Owning, Using and Renting: Some Simple Economics of the "Sharing Economy"*

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January 15, 2019

Abstract

New Internet-based "sharing economy" markets enable consumer-owners to rent out their durable goods to non-owners. We model such markets, and explore their equilibrium both in the short-run, before ownership decisions can be revised, and in the long-run, in which they can. We find that "sharing economy" markets always expand consumption and increase surplus, but may increase or decrease ownership. Our analysis also considers the costs of bringing unused capacity to the market. To complement our theoretical work, we conduct a survey of consumers, finding broad support for our modeling assumptions. For example, ownership is determined by individuals' forward-looking assessments of planned usage weighed off against the price of the good. The survey also allows us to offer a partial decomposition of the bring-to-market costs, based on attributes that make a good more or less amenable to being shared.

*Thanks to Andrey Fradkin, Samuel Fraiberger, Joe Golden, Ramesh Johari, Arun Sundararajan, and Hal Varian for helpful discussions and comments. Author contact information and code are currently or will be available at `http://www.john-joseph-horton.com/`.

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1 Introduction

In traditional rental markets owners hold assets to rent them out. In recent years, several firms have created a new kind of rental market, in which owners sometimes use their assets for personal consumption and sometimes rent them out. Such markets are referred to as *peer-to-peer* (P2P) or "sharing economy" markets. To be sure, some renting by consumer-owners has long existed, but given the high transaction costs per rental, it was largely confined to expensive, infrequently used goods, such as vacation homes and pleasure boats, usually with rental periods of longer duration. More often, goods were shared among family and friends, commonly without explicit payment. In contrast, these peer-to-peer rental markets are open markets, and the good is "shared" in exchange for payment.

Airbnb is a prominent example of a P2P rental market, enabling individuals to rent out spare bedrooms, apartments, and entire homes. Airbnb and platforms like it have been heralded by many, as they promise to expand access to goods, diversify individual consumption, bolster efficiency by increasing asset utilization, and provide income to owners (Sundararajan, 2013, 2016; Edelman and Geradin, 2015; Botsman and Rogers, 2010). The business interest in these platforms has been intense; Airbnb alone has attracted nearly $4.4 billion in venture capital investment and was valued at $31.5 billion during its most recent funding round.[1]

Companies organizing sharing markets have also attracted substantial policy interest, much of it negative (Slee, 2015; Malhotra and Van Alstyne, 2014; Avital et al., 2015; Filippas and Horton, 2018). Critics charge that the primary competitive advantage of these platforms is their ability to duck costly regulations—regulations that protect third-parties and remedy market failures.[2] However, the counter-argument is often made that existing regulations were designed to solve market problems that these sharing economy platforms solve in an innovative fashion, primarily with better information provision and reputation systems, thereby making top-down regulation unnecessary (Koopman et al., 2014). Progress in advancing this policy debate requires a better understanding of these markets—particularly, what economic problem these markets address, why they are emerging now, and what their properties are likely to be in both the short- and long-run. This is the goal of this paper.

[1]See `http://www.crunchbase.com/organization/airbnb`. Uber, which also has a substantial P2P rental market—albeit with a substantial labor component—was valued at $62.5 billion in their last funding round (see `https://techcrunch.com/2018/05/23/uber-q1-2018/`).

[2]For example, Dean Baker, in an opinion piece for the Guardian characterizes Airbnb and Uber as being primarily based on "evading regulations and breaking the law" (see also `http://www.theguardian.com/commentisfree/2014/may/27/airbnb-uber-taxes-regulation`, accessed online January 15, 2019). Edelman and Geradin (2015) discuss both the promised efficiencies of "sharing economy" platforms as well as the regulatory issues they raise. Cannon and Summers (2014) offer a playbook for sharing economy companies to win over regulators.

Our first major question is why P2P rental markets only became a force in the 21st century. The economic problem P2P rental markets are able to solve—under-utilization of durable goods—is hardly new. We argue that technological advances, such as the mass adoption of smartphones with high-definition digital cameras, and the falling cost and rising capabilities of the Internet, while clearly important, only provide part of the story. In addition to technological advances, P2P rental markets rely heavily on the hard-won industry and academic experience in the design and management of online marketplaces.

In particular, we identify three broad categories of mechanisms/features intended to solve characteristic problems of matching markets, and which are now ubiquitous in online marketplaces. First, an array of market-thickening mechanisms, including taxonomies, search algorithms, and recommendation systems. Second, reputation systems conveying information that allows P2P rental platforms to overcome—or at least substantially ameliorate—traditional market problems, such as moral hazard and adverse selection. Third, mechanisms that reduce "practical" transaction costs, such as ways of accepting payments, escrow services, self-marketing features, and other software tools. We argue that these mechanisms emerged during the early days of electronic commerce, and are central to the function of modern P2P rental markets; we develop this argument in depth, and point out relevant works from the literature.

Our second major question is what economic properties characterize P2P rental markets. For example, what determines the rental rate and the quantity exchanged in a P2P rental market? How much total surplus do such markets "unlock," and how is it distributed? Does consumption and ownership increase or decrease following the emergence of these market? When there are substantial *bringing-to-market* costs (such as labor, excess depreciation, and transaction costs), who bears them, and how does that distribution affect market outcomes?

To address these questions, we develop a simple model in which consumers decide whether to purchase a good or not based on their expected personal usage. We initially consider a market where consumers do not have the option to rent out their assets, reflecting the status quo. In this market, consumers segment themselves to owners and non-owners by weighing their planned usage against the purchase price of the good. Owners use the good less than 100% of the time, leaving some of its capacity unused. Non-owners do not purchase the good, but would use it some of the time if they did own it—but less time than the current owners use it.[3] Purchased goods remain unused some of the time even though there is some demand for the excess capacity, as owners lack a way to transfer it to non-owners.

[3] Other equilibria are possible, such as one where everyone owns the good (for example, this is the equilibrium of the market for toothbrushes). To support a P2P rental market, the purchase price of the good must be low enough that there is a pool of owners, but not so low that everyone with any usage demand for the good already owns the good. Of course, ownership decisions can be revised in the long-run.

Some technological/entrepreneurial innovation then creates a P2P rental market that allows owners to rent their unused capacity to non-owners. For clarity, we initially assume that owners can make their unused capacity available on the P2P rental market without incurring any cost. After the P2P rental market emerges, the consumption problem of both owners and non-owners changes. Non-owners now have the option to rent the good for some time, facing the market-clearing rental rate. For owners, the possibility of rental creates a new opportunity cost for their own usage: owners can not only rent out their excess capacity, but also have an incentive to reduce their own consumption, in order to make more of the good available for rental. As a result, owners consume the good less, and some non-owners consume the good more; all consumers use the good as if they were renting it at the market-clearing rental rate.

We first examine how the P2P rental market clears in the short-run, where we assume that ownership decisions are fixed, having been made before renting was an option. The short-run rental market does not necessarily clear: if the pre-rental unused capacity exceeds demand, a glut results. In the case of a glut, owners do not need to reduce their consumption of the good; instead rental rates are pushed to zero. If the pre-rental unused capacity cannot meet the demand, the market clears at some positive rental rate, and owners reduce their consumption. The market-clearing rental rate is increasing in the valuation of the owners, which reduces supply, and the valuation of the renters, which increases demand. As such, the market-clearing rental rate is also increasing in the purchase price of the good.

We then consider the long-run equilibrium, where owners and renters alike can revise their ownership decisions. We find that if the short-run rental rate is below the purchase price, then ownership becomes less attractive, and vice versa. This result also offers an intuitive test for whether total ownership will decrease in the long-run. Ownership adjusts so that the long-run rental rate equals the purchase price. As a result, owners and renters receive the same utility at the margin, thereby decoupling individual preferences from ownership.

While ownership may increase or decrease in the long-run, the P2P rental market can have a market-expanding effect. The existence of a rental option allows for a higher maximum price in the product market, as the good can be made available to consumers who would previously not consume any of the good, but now obtain high utilities by consuming some of it. As a result, positive demand can be generated for a good at prices for which consumers with high valuations would not buy without the possibility of rental.

Surplus increases both in the short- and the long-run P2P rental market equilibria relative to the pre-sharing status quo. Although owners consume less in both equilibria, they are more than compensated with rental income that exceeds their utility loss. From a distributional perspective, owners with lower valuations are the biggest beneficiaries, as they consume the good less of the time, and hence they have more excess capacity to make available for rentals. Similarly, non-owners with higher valuations are the ones who see the largest increase in surplus. As such, the greatest gains in surplus are obtained when original non-owners value the good nearly as highly as owners, suggesting that goods where income (rather than taste or planned usage) explains ownership could offer the greatest increase in surplus.

Although we began by assuming that owners can costlessly rent out their unused capacity, in practice, making a good available for rentals is inherently costly—as we argued, one could conceptualize the recent rise of the "sharing economy" as caused by a decrease in these costs. Some of these bring-to-market (BTM) costs are straightforward, such as labor, depreciation, and complementary consumables. For example, driving with Uber requires labor, and increases the car's mileage, and consumes gas. Of course, goods will differ in the cost of bringing them to market, and this affects the outcomes of the P2P rental market.

When we assume that owners do face BTM costs, the predictions of our model change in several important ways. We find that if BTM costs are sufficiently high relative to the purchase price of the good, a P2P rental market cannot be supported. If the market can exist, BTM costs lower the quantity of the good transacted in the market and raise the rental rate, both in the short- and the long-run. In particular, we show that BTM costs do get incorporated into rental rates, however, being the equivalent of a per-unit sales tax, they are not fully passed through in the rental rate, in neither the short-run or long-run.

The incomplete pass through of BTM costs is what makes consumers with a higher valuation tilt towards ownership. The reason for the tilt is that as BTM costs are partially incorporated into the rental rate, consumers with higher valuations—and hence more planned usage—find ownership relatively more attractive, since they bear no BTM costs for own-consumption. Furthermore, an important managerial implication of the incomplete pass through finding is that firms would find it unprofitable to buy the good solely to rent it out—though this result requires that there are no economies of scale in offering rental services.

We next test our model assumptions and explore the role of BTM costs in P2P rental markets empirically. To do this, we surveyed a convenience sample of consumers, asking a series of questions about a good (e.g., a BBQ grill). These questions included whether consumers own the good, whether they have lent it out or borrowed it, and how much they do or would use it. We also asked questions about how the good in question is characteristically used, focusing on how predictable that usage is and the typical size of usage "chunks."

Our main finding is that income is only important in determining ownership for a small number of the goods we asked about (e.g., vacation homes); for most goods, planned usage was the primary driver, thus supporting our basic modeling framework. Looking across the population, goods that are owned more frequently are rented less frequently, with the notable exception of cars. There is also a strong correlation between goods that have predictable usage, and goods being used in large chunks of time. This positive correlation implies that a larger class of goods would have relatively lower BTM costs than would be the case in the absence of this positive correlation.

The survey also allows us to decompose the "temporal division" component of BTM costs. We find that goods where usage can be planned for and easily adjusted are easier to rent out, with little loss in utility to the owner. Similarly, goods that are used in large chunks of time—with no use in between—are more amenable to rental than goods that have usage broken up into many small chunks of time.

As the sharing economy is a relatively recent phenomenon, we conclude our paper with some thoughts on how P2P rental markets might evolve. Although our analysis focuses on a single homogeneous good, but a key advantage of P2P rental markets might be in facilitating greater diversity in goods offered and consumed. Beyond the direct utility this diversification provides, it might also increase the stock of people with direct experience with a particular good, which combined with the continued proliferation of consumer-generated reviews and ratings might stimulate quality improvements. In that same vein, producers of goods might do more than simply improve quality. They might also explicitly modify their goods to make them more amenable to rental.

The paper is organized as follows. Section 2 explores the reasons behind the recent emergence of P2P rental markets, and reviews extant work on their economic effects. Section 3 develops the model and presents the main equilibrium results, and Section 4 examines the implications of rentals for consumers' consumption, ownership, and surplus. Section 5 extends the base model by adding BTM costs. Section 6 presents the consumer survey, confirms the main modeling assumptions, and examines the temporal division aspect of BTM costs. Section 7 discusses the managerial implications of our findings, and Section 8 concludes with thoughts on directions for future research.

2 The rise of P2P rental markets

2.1 Explanatory factors

The economic rationale for P2P rental markets is that owners of most durable goods use them less than 100% of the time. This under-utilization generates excess capacity that can then be rented out to non-owners who would like to use the good, but not enough to purchase it.[4] Given the obvious rationale for these markets, sharing is not a recent phenomenon.[5] But if sharing makes economic sense, then why have P2P rental markets only begun to flourish in recent years? The reason is that the emergence of P2P markets could only happen at the confluence of two significant innovations.[6]

The first reason is a number of technological advances that entrepreneurs have taken advantage of in building these platforms. Chief amongst these technological shocks are the maturation and increasing penetration of the Internet, and the proliferation of smartphones with high-resolution digital cameras. Would-be trading partners use these new capabilities to find and assess each other and the goods being traded more efficiently.[7] For example, Uber is only possible because both sides of the market can find each other, and also carry with them taximeters (when running the appropriate software) at all times: a smartphone enabled with GPS technology allows for the precise measurement of distance traveled. In fact, this computer-mediated approach works better than the traditional taximeter in that both parties can verify that the best route was taken (Liu et al., 2018). Similarly, Airbnb benefits greatly from the proliferation of high-resolution digital cameras that make it easier for parties to inspect goods ex ante, and leave credible reviews ex post.

The second, often understated, reason behind the proliferation of P2P rental markets is that these markets have stood on the shoulders of their electronic commerce predecessors, such as eBay, that provide more than 20 years of industrial experience in building online marketplaces and solving their fundamental problems. There is now accumulated experience that a creator of a potential P2P rental market can leverage on to overcome a variety of problems, including search, informational, and other transactional costs. At the same time, several aspects of these fundamental problems are different in the P2P context, requiring innovative solutions.

Online markets generally lack the market-thickening mechanisms available in physical markets, such as coordinating on time and geography.[8] To compensate, online marketplaces create taxonomies and extensively classify goods, and capitalize on the vast numbers of

[4] A non-owner might mean a non-owner in a particular place and time. Many Airbnb guests are home owners, but they do not own homes everywhere.

