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

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Abstract

Entrepreneurs have created a number of new Internet-based platforms that enable owners to rent out their durable goods when not using them for personal consumption. We develop a model of these kinds of markets in order to analyze the determinants of ownership, rental rates, quantities, and the surplus generated in these markets. Our analysis considers both a short run, before consumers can revise their ownership decisions and a long run, in which they can. This allows us to explore how patterns of ownership and consumption might change as a result of these new markets. We also examine the impact of bringing-to-market costs, such as depreciation, labor costs and transaction costs and consider the platform's pricing problem. An online survey of consumers broadly supports the modeling assumptions employed. For example, ownership is determined by individuals' forward-looking assessments of planned usage. Factors enabling sharing markets to flourish are explored.

JEL L1, D23, D47
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1 Introduction

In traditional rental markets, owners hold assets to rent them out. In recent years, technology startup 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* or "sharing economy" markets. To be sure, some renting by consumer-owners has long existed, but it was largely confined to expensive, infrequently used goods, such as vacation homes and pleasure boats, usually with longer duration rental periods. More often, consumer-owner goods were shared among family and friends, commonly without explicit payment. In contrast, these peer-to-peer (P2P) rental markets are open markets, and the good is "shared" in exchange for payment.

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A prominent example of a P2P rental market is Airbnb, which enables individuals to rent out spare bedrooms, apartments, or even 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; Edelman and Geradin, 2015; Botsman and Rogers, 2010). The business interest in these platforms has been intense; Airbnb alone has attracted nearly $2.4 billion in venture capital investment and was valued at $25.5 billion during their most recent funding round.[1] Companies organizing sharing markets have also attracted policy interest, much of it negative (Slee, 2015; Malhotra and Van Alstyne, 2014; Avital et al., 2015).

Critics charge that the primary competitive advantage of these platforms is their ability to duck costly regulations—regulations that protect third-parties.[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 (Koopman et al., 2014), thereby making top-down regulation unnecessary. A better understanding of these markets, and progress in resolving this policy debate, requires elucidating 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-runs. This paper seeks to provide that elucidation.

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 and the falling cost and rising capabilities of the Internet, while clearly important, only provide part of the story. P2P rental markets rely heavily on the hard-won industry and academic experience in the design and management of online marketplaces. In particular, recommender systems and reputation systems, which emerged during the early days of electronic commerce, are central to the function of P2P rental markets. The knowledge so conveyed allows P2P rental platforms to overcome—or at least substantially ameliorate—market problems such as moral hazard and adverse selection. We develop this argument in more depth and point out relevant works from the literature.

Our second major question is what are the economic properties of P2P rental markets. For example, what determines the rental rate and the quantity exchanged in a P2P rental market? How much total surplus is "unlocked" by the P2P rental market, and how is it distributed? How does the short-run situation—where existing owners rent to non-owners—differ from the long run in which owners and

[1] 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. http://www.wired.com/2015/12/airbnb-confirms-1-5-billion-funding-round-now-valued-at-25-5-billion/.

[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." "Don't buy the sharing economy hype: Airbnb and Uber are facilitating rip-offs.", The Guardian, May 27th, 2014. Access online on January 19th, 2016. `http://www.theguardian.com/commentisfree/2014/may/27/airbnb-uber-taxes-regulation`. See Horton (2014b) for a discussion of the externalities imposed by Airbnb-style subletting in rented apartments. 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.

non-owners alike can revise their ownership decisions in light of the presence of a P2P rental market? Does overall ownership increase or decrease, and who owns what goods in the new equilibrium? When there are substantial *bringing-to-market* costs (such as labor, excess depreciation, and transaction costs), who bears them, and how does it affect the short- and long-run equilibria?

To address these questions, we develop a simple model in which consumers initially decide whether to purchase a good based on their expected usage. We consider a case where there are owners and non-owners, with the owners using the good less than 100% of the time and non-owners, while not purchasing the good, would use it some of the time if they did own it.[3] Some technological/entrepreneurial innovation then creates a P2P rental market that allows owners to rent their unused capacity to non-owners. For clarity, we first assume that owners face no bringing-to-market (BTM) costs (i.e., no depreciation, labor or transaction costs from rentals).

