1

Introduction

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A lawyer, an engineer, a sociologist, and an economist are sitting in a bar. The lawyer says, "The sharing economy is a tough regulatory nut to crack. Platform-based systems clearly have the potential to benefit many participants in markets for rides, rooms, tasks, and so much else. But there is already exploitation and manipulation in these markets, and technology keeps outpacing our ability to regulate them." The sociologist adds, "Indeed, the social phenomenon of the sharing economy is so rapidly changing and developing that it is hard even to know what to call it – platform economy, gig economy, collaborative economy … And I would anticipate that the stakes will be even higher as the sharing economy spreads to markets for such things as energy and health care." The economist interjects, "No matter what you call it or what the context is, the key to a successful platform-based system is to understand how technologies, extrinsic incentives, and intrinsic motivations impact behaviors of all relevant stakeholders." The engineer comments, "If technology is the confounder here, could it also be part of the solution? Could we talk about designing platforms that address some of the social and regulatory problems we are seeing? And could such platforms succeed in the competitive market environment?"

While this conversation may start out sounding like a bad lawyer joke, the purpose of this book is to demonstrate that conversations like this are essential to understanding, designing, regulating – and participating in – the sharing economy of the future. This book is a product of just such a conversation (though it took place in a classroom, not a bar) among an interdisciplinary group of industrial, civil, and environmental engineers, computer scientists, sociologists, economists, business experts, and lawyers. Our purpose in coming together was to understand and address the challenges of the sharing economy. In our conversation, we noted the deep commonalities in our articulation of these challenges, even

as we used the varied vocabularies of our own disciplines. We also have come to recognize that addressing these challenges requires us to achieve convergence in our thinking.

The core argument of this book is that our predominant understandings of the sharing economy have led to a range of system-wide deficiencies even as the sharing economy has produced distinctive benefits and advantages for some (and at times many) of its participants. As the sharing economy continues to develop, it will be necessary to shape its development in order to correct those deficiencies. In particular, it is incumbent upon all of us to reengineer a sharing economy that is more equitable, democratic, sustainable, and just. But doing so will require us to reach new understandings of how to engineer, participate in, regulate, and govern future generations of the sharing economy. Our goal is to optimize not just toward efficiency in sharing markets and platforms, but also toward these other features. To achieve this goal, we must translate concepts of sharing into technological designs and applications. We must also examine closely the particular contexts in which such sharing has already occurred and in which it will likely occur as platforms continue to develop.

We intend for this book to serve as a template for convergent thinking – and convergent design – of sharing technologies, markets, and systems. Much of the literature on the sharing economy has noted its disruptive impact on markets and communities. The resulting fragmentation has produced marked inequalities in access, participation, and benefits. The first generation of sharing markets has led some commentators to ask shockingly basic, yet apt, questions: Will there be any workers in the sharing economy? Can we possibly know enough about these technologies to be able to regulate them? Is there any way to avoid the monopolization of assets, information, and wealth? By addressing these questions from a range of disciplinary perspectives, we provide a framework for finding meaningful answers to the core challenges created by this new and disruptive market force.

As this book describes, we all need the sharing economy more than we ever thought we would. However, to make the fairest and best use of the sharing economy, we also need interdisciplinary and systemic dialogue and research that can help us to understand its complexities. What is needed today is a convergent, transdisciplinary dialogue to understand, predict, design, optimize, manage, regulate, and govern the distributional impacts of the sharing economy. We envision that such dialogue will result in an enhanced capacity to integrate applicable findings and theories in business, law, and social science into ethical engineering design and practice. At the same time, such a dialogue will contribute to an understanding of how technological innovations create value for different stakeholders and how they impact society at large.

The purpose of this brief introductory chapter is to lay a foundation for the interdisciplinary conversation that follows in this volume. The contributors to this conversation present a range of perspectives and approaches to reengineering a more

just sharing economy. Our effort here is to provide the context and vocabulary that will make their contributions both more accessible and more impactful.