[5] One third of nineteenth century American households took in boarders (Jefferson-Jones, 2014).

[6] As we will argue, much of what explains the rise of the sharing economy platforms also explains the rise of online labor markets and crowdsourcing sites that focus on the completion of tasks, the solicitation of experts, and the development of new product ideas (Huang et al., 2014).

[7] As Varian (2010) points out, advances in information technology are often advances in measurement. Advances in measurement then allow for new applications, similarly to how advances in scientific measurement allow for new theories (Kuhn, 2012).

[8] Buyers and sellers of stocks benefit from agreeing that the New York Stock Exchange is open from 9:30-4:00. Geography also matters; buyers and sellers of vegetables benefit from agreeing that the Union Square green market in Manhattan is located in the northwest side of Union Square Park.

potential customers. A complementary approach is to make extensive use of search algorithms and recommendation systems (Resnick and Varian, 1997; Adomavicius and Tuzhilin, 2005), as well as exposing co-purchase networks between products (Oestreicher-Singer and Sundararajan, 2012). These kinds of approaches are particularly important in P2P rental markets, because both the goods being rented and consumers' preferences for these goods are often highly differentiated, making the matching aspect more important.[9] P2P rental market platforms continue to invest heavily in research designed to improve matching, some of it in collaboration with researchers. For example, Fradkin (2013) shows how personalized recommendations could improve match rates by 10% on Airbnb. Benjaafar et al. (2015) explicitly consider the matching aspect of P2P rental markets, modeling how a participant's utility from being an owner or renter can depend on the possibility of finding the appropriate counter-party.

Another key challenge in all markets is facilitating trust among strangers. This problem is acute in P2P rental markets, given the "opportunity" renters have to misuse or destroy the owner's capital: whereas the buyer's type matters little to the seller in most markets, in rental markets the buyer's type can be critical. Online reputation systems represent one important platform innovation that attempts to solve this problem, through essentially digitizing word-of-mouth information about product and service quality (Dellarocas, 2003). A substantial literature characterizes their practical importance to the functioning of the market (Cabral and Hortaçsu, 2010; Resnick et al., 2000; Resnick and Zeckhauser, 2002; Moreno and Terwiesch, 2014). Other papers in this literature document ongoing efforts by platforms to fix common problems with reputation systems. Topics include: reducing the role of reciprocity (Bolton et al., 2013); incentivizing the provision of feedback (Fradkin et al., 2015); introducing new signals of quality, such as badges or other constructed measures (Hui et al., 2014; Nosko and Tadelis, 2015); addressing the incentives for review fraud (Luca and Zervas, 2016); and dealing with the tendency towards inflated reputations (Filippas et al., 2018). The rise of social networks, such as Facebook, has given platforms new opportunities to inject information into the platform that parties can use to decide whether to contract.

Informational problems are but one major set of obstacles in creating rental markets; another, equally important category of problems, pertains to more "practical" transaction costs. Individuals typically lack marketing budgets and expertise, ways of accepting payments that are convenient for customers, standard contracts and procedures to draw upon,

[9] Dinerstein et al. (2014) uses data from eBay to highlight the difficulty in creating search and ranking algorithms for differentiated products where price is only one dimension of interest; they show examples where limiting choice might be pro-competitive. There is an increasing understanding of how individuals do search online: De los Santos et al. (2012) use detailed web browsing data to show that customers rely more on a fixed sample size search strategy rather than sequential search.

well-adapted insurance products, procedures and facilities for re-setting goods after use, and so on. Individual participants would find too costly—or even impossible—to build and maintain these functionalities themselves.[10] For P2P rental markets to draw in individual owners, the platform must find ways to fill in these gaps and give owners firm-like resources. Platforms enjoy scale economies for many costly tasks compared to individual owners, and typically provide services for these tasks in exchange for a fraction of the transaction value. For example, platforms handle credit card payments, create tools for "self-serve" marketing (such as through attractive profile pages), and through general platform marketing to bring renters to the platform. Furthermore, platforms also create software tools that let owners manage their availability, learn about the attributes of potential renters, and so on.[11]

Considerable advances have also been made in the understanding of the business models used by two-sided marketplaces more generally. This literature initially focused on traditional two-sided markets, with motivating examples drawn from the credit card, video game, and newspaper industries (Rochet and Tirole, 2003, 2006; Parker and Van Alstyne, 2005). In recent years, it has been increasingly motivated by electronic commerce examples, and has focused on the key decisions faced by would-be platforms. For example, Hagiu and Wright (2014) analyzes whether it is better to be a marketplace or a re-seller (with the Amazon versus eBay question being a clear motivation). Casadesus-Masanell and Hałaburda (2014) and Halaburda et al. (2016) consider the platform's incentives to expand or limit the choices available to platform participants. Hagiu (2014) discusses the strategic decisions faced by a would-be platform and is close to a "how to" for would-be platform builders. Similarly, Eisenmann et al. (2006) offer strategic advice for businesses in markets with a two-sided component.

2.2 Previous work on economic effects of P2P rental markets

Given both the lack of firm-like resources and the inherent information problems of rental markets, consumer-owned goods have historically just been shared only among family members, neighbors and friends rather than strangers, except when the potential gains from trade are quite large (such as in the example of vacation homes and boat rentals). P2P rental markets allow owners to rent out their underutilized assets easily to a more diverse

[10] As it is, even ostensibly "peer" platforms do seem to tilt towards quasi-firms that can reap economies of scale or enjoy other firm benefits. For example, there are Uber "drivers" who manage fleets of vehicles and Airbnb "hosts" with multiple properties.

[11] Both Horton (2014) and Fradkin (2013) consider that platforms play in overcoming search frictions related to buyers trying to match with unavailable sellers—Fradkin in the case of Airbnb and Horton in the case of oDesk/Upwork. In the context of online dating sites, Hitsch et al. (2010) present evidence that the realized matches are *close* to what the Gale-Shapley algorithm would deliver, based on their estimates of underlying preferences.

audience. Einav et al. (2015) develop a model where rental platforms reduce entry costs for individual providers, for whom it would be previously unprofitable to enter the market. Einav et al. also stress that much of the increase in surplus is due to fact that the added supply is highly elastic, especially in markets where demand is highly variable. Farronato and Fradkin (2018) empirically verify this claim in the case of home-sharing.

Benjaafar et al. (2015) consider the ownership choice with and without the possibility of P2P rental, with participants differing in their expected usage. Although finding several results similar to our own—for example, they also find that total ownership could increase following sharing, for more or less the same economic reasons we identify—this paper differs in at least two important ways. First, Benjaafar et al. explicitly consider the matching aspect of these markets, modeling how a participant's utility from being an owner or renter can depend on the possibility of finding the appropriate counter-party. For some questions, explicitly modeling these considerations is likely to be important, though for others—say in markets where platform pricing choices clear the market—explicitly modeling the matching aspect is likely to be less important. Second, in our model, owners and renters decide how intensively to use a good in light of the rental rate (or in the case of owners, the opportunity cost created by the rental market). For some kinds of markets, such as for rental housing, this economization is likely to be important, though for other goods with very low usage rates, this factor is likely to be less important. Another related paper is Fraiberger and Sundararajan (2015), who offer a calibrated model of the P2P rental market, focusing on automobiles. They also model consumers choosing among ownership, rental and non-participation. They find that the introduction of sharing would decrease ownership but increase utilization. As in our model, the biggest gains in surplus come to previous non-owners who gain access to the good.

Previous work has examined the effects of entry of online platforms on offline competitors (Seamans and Zhu, 2013; Kroft and Pope, 2014). As sharing economy platforms affected several industries, much of the early literature has focused on identifying economic effects on incumbents. For example, Zervas et al. (2017) exploit the natural experiment created by the introduction of Airbnb in Texas and show that a 10% increase in Airbnb supply resulted in a 0.35% drop in monthly hotel revenues, with lower-priced accommodation options bearing a larger percentage of this decrease. While these effects can be sizable, the waxing and waning of various industries does not constitute market failure. In contrast, as sharing economy platforms blur the lines between the personal and the professional, they create new social costs and benefits; Edelman and Geradin (2015) discuss the regulatory policy implications of sharing economy companies using the traditional "market failure" framework that motivates much of public economics. An interesting example is found in the case of home-sharing, where residential houses now become mixed-use real estate, creating negative externalities that can lead to market failure, and which previous public policy responses are not fit to address (Filippas and Horton, 2018).

3 A model of the introduction of a P2P rental market

3.1 Consumption and ownership decisions

Before anyone can "share" someone has to own, and someone has to not own but still want to use the good, at least some of the time. To explain how consumers make ownership decisions, we assume that goods can be thought of as having an intensive margin of usage—how much a good is used—which drives the extensive margin decision, i.e., ownership.[12] Individuals differ in their intensive margin of usage, and hence in the utility they derive from the good.

Every consumer has a unit of time to allocate to various activities. Some of these activities involve using the good, and consumers have to decide how much time $x \in [0,1]$ to devote to using that good. By using the good, a consumer receives a benefit of $b(x,\alpha) = 2\alpha x$, where $\alpha \in (0,1)$ differs amongst individuals. The consumer also incurs a cost of $c(x) = x^2$, which can be thought of as the opportunity cost of time, increasing in the time spent with the good rather than with the best alternatives. The consumer's utility is then $u(x,\alpha) = b(x,\alpha) - c(x) = 2\alpha x - x^2$, and hence an owner's optimal usage and utility are

$$x(\alpha) = \alpha, \quad u(\alpha) = \alpha^2.$$

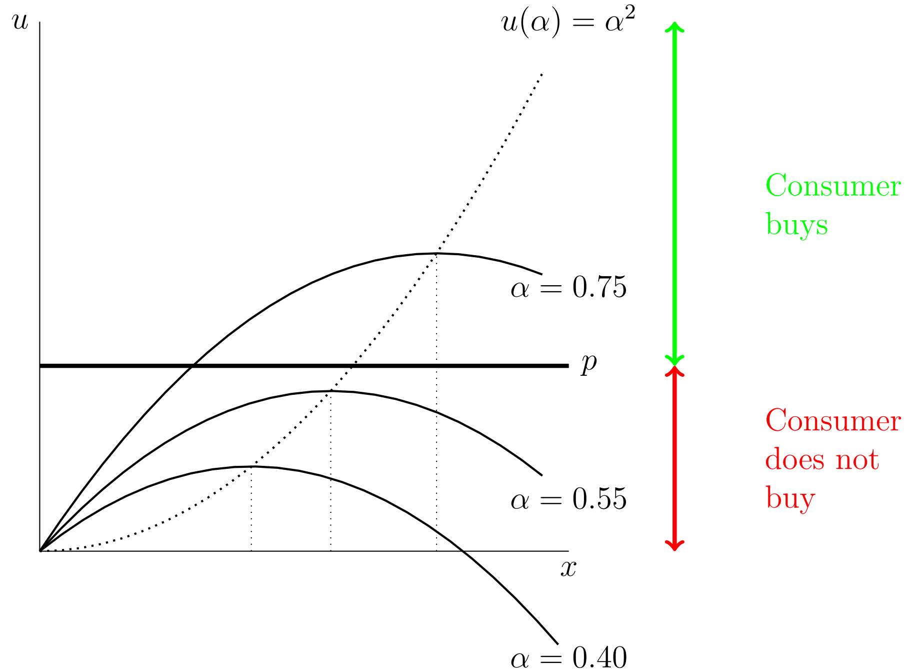
Note that α admits the convenient interpretation of the fraction of time the good would used by an owner.

Assume for now that the price of the good is exogenously set to $p > 0$. Consumers with valuation $\alpha^2 > p$ will buy the good and become owners, and all others will choose to live without the good. The purchase price p and the individual's valuation α are the determinants of ownership in the absence of a rental market. Figure 1 illustrates the consumer's problem, showing the utility from various levels of usage depending on a consumer's valuation α. Owners' utility falls along the curve traced out by x^2.

In what follows, we assume without loss of generality that the market consists of a unit mass of consumers, with valuations following some distribution $F : [0,1] \to [0,1]$. The ownership for the good at price $p \in [0,1]$ is then $Pr(\alpha^2 \geq p) = 1 - F(\sqrt{p})$, which can also be interpreted as a convex downward sloping demand function.

[12] The assumption that consumers consider the time required to use a good in making their consumption plan follows in spirit to Becker (1965).

Figure 1: Consumer's optimal usage of a good and resultant purchase decision



Notes: This figure illustrates the utility derived from different levels of usage of a good, with individuals differing in their values from usage based on their α parameters.

3.2 Consumption and ownership decisions with P2P rentals

Now suppose that through some technological advance it becomes possible for owners to rent their excess capacity to non-owners.[13] With rentals being possible, owners with valuation α are able to immediately rent out their $1 - \alpha$ unused capacity and, possibly, whatever additional amount that they choose to make available: the existence of the rental market may incentivize owners to economize their usage in order to earn rental income.

Assume that owners of the good can provide their unused quantities to the market at a rental rate r.[14] The owner's problem becomes

$$x^O(\alpha, r) = \underset{x \in [0,1]}{\text{argmax}} \quad 2\alpha x - x^2 + \underbrace{r(1-x)}_{\text{rental income}} = \max\{0, \alpha - \frac{r}{2}\}, \tag{1}$$

[13]The possibility of sharing a good bears some similarity to Varian (2000), who discusses how planned usage affects the rent-versus-own decision, but focuses on information goods.

[14]In Section 5, we examine the case where making the excess capacity available in the market is costly.

to obtain utility

$$u^O(\alpha, r) = \alpha^2 - \alpha r + \frac{r^2}{4} + r - p. \tag{2}$$

In the presence of the rental market, owners of the good reduce their usage intensity to gain the benefits of sharing. Owners cannot be worse of, as they can choose to not participate in P2P rentals, behaving as if the rental option did not exist.

