INTRODUCTION

Technological advances in processing and communicating information have begun what may be the largest transformation of the economy since the industrial revolution. The dramatic improvements in information technology (IT) and information systems (IS) decrease the cost of activities and makes activities previously too expensive or cumbersome attractive.[1] As IT adoption proliferates both demand- and supply-side externalities increase, making the technology cheaper and more valuable to additional users, spurring further adoption and development of new applications. This virtuous circle has enabled the dramatic growth of applications and businesses. The economic models upon which many of these businesses are based on are old, e.g., auctions trace back to the Egyptians, but the ability to easily connect vast parts of the population to businesses and other users anywhere in the world makes raise new issues in new settings and for far wider ranges of applications.

At the beginning of the Internet boom, the popular press promulgated the view—often the view of firms either supplying the technology, using the technology, or funding the firms using and supplying the technology—that the Internet would cause everything to be different; with the primary difference being that competition between firms would be enhanced by creating frictionless markets and that information would be free.[2] One of the first and best attempts to deflate this hype was *Information Rules* by Carl Shapiro and Hal Varian. This book succeeded in bringing to bear in lucid text some of the academic literature on price discrimination and damaged goods, customer switching costs and lock in, and network externalities and the associated compatibility issues and standard wars. It is my hope that this volume will help further our scholarly understanding on these and other topics, which will be discussed further.

[1]The distinction between IS and IT is subtle and much debated, with IT often defined as actual information technology and IS as its implementation in complex activities and systems of activities. This volume focuses more on the economics of the IS uses, but these closely depend on the details of the economics of the underlying IT. See Footnote 3 in Dan Spulber's chapter for a more detailed industry definition of information systems.

[2]Table 1 in Dan Spulber's chapter in this volume provides an excellent summary of how reducing communication and computation costs can affect the way buyers and sellers interact.

Information has risen to prominence in economics, for example, the 2001 Nobel Prize or Fig. 1 in Baye, Morgan, and Scholten in this volume. However, economists often model technology in abstract ways. In contrast, IS researchers often focus on the details of the technology without fully exploring the implications of the systems' capabilities for economic interaction. This volume attempts to bridge these approaches by highlighting areas where IT is changing the importance of different economic forces and illustrating the economics that lay behind the use of many types of information systems.

While the areas of economics and other related disciplines impacted by the growth and improvements in IS are too numerous to catalogue and examine in a single volume, this book's chapters survey many of the most significant issues and our progress on them. The chapters in this volume focus on various individual interrelated subjects regarding the economics of information systems: the adoption and diffusion of information technologies; the pricing of data communications; the ways firms organize and transform themselves as information is better captured and disseminated within and across firms and customers; the means and tactics firms use to compete with each other; the manner in which firms interact with and distribute goods to customers; the methods and mechanisms for anonymous and infrequent interactions between users, firms, and customers in far reaching locations; and the type and use of information on customers and their behavior. These issues span areas of economics and disciplines within business schools.

The chapters that follow flesh these areas out in detail. With the chapters spanning such a broad topic from a variety of perspectives, there are many ways to structure and order the chapters. I choose simply to start with two chapters studying the aspects of the economics of the IT infrastructure: diffusion, adoption, and pricing of information and communication technologies. The next three chapters examine the impact IT is having on markets (networks of buyers and sellers), organization of firms, and methods of innovation. The remaining chapters focus on how IT is transforming firm competition through the frictions in competition, firms' knowledge of their customers, and improvements in the mechanisms by which prices are adjusted and information is collected.

In *Diffusion of Information and Communication Technologies to Businesses*, Chris Forman and Avi Goldfarb survey the literature on the adoption and diffusion of information and communication technologies with a focus on technologies that facilitate communication within and across firm boundaries. These technologies improve the monitoring and coordination capabilities of organizations. The chapter examines work on adoption costs and benefits and how these are influenced by firms' internal organization and firms' external environment. For the internal aspects, they examine how organizational characteristics, firm boundaries, internal decision-making rights, and individual incentives influence adoption. For the external

factors, they examine firms' geographic location—both rural versus urban and across countries, the role of network effects, and the interaction between the internal and external influences.

In *Economics of Data Communications*, Philipp Afèche surveys core aspects and roles of pricing data transport services with a focus on three fundamentally different types of service contracts: guaranteed services, congestion-prone best effort services, and adaptive bandwidth sharing. The discussion is organized according to a unifying framework that compares and contrasts the key features of service demand and delivery, develops the basic pricing principles for socially optimal allocation, studies issues of service differentiation and customer incentives, and considers iterative and dynamic price mechanisms. The chapter then examines the value of auctions for data transport services and closes with a discussion of the relative merits and challenges of alternative quality of service approaches.