After the P2P rental market emerges, owners and non-owners use the good as if they were renting the good at the market-clearing rental rate. Renters do face the rental rate, while for owners, the possibility of rental creates a new opportunity cost for their own usage. The rental rate is increasing in the valuation of the owners, which reduces supply, and the valuation of the renters, which increases demand. The short-run rental market does not necessarily clear: if pre-P2P rental unused capacity exceeds demand, a glut results. In practice, the inherent costs of bringing excess capacity to the market assures an above zero price floor.

In addition to the short run, we consider a long run where owners and renters alike can revise their ownership decisions. We find that if the short-run cost to rent the good 100% of the time is below the purchase price, then ownership is less attractive. This will reduce *purchase* demand for the product. In the long-run P2P rental market equilibrium, the purchase price equals the rental rate (when normalizing the life of the good to 1). Owners and renters receive the same utility at the margin, thereby decoupling individual preferences from ownership. The model offers an intuitive test for whether total ownership will decrease in the long run: ownership decreases if the short-run rental rate is below the purchase price.

Surplus increases in both the short- and long-run P2P rental market equilibria relative to the pre-sharing status quo. Although owners have less consumption, they are more than compensated with rental income that exceeds their utility loss. 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. The existence of a P2P rental market allows for a higher maximum price in the product market, as it can generate positive demand for a good at prices for which even high-types would not buy without the possibility of rental.

When we assume that owners do face BTM costs, the model predictions change in several important ways. If BTM costs are sufficiently high, no P2P rental market can exist in the short run. If the market

[3] While we assume a purchase price that splits consumers into owners and non-owners, other equilibria are possible, such as one where everyone owns the good. For a given set of consumer valuations, there is a range of product market prices that can support a short-run P2P rental market. 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, in the long-run ownership decisions can be revised.

can exist, the BTM costs raise the rental rate and lower the quantity of the good transacted in the market, in the both the long run and short run. However, BTM costs—being the equivalent of a per-unit sales tax—are not fully passed through in the rental rate, in either the short run or long run.

The presence of BTM costs changes the predictions about long-run ownership. Consumers with a higher valuation now tilt towards ownership. The reason for the tilt is that owners using the good for their own consumption avoid some of the BTM costs such as extra cleaning, handing off keys, dealing with disputes, and so on. As in the short-run case, in the long run there is incomplete pass through of the BTM costs. An implication of this finding is that the rental rate is lower than the purchase price (when the life of the good is 1). As such, a firm 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 renting).

One important BTM cost is the fee imposed by the platform. If the platform keeps the fee constant, the incentive for reducing BTM costs depends in part on the elasticity of demand in the P2P rental market, in that the platform finds it more attractive to lower BTM costs when demand is elastic since the increase in quantity transacted will offset the relatively small reduction in the rental price. However, the platform can always increase revenue by lowering BTM costs, as it can simply increase its own fee accordingly, keeping the rental rate and transaction volume unchanged (but making more revenue on each unit transacted). Whether this is optimal depends on the elasticity of BTM costs with respect to the platform's efforts.

Of course, goods will differ in the cost of bringing them to market, and this affects the P2P rental market. Some of these BTM costs are straightforward, such as labor, depreciation, and complementary consumables. For example, driving with Uber requires your labor, puts additional miles on your car, and consumes gas. However, another aspect that is relevant to BTM costs is how amenable a good is to "temporal division" and, hence, renting. For example, 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.

Our third and final question is how the usage patterns for different goods are likely to affect BTM costs. To do this, a convenience sample of consumers was asked a series of questions about a good (e.g., a BBQ grill), such as whether they own one, whether they have lent it out or borrowed it, and how much they do or would use it (depending on ownership). If they do not own it, they were asked why. 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." We selected a number of goods and encouraged respondents to answer our questions about multiple goods, as in some cases this allows us to control for the identity of the respondent. The respondents were also asked for their household incomes.

Our main finding is that income is only important in determining ownership for a small number of goods (e.g., vacation homes); for most goods, planned usage was the primary driver, 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 ("you know when you are going to use it") and the good being used in large chunks of time. This positive correlation implies that a larger class of goods would have relatively low BTM costs than would be the case in the absence of this positive correlation. The survey results suggest that important components of BTM costs are the ease with which usage can be shifted around in time and the size of typical usage sessions.

The sharing economy is a relatively recent phenomenon. Thus, we conclude our paper with some thoughts on how P2P rental markets might evolve. 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, but also explicitly modify their goods to make them more or less amenable to rental.