Non-owners can choose to become renters. The renter's usage-optimization problem is

$$x^R(\alpha, r) = \underset{x \in [0,1]}{\operatorname{argmax}} \quad 2\alpha x - x^2 - \underbrace{rx}_{\text{rental cost}} = \max\{0, \alpha - \frac{r}{2}\}, \tag{3}$$

through which the renter obtains utility

$$u^R(\alpha, r) = \alpha^2 - \alpha r + \frac{r^2}{4}. \tag{4}$$

With P2P rentals, non-owners can now consume the good some of the time, and hence their utility increases. Non-owners with valuations less than $\frac{r}{2}$ are still excluded from consumption.

3.3 Short-run equilibrium (fixed ownership)

To examine the short-run effects of the emergence of a P2P rental market, we first assume that consumers cannot revise their original ownership decision in light of the option to rent out their assets. In other words, we assume that owners cannot become renters, and non-owners cannot buy the good in the short-run.

Before we derive the short-run equilibrium, note that a product market will always support the existence of an associated P2P rental market. The highest-valuation potential renter is the one who was previously indifferent owning and not owning the good, and hence for any quantity to be rented, $r_S \leq 2\sqrt{p}$. As owners can make their capacity available on the market without costs, owners have an incentive to rent out their good if $r_S \geq 0$. The short-term rental market is hence supported so long as $p > 0$.

With ownership being fixed, the short-run equilibrium is characterized by the equilibrium market rental rate r_S. The supply offered by owners in the rental market at rental rate r is

$$S(r; \sqrt{p}) = \int_{\sqrt{p}}^{1} 1 - \alpha + \frac{r}{2} dF(\alpha). \tag{5}$$

Let $S_0 = S(0; \sqrt{p})$ denote the minimum available supply, that is, the total amount of unused capacity before renting was an option. This is the amount of capacity that could be made available on the rental market, even if owners had no incentive to reduce their usage of the good ($r_S = 0$). Similarly, renter demand for the good is

$$D(r; \sqrt{p}) = \begin{cases} 0, & \text{for } r > 2\sqrt{p} \\ \int_{r/2}^{\sqrt{p}} \alpha - \frac{r}{2} dF(\alpha), & \text{for } r \leq 2\sqrt{p} \end{cases}, \tag{6}$$

with $D_0 = D(0; \sqrt{p})$ denoting the maximum demand, that is, the demand under $r = 0$. As we would expect, supply increases in r, as owners further reduce their usage to make more capacity available in the rental market. Demand decreases in r, as the renting activity narrows both in size and in intensity: fewer non-owners become renters, and these renters choose to rent the good less.

The short-term market-clearing process depends on the distribution of users' valuations for the good, and the purchase price of the good. There are two distinct cases in how the market will clear in the short-run. The first case is when the unused capacity exceeds the maximum demand for rentals. In the language of our model, this happens when $S_0 \geq D_0$, which can be usefully rewritten as

$$\int_{\sqrt{p}}^{1} dF(\alpha) \geq \mathbb{E}[\alpha]. \tag{7}$$

In words, the total asset capacity under the current ownership level exceeds the total population demand for consuming the good, and a glut results. As the unused quantity of the good from owners is enough to fulfill the demand of all would-be renters, owners compete on rental prices. The P2P rental market equilibrium is then equivalent to that of Bertrand competition with zero marginal production costs—because making the unused capacity available on the market is costless—and the market-clearing rental rate is $r_S = 0$.

The second case is when the unused capacity does not exceed the maximum rental demand. Owners then have the incentive to not only rent out their excess capacity, but also to reduce their usage, in order to rent their good out more on the rental market. As such, owners now essentially choose "production" quantities and the short-term rental market equilibrium is equivalent to that of a Cournot market. The market clears at the rental rate $r_S \in (0, 2\sqrt{p})$ for which demand equals supply, i.e., $S(r_S; \sqrt{p}) = D(r_S; \sqrt{p})$.

It is straightforward to show uniqueness of the short-term equilibrium using the monotonicity properties of the supply and demand curves (see Equations 5 and 6). Furthermore, the short-run equilibrium rental rate r_S is increasing in p, as more high-valuation would-be renters are added to the demand pool, while the owners with the highest capacities are removed from the supplier pool.

3.4 Long-run equilibrium (revised ownership)

We now consider what happens in the long-run, when both owners and non-owners can revise their ownership decisions. In real-life markets, the long-run equilibrium will emerge through good depreciation and replacement, as well as consumers entering and exiting the market.

Whether consumers will choose to become owners or opt for renting the good will depend on the comparison of the corresponding utilities. From Equations 2 and 4, we get:

$$u^O(\alpha, r) - u^R(\alpha, r) = r - p. \tag{8}$$

From Equation 8 we see that if $r_L > p$ every consumer wants to own the good, whereas if $r_L < p$ every consumer wants to rent the good. Consequently, the long-run equilibrium rental rate equals the purchase price, that is,

$$r_L = p. \tag{9}$$

In the long-run P2P rental equilibrium, the rental rate equals the product market purchase price, and ownership does not depend on either usage patterns or valuation. The economic rationale is that owners and renters must receive the same utility at the margin; the P2P rental market decouples individual preferences from ownership at the limit.

To derive the equilibrium ownership, we will assume that there is some α_L such that consumers with $\alpha \geq \alpha_L$ will become owners in equilibrium.[15] Let $\theta = 1 - F(\alpha_L)$ be the equilibrium ownership level, which is also the total available product capacity. For the market to clear in equilibrium, $S(r_L; \alpha_L) = D(r_L; \alpha_L)$, from which we get

$$\theta = \int_{p/2}^{1} \alpha - \frac{p}{2} dF(\alpha). \tag{10}$$

From Equations 9 and 10 we can see that as the purchase price of the good increases then, all else equal, the long-run equilibrium rental rate increases and ownership decreases.

[15] We show in Appendix A that this threshold structural property holds for any positive "bring-to-market" cost. Our assumption is hence equivalent to assuming that the same property holds in the limit.

4 Economic effects for consumers

4.1 Owning

Many commentators on the "sharing economy" have argued that the emergence of P2P rental markets would result in reduced ownership. Their argument assumes that there is a fixed amount of consumption for goods, a "lump of consumption," and that when unused goods are pulled into the market, demand can be met with fewer goods owned.

Our model shows that reduced ownership does not necessarily follow, and points to the condition under which total ownership would increase or decrease. The condition is that ownership decreases in the long-run if the short-run rental rate r_S is lower than the purchase price p. If the short-run rental rate is below the purchase price, it is attractive for some owners to revise their ownership decision, that is, to become renters. In this case, rental demand for the good grows, and rental prices increase in the long-run. Similarly, if the short-run rental rate is higher than the purchase price, some non-owners are better off purchasing the good, and ownership increases in the long-run. This is more likely to occur in situations where consumers have high valuations, making demand high and supply limited. Figures 2a and 2b illustrate this effect of P2P rentals for the case of uniformly distributed population valuations on the unit interval.[16]

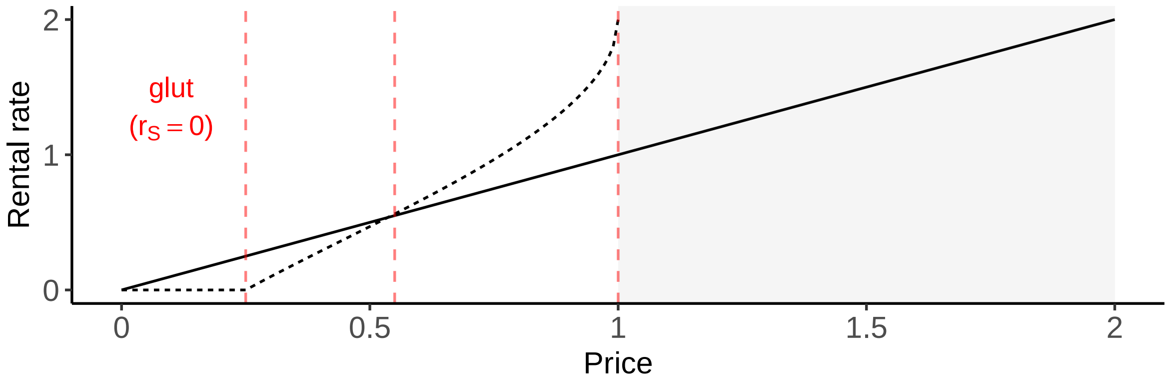
A P2P rental market may boost or reduce ownership. However, sharing always has a market-expanding effect, i.e., it can increase the price at which there is non-zero demand for the good by owners. In our model, the highest possible price for the good that can support a pre-P2P rental market is $p = 1$. In the long-run P2P market, however, consumers demand $\alpha - p/2$, and hence a market can be supported up to $p = 2$: there is still positive demand from high-valuation consumers at a price that would foreclose the possibility without P2P rentals. The shaded area in Figure 2 depicts the equilibrium quantities in the market-expansion regime of the P2P rental option.

One example of renting-increases-demand phenomenon can be seen with the market for season tickets to professional sports teams. Many teams now facilitate a resale market for their season ticket holders, charging a modest fee to enable resales over the Internet. Presumably, these teams find that this quasi-secondary market increases demand for season tickets. Along the same line, Belk (2014) points to the example of time-sharing condominiums expanding, rather than contracting, the second-home vacation market.

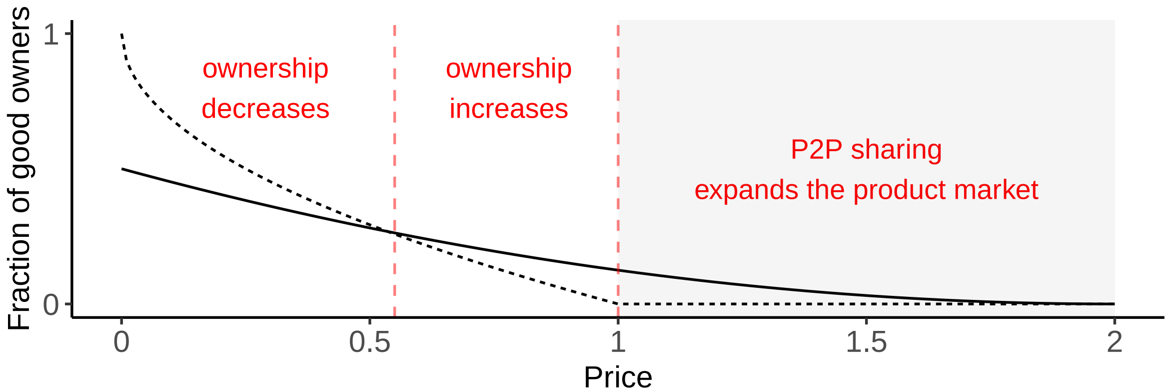
[16] We maintain the uniformly distributed valuations assumption throughout our figures, as it is helpful in illustrating our results. The analysis can be straightforwardly carried out for other distributions.

Figure 2: Rental rate, ownership, and surplus with a P2P rental market

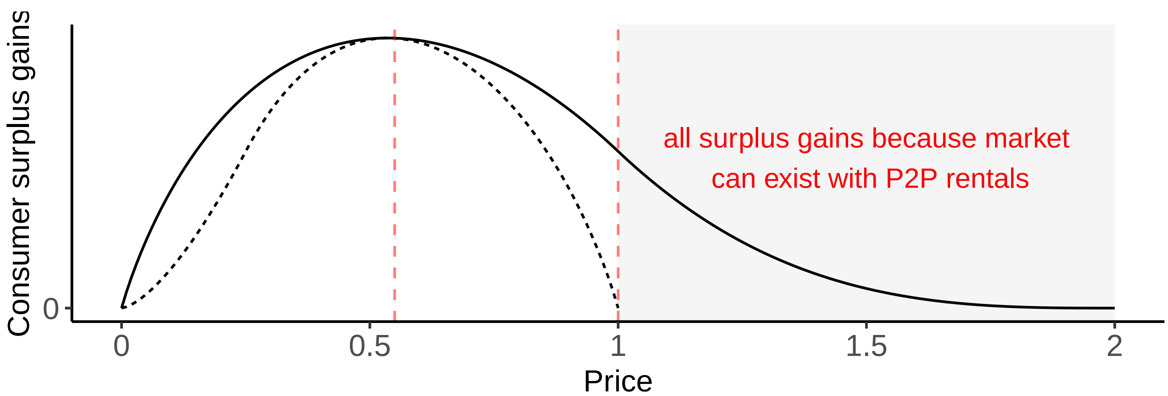
(a) Market-clearing rental rate in the short- and long-run.



(b) Product ownership in the short- and long-run.



(c) Consumer surplus gains in the short- and long-run.



Notes: This figure plots short- and long-run rental market outcomes after the introduction of the P2P rental market, for the case of uniformly distributed consumer valuations on the unit interval, i.e., $\alpha \sim U[0,1]$. In the short-run, a glut occurs if $p \leq 1/4$ and $r_S = 0$, else the market clears at $r_S = 2(1 - \sqrt{2}\sqrt{1-\sqrt{p}})$. In the long-run equilibrium, $r_L = p$, and ownership is $\theta = \frac{1}{8}(2-p)^2$. Panel 2a shows the P2P market-clearing rental rates, Panel 2b plots the level of ownership before rentals, and Panel 2c plots the gains in aggregate consumer surplus. The short-run equilibrium is indicated by the dashed line, and the long-term equilibrium by the solid line. In all panels, the shaded area denotes the market expansion region due to the emergence of the P2P rental option.

4.2 Using, renting, and distributional consequences

Following the introduction of the P2P rental option, owners decrease their consumption, from $x(\alpha) = \alpha$ to $x^O(\alpha) = \alpha - \frac{r}{2}$. While owners' utility from consuming the good decreases, their utility from renting increases, for a net change equal to

$$\Delta u^O = (1-\alpha)r + \frac{r^2}{4}. \tag{11}$$

From Equation 11, we get that if $r > 0$ then $\Delta u^O > 0$ and hence the utility of all owners increases. As $\frac{d\Delta u^O}{d\alpha} < 0$, owners with low valuations obtain the highest benefits from renting: usage is analogous to valuation, and hence owners with low valuations have more excess capacity that they can rent out. Furthermore, if $r_S < p$ then $r_L > r_S$, and owners see their utility increase further in the long-run (the opposite holds if $r_S > p$).