1.1 A BRIEF REVIEW OF THE SHARING ECONOMY'S ENABLERS

As a beginning point, it may be useful to examine the major enablers of the sharing economy at different development stages and across varied contexts. Except in certain communities where sharing predominates over private ownership (such as in Amish and some Native American communities in the United States and Kibbutzim in Israel), much of the world today operates with economic systems in which the concept of private ownership seems foundational. Thus, it is commonly perceived that the only way to consume any good is either to own it directly (typically after purchasing it at a market price) or to rent access to the good from somebody who owns it. However, ownership is inherently an inefficient arrangement for many assets and goods that are of low "granularity," defined by Yochai Benkler (2004) as the extent to which an asset is utilized relative to its total capacity. Examples of goods with a relatively low granularity are cars and trucks (unless they are driven constantly), second homes, private airplanes, and large equipment (such as lawn mowers or power drills). Some intangible assets (such as the ability and license to drive) may also fall into this category. Another inefficiency may stem from the high degree of "lumpiness" of many assets, defined as the impossibility of purchasing some rather than all asset features, such as the power of a computer's central processing unit (Benkler 2004). Owners may well prefer to reduce this inefficiency by unbundling and allowing temporary access to their assets and goods by consumers who would prefer to pay only for what is used and when it is used.

While theoretically such matching could be done by allowing market-based exchanges to allocate access to goods and expertise in such a way as to fully utilize available capacities, high transaction costs historically prevented exchanges that would otherwise benefit all parties involved. For example, imagine you own an apartment that you only visit infrequently. In order to be paid for use of its unutilized capacity when you are not there, you would need to first find somebody interested in a short-term rental of the type of apartment you own and in the given location; then figure out the contractual arrangements for receiving payment, organizing temporary access to your apartment, and guarantying that the apartment will not be damaged; and finally, be able to trust your counterparty to fulfill their part of the contract. Munger (2018) refers to these three components of transaction costs as *triangulation* (information about identity and location, and agreement on terms, including price), *transfer* (a way of transferring payment and goods that is immediate and as invisible as possible), and *trust* (a way of outsourcing assurance of honesty and performance of the terms of the contract).

While access-driven economic activity is not new, such as the apartment rental described, substantial decreases in these transaction costs enabled by

rapid advances in information and communication technologies have spurred the development of the modern sharing economy. Founded in 1995, eBay pioneered a peer-to-peer retail marketplace model. Though it is often described as just a distant cousin of today's sharing economy (Sundararajan 2016), the reputation and feedback systems the company created for building the trust needed for online markets to work have substantially impacted the ways that sharing economy platforms digitize trust today. Triangulation and transfer costs for sharing economy participants also declined as smartphones, geolocation services, online social networks, and digital payments became ubiquitous in the latter half of the 2000s.

Once consumerization of digital technologies lowered transaction costs, another major driver of the sharing economy's growth occurred in the form of socioeconomic changes following the Great Recession. Many owners of assets and skills saw the new opportunities enabled by sharing economy platforms as a means of replacing lost earnings resulting from unemployment during that period. At the same time, consumers were looking to save by shifting from purchasing and maintaining goods to paying for access only. Beyond purely economic reasons, two other consumer trends sped up sharing economy growth over the past decade and a half. First, it was generally assumed that many younger consumers no longer considered car or home ownership as an important status symbol, with one survey finding that 43 percent of American consumers viewed such ownership as mainly a hassle associated with acquiring, maintaining, storing, and securing assets (PWC 2015). However, as the final chapter of this book discusses, this assumption must be reevaluated based on the structural changes in people's consumption patterns since the early 2020s. Second, the same survey found that environmentally friendly and sustainable consumption has been growing in importance, especially for younger consumers, and that 76 percent of American adults who are familiar with the sharing economy believe that sharing-based business models are more environmentally friendly (PWC 2015). (Eckelman and Kalmykova discuss the extent to which this belief is matched by reality in Chapter 2 on the sharing economy and environmental sustainability.)

1.2 THE SHARING ECONOMY TODAY

Today, the increasing digitization of the economy and resulting growth of digital platforms have dramatically altered how individuals, organizations, and governments exchange and allocate resources. Experts believe that by 2025, over $60 trillion (approximately 30 percent of forecasted total world revenue) will be mediated by digital sharing economy platforms (Atluri et al. 2017). Such platforms have already disrupted multiple industries, upended labor economics and practices, and fundamentally transformed resource management, asset allocation, and market design. These heterogeneous impacts have produced a range of conundrums.