2 Related work on modeling and quantifying the sharing economy

Other work on the "sharing economy" has discussed its features and implications qualitatively. For example, Belk (2014) offers a number of examples of these different platforms and identifies their commonalities: (1) use of temporary, non-ownership models of using consumer goods and (2) a reliance on the Internet to bring this about. Edelman and Geradin (2015) represents another example in this vein. It enumerates the efficiency gains from P2P rental markets, such as reducing transaction costs and improving allocative efficiency. Edelman and Geradin is distinctive in that it discusses the regulatory policy implications of sharing economy companies using the traditional "market failure" framework that motivates much of public economics. Other work has been more practically oriented, similar in spirit to the empirical portion of our paper. For example, Hampshire and Gaites (2011) analyzes the feasibility of P2P car-sharing in Pittsburgh.

The paper most closely related to ours is Benjaafar et al. (2015), who also 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—the papers differ 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 closely related paper (in part) is Einav et al. (2015), which covers some of the same ground in explaining why peer-to-peer markets are flourishing now. They emphasize the role played by platforms in matching buyers and sellers, maintaining a reputation system and using prices to clear the market. They also provide a model of the economy, though the focus is on peer-to-peer sellers competing with traditional firms.

Fraiberger and Sundararajan (2015) offers a calibrated model of the peer-to-peer 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.

3 Factors explaining the rise of peer-to-peer rental markets

The somewhat obvious economic rationale for P2P rental markets is that the owners of most durable goods use them far less than 100% of the time. This under-utilization generates excess capacity that could be rented out. The demand side in such a market would be non-owners who would like to use the good, but not enough to purchase it.[4]

Given the obvious rationale for these markets, why have they only begun to flourish in recent years? The creator of a potential rental market has to overcome a variety of problems. As with any market, there are the typical search costs, such as finding and evaluating trading partners, and the Internet certainly dramatically reduces these costs (Bakos, 1997). Furthermore, there are now nearly 20 years of industrial experience in building online marketplaces and solving their characteristic problems. However, informational problems are but one major obstacle in creating rental markets; the other is resources.

Individuals lack the resources of firms that have historically dominated rental markets. For example, individuals lack marketing budgets and expertise, ways of accepting payments that are convenient for customers, standard contracts and procedures to draw upon, well-adapted insurance products, procedures and facilities for re-setting goods after use, and so on.[5] Individual sellers lack brands, which have proven highly relevant even in cases when quality differences are nonexistent (Bronnenberg et al., 2014); in cases where goods truly are heterogeneous, a lack of a market reputation might completely foreclose the possibility of trade. 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. Given both the lack of firm-like resources and the inherent information problems of rental markets, consumer-owned goods have historically just

[4]A non-owner might mean a non-owner in a particular place and time. Many Airbnb guests own homes—they just don't own homes everywhere.

[5]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 that manage fleets of vehicles and Airbnb "hosts" with multiple properties.

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 have emerged as entrepreneurs have taken advantage of technological advances to build facilitating platforms. The platforms dramatically lower transaction costs and provide individual owners tools previously only available to firms. The maturation and increasing penetration of the Internet and the proliferation of smartphones (with high-resolution digital cameras) were the technological shocks that made some of these P2P rental markets feasible. For example, Uber simply does not "work" in a world where few consumers have GPS-enabled smartphones. Although these technology advances are important, these P2P rental markets have also stood on the shoulders of their electronic commerce predecessors, such as eBay, that made strides towards solving some of the informational problems inherent to online marketplaces.

A key challenge in all markets is facilitating trust among strangers, and this problem is acute in P2P rental markets, given the "opportunity" renters have to misuse or destroy the owner's capital. In most markets, the buyer's type matters little to the seller; in rental markets, the buyer's type can be critical. Facilitating trust is not an easily solved problem in online markets, but the experiences of early electronic commerce pioneers such as eBay provided P2P rental market entrepreneurs a number of effective solutions to market problems related to trust. The flaws in early versions of these systems—such as the ability and inclination of parties to condition their feedback on their trading partner's feedback—also clearly influenced the design of follow-on systems used in P2P rental markets. 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.

Online markets in general lack many of the market-thickening coordination mechanisms available in physical markets such as coordinating on time and geography.[6] To compensate for the lack of geography and time as a coordinating mechanism, online marketplaces create taxonomies and extensively classify goods, and capitalize on the vast numbers of potential customers. A complementary approach is to make extensive use of search algorithms and recommendation systems (Resnick and Varian, 1997; Adomavicius and Tuzhilin, 2005). These kinds of approaches are particularly important in P2P rental markets because the goods being rented are often highly differentiated (such as apartments), as are consumer preferences, making matching more important.[7] 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.