Non-owners—who previously obtained zero utility—can now become renters and consume some of the good, increasing their consumption from 0 to $x^R(\alpha) = \alpha - \frac{r}{2}$, and obtaining utility

$$\Delta u^R = (\alpha - \frac{r}{2})^2. \tag{12}$$

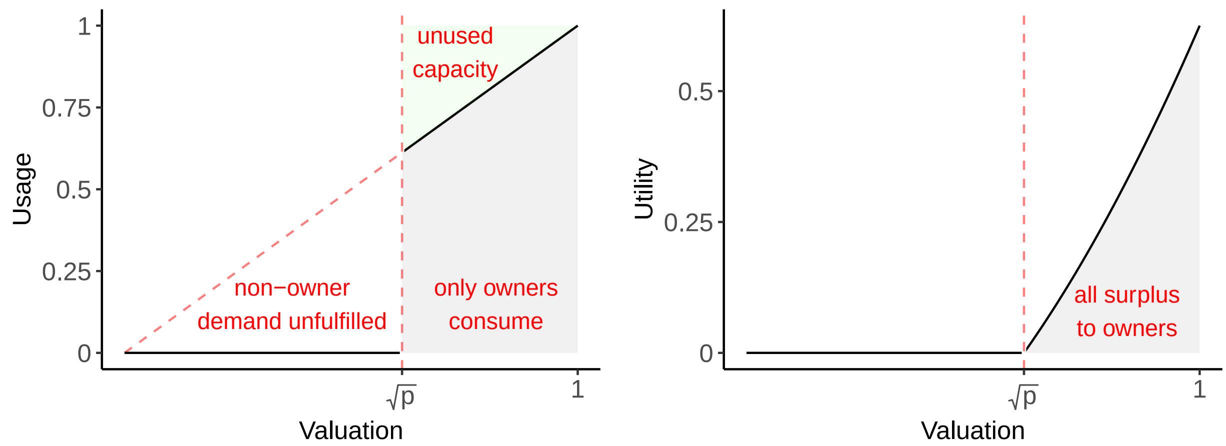
Unlike owners, it is the renters with higher valuations who obtain the highest benefits from the introduction of the P2P rental option. Furthermore, if $r_s < p$, renters see their utility decrease in the long-run (the opposite holds if $r_s > p$). Of course, the rental option does not benefit every non-owner, as some non-owners will still not consume any of the good. Consumers with $\alpha \in [0, \frac{r}{2}]$ are still excluded from consumption due to competition driving prices to higher than zero. Figure 3 shows this effect of the P2P rental market, by comparing the pre- and after-rentals consumption and utilities of consumers.

The biggest beneficiaries from the emergence of the P2P rental market are those consumers that are near the extensive margin, i.e., ownership. In the short-run, these consumers see their utilities increase the most, as they constitute the highest-valuation non-owners and the lowest-valuation owners (see Equation 11 and 12). In the long-run, these are the consumers who will revise their ownership and see the highest gains: maintaining their previous ownership decision is made more attractive than without the P2P rental option, but these consumers are even better off revising their former ownership decision.

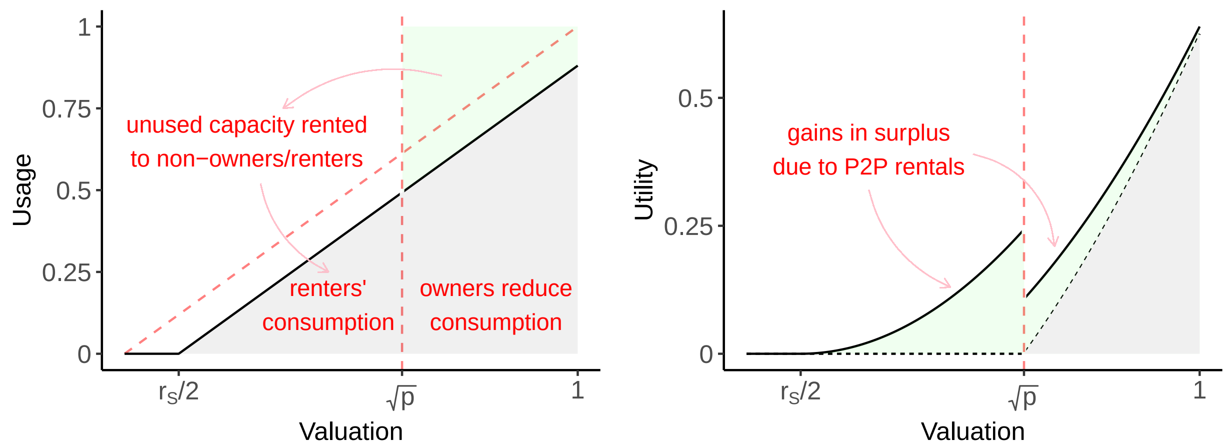
It is worth to note that owners never rent out their entire capacity. This commonly cited "pathological" outcome never occurs, as owners have higher valuations than renters, and any price that would incentivize owners to rent out their entire capacity would be met with zero demand. Furthermore, owners always use the good more than renters (see Equations 1 and 3). As such, total consumption of the good strictly increases.

Figure 3: Consumer usage, renting, and utilities before and after P2P rentals

(a) Pre-P2P rental market.



(b) After the emergence of the P2P rental market.



Notes: This figure plots consumers using and renting before and after the introduction of the P2P rental market, for the case of uniformly distributed valuations on the unit interval and $p = \frac{3}{8}$. Panel 3a plots the consumers' usage (left) and utilities (right) before the introduction of the P2P rental market. In the upper left panel, the gray shaded area depicts the consumption of the good, and the green shaded area depicts the unused capacity. In the upper right panel, the gray shaded area depicts the corresponding utility. Panel 3b plots the consumers usage and renting (left) and utilities (right) in the short-run equilibrium of the P2P rental market. In the lower left panel, the gray shaded area depicts the consumption of the good. Note that non-owners consumption is equal to the unused capacity (green shaded area), as a glut does not occur. In the lower left panel, the green shaded area depicts the surplus gains to consumers in the short-run equilibrium.

4.3 Surplus

The aggregate consumer surplus before the introduction of the rental option is

$$U_0 = \int_{\sqrt{p}}^{1} \alpha^2 - p dF(\alpha). \tag{13}$$

After the emergence of the P2P rental option, the short-term consumer surplus becomes

$$U_S = U_0 + \underbrace{\int_{\sqrt{p}}^{1} (1 - \alpha + \frac{r_S}{4}) r_S dF(\alpha)}_{\text{increase in owners' utility}} + \underbrace{\int_{r_S/2}^{\sqrt{p}} (\alpha - \frac{r_S}{2})^2 dF(\alpha)}_{\text{increase in non-owners' utility}}. \tag{14}$$

As we reasoned above, it is straightforward to show that $U_S \geq U_0$: owners put underutilized capacity to use and non-owners consume more of the good. It is worth noting that in the case of a glut all market gains accrue to the side of the renters, and the utility of the owners remains constant. Furthermore, the greatest gains in short-run surplus obtained when non-owners value the good nearly as highly as owners, that is, when the valuation distribution function F has significant mass around $\sqrt{p}$. This suggests that goods where income—rather than taste or planned usage—explains ownership offer the greatest increase in surplus.

The long-run consumer surplus with P2P rentals is

$$U_L = \int_{1-\alpha_L}^{1} \alpha^2 - p + (1 - \alpha + \frac{p}{4}) p dF(\alpha) + \int_{p/2}^{1-\alpha_L} (a - \frac{p}{2})^2 dF(\alpha). \tag{15}$$

Note that as ownership may either increase or decrease in the long-run equilibrium, we have to explicitly account for this effect in the calculation of U_L.

We can show that $U_L > U_0$, that is, that the rental market increases aggregate consumer surplus in the long-run. To see why, if ownership increases in the long-run, then the new owners obtain greater utility than when they did not consume any of the good. If ownership decreases, then the new renters obtain greater utility, else they would still own the good. Consumers who did not revise their ownership decision see their utilities strictly increase in the long-run, as the rental price is $p \geq 0$ (see Equation 11). This result is graphically depicted in Figure 2c for the case of uniformly distributed consumer valuations.

As the consumption of the focal good increases, so will the consumption of complementary goods and labor, which may result in further increases in surplus. However, increased consumption of goods with negative externalities may lead to a decrease in surplus, or even a market failure (Filippas and Horton, 2018). A complete assessment of the surplus implications of rentals would hence to have to consider industry-specific factors.

5 Bring-to-market costs

We have thus far assumed that owners can rent out their unused capacity at no cost. We now extend our model by assuming that owners incur "bring-to-market" (BTM) costs. Some BTM costs are straightforward: labor costs for goods that require a labor input, complementary consumables, and asset depreciation. For example, driving with Uber requires both labor and gas, and increases the mileage of a car. Other BTM costs include the transaction costs inherent in finding trading partners, coming to terms, executing payments, and handing off the good. Goods generally differ in their BTM costs, and these differences will in turn affect the feasibility of a P2P rental market, as well as its characteristics.[17]

Assume that owners incur BTM costs at rate γ, linear in renting intensity and of the same magnitude for all owners. The owners' consumption problem becomes

$$x^O(\alpha, r) = \underset{x\in[0,1]}{\operatorname{argmax}} \quad 2\alpha x - x^2 + \underbrace{(r-\gamma)(1-x)}_{\text{rental income}} = \max\{0, \alpha - \frac{r-\gamma}{2}\}. \tag{16}$$

With BTM costs, renting becomes less profitable. As a result, owners reduce their consumption less, and make the good less available on the P2P rental market. Owners' utility becomes

$$u^O(\alpha, r) = \alpha^2 - p + (1 - \alpha + \frac{r-\gamma}{4})(r-\gamma). \tag{17}$$

From Equation 17 we can observe that increases in γ result in larger decreases in the utility of lower-valuation owners. As owners with lower valuations use the good less, they have more excess capacity that they rent out through the P2P rental market, and hence they incur a larger decrease in utility as BTM costs increase. The renter's decision problem does not change (see Equation 3 and 4).[18]

5.1 Market emergence and short-run equilibria

With BTM costs, not every product market will support an associated P2P rental market. To see why, consider the marginal non-owner—the highest-valuation potential renter, who was previously indifferent between owning and not owning the good. This renter's valuation

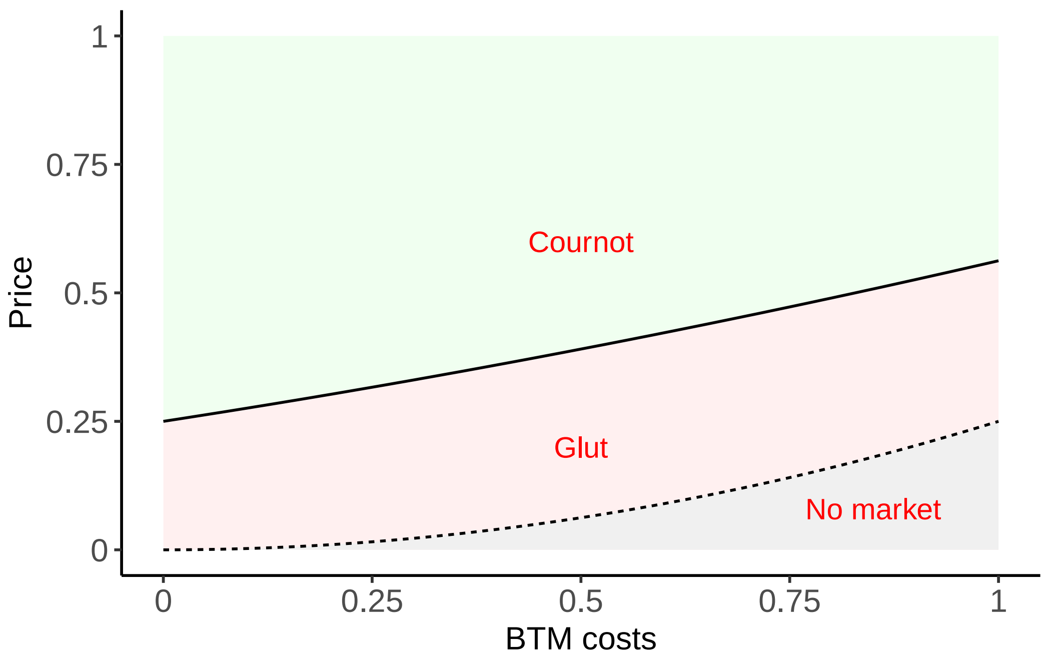
[17] An attribute relevant to BTM costs is how amenable a good is to "temporal division." Goods for which usage can be planned for and easily adjusted are easier to rent out with little loss in utility to the owner. Furthermore, goods that are used in large chunks of time—with no use in between—can presumably be rented out more easily than goods that have usage broken up into many small chunks of time. We further examine the degree of temporal division for various goods in Section 6.

[18] The derivations of the results for the case of positive BTM costs are similar to those for the case of zero BTM costs. For brevity, we choose to present these derivations in Appendix A.

is $\sqrt{p}$, and hence for rentals demand to be positive, $r \leq 2\sqrt{p}$. As owners have incentive to rent only if $r \geq \gamma$, the necessary condition for a P2P rental market to emerge is $\gamma \leq 2\sqrt{p}$. When the price of a good is so low that nearly every everyone owns it, no P2P rental market can exist, even when total usage is low and the good is durable: a sufficient stock of non-owners does not exist. For example, nearly every household owns a pair of scissors, and despite being used very infrequently (on average, probably seconds a day), there is not a latent pool of non-owners who would like access the scissors of owners.

If a P2P rental market can be supported, then the short-term market clearing process is similar as in the $\gamma = 0$ case. For a given BTM cost γ, a glut is more likely to occur in the short-run if the purchase price p is lower, as the pool of owners is larger. As the price increases, less consumers own the good, and more consumers want to rent it; a glut no longer occurs, and owners will begin reducing their consumption to rent out the good more. Figure 4 illustrates this result for the case of uniformly distributed consumer valuations.

Figure 4: Short-run market outcomes with BTM costs.



