summer in conjunction with the NBER Summer Institute in Cambridge, MA to present and discuss latest research in the field in a 2-day conference. About 100-120 people participate every year. See below for programs from the past versions of these meetings.

- **2011:** http://conference.nber.org/~confer/2011/SI2011/PRIT/PRITprg.html
- **2012:** http://conference.nber.org/~confer/2012/SI2012/PRIT/pritprg.html
- **2013:** http://conference.nber.org/~confer/2013/SI2013/PRIT/pritprg.html
- **2014**: http://conference.nber.org/confer/2014/SI2014/PRIT/PRITprg.html
- **2015**: http://conference.nber.org/confer/2015/SI2015/PRIT/PRITprg.html
- **2016**: http://conference.nber.org/confer/2016/SI2016/PRIT/PRITprg.html
- **2017:** http://conference.nber.org/sched/SI17PRIT
- **2018:** http://conference.nber.org/sched/SI18PRIT
- **2019:** http://conference.nber.org/sched/SI19PRIT
- **2020:** http://conference.nber.org/sched/SI20PRIT

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Digital Economics†

Avi Goldfarb and Catherine Tucker*

Digital technology is the representation of information in bits. This technology has reduced the cost of storage, computation, and transmission of data. Research on digital economics examines whether and how digital technology changes economic activity. In this review, we emphasize the reduction in five distinct economic costs associated with digital economic activity: search costs, replication costs, transportation costs, tracking costs, and verification costs. (JEL D24, D83, L86, O33, R41*)*

1. *What Is Digital Economics?*

Digital technology is the representation of information in bits. This reduces the cost of storage, computation, and transmission of data. Research on digital economics examines whether and how digital technology changes economic activity.

Understanding the effects of digital technology does not require fundamentally new economic theory. However, it requires a different emphasis. Studying digital economics starts with the question of "what is different?" What is easier to do when information is represented by bits rather than atoms? economic models change as certain costs fall substantially and perhaps approach zero. We emphasize how this shift in costs can be divided into five types:

(i) Lower search costs

(ii) Lower replication costs

(iii) Lower transportation costs

(iv) Lower tracking costs

(v) Lower verification costs

Definitions

- ***Digital technology*** is the representation of information in bits.

- This has reduced the cost of storage, computation, and transmission of data.

- ***Digital economics*** examines whether and how digital technology changes markets.

What is different?

- “What is different if information is represented in bits?”

- “What is easier to do when information in represented in bits relative to when information is represented in atoms?”

Understanding digital economics

The focus of digital economics

Three ways to think about digital for economists:

1. Digital is a lab for testing existing models.

2. Digital motivates new models.

3. Digital makes some existing models more salient and important to understand. While these models might have been below the radar, now they matter.

The focus of digital economics

Three ways to think about digital for economists:

1. Digital is a lab for testing existing models
2. Digital motivates new models.
3. Digital makes some existing models more salient and important to understand. While these models might have been below the radar, now they matter.

Importance of (already-established) theory

- Empirical work has dominated the published research, and the NBER Digitization Conference.
- Still, theory motivates the most influential papers.
- Key models are pre-internet papers:
  - Hotelling (1929), Stigler (1961), Becker (1965), Akerlof (1970), Diamond (1971), Spence (1973), Butters (1977), Holmstrom (1979), Salop (1979), Varian (1980), Klein and Leffler (1981), Rosen (1981), Grossman-Shapiro (1984), etc.

Importance of (already-established) theory

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- **Generally, the key question is what happens to markets when the marginal cost of some, but not all, activities approaches zero?**

Organizing the literature

Five distinct changes

Thus far, the literature has emphasized five distinct changes:

1. Low search costs for information.
2. Zero marginal costs of production of information.
3. Low cost of transportation of information.
4. Low cost of tracking behavior.
5. Low cost of verification of information.

