

Digital Economics†

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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 is 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

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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.

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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/Waldfoegel)
 - 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