Notes: This figure depicts the short-run outcomes of the P2P rental market as a function of the BTM costs γ and the purchase price p, for uniformly distributed consumer valuations on the unit interval. A market fails to emerge for $\gamma \leq 2\sqrt{p}$. If a market emerges and $\sqrt{p} \leq \frac{1}{2} + \frac{\gamma}{4}$, a glut results, and $r_S = \gamma$. Otherwise, the demand for renting the good is higher than the unused capacity, owners decrease their usage, and the market clears at $r_S = 2 - 2\sqrt{(1-\sqrt{p})(2-\gamma)}$.

5.2 Ownership

Introducing BTM costs affects our model's predictions about long-run ownership. Consumers with higher valuations now tilt towards ownership, while consumers with low valuations tilt towards renting. The economic rationale behind this separation result is that consumers with higher valuations want to use the good more, and since they bear no BTM costs for own-consumption, they find ownership relatively more attractive than renting. As such, while the sharing option decouples preferences—consumer valuations for the good—from ownership decisions if BTM costs are zero, introducing positive BTM costs links preferences and ownership again.

Of course, the separation result depends on the nature of BTM costs, and may be reversed for other assumptions on cost structures. For example, if there are diminishing costs to renting or large setup costs, ownership may revert to lower-valuation consumers. We further discuss the implications of alternative BTM cost structures in Section 7.1.

5.3 Pass through

As rental supply decreases in BTM costs while demand remains the same, rental rates increase in BTM costs. However, there is incomplete pass through of the BTM costs to the rental price, both in the short- and in the long-run. The argument that BTM costs are not fully passed through to the long-run P2P rental market rate becomes intuitive if we consider that γ plays a role equivalent to a per-unit sales tax. Therefore, so long as neither side is completely inelastic to price changes, the incidence of the tax will not fall wholly on the demand side (as would be the case if $r_L = p + \gamma$).

An important implication of the incomplete pass through is that it becomes unprofitable for consumers to buy a good to solely rent it out. This result, however, hinges upon the assumption that there are no economies of scale in offering rental services. Furthermore, the incomplete pass through of costs also implies that both renting and owning become less profitable as BTM costs increase. As a result, ownership can both increase or decrease as BTM costs rise, depending on the demand and supply elasticities.

6 Attributes of goods and the feasibility of sharing

Our model posits that the purchase price, the valuations of consumers, and the BTM costs of a good affect whether a P2P rental market is possible, as well as the market outcomes both in the short- and in the long-run. In this section, we test our model's assumptions and predictions, by collecting data on a large set of goods using a consumer survey conducted on

Amazon Mechanical Turk. The survey also allows us to offer a partial decomposition of the BTM costs, based on attributes that make a good more or less amenable to being shared.[19]

We hired US-based "Master" workers to answer questions about a consumer good. Although MTurk offers a convenience sample, there is little reason to think its members would have highly idiosyncratic consumption patterns. Furthermore, for our purposes, the MTurk population is well-suited to answer a tedious set of questions carefully.[20] We asked questions about a total of 26 goods, including a BBQ grill, a pick-up truck, a men's suit, a canoe, and so on. We selected the goods because we thought they would yield interesting answers and varied in purpose (e.g., recreation, home improvement, cooking and so on), purchase price, predictability, and usage size.

We asked MTurk workers whether they owned the good; whether they had ever rented or lent out the good; how much they would use the good, regardless of whether they owned the good; whether they would use the good in one large chunk, or in many small chunks; whether their usage was predictable; why they did not own the good; and finally, their household income. See Appendix B for the full list of goods and the survey questions and answers.

6.1 Testing the relationship of planned usage and ownership

A basic assumption in our model is that consumers are more likely to own if they plan to use the good more often: consumers consider how much they will use a good, and compare their expected utility from using the good against its purchase price. To test this assumption, we asked respondents to select how often they would use a good. In Column (1) of Table 1 reports an OLS estimation of

$$\textsc{Own}_{ig} = \beta_0 + \beta_1 \log x_{ig} + c_g + \epsilon_g, \tag{18}$$

where $\textsc{Own}_{ig}$ indicates ownership by respondent i of good g, x_{ig} is the respondent's reported fraction of time they estimate they would spend using the good, and c_g is a good-specific fixed effect. In Column (2), a control for the log of family income is included, and in Column (3) a respondent fixed effect is added.

[19]The attributes that make a good "shareable" have received some attention in the past. most notably from Benkler (2004). Benkler points out that some goods are "lumpy," that is, less than some threshold amount cannot be bought, but once purchased, the owner invariably has excess capacity. Benkler provides the example of a personal computer, which cannot be purchased in fractional amounts but, once purchased, remains unused for prolonged amounts of time. This notion of "shareability" as being related to the patterns of how goods are characteristically used also interests us, although our approach differs from Benkler in that ownership and consumption are not product attributes, but rather endogenous economic decisions.

[20]Workers on MTurk whose work is "rejected" by dissatisfied employers become ineligible for the highest-paying jobs on the marketplace, and therefore are diligent, making them useful for certain types of questions. For example, Kuziemko et al. (2015) use MTurk to study elasticities of demand for redistribution.

We find evidence that ownership is positively associated with higher estimated usage. The coefficient on the estimated usage regressor in Column (1) of Table 1 implies that a doubling of expected usage for some good—say using a BBQ grill two hours a week instead of one hour—is associated with about a 2.5 percentage point increase in the probability of ownership. In Column (2), the coefficient on the usage regressor is of the same magnitude, despite including self-reported household income in the specification. As we would expect given that most of the goods listed are normal, a higher income is associated with greater probability of ownership—a 10% increase in household income is associated with a 1% increase in the probability of ownership. However, the lack of change in the usage regressor implies that the pattern found in Column (1) is not the result of higher income respondents being more likely to own and report greater expected usage, e.g., because of greater leisure time. In Column (3), we re-estimate Column (1) including respondent-specific fixed effects. As with the other specifications, the strong positive relationship between expected usage and ownership persists.

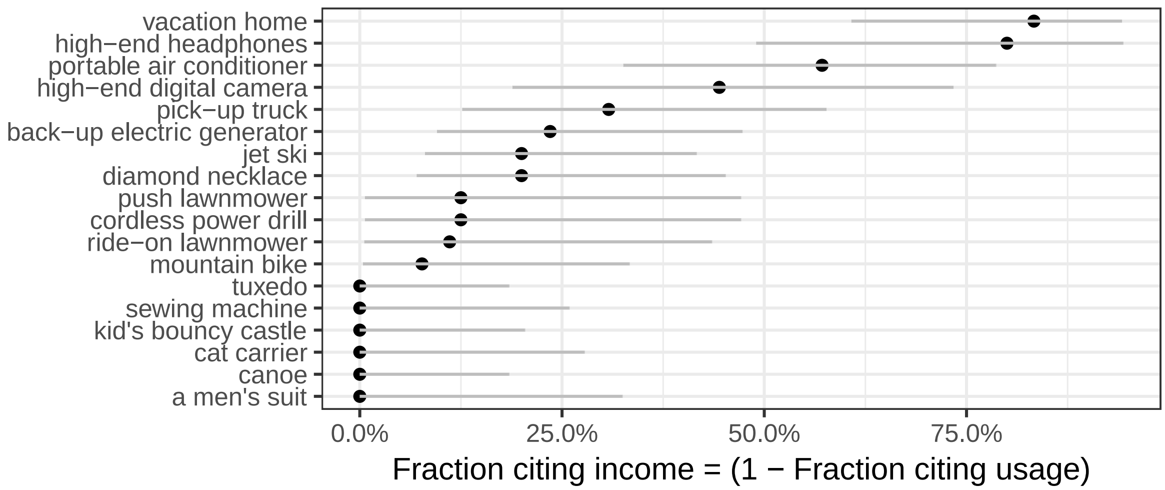
Table 1: Respondent estimates of the usage of a good, and ownership decisions

	Dependent variable:		
	Respondent owns the item?, ($\text{Own}_{ig} = 1$)		
	(1)	(2)	(3)
Log estimated usage, $\log x_{ig}$	0.0262**	0.0259**	0.0264**
	(0.0111)	(0.0109)	(0.0110)
Log household income, $\log y_i$		0.1019***	
		(0.0254)	
Good FE	Y	Y	Y
Respondent FE	N	N	Y
Observations	411	411	411
R^2	0.4447	0.4651	0.5672

Notes: This table reports OLS regressions where the dependent variable is an indicator for whether a respondent reported owning a particular good. In Column (1), the independent variable is that respondent's estimate of the fraction of time she/he would spend using the good (in logs). In Column (2), we add a regressor for the log of the respondent's self-reported household income. In Column (3), we add a respondent-specific fixed effect to the specification of Column (1). The sample is restricted to respondents who reported positive predicted usage of the good, and reported their household income. All regressions include good-specific fixed effects, and standard errors are clustered at the good level. Significance indicators: $p \leq 0.05 : *$, $p \leq 0.01 : **$, and $p \leq .001 : ***$.

The results in Table 1 suggest that both income and predicted usage are important for explaining ownership decisions. In Figure 5, we plot the per-good percentage of non-owners citing income as the reason for non-ownership (out of non-owners that cited either income or usage—very few cited space). Explanations for non-ownership tilt strongly towards usage rather than income considerations—the only goods where a larger fraction of respondents cited income rather than usage were high-end headphones and vacation homes.

Figure 5: Fraction of respondents citing income as the reason for not owning a good



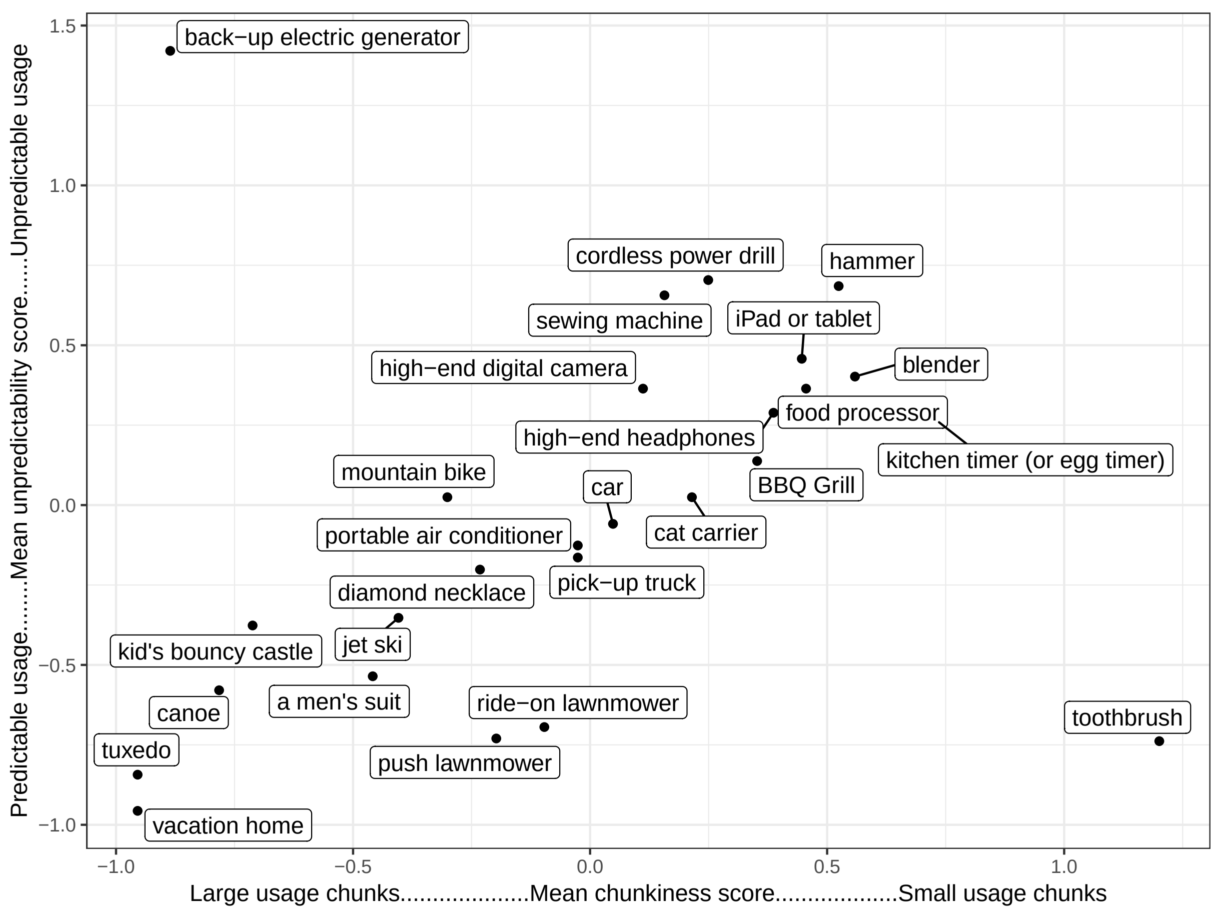
Notes: This figure plots the fraction of non-owners for each good citing income, among those that cited either income or usage as the reason for non-ownership. Non-owners were asked for the primary reason for not owning a good and could cite usage ("We wouldn't use it enough to justify the purchase price"), income ("We would use it, but we simply do not have the money") or space ("We don't have space for this item."). Goods with seven or more non-owners are included. Each point estimate is contained within a 95% CI, calculated using the Wilson method (Wilson, 1927).

6.2 Predictability and chunkiness as BTM costs

Goods for which consumers can easily predict when they will be needed are easier to both lend out for owners, and rent for renters. In contrast, goods that have inherently unpredictable usage or, equivalently, goods where there is little flexibility in when they are used, are harder to rent out without substantial utility loss to both owners and renters. Similarly, for goods that are used in numerous small sessions, renting or lending out the good to others would create high transactions costs. For example, a hammer is used in small chunks of time and this usage is unpredictable—e.g., when hanging a picture. On the other hand, a tuxedo is used for a substantial amount of time, and that usage can be predicted far in advance—e.g., when attending a wedding.

In the language of our model, a good's predictability and size of use sessions can be thought of as being inversely analogous to BTM costs, and hence can be important determinants of how amenable a good is to being rented. We asked subjects to rate the unpredictability of use and the chunkiness for a set of goods, which we plot in Figure 6. We observe a strong relationship between chunkiness and predictability.[21] Goods near the origin—for which use occurs in large chunks—are often goods for which conventional rental markets already exist. Examples include formal wear (tuxedos), vacation homes, bikes, sporting equipment (canoes and jet skis for rent at lakes), and so on. Rental markets are less likely to exist for goods such as lawnmower and jewelry, which are a bit further from the origin, but these goods seem to have the attributes necessary to support such a market—assuming enough non-owners exist.