As an economic matter, even though sharing economy platforms were quick to capture large market shares and change the way society acquired services, to date many of these platforms are still not profitable. Their costs of operations are higher than the revenue they generate. For example, Uber had operating losses exceeding $8.5 billion in 2019 (Statista 2021). Many experts believe that some of the largest sharing economy platforms are not optimally designed because they are too complex and offer too much flexibility. As an economic proposition, this drives up operating costs (Lee and Nahmias 1993). These design features, combined with artificially low prices that are intended to capture larger shares of the market as fast as possible, have resulted in some business failures and many examples of businesses operating without profits for extended periods – despite their development and dissemination of new technologies.

From sociological and regulatory perspectives, platforms have democratized the provision of and access to services and products with low entry and transaction costs. Yet their broader impact on society remains unknown. For example, during the COVID-19 emergency, knowledge of the design and operation of digital platforms enabled the quick development of platforms that took in demand and supply information and guided the matching of severely limited resources to urgent need. The repeated success of such platforms operating in core sectors, for example in matching medical personnel to nursing homes (Zarei et al. 2021; Zarei et al. 2023), saved lives and built societal resilience. However, the pervasive adaptation of digital platforms to different uses has outpaced knowledge about and regulation of the societal impacts on the workforce, public services, the environment, information privacy, and equity. One need look no further than examples such as the impact of Airbnb on housing affordability (Barron et al. 2018), concerns related to user data sharing across different digital platforms (Chakravorti 2020), or Amazon's direct competition with its own suppliers (Zhu and Liu 2018) to understand why the developers of new sharing economy technologies, namely engineers and computer scientists, must consider the social effects of these new technologies. These same phenomena demand the attention of policy makers and regulators, for whom it is now imperative to understand digital platform technologies that enable sharing economy ecosystems.

The economic, sociological, and regulatory challenges posed by the sharing economy are exacerbated by the enormous complexity of sharing economy systems (see Chapter 2), which produce many potentially unexpected consequences. As our contributors discuss, one should not evaluate the environmental impact of bike-sharing systems without considering the emissions from vans used to reposition bikes throughout the cities (Chapter 3). Similarly, the congestion and emissions impacts of delivery lockers could depend on many factors including population density, customer preferences, and other mobility patterns, as well as how customers and lockers are distributed over the area of concern (Chapters 3 and 12). Hence in many cases the answer to the question of total societal impact of a sharing economy system, or the appropriate regulations, is "it depends." Any truly meaningful version

of this answer calls for holistic and systemwide analysis, evaluation, and redesign of sharing economy ecosystems with a multidisciplinary perspective that considers the impact on all stakeholders.

1.3 THE SHARING ECONOMY OF TOMORROW? THE CHALLENGE OF REENGINEERING A COMPLEX SYSTEM

From an engineering perspective, the multiple conundrums posed by the sharing economy raise the following urgent question: Can we envision future sharing economy systems that have sustainable business models and contribute to the public good while producing minimal negative externalities? The very question smacks of an engineering perspective – a sweet spot between those who love and those who hate the sharing economy. This perspective includes a problem-solving approach and involves understanding, recognizing, and modeling various trade-offs. It requires the use of broad design methodologies not just to balance the underlying trade-offs between business efficiency and societal benefits, but to push their frontiers to enable system-level improvements for the benefit of all relevant stakeholders. Finally, it posits that sharing conducted over technology-enabled platforms covers a wide spectrum of needs, behaviors, resources, applications, and goals. Thinking about the entire spectrum of sharing economy markets and behaviors as a system can be a powerful mechanism that enables the design of sharing technologies toward certain goals, a process that engineers describe as optimization.

The engineering system perspective also can help broaden the notion of the engineering design process. This can be achieved by pushing the boundaries of *engineering* beyond just the task of satisfying the technical requirements of sharing platforms. It requires the adoption of a sociotechnical approach to design decisions, related to platform algorithm and architecture, within an ecosystem that includes various stakeholders' perspectives, market mechanisms, and regulation and governance considerations. As several chapters in this book show, this sociotechnical perspective is essential for asking the right questions and identifying key trade-offs.