1. Low cost of search

- Price dispersion
- Efficiency
- Matching
- Two-sided markets and peer-to-peer markets

If the internet lowered search costs…

- Internet technology should reduce prices
  - Life insurance: Brown and Goolsbee (2002)
  - Books and CDs: Brynjolfsson and Smith (2000)
- Internet technology should lower price dispersion
  - It might have: Brynjolfsson and Smith (2000)
  - It is still substantial: Baye, Morgan, and Scholten (2004)
- Internet technology should reduce unemployment and vacancies
  - Mixed evidence: Autor (2001), Kuhn and Skuterud (2004), Stevenson (2008), Kuhn and Mansoor (2014)
- The types of products offered should change
  - Theory: Bar Isaac, Caruana, and Cunat (2012)
  - Long tail: Brynjolfsson, Hu, and Simester (2009), Fleder and Hosanagar (2009)
- The search algorithm should matter
  - Easy quality search reduces price sensitivity: Lynch and Ariely (2000)
  - Manipulation of the search process to raise margins: Ellison and Ellison (2009), Hossain and Morgan (2006).
  - The search algorithm affects matching: Hitsch, Hortacsu, and Ariely (2010)

2. Zero MC of production

- Open source/Wikipedia
- Public goods
- Government information
- Copyright and “Piracy”
- Bundling
- Inequality

Economics with zero MC

- **Old ideas are interesting again!**

- Copyright (and piracy)
  - Media revenues fall (Waldfogel, Smith/Telang, Zentner).
  - In the static model, piracy is good for welfare (Waldfogel).
  - Production costs fall so media quality and variety may be rising (Waldfogel).
- Public goods
  - Open source and Wikipedia. Why contribute? Biases in open platforms? (Greenstein/Zhu, Lerner/Tirole, Nagaraj)
- Inequality
  - Scalability of innovation without need for many employees.
- Bundling
  - Bundling models got interesting again! (Brynjolfsson)

3. Low cost of transportation

- Market definition and scope of competition
- Homogenization
- Online sales of physical goods
- Online sales of digital goods
- Collaboration
- Agglomeration vs dispersion
- Centralization vs decentralization
- Taxes and jurisdiction

Low transportation costs but location still matters

- Offline options matter
  - Balasubramanian (1998), Brynjolfsson, Hu, and Rahman (2009), Forman, Ghose, and Goldfarb (2009), Choi and Bell (2011), Lieber and Syversson (2012), Gentzkow and Shapiro (2011), Sinai and Waldfogel (2004)
- …Government policy
  - Taxes: Goolsbee (2000), Ellison and Ellison (2009), Anderson et al (2011), Einav et al (2014)
  - Copyright policy: Gomez Herrera and Martens (2014)
  - Privacy policy, cultural policy (play and download limits), etc.
- …Trust is easier locally
  - Jin and Kato (2007), Douglas, Hortacsu, and Martinez-Jerez (2009)
- …Spatial correlation in tastes (local culture)
  - Blum and Goldfarb (2006), Sinai and Waldfogel (2004), Gandal (2006), Gentzkow and Shapiro (2011)
- …Social networks are disproportionately local
  - Gaspar and Glaeser (1998), Hampton and Wellman (2002), Forman, Ghose, and Weisenfeld (2008), Agrawal and Goldfarb (2008), Agrawal, Catalini, and Goldfarb (2015)

4. Low cost of tracking

- Price discrimination
- Targeting and personalized advertising
- Privacy
- Data and analytics

Low tracking costs

- Price discrimination
  - Behavioral price discrimination (Fudenberg/Villas Boas, Shin/Sudhir, Acquisti/Varian)
  - Versioning (Bhargava/Choudhary, Fay/Xie, Rao, Lambrecht/Misra, etc.)
  - Too little (Shiller/Waldfogel)
  - First degree (Dube/Misra)
- Personalized advertising
  - Two-sided markets (Baye/Morgan, Athey/Calvano/Gans, etc.)
  - Targeting opportunities (Goldfarb/Tucker, Bergemann/Bonatti, Iyer/Soberman/Villas Boas)
  - Ad measurement (Lewis/Rao/Reiley, Blake/Nosko/Tadelis, Gordon/Zettelmeyer)
  - Pricing by auction (Varian, Edelman/Ostrovsky/Schwarz)
- Privacy
  - Price discrimination (Taylor, Acquisti/Varian)
  - Regulation (Goldfarb/Tucker, Johnson, Miller/Tucker, Kim/Wagman)