Figure 6: Usage predictability versus chunkiness



Notes: This figure plots goods' mean unpredictability score (1 is highly predictable, and 5 is highly unpredictable) versus their mean chunkiness score (1 is high chunkiness, and 5 is low chunkiness). Scores are calculated by normalizing the 1-5 scores across all goods and all respondents. Lower chunkiness scores imply that the good is characteristically used in large chunks, and low unpredictability score implies predictable usage patterns.

[21] Two notable outliers are the toothbrush and the generator. A toothbrush is used in small chunks (2 minutes according to the ADA) and its use is highly predictable (after every meal, if ADA prescriptions are followed). The back-up electric generator is the toothbrush's opposite—power can go out for days or even weeks during a disaster, and this event is rarely predictable.

We may also examine the relationship of predictability and chunkiness measures to individual ownership. In Column (1) of Table 2 we report an estimate of

$$\text{Own}_{ig} = \beta_0 + \beta_1 \textsc{UnpredictabilityScore}_{ig} + c_i + \epsilon_i, \tag{19}$$

where $\textsc{UnpredictabilityScore}_{ig}$ is the normalized unpredictability score by respondent i for good g. The coefficient of the unpredictability score is positive and highly significant: one standard deviation decrease in predictability increases the probability of ownership by about 14 percent. In Column (2) we use the chunkiness measure as the predictor, and also find a positive and highly significant effect of about the same magnitude. These estimates support our argument that goods with unpredictable usage that occurs in small chunks are substantially more likely to be owned. We interact the chunkiness and predictability measures in Column (3). The effect for each measure is reduced, though a formal hypothesis test would fail to reject a difference relative to the estimate when each measure appeared alone. Their interaction term, while negative, is small and far from significant. In words, predictability and chunkiness are not simply capturing some single latent "rentability" measure, and each seems to have an independent effect on the probability of ownership.

One concern with our approach might be that respondents prone to reporting high or low chunkiness and predictability scores might be idiosyncratically more or less likely to own the good. In other words, the patterns from Columns (1) through (3) might reflect individual differences rather than general attributes about the good. Column (4) uses the same specification as Column (3), but includes a good-specific effect. With this effect, the coefficients on each regressor end up close to zero, which supports the notion that the patterns in the previous regressions are indeed driven by the nature of the good.

7 Discussion

7.1 Alternative BTM cost structures

We have thus far assumed that BTM costs are constant and linear in the amount of the good rented. However, other possibilities are quite plausible. It is useful to examine the economic import of other types of cost structures. For example, fixed costs to renting would create an economy of scale that would favor consumers who could make more capacity available on the rental market, i.e., lower valuation consumers. In the presence of significant fixed costs, ownership tilts back towards those who do not value their own consumption, e.g., traditional rental firms. Costs that diminish in renting activity would have the same effect.

In practice, costs are not homogeneous for all sellers in the P2P rental market. Further-

Table 2: The relationship of unpredictability and chunkiness with good ownership.

	Dependent variable:			
	Item is owned			
	(1)	(2)	(3)	(4)
Unpredictability Score (US)	0.139***		0.095***	0.003
	(0.030)		(0.034)	(0.034)
Chunkiness Score (CS)		0.135***	0.091***	−0.018
		(0.025)	(0.029)	(0.025)
US x CS			−0.009	0.006
			(0.018)	(0.018)
Respondent FE	Y	Y	Y	Y
Good FE	N	N	N	Y
Observations	489	489	489	489
R^2	0.170	0.169	0.191	0.500

Notes: This table reports OLS regressions where the dependent variable is an indicator for whether a respondent reported owning a particular good. In Column (1), the independent variable is the respondent's estimate of the unpredictability of using that good. In Column (2), the independent variable is the respondent's estimate of the chunkiness of using that good. The two independent variables are normalized responses to the 1-5 scale questions on usage chunkiness and unpredictability, pooled over all respondents and goods (see Appendix B for the actual survey language and responses). Toothbrushes and backup generators are excluded from the sample. In each regression, a respondent-specific fixed effect is included. Standard errors are clustered at the level of the individual respondent. Significance indicators: $p \leq 0.05 : *$, $p \leq 0.01 : **$, and $p \leq .001 : ***$.

more, costs may rise with the quantity provided. To illustrate the rising cost context, Uber drivers may find it cheap to supply one hour of labor after their 9-5 jobs, but find two hours nearly impossible if they have to pick up their kids from daycare at 6pm. Indeed, Hall and Krueger (2015) report that Uber drivers work surprisingly few hours relative to taxi drivers despite generally higher wages, suggesting that they face increasing marginal costs per shift.

In the case of differential costs, and in the case of costs that rise with output, the equilibrium is effectively the same as we outlined. In equilibrium, owners will be operating at the margin with BTM costs of γ. However, many owners will be reaping inframarginal benefits because their BTM costs are below those priced into the market. Both the heterogeneity of costs and the possibility of fixed costs suggest that in practice, the extensive margin of supply is important: when rental rates go up, more owners are pulled into the market.

7.2 Product prices

The introduction of the rental market allows owners to monetize their unused capacity, thereby changing how much consumers value the good. Many commentators on the "sharing economy" have argued that this will result in an overall increase in purchase prices for goods that can be rented. This outcome is certainly plausible in monopolies, but less so as the market structure approaches perfect competition.

Our model illustrates a number of additional reasons why prices may not increase in the long-run. First, we showed that the emergence of a P2P rental market leads to increased consumption. For goods that depreciate fast in usage, this may lead in an overall increase in purchases, and hence in an overall increase in firm profits. Similarly, as renting out goods requires complementary consumables and labor, production firms may find success in making their goods more "shareable," while entering the markets for complementary consumables. Furthermore, the market-expansion property suggests that renting can help support a market in cases where high production costs would otherwise make a product prohibitively costly to purchase—this is equivalent to a reduction in prices.[22]

7.3 Competition with conventional rental firms

The model predicts that in the long-run, owning a good purely to rent it out offers no profits when BTM costs are zero, and a loss when BTM costs are positive. This result is grim news for conventional rental firms, though if there are economies of scale in rental, say, due to fixed costs, the situation is improved, and possibly reversed.

There is already some evidence that P2P rental markets are affecting traditional rental firms: Byers et al. (2013) find that Airbnb is already winning customers from hotels that cater to the lower end of the market. The entrance of Airbnb lowered revenues by as much as 10% in some market segments; it also seems to be lowering prices. Neeser et al. (2015) do not find the same revenue effects but do offer some evidence that Airbnb may have pushed down prices in Nordic countries. On the ride-sharing side, there is clear evidence that Uber is securing market share at the expense of existing taxi firms, such as falling medallion prices, notable bankruptcies, and fierce efforts by the taxi industry to restrict Uber.[23] The effects of competition are also potentially showing up in service quality: Wallsten (2015) presents suggestive evidence from Chicago that consumer complaints for traditional taxis fell following the entry of Uber.

Firms do have advantages over consumer-owners. They can enjoy economies of scale and expertise in minimizing transaction costs. Edelman and Geradin (2015) provide the example of how a conventional hotel can, with a front-desk, handle the exchange of keys for hundreds of guests—a common source of friction for Airbnb rentals. However, they also point out

[22]For example, P2P rental markets for 3D printers have already emerged, helping proliferate the adoption of new technological products. See `https://www.powerpeers.nl/about`, accessed online January 15, 2019.

[23]For example, see `http://www.sfexaminer.com/yellow-cab-to-file-for-bankruptcy/`, accessed online January 15, 2019.

that, unsurprisingly, P2P rental platforms invest heavily in trying to solve these kinds of problems. Indeed, Fradkin (2012) finds that in the case of Airbnb, matching probability increased 18% over a two-year span, after controlling for search intensity. A contributing factor was Airbnb reducing transaction costs by, for example, minimizing the amount of information that had to be exchanged before completing a booking. In addition to these platform-led efforts, there is now a burgeoning industry providing complementary services to Airbnb hosts and would-be Uber drivers.[24]

7.4 Platform fees as a BTM cost

One of the BTM costs faced by participants in P2P rental markets is the fee imposed by the platform. While more complicated price structures are possible, the most common price structure seems to be an ad valorem charge (sometimes with a minimum payment amount and some fixed fees): this is the pricing structure employed by both Airbnb and Uber.

At a fixed rental rate r, we can think of the ad valorem charge as equivalent to a charge on the quantity transacted (rather than on the dollar value of what was transacted), which allows us to write total BTM costs as $\gamma = \gamma_0 + \tau$, where τ is the platform's charge and γ_0 are the "true" BTM costs (such as depreciation, labor and so on). An owner renting out $1 - x$ units of the good would receive $(1 - x)r$ in rental income, bear "true" BTM costs $(1 - x)\gamma_0$ and then remit $(1 - x)\tau$ to the platform. For any level of the BTM cost, the platform can obtain higher revenue by reducing γ_0 and raising τ by an offsetting amount. Of course, the attractiveness of doing so depends on the elasticity of γ_0 with respect to the costs the platform incurs to reduce these BTM costs.

Lowering γ_0 without increasing τ has an ambiguous effect on platform revenue, as it lowers the rental rate but increases the quantity transacted. This suggests that the platform has stronger incentives to lower BTM costs when demand is elastic, as the shifting out of the supply curve will greatly enlarge the quantity transacted without significantly reducing price. This incentive for BTM cost reduction when the platform demand is elastic suggests the benefits to society of having competing platforms (which presumably make demand more elastic), at least in this simple treatment of the platform's pricing problem.

If we assume that the platform has removed all BTM costs and simply needs to set an optimal quantity charge, τ, then in the short-run case the platform's problem is

$$\underset{\tau}{\text{argmax}} \quad \tau \left[Q - \frac{1}{2}\tau(1-\theta)\theta \right] \tag{20}$$

[24]For example, a recently launched startup called Guesty aims to be a kind of property management company for Airbnb rentals.

which gives us a first-order condition of $\tau^* = 1 - (\alpha_H + \alpha_L)$, or

$$\tau^* = \frac{Q}{(1-\theta)\theta}. \tag{21}$$

The platform sets its optimal charge so that the realized transaction volume is half of what it would be in the absence of the its charge. With this formulation, the platform charges the highest rates when the market is imbalanced with respect to owners and sellers, which is also where quantity transacted changes little with the imposition of the charge (i.e., the $\frac{1}{2}\tau(1-\theta)\theta$ term is small).

8 Conclusion

The sharing economy has dramatically impacted several important markets in just a few years, notably those for ride-sharing services and home-sharing. Given the energy and vision of entrepreneurs, new developments in both technology and the effective communication of information, P2P rental markets have the potential to transform additional markets.

One area where P2P rental markets could have a long-term effect is on the diversity of goods most individuals consume. Consider that in some formulations of the consumer problem, consumers consume some positive amount of every good offered. This is obviously a large departure from empirical reality if we draw fine-grained distinctions among "goods." For example, Amazon currently lists 6,238 results for "blender" in the Home & Kitchen category: presumably most households own far fewer than this number, with most owning one or none.[25] The reason for this pattern in the language of this model is clear: a consumer's valuation α for Blender 2 *conditional* upon owning Blender 1 is quite low; thus a second blender is not purchased. However, if a low-BTM rental market existed for both blender types, consumers could act upon their taste for diversity and use both types without owning both blenders.

One potential long-term reaction to the rise of P2P rental markets is that firms would change the goods that they offer. As P2P rental markets become commonplace, manufacturers will begin designing products that cater to this additional purpose. For example, locks on cars and houses that allow remote entry will be more appealing. The emerging Internet-of-Things will make it easier to identify goods that are not being used at a moment in time and perhaps facilitate nearly seamless trade. If autonomous vehicles and drones become commonplace, even the seemingly unavoidable transaction costs associated with moving goods

[25] As of October 8th, 2014.

to where they are needed might diminish substantially.[26] Similarly, technologies that make it easier to monitor usage (GPS, embedded sensors, streaming video of how they are being used, and so on) should make contracting easier and reduce some of the informational asymmetries that contribute to transaction costs. As more of economic and social life is computer-mediated, platforms will use the information gained to verify the identity and reputation of buyers and sellers, further mitigating both moral hazard and adverse selection.

[26] Thanks to Jonathan Hall for making this point.

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A Derivations for linear BTM costs

A.1 Short-run equilibrium

We assume in what follows that $\gamma \leq 2\sqrt{p}$, i.e., that the product market can support an associated P2P rental market. In the short-run, ownership is fixed, and the total supply offered in the P2P rental market at rental rate r is

$$S(r;\sqrt{p},\gamma) = \begin{cases} \int_{\sqrt{p}}^{1} 1-\alpha+\frac{r-\gamma}{2} dF(\alpha), & \text{for } r > \gamma \\ 0, & \text{for } r \leq \gamma \end{cases}, \tag{A1}$$

Let $S_0 = S(\gamma;\sqrt{p},\gamma)$ be the minimum available supply, that is, the total amount of time that the owners' products were unused before renting was an option. Renter demand is

$$D(r;\sqrt{p},\gamma) = \begin{cases} 0, & \text{for } r > 2\sqrt{p} \\ \int_{r/2}^{\sqrt{p}} \alpha - \frac{r}{2} dF(\alpha), & \text{for } r \leq 2\sqrt{p} \end{cases}, \tag{A2}$$

with $D_0 = D(\gamma;\sqrt{p},\gamma)$ denoting the maximum demand under any rental market that can be supported for BTM cost γ.