[6] 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 is located in the northwest side of the Union Square Park.

[7] Dinerstein et al. (2014) uses data from eBay to highlight the difficulties 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.

In addition to simply finding each other, would-be trading partners must assess both each other and the goods being traded. These assessments are aided by verifiable measurements made by the platform on a number of dimensions, including past market history. As Varian (2010) points out, advances in information technology are often advances in measurement. Consider that Uber is only possible because both sides of the market now carry with them taximeters (when running the appropriate software) at all times: a smartphone with GPS technology allows for the precise measures of distance traveled. In fact, this computer-mediated approach works even better than the traditional taximeter in that both parties can verify that the best route was taken. The proliferation of high-resolution digital cameras has similarly made it easier for parties to inspect goods ex ante (Airbnb in particular benefits from this innovation).

One important platform innovation has been in reputation systems, which essentially digitize 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). 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); and dealing with the tendency towards inflated reputations (Horton and Golden, 2015).

The reputation system is one particularly important example of an aspect of the market that individual participants would find too costly (or even impossible) to build and maintain. Platforms enjoy scale economies for many costly tasks compared to individual owners. For example, they handle credit card payments. They create tools for "self-serve" marketing (such as through attractive profile pages) and through general platform marketing to bring renters to the platform. They also create software tools that let owners manage their availability, learn about the attributes of potential renters, and so on.[8]

In addition to the nuts-and-bolts issues of running online marketplaces, there have also been considerable advances 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), but in recent years it has seemed to be increasingly motivated by electronic commerce examples and 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). 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.

[8]Both Horton (2014a) and Fradkin (2013) consider the role played by platforms 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.

4 Model

Before anyone can "share," someone has to own and others have to not own (but still want to consume at least some of the good). Our model's first task is to explain how consumers divide between owners and non-owners. Our model is built on the notion that goods can usefully be thought of as having an intensive margin of usage, which in turn drives the extensive margin decision (i.e., ownership). The assumption that consumers must consider the time required to use a good in making their consumption plan is similar in spirit to Becker (1965). The possibility of sharing a good bears similarities to Varian (2000). Varian discusses—in the particular context of information goods—how planned usage affects the rent-versus-own decision.

We first consider what happens when the possibility of P2P rental emerges, thus allowing the existing pool of owners to rent to non-owners. First, we assume that there are no BTM costs (such as labor and transaction costs). We determine the equilibrium rental rate, the quantity transacted, and the changes in consumer surplus. Next, we introduce BTM costs (such as depreciation, labor, and transaction costs) and see how this changes the short-run equilibrium and whether a P2P rental market can emerge.

We then turn our attention to the long-run case, where owners and non-owners can revise their ownership decisions. First, we derive the equilibrium without any BTM costs and determine who owns in equilibrium and what happens to total ownership. Then, we perform the same analysis, but assume non-zero BTM costs.

4.1 Consumer decision about ownership based on expected usage

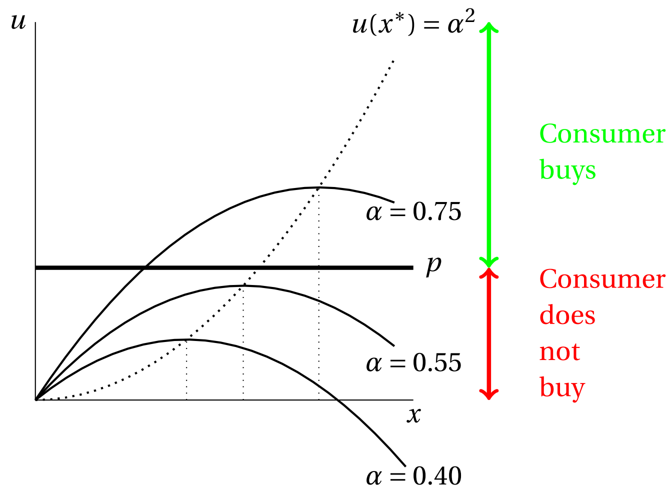
Every consumer has a unit of time to allocate to various activities, some of which involve using a good. The good has a one-period lifetime. Consumers have to decide how much time, $x \in [0,1]$, to devote to using that good. Using the good brings decreasing marginal utility. The consumer receives a benefit of $b(x) = 2\alpha x$, but also incurs opportunity cost $c(x) = x^2$, where $\alpha \in (0,1)$ parameterizes their valuation of the good. With the functional forms chosen, α has a convenient interpretation, which is that α is the fraction of the time a good would be used by an owner. The $c(x)$ term is the opportunity cost of time, which grows as more time is spent with the good in question rather than with the best alternative use of one's time.