After the first two chapters on the economics of the adoption and pricing of information communications technology, the book moves to three chapters covering IS and markets, organizations, and innovation at high levels. In *Networks and Two-Sided Markets*, Daniel Spulber represents decentralized and centralized two-sided markets using network theory to shed light on decentralized mechanisms in which consumers transact directly and centralized mechanisms operated by one or more firms acting as intermediaries. After an excellent introduction—as with many of the chapters, I recommend readers to study the introductory sections for less technical background on the topics; this chapter's introduction is particularly exceptional, the chapter explores the implications of costly communication for the design and efficiency of market mechanisms for allocations of homogeneous and differentiated goods in buyer–seller networks. Firms' employ IS to improve communication between buyers and sellers and to improve computation through centralized market mechanisms. Firms charging subscribers for admission to a communications network provide centralized allocation mechanisms that can increase economic efficiency and reduce transaction costs relative to decentralized exchange. The chapter also presents how the network can be used via double auctions to link buyers and sellers. Finally, the chapter considers the connection between search models and random networks and compares the efficiency of buyer–seller search with centralized assignments.

In *Organizational Structure*, Thomas Marschak examines formal models of organizations that regularly acquire information about a changing environment in order to optimize their actions.

Each member of the organization privately learns about particular aspects of the new environment. The organization operates a mechanism to process this information and act on it. The mechanism has various informational and agency costs and balances these costs against the benefits in performance. As costs drop, due to improved IT, the properties of good mechanisms, and hence the structure of the organizations that adopt them change.

In *Open Source Software: The New Intellectual Property Paradigm*, Stephen Maurer and Suzanne Scotchmer study how a new form of innovation and intellectual property is developing in information systems: open source methods for creating software which rely on voluntarily revelation of code. Open source incentives differ from other intellectual property paradigms, leading to different types of inefficiencies and different biases in R&D investment. Open source remedies a defect of intellectual property protection—the lack of requirements or encouragement to disclose source code. The lack of disclosure in proprietary innovation hampers interoperability in complex systems. The chapter analyzes developers' incentive to participate in open source collaborations, studies when open source is most likely to predominate, and evaluates the extent to which open source may improve welfare compared to proprietary development.

As noted above, the Internet was claimed to move us into a frictionless utopia where the "law of one price" would truly apply. In *Information, Search, and Price Dispersion*, Michael Baye, John Morgan, and Patrick Scholten establish that remarkably little progress has been made toward this idealistic state. The chapter provides a unified treatment of various search models that have been proposed to rationalize price dispersion in markets for homogeneous products: sequential search, fixed sample search, and clearinghouses. These models reveal that reduction or elimination of consumer search costs do not always reduce or eliminate price dispersion. The links the authors draw between the models is a significant contribution. The chapter further connects the search literature to mechanism design by showing how auction tools can simplify and even generalize existing results. The chapter concludes with an overview of the burgeoning empirical literature, which suggests that price dispersion in both online and offline markets is sizeable, pervasive, and persistent.

Just as IT changes consumers' ability to gather information about firms and their prices, information technologies and the Internet allow firms to keep, gather, and process more information about their past customers. This increase in information has led to the proliferation of customer relationship management practices in most industries. In *Behavior-Based Price Discrimination and Customer Recognition*, Drew Fudenberg and Miguel Villas-Boas examine how when firms have information about consumers' previous purchases, they can use it to offer different prices and/or products to consumers with different purchase histories—practice "behavior-based price discrimination" (BBPD). Throughout the chapter firms' commitment problem arises: although having more information helps extract more surplus with its current prices, consumers may anticipate this possibility and alter their initial purchases. A second theme is that more information may lead to more intense competition between firms, creating a potential prisoner's dilemma where each firm would gain from practicing BBPD, but industry profits fall when all practice it. The chapter also surveys the literature on firm competition, short- and long-term contracts

between firms and customers, and firms' optimal product lines under numerous variations.

One of the most important aspects of multi-period interactions between firms and customers is how consumers' past purchases impact their future ones, which implicitly produce one type of demand-side externality: switching costs. In *Information Technology and Switching Costs*, Pei-yu Chen and Lorin Hitt investigate how firms can influence consumer-switching costs with a focus on "information-intensive" markets which often have significant standardization and compatibility issues. The chapter presents a formal definition of switching costs, clarifies some general points about switching costs, and reviews some theoretical and empirical studies of IT and switching costs. The chapter highlights how switching costs arise endogenously in high-tech and information-intensive markets while discussing instruments for influencing these costs. Finally, the chapter provides a discrete choice model for managing and estimating customer switching costs.