Crucially, optimizing in the direction of a more equitable, fair, and just sharing economy is a fundamentally interdisciplinary pursuit. Indeed, the push to generalize the engineering approach in the direction of sociotechnical systems is not just coming from the engineering community. Social scientists, especially economists, have increasingly been moving beyond simply examining existing markets into designing and engineering new ones (Roth 2002).

Moreover, this new and audacious optimization challenge will require convergent thinking and solutions. Presently, enormous gaps exist among different disciplines, and between different sectors of the sharing economy, on questions as fundamental as the *normative value* of sharing. What does collaboration mean? What goals underlie the impulse to share and how do those goals translate into technology design? Who are the appropriate beneficiaries of the sharing economy?

Such basic questions currently generate widely divergent answers depending on who is asked. While existing scholarship about the sharing economy examines critical issues and concerns, much of this scholarship is limited just to one disciplinary focus and often just to one or a few sectors of the sharing economy. However, to address a core problem such as inequitable access, the sociologists and lawyers among us must articulate the behaviors that lead to such inequities, the economists and psychologists must disentangle how external market forces and internal human motivations lead to such behaviors, and the engineers and computer scientists must design technological responses to such behaviors. Convergent thinking is an essential feature in addressing this core challenge.

Consider the possibilities enabled by combining the systemic perspective and engineering approach. One area of significant research progress could involve the development of more informed approaches to platform governance. Platform governance is a set of guiding principles that determine who makes what decisions about the platform (Gorwa 2019). Such decisions address the rules and modes of interaction among different sides of the platform. They also structure the interaction of key constituents in the platform ecosystem, such as users, workers, platform owners, local and national governments, complementary businesses, and regulatory authorities. One goal of reengineering sharing should be to create and evaluate a set of metrics relevant to platform governance. By means of cross-sectional analysis, comparison of different sharing markets using both qualitative and quantitative methodologies, historical analyses of the first generation of sharing technologies, and controlled experiments, it should be feasible to promote and nurture certain features of sharing markets and also to inhibit and limit other features. Another goal should be to identify decisions – by the platform owners or regulators – that could act as leverage points to implement the desired outcomes. This book applies systemic approaches such as this in a range of sharing economy contexts and to address a variety of contemporary conundrums in the sharing economy.

1.4 THE APPROACH OF THIS BOOK: A BRIEF OVERVIEW

In meaningful respects, the contributions to this volume are intended to demonstrate the core principle of this book, namely that reengineering the sharing economy to optimize for goals such as sustainability, fairness, and equity will require interdisciplinarity and convergent thinking. We intend for the interdisciplinary approaches that are described in this volume to help platform owners with a range of decisions to increase their value and make their business models more sustainable. Such decisions at times concern familiar technologies that can be redesigned to produce better matching between different sides of the platform or better resource-management solutions (for example, more efficient routing algorithms). They also include design decisions geared to more complex sociotechnical constructs such as trust towards the platform or the optimal level of control over platform-enabled transactions.

We also intend that the full range of our contributions will be relevant to policy-makers and researchers interested in developing new principles for regulating and governing the sharing economy. The theoretical foundations and methodologies discussed in this volume are intended to provide interdisciplinary guidance to those seeking to create better outcomes for a broader collection of stakeholders.

Finally, and as importantly, we intend for this volume to be a source of information for consumers and workers involved in the sharing economy. Still today, much of the most informative work on the design, operation, and regulation of the sharing economy is written for sharing platform proprietors – and not for users. This volume is intended to correct that informational imbalance by providing straightforward, often critical, perspectives on a range of sharing economy platforms.

Part I provides a cross-disciplinary theoretical foundation for engineering a more just sharing economy. The Part includes six chapters, each of which provides a discrete disciplinary perspective on the sharing economy while also connecting that perspective both to the development trajectory of the sharing economy and to other disciplinary approaches required to reengineer – and redirect the development of – the sharing economy. Chapter 2 explicates the sociotechnical ecosystem perspective on the sharing economy that serves as the foundation for much of the convergent thinking undertaken by the interdisciplinary group that has contributed to this volume. This perspective takes a multi-stakeholder approach that includes platform owners, policymakers, and users, and that incorporates contextual and stakeholder forces that drive the formation and evolution of sharing economy systems.