5. Low cost of verification

- Reputation systems
- Trust
- Brands
- User generated content and social media
- Blockchain
- Discrimination

Low verification costs

- Historically, branding (Tadelis, Waldfogel/Chen)

- Move to reputation systems
  - Ebay (Resnick/Zeckhauser, Cabral/Hortacsu)
  - Theory of feedback (Dellarocas 2003)
  - Intermediaries (Stanton/Thomas, Jin/Kato)
  - Reviews and user generated content (Mayzlin/Chevalier, Godes/Mayzlin, Fradkin)
  - Online reputation systems for offline products (Luca, Hollenbeck)
  - Manipulation of reputation systems (Mayzlin/Dover/Chevalier, Luca/Zervas)

- Secure payments
  - In developing markets (Economides/Jeziorski)
  - Through blockchain (Catalini/Gans)

- Discrimination
  - Reduced: Scott Morton/Zettelmeyer
  - Enabled by accident: Lambrecht/Tucker
  - Enabled on purpose: Edelman/Luca

Wrap-Up

Frameworks are useful

The opportunity

- In my own research, I try to think through what the new technology enables.
- This involves thinking through “what’s different?” and “what’s not different?”
- Often this can be see as a reduction in some kind of economic friction, or, in other words, a reduction in some kind of cost.
- You are in a nice position: Technology is changing rapidly and the literature has not caught up.

All times are Eastern Daylight Time

Wednesday, March 17

11:00 am	Warm Up
11:45 am	Digital Economics -- Avi Goldfarb, University Of Toronto And NBER (Reading: Digital Economics In The Journal Of Economic Literature)
12:45 pm	Group Discussion
1:15 pm	Break
1:45 pm	Joel Waldfogel, University Of Minnesota And NBER *Digitization, The Value Of New Products, And Product Discovery* *(**Reading1**)* *(**Reading2**)* *(**Reading3**)*
2:45 pm	*Break*
3:00 pm	*Fiona Scott Morton, Yale University And NBER* *Digitization And Antitrust* *(**Reading1**)* *(**Reading2**)* *(**Reading3**)*
4:00 pm	*Break*
4:15 pm	*Group Discussions*
5:00 pm	*Adjourn*

Thursday, March 18

11:00 am	*Catherine Tucker, Massachusetts Institute Of Technology And NBER* *Data, Privacy And Discrimination* *(**Reading1**)* *(**Reading2**)* *(**Reading3**)*
12:00 n	*Group Discussions*
12:30 pm	*Break*
1:00 pm	*Daniel Bjorkegren, Brown University* *Digitization And Developing Societies* *(**Reading List**)*
2:00 pm	*Group Discussions*
3:00 pm	*Break*
3:15 pm	*Digital Economics Wrap Up*
4:15 pm	*Adjourn*

- Over the course of this workshop, you will work in groups to develop and present a description of the biggest unanswered question in your research area.

- Each group will be assigned a number, and then you will work in those groups for your breakouts later today and tomorrow.

Group discussions

1. What is the biggest unanswered research question in your particular area of interest?
   - One sentence. Ending in a question mark.

2. Describe the idea, paper, or discussion point that you heard at the workshop that is most related to this unanswered research question.
   - Did it make the open research question clear? Why?
   - Did it make progress toward answering it? How?

3. (If time) Develop a concrete research idea to address the research question.
   - Core literature(s) that you will reference.
   - Overall framework for the research project.

I look forward to hearing your ideas over the next few days!

And in the future…

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QUESTIONS?