If the pre-rental unused capacity exceeds the unfulfilled demand for the good, i.e., $S_0 \geq D_0$, a glut results. Owners then compete on rental prices, and the market clears at $r_S = \gamma$, with rental rate being pushed to the marginal "production" cost—the BTM cost γ. If $S_0 < D_0$, owners reduce their usage intensity in order to rent the good out more on the rental market. As $S(r;\sqrt{p},\gamma)$ is increasing in r, and $D(r;\sqrt{p},\gamma)$ is decreasing in r with $D(2\sqrt{p};\sqrt{p},\gamma) = 0$, the market clears at the rental rate $r_S \in (\gamma, 2\sqrt{p})$ for which $S(r_S;\sqrt{p},\gamma) = D(r_S;\sqrt{p},\gamma)$, which can also be usefully rewritten as

$$\int_{\sqrt{p}}^{1} 1dF(\alpha) - \underbrace{\int_{r/2}^{1} \alpha dF(\alpha) + \int_{r/2}^{\sqrt{p}} \frac{r}{2} dF(\alpha)}_{\text{(I)}} + \underbrace{\int_{\sqrt{p}}^{1} \frac{r}{2} dF(\alpha)}_{\text{(II)}} - \underbrace{\int_{\sqrt{p}}^{1} \frac{\gamma}{2} dF(\alpha)}_{\text{(III)}} = 0. \tag{A3}$$

By the monotonicity property of the supply and the demand, the equilibrium market-clearing rental rate is unique.[27]

The short-run equilibrium rental rate r_S is increasing in γ, as it becomes less profitable for owners to reduce their usage and provide their excess supply, while demand remains unchanged. Formally, if a glut occurs then $r_S = \gamma$, and hence r_S is increasing in γ and there

[27] Note that the derivations for the case of zero BTM costs and positive BTM costs are similar, i.e., adding BTM costs does not substantially change the predictions of our model.

is complete passthrough of costs. If demand for rentals outweighs the unused capacity, we see from Equation A3 that Term (III) increases in γ, and terms (I) and (II) increase in r. Clearly, increases in γ have to be offset by increases in r_S for equilibrium to occur. Furthermore, there is incomplete passthrough of costs to the rental rate; assuming the opposite would require term (I) to not increase in r, which can only happen for infinitely elastic demand. But if demand was infinitely elastic, every consumer would already own the good, which makes our analysis trivial.

A.2 Long-run equilibrium

To derive the long-run equilibrium with BTM costs, we first observe that for any $\gamma > 0$, if $u^O(\alpha_0, r) \geq u^R(\alpha_0, r)$, then for every $\alpha > \alpha_0$ we have $u^O(\alpha, r) > u^R(\alpha, r)$, as the utility from owning increases faster in valuation than the utility of renting (see Equations 4 and 17). Following the same argument, if $u^O(\alpha_0, r) \leq u^R(\alpha_0, r)$ then for every $\alpha < \alpha_0$ we get $u^O(\alpha, r) < u^R(\alpha, r)$. Consequently, the equilibrium is characterized by a critical valuation α_L, above which consumers own and below which consumers rent. This critical valuation is the valuation of the marginal owner—the consumer who is indifferent between renting and buying the good—for whom $u^O(\alpha_L, r) = u^R(\alpha_L, r)$, which simplifies to

$$\alpha_L = \frac{p - r(1 - \frac{\gamma}{2}) + \gamma(1 - \frac{\gamma}{4})}{\gamma}. \tag{A4}$$

The long-run equilibrium is then characterized by a critical valuation α_L and a rental rate r_L for which market supply equals market demand, that is, $S(r_L; \alpha_L, \gamma) = D(r_L; \alpha_L, \gamma)$.[28]

For any triplet (p, γ, F), a P2P rental market can be sustained if there exists some $r_L \geq \gamma$ for which $\alpha_L \in (\gamma/2, 1)$—if $\alpha_L \leq \gamma/2$, no renting takes place. This happens when $\gamma \leq 2\sqrt{p}$. If a market forms, there exists a unique equilibrium: as α_L is continuous and decreasing in r, for any distribution F that has a density with continuous support, $S(r; \alpha_L, \gamma)$ is continuous and increasing in r, and $D(r; \alpha_L, \gamma)$ is continuous and decreasing in r, and uniqueness follows.

In the long-run equilibrium, the rental rate r_L increases in the BTM costs γ, but there is incomplete pass through. To see why, consider any triplet (p, γ, F) and let α_L, r_L be the resulting long-run equilibrium of the P2P rental market. For equilibrium to occur, demand should equal supply, from which we get

$$\int_{\alpha_L}^{1} 1 - (\alpha - \frac{r_L - \gamma}{2}) dF(\alpha) = \int_{r_L/2}^{\alpha_L} a - \frac{r_L}{2} dF(\alpha).$$

[28]The supply and demand terms are as in Equations A1 and A2, with the only difference being that the integrand limit—which was formerly determined only by the price of the good—is now an equilibrium quantity.

Now assume that BTM costs increase by some amount $\epsilon > 0$. This results in a decrease of the available market supply (LHS in the equation above), but demands remains constant, and hence prices should increase for the market to clear. If r increases by some amount greater or equal to ϵ, then all previous owners still decide to own, as the utility from owning remains the same, and the utility from rentals decreases (see Equations 4 and 17). These owners also rent out the same amount—or more—as they did before (see Equation 16). Furthermore, as renting becomes more expensive, some previous renters may now choose to now own the good. As a result, supply does not decrease. At the same time, demand decreases both in size (lower integration limit in the RHS of the equation above) and in intensity (integrand in RHS). The resulting contradiction proves that there cannot be perfect cost pass through, i.e. that the new market equilibrium rental rate is lower than $r_L + \epsilon$. We can similarly prove that r_L has to increase, and hence that there is incomplete pass through.

B Design of the survey

B.1 Choice of goods and sample

Goods that traditionally have been rented are expensive, durable goods that are used infrequently but whose usage can be planned in advance. Examples include cars and hotels in distant cities, tuxedos, certain kinds of specialty tools (e.g., rototillers, carpet shampooers), and so on. In the language of our model, these are goods with high purchase price p, broad-based appeal (meaning a large pool of non-owners with a non-zero valuation α), and a sufficiently low BTM cost (low γ) relative to the purchase price.

Other goods make poor rental candidates because their usage is difficult to plan. Some goods have a highly predictable usage pattern—a family might arrange to rent a vacation home months in advance—whereas other goods are much less predictable in their normal patterns of usage—the need for a back-up electric generator is almost always a surprise in most locales. Goods with hard-to-plan usage are unlikely to be rented easily as the temporal division problem is acute.

Another factor that affects suitability for rental is how much value a single session of usage offers, and thus whether renting can overcome the inherent transaction costs. While amount of time rented is not necessarily proportional to the value created,[29] the time of use is almost always related to value. Goods that are used in small sessions are likely to make poor rental candidates. Goods surely differ on this dimension: a person might use her

[29]Consider that owners of champion racehorses can earn many hundreds of thousands of dollars from renting their animal's stud services for what could be a very small amount of time.

vacation home in week-long chunks of time, her lawn-mower in hour-long chunks, and her toothbrush in minute-long chunks.

We asked questions about a total of 26 goods that we selected because we thought they would yield interesting answers and varied in purpose (e.g., recreation, home improvement, cooking and so on), purchase price, predictability, and usage size. The goods we administered the survey for were: BBQ Grill, toothbrush, a men's suit, blender, canoe, car, cordless power drill, hammer, diamond necklace, food processor, hammer, cat carrier (for transporting cats), high-end audio headphones, high-end digital [sic] camera, iPad or tablet, jet ski, kid's bouncy [sic] castle, kitchen timer (or egg timer), mountain bike, pick-up truck, push lawnmower, ride-on lawnmower, tuxedo, vacation home, back-up electric generator, portable air conditioner, sewing machine.

Each "human intelligence task," or HIT, comprised a total of eight questions about one particular good, with one question about family income. Workers were allowed to answer for each of the sampled goods.

B.2 Survey questions

The survey questions were the following:

1. Does your household own a **good**?
    - Yes
    - No
2. Have you ever lent your **good** to someone else?
    - Yes
    - No
    - NA - we do not own one.
3. Have you ever borrowed a **good** from someone else?
    - Yes
    - No
    - NA - we own one.
4. Have you ever rented a **good**?
    - Yes

- No
- NA - we own one.

5. Regardless of whether your household owns a **good**, if you did own one, how much do you estimate it would be used by members of your household on average?

   - We would not use this at all
   - 1 minute a week (about 1 hour a year)
   - 5 minutes a week (about 4 hours a year)
   - 1/2 an hour a week
   - 1 hour a week
   - 1/2 an hour a day
   - 1 hour a day
   - 2 hours a day
   - 4 hours a day
   - 8 hours a day
   - 16 hours a day
   - 24 hours a day (I would continuously be using this good)

6. Regardless of whether you actually own a **good**, how do you imagine it would be used if it was owned by your household (on a scale of 1 to 5):

   - 1 - Used in one big block of time
   - 2
   - 3 - Used in a mixture of large and small blocks of time
   - 4
   - 5 - Used in many small blocks of time

7. Regardless of whether you actually own a **good**, how predictable would your usage of it be if you did own it:

   - 1 - Very predictable—I can plan usage many weeks in advance
   - 2
   - 3 - Somewhat predictable

- 4
- 5 - Very unpredictable—I would never know exactly when I would need to use it until right beforehand.

8. If you do not own a **good**, what is the primary reason?

    - NA - we own one.
    - We wouldn't use it enough to justify the purchase price
    - We would use it, but we simply do not have the money.
    - I don't have the space for this item

9. What is your total household income?

    - Less than $10,000
    - $10,000-$19,999
    - $20,000-$29,999
    - $30,000-$39,999
    - $40,000-$49,999
    - $50,000-$59,999
    - $60,000-$69,999
    - $70,000-$79,999
    - $80,000-$89,999
    - $90,000-$99,999
    - $100,000-$149,000
    - More than $150,000

It is worth making some observations about choices we made in designing the survey. First, to elicit expected usage, we asked respondents to select how often they would use a good in time units, using familiar measures of time to label the responses, e.g., one hour a week, one hour a day and so on. We framed the choices as being approximately on a logarithmic scale, with each increase in usage being approximately a doubling of the fraction of time. Second, in our estimation, incomes were imputed by taking the midpoint of the range associated with each bin (i.e., a respondent's selecting $10,000-$19,999 is imputed to have a $15K family income). There was only one top-coded respondent, who was given an imputed income of 1.5 times the censoring threshold.

B.3 Aggregate ownership and renting patterns

The recent flourishing of P2P rental markets helped motivate this paper. Thus, asking respondents whether they have rented a particular good in such a market would likely yield few results, given how new these markets are. Existing P2P rental market platforms seem to be focusing on sectors where conventional rental markets already existed (or at least met the same want, say in the case of Airbnb offering a substitute for hotels). As such, asking respondents if they have ever rented a good at all might be a reasonable proxy for whether they would eventually rent such a good in a P2P rental market.

For each good, we asked whether the respondent's household (a) owned the good and (b) had ever rented the good. In Figure 7, the fraction owning is plotted on the x-axis and the fraction renting on the y-axis. Both axes employ a square root scale to better display the data. Some notable goods are labeled—see Appendix B.4 for the precise by-good fractions for every good. Renting and owning are gross substitutes in the data, when cars are excluded—cars show a high level of both ownership and rental. Unsurprisingly, goods that are nearly universally owned show little renting. There are a number of goods that show medium ownership levels (e.g., around 50%) and yet zero recorded instances of renting, which could indicate potential P2P rental market candidates. Goods used during special occasions such as weddings, celebrations, and vacations show the highest rates of rental and lowest rates of ownership, e.g., tuxedos, vacation homes, jet ski, tuxedos, canoes, and bouncy castles.

To confirm the visual pattern of renting declining in ownership, Column (1) of Table 3 reports an estimate of

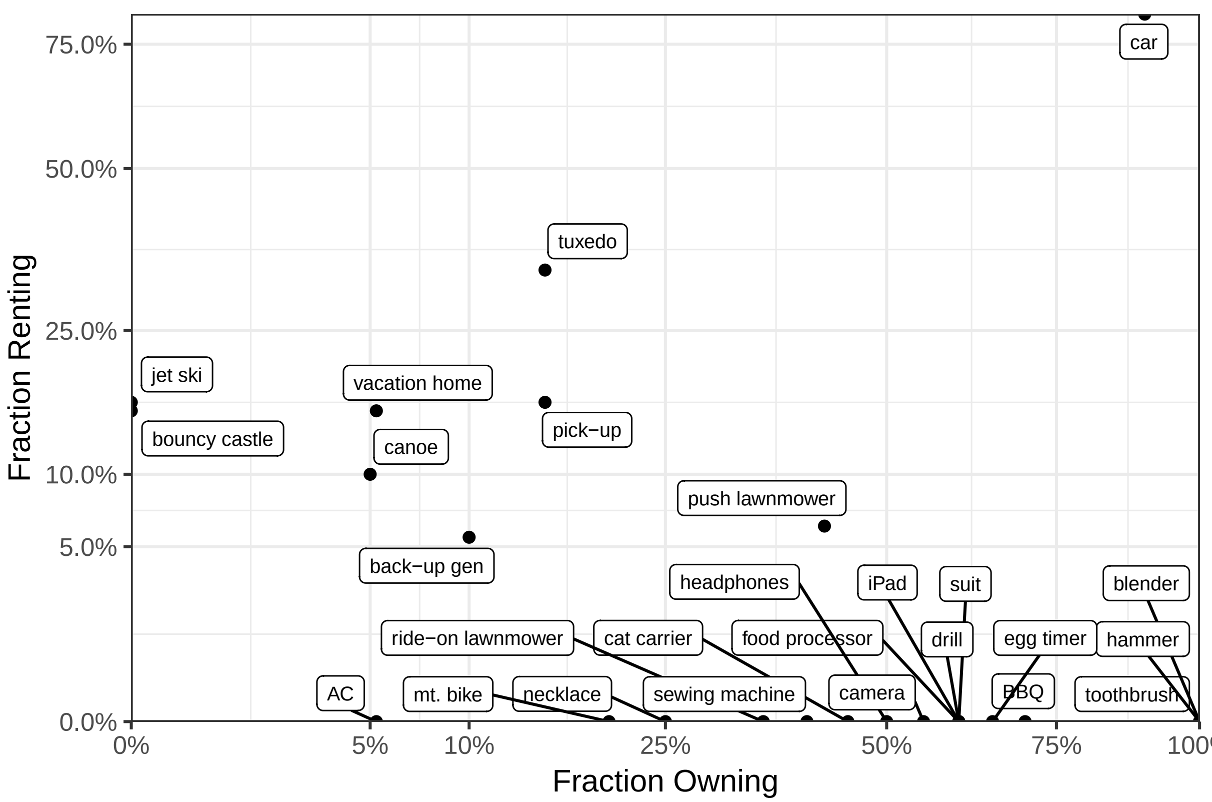
$$\textsc{FracRent}_g = \beta_0 + \beta_1 \textsc{FracOwn}_g + \epsilon, \tag{A5}$$

where $\textsc{FracRent}_g$ is the fraction of respondents reporting having rented the good g, and $\textsc{FracOwn}_g$ is the fraction reporting owning the good g. Column (1) reports the estimated regression of this equation with cars, while in Column (2) cars are excluded. If we exclude cars, there is a strong negative relationship between owning and renting; a 10% increase in the fraction owning reduces the fraction of households renting by a little more than 1.5 percentage points.