While IT could benefit consumers by more precisely identifying their needs, it can also be used to price discriminate (as in BBPD) or to exclude individuals with less attractive characteristics. Furthermore, organizations sell customer information to third parties, subjecting their customers to their information being used "against" them more broadly. In *The Economics of Privacy*, Ivan Png and Kai-Lung Hui examine the issue of who should control what information is tracked and stored through an economic analysis of privacy. The chapter begins with the "free market" critique of privacy regulation. Because welfare may be non-monotone in the quantity of information—due to the cost of information or some consumers being priced out of the market when it is socially efficient for them to consume—there may be excessive incentive to collect information. This result applies to both non-productive and productive information and is exacerbated when personal information is exploited across markets. Furthermore, the "free market" critique does not apply to overt and covert collection of information that directly causes harm, for example, a flood of unsolicited promotions. The chapter then reviews research on property rights and the challenges in determining their optimal allocation to examine whether or not individuals might voluntarily or be paid to reveal their personal information.

IT enabling more flexible pricing policies has increased price discrimination in many ways. In *Product Bundling*, Xianjun Geng, Maxwell Stinchcombe, and Andrew Whinston study product bundling, especially for information goods whose low marginal cost and flexibility facilitates bundling. While bundling can reduce integration, transaction, and distribution costs, the straightforwardness of this argument has limited its presence in the literature. Therefore, this chapter focuses on bundling for price discrimination and bundling as a competition tool. Price discrimination arises most easily where buyer valuations over two products are negatively correlated. In general, bundling benefits a seller when it reduces valuation

heterogeneity and if marginal cost is low. However, these are not necessary conditions and the chapter explores when bundling emerges in a broader range of cases. Research on using bundling as a competition tool falls into two categories: entry deterrence (tying) and product differentiation. While the literature on using bundling for entry deterrence focuses on how a seller can fend off all rivals, the literature on using bundling for product differentiation asks the question of when two or more *ex-ante* homogeneous sellers can coexist and both reap positive profits using bundling.

Another aspect of pricing impacted by information technologies' ability to track and analyze information is dynamic pricing, also known as yield management or revenue management, which is most useful when the products expire at a point in time and where the capacity is fixed. Airlines are a natural instantiation of these characteristics and in the 1980s airline pioneered the use of complex IS to constantly monitor and vary their prices. In *Dynamic Pricing in the Airline Industry*, Preston McAfee and Vera te Velde go beyond surveying of yield management research to expand a common existing model to a more standard case. Then, by examining the efficient allocation, rather than the profit-maximizing allocation, the chapter shows that many of the conclusions attributed to profit-maximization are actually consequences of dynamic efficiency. The chapter proposes the perspective of selling options and suggests that airlines should sell two kinds of tickets: a guaranteed use ticket and a ticket that can be delayed at the airline's request. Finally, airline pricing data is used to generate stylized facts about the determinants of pricing, facilitating the evaluation of different models.

The prior chapters on firms' pricing decisions implicitly assume variants on posted price schemes. Improvements in IT also enhance the attractiveness of more general selling mechanism such as auctions. Auctions have the advantage of price discovery and the disadvantage of higher transaction costs. IS improve both sides of the trade-off in auctions favor by reducing the transaction costs of auctions and raising the value of price discovery by increasing the number of potential participants. In *Online Auctions*, Axel Ockenfels, David Reiley, and Abdolkarim Sadrieh provide an overview of some of the theoretical, empirical, and experimental research on online auctions. The chapter first compares theoretical single-object-auction results to experimental findings and empirical observations online. The chapter then focuses on auction design details: public and secret reserve prices including minimum bids and shill bids, late and incremental bidding, and the buy-now option. The buy-now option creates an outside option for bidders, which is also provided by parallel auctions and other outside options by other sellers. The chapter also discusses multi-object auctions, although these are both theoretically and empirically more difficult than the single-object auctions. Finally, the chapter concludes with general remarks on the design of online auctions.

When large numbers of buyer and sellers interact with one infrequently, reputation and brand become weaker and the adverse selection and model

hazard problems become more acute. Auctions are the most extreme example of this, but it is a widespread phenomenon. Online reputation mechanisms using the Internet's bi-directional communication capabilities mitigate these concerns by allowing individuals to share opinions and experiences on a wide range of topics. In *Reputation Mechanisms*, Chrysanthos Dellarocas surveys our progress in understanding the limitations inherent in these mechanisms. The chapter discusses how technology-based reputation mechanisms differ from traditional word-of-mouth networks, for example, the global reach and anonymity of online interactions. The chapter combines an overview of relevant work in game theory and economics as well as insights from computer science, marketing, and psychology to evaluate the design, evaluation, and use of reputation mechanisms in online environments.

I am very pleased with this volume. The authors deserve congratulations for their outstanding work. I want to thank all of them for this and for their forbearance in the delays in the publication process. I believe that the volume will provide a survey of our current state of knowledge in theses areas and frame the most fruitful directions for future research.

Terrence Hendershott