Chapter 3 uses an environmental engineering and design perspective to evaluate the extent to which the key rhetorical norm of sustainability in the sharing economy has in fact been made a reality. The chapter documents the unintended consequences that have been observed for different sharing platforms, including for mobility, housing, and secondhand goods, many of which are mediated by the economic rebound effect, concluding that the real story of sustainability in the sharing economy is quite complex.

Chapters 4 and 5 provide perspectives from economics and market analysis by focusing on core issues that connect consumers with proprietors in sharing economy markets. Chapter 4 examines the exchange of information among various stakeholders in sharing economy systems and provides a comprehensive framework for examining the privacy issues that recurrently arise in this context. Chapter 5 addresses the development of feedback and reputation systems that are critical for fostering trust and are central to the operations of every sharing economy platform.

Chapters 6 and 7 add the perspectives of additional stakeholders in the sharing economy. Written by two sociologists, Chapter 6 provides essential information about the rights, needs, and treatment of workers across a range of sharing economy platforms. The chapter provides multifaceted perspectives on labor in the sharing economy. As with many of the contributions to this volume, the chapter concludes by raising a number of important questions that must be answered in the journey

toward a more just sharing economy. Chapter 7 contributes a legal perspective on the sharing economy. After surveying the regulatory approaches to the first generation of sharing platforms, this chapter proposes new regulatory principles for governing future sharing economy systems.

Part II of the book offers a range of disciplinary perspectives on both highly popular sharing economy contexts and markets, and on some that are new and emerging. Part II-A covers the popular contexts of mobility and lodging. Although these contexts have been the subject of significant study, the contributions in this section add important new perspectives, often as a result of new methodologies and original research.

Chapters 8 and 9, both written by engineers, cover ride sharing and mobility platforms. Chapter 8 focuses largely on the significant externality of traffic congestion. The chapter analyzes the current debate on the impact of ride-sharing services on urban traffic congestion and proposes future research opportunities that could help settle this debate. Chapter 9 takes a broader perspective on mobility platforms by examining the tension between on-demand mobility and shareability. Relying on original empirical research using a large dataset, the chapter proposes alternative business models to improve shareability.

Chapter 10, which reflects collaboration between engineering and public policy experts, also features original empirical research, in this case focusing on the multiple effects of Airbnb at the neighborhood level. According to this chapter, as sharing economy platforms have provided new mechanisms for transactions and commerce, they have shifted *where* such transactions are most likely to occur. Understanding the externalities produced as a result of this geographical shift is crucial for advancing the design state of platforms, and for supporting policy makers in crafting effective regulations.

Part II-B of the book focuses on freshly emerging sharing contexts, specifically the domains of energy systems and last mile delivery. Chapter 11, which also features a collaboration among public policy and engineering scholars, explores the integrated potential of technological and social innovations enabling sharing in future energy systems. As this chapter discusses, sharing in future energy systems has the potential to radically disrupt relationships governing utilities, energy consumers, and distributed electricity generation at the individual and household levels, at the community and organizational levels, and at the regional, state, national and even international levels. The chapter also explores the potential for such sharing to contribute to the concept of "energy democracy." Chapter 12 examines the potential for sharing platforms to improve options for last mile delivery while also optimizing for positive societal impacts. As this chapter discusses, sharing economy platforms may provide a promising solution for reducing both delivery costs and emissions in last mile delivery. The chapter identifies the gaps and opportunities for improved economic, social, and environmental outcomes in last mile delivery systems.

This volume concludes with a chapter drawing substantive lessons that provide a framework for engineering a just sharing economy. We consider some of the

core principles and features that should be relevant to those engaged in convergent thinking about future sharing economy systems. We also highlight key questions for future research and exploration. As we discuss, while there are still many unknowns, there is also great potential for future sharing platforms to optimize for a range of socially beneficial outcomes.

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