B.4 Additional empirical results

Figure 8a shows the fraction of respondents reporting owning various goods, as well as 95% confidence intervals for that point estimate computing using the Wilson method for a binary proportion. There are few surprises: nearly everyone owns a toothbrush, a hammer, and

Figure 7: Fraction of respondents reporting having rented versus fraction owning a good



Notes: This figure plots the fraction of respondents reporting having renting good at least once, versus the fraction reporting owning the good.

Table 3: Fraction of respondents owning a good versus fraction having rented a good

	Dependent variable:	
	Fraction reporting renting the good (FracRental)	
	(1)	(2)
Fraction reporting owning the good	−0.009	−0.160***
	(0.109)	(0.046)
Constant	0.081	0.115***
	(0.059)	(0.024)
Sample	All Goods	Cars Excluded
Observations	26	25
R^2	0.0003	0.345

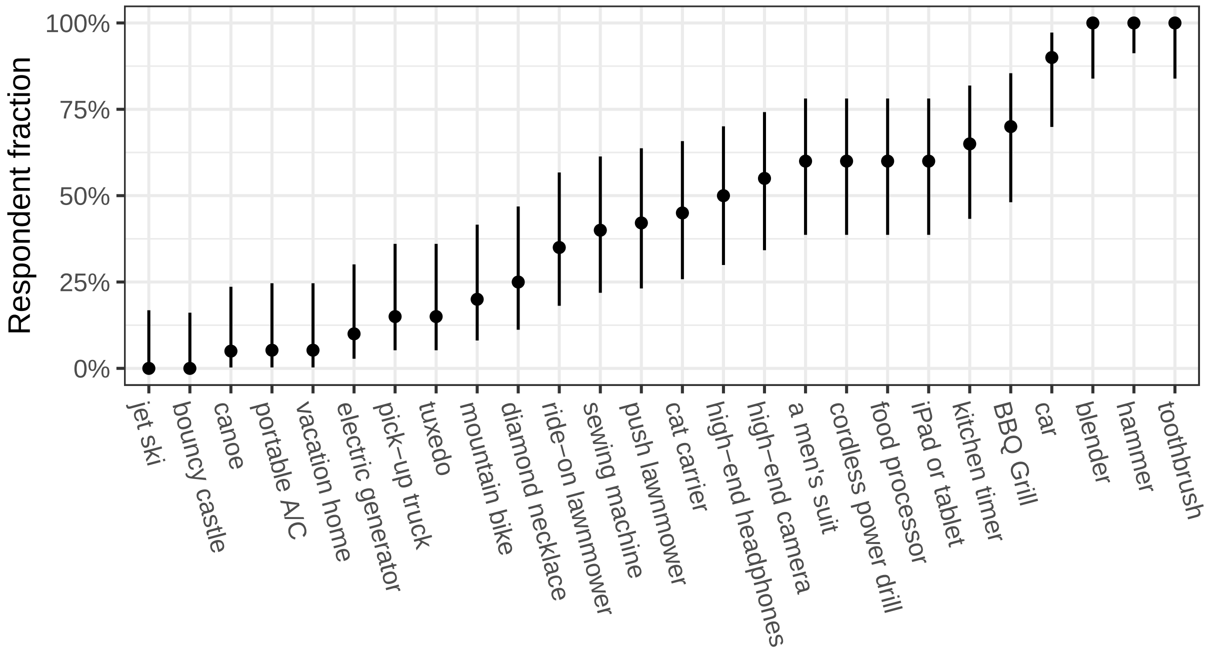
Notes: This table reports OLS regressions where the dependent variable is the fraction of respondents reporting having rented a good, and the independent variable is the fraction reporting owning that good. Column (1) includes all goods surveyed, while Column (2) excludes cars. For the full list of goods and the survey language, see Appendix B. Significance indicators: $p \leq 0.05 : *$, $p \leq 0.01 : **$, and $p \leq .001 : * * *$.

a blender; no one reported owning a jet ski, and only one respondent reported owning a vacation home. Figure 8b shows the fraction of respondents reporting having rented the various goods. Generally, ownership and renting appear to be gross substitutes, with the notable exception of cars, presumably because people rent cars when traveling.

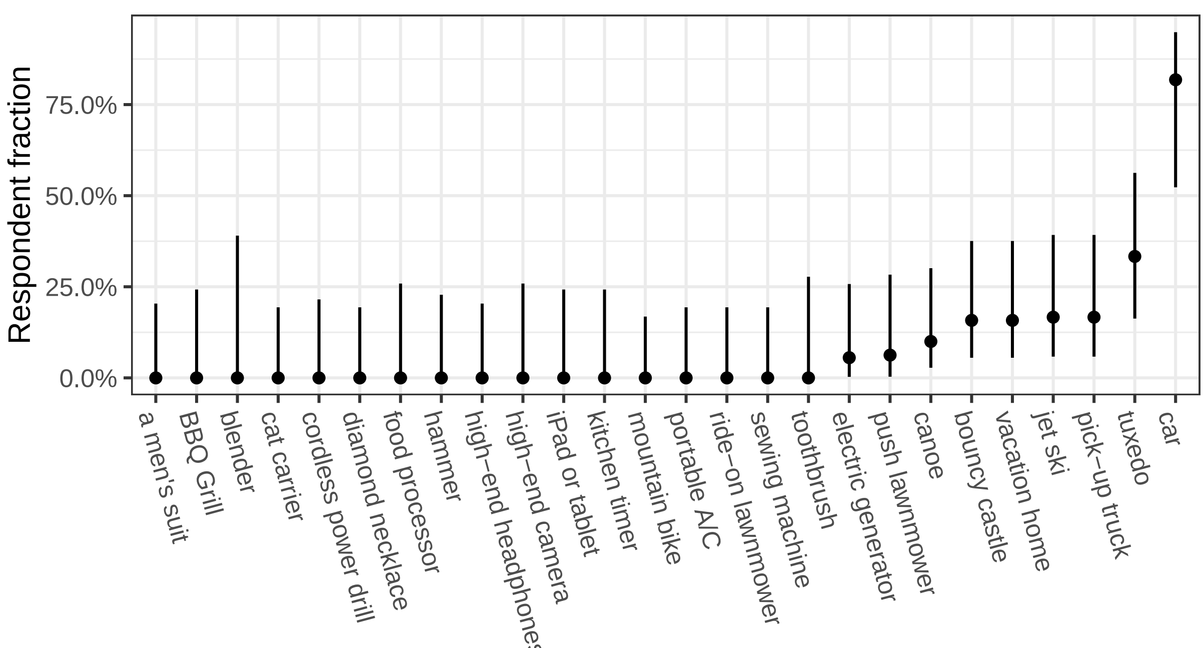
The mean unpredictability scores by good seem sensible: Figure 9a shows the mean unpredictability index per good. The most predictable goods are either those associated with planned recreation (e.g., vacation home, canoe, jet ski, tuxedo) or predictable chores (e.g., toothbrush, the two kinds of lawnmowers). The most unpredictable goods are associated with either food preparation (e.g., blender, food processor) or repairs (e.g., hammer, sewing machine, cordless power drill). Back-up electric generator is a clear (and unsurprising) outlier—you are in a sense always "surprised" when you need to use it. Figure 9b shows the mean chunkiness index per good. There appears to be some similarity in highly predictable usage, but some goods used in small chunks of time also appear to have highly predictable usage—namely the toothbrush.

Figure 8: Fraction of respondents reporting owning and renting various goods

(a) Fraction of respondents reporting owning various goods



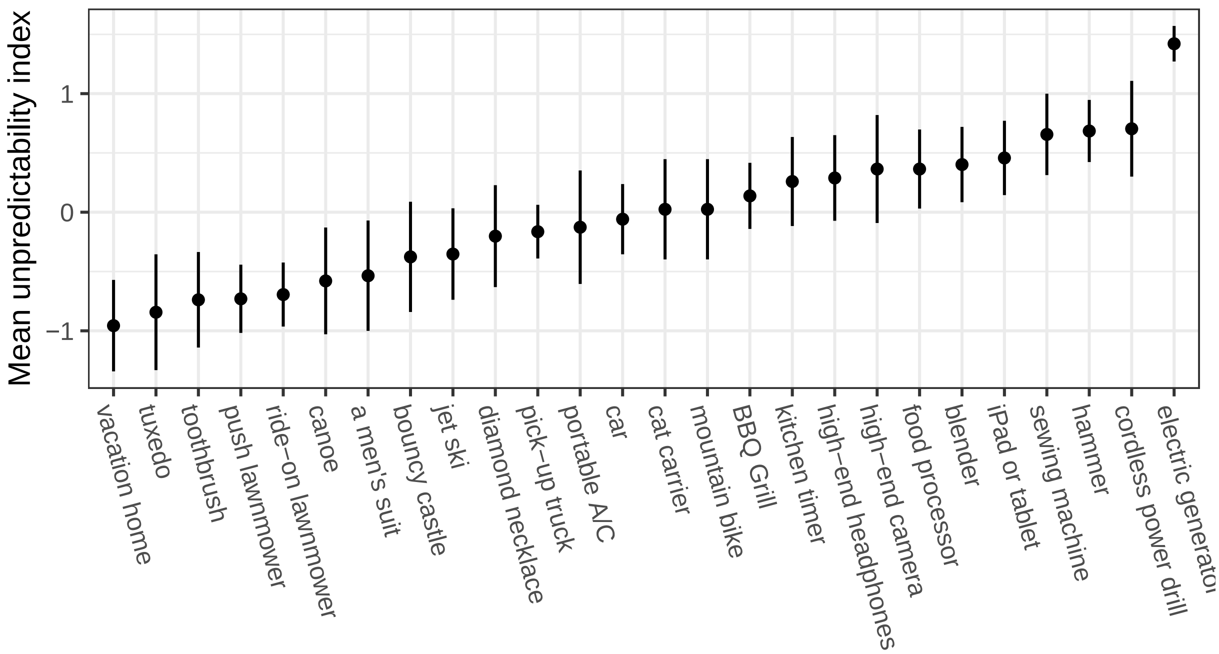
(b) Fraction of respondents reporting having rented various goods.



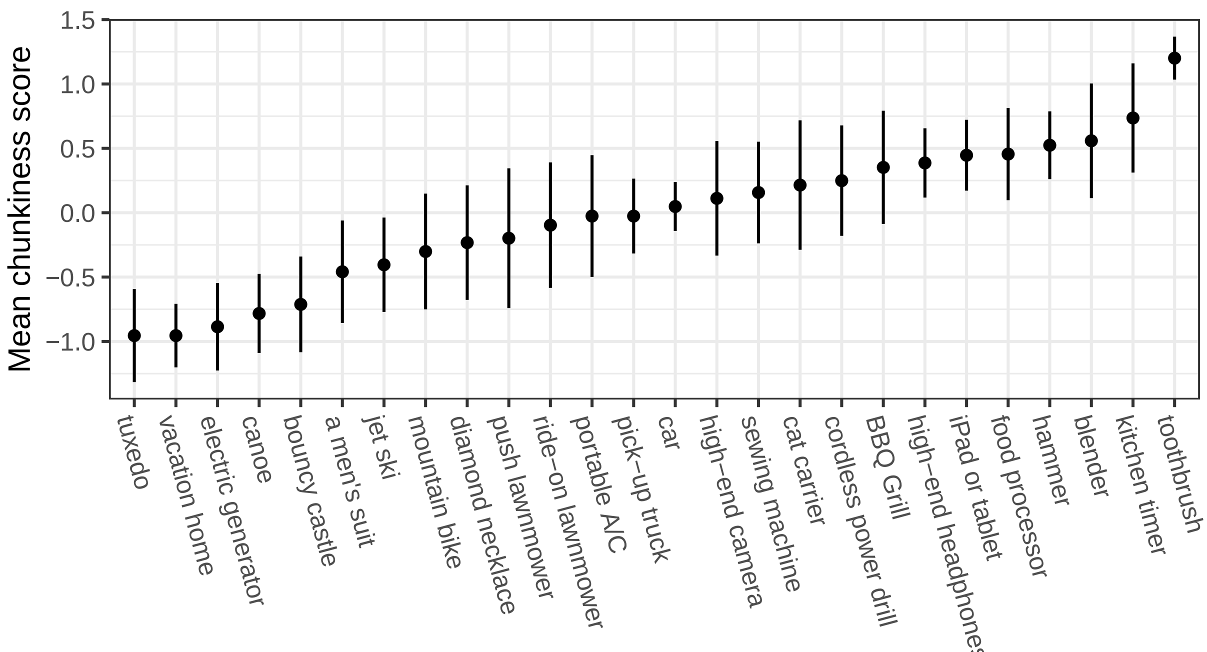
Notes: This figure plots the fractions of respondents reporting owning and having rented various goods. The 95% confidence intervals is plotted for each point estimate, computed using the Wilson method for a binary proportion.

Figure 9: Mean unpredictability and chunkiness indices for various goods

(a) Mean unpredictability index by good



(b) Mean chunkiness index by good.



Notes: This figure plots the mean unpredictability and chunkiness indices reported by the survey respondents, for the goods surveyed. A 95% confidence interval is plotted for each point estimate.