The consumer's utility for a given x is $u(x) = b(x) - c(x) = 2\alpha x - x^2$, and so the individual's optimal usage, conditional upon owning the good, is $x^* = \alpha$, yielding indirect utility

$$v(\alpha) = u(x^*) = \alpha^2. \tag{1}$$

The purchase price of the good is p, and so a consumer will buy the good only if $\alpha^2 > p$. Figure 1 illustrates the consumer's problem, showing the utility from various levels of usage depending on that consumer's value of α. The usage solution for each consumer is his or her α parameter, and since indirect utility is just α^2, the optimal usage for each value falls along the curve traced out by x^2. The purchase

Figure 1: Consumer's optimal usage of a good and resultant decision about whether to purchase that good



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.

price p determines who purchases the good, with all those having $\alpha^2 > p$ deciding to own, and those below choosing not to purchase the good.

Note that all owners have an amount of time, $1 - x^*$, when they are not using the good. This unused capacity is what they will be able to rent out, plus whatever amount becomes available because the owner reduces their usage to reap rental income.

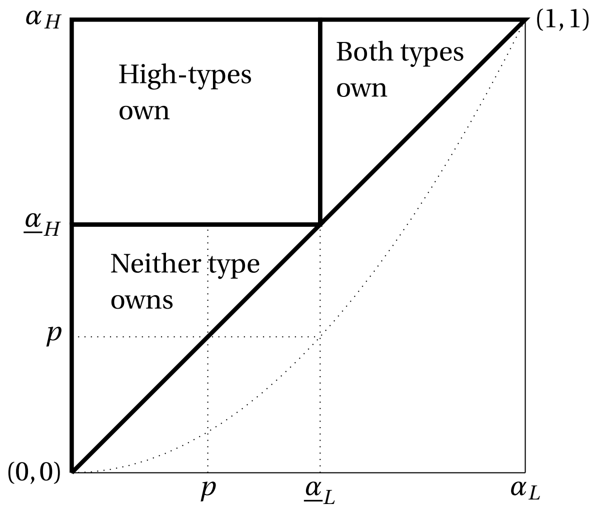
4.2 Three consumption possibilities with two consumer types but no rentals

There are three important potential market configurations with respect to ownership: (1) everyone owns, (2) no one owns, and (3) some own and others do not. For our purposes, (3) is the interesting case. A simple way to obtain this possibility is to assume two consumer types: α_H and α_L, with $\alpha_H > \alpha_L$, and to assume a price that divides consumers into owners and non-owners, namely a p such that $\alpha_H^2 > p > \alpha_L^2$. Assume that there is a unit mass of consumers, with a fraction θ being high-types with $\alpha = \alpha_H$ and the remaining $(1-\theta)$ fraction of consumers being low-types with $\alpha = \alpha_L$.

The product market demand curve for the good is

$$D(p) = \begin{cases} 0 & : p > \alpha_H^2 \\ \theta & : \alpha_H^2 \geq p > \alpha_L^2 \\ 1 & : p \leq \alpha_L^2 \end{cases} \tag{2}$$

Figure 2: Three consumer market possibilities in the absence of peer-to-peer rental, with two consumer types



Notes: Three consumer ownership possibilities.

The three market possibilities are shown in Figure 2, where the x-axis shows possible values of α_L and the y-axis shows possible values for α_H. Since $\alpha_H > \alpha_L$ by definition, we only consider the space above the 45-degree line, which is partitioned into spaces where neither owns, both own, and only the high-types own. The associated minimal-but-still-purchasing valuation parameter is shown as $\underline{\alpha}_H$ and $\underline{\alpha}_L$ for the high- and low-types, respectively. The faint dotted lines illustrate the construction of the regions.

We are particularly interested in the rectangle where high-types own but low-types do not, because in this region the purchasing high-types have excess capacity, $\alpha_H < 1$, but the low-types still value usage of the good, $\alpha_L > 0$, despite their non-purchase. In this region, the immediate possibility of mutually beneficial rental exists between the two types (in the other market configurations a revision in the ownership decision is needed to support a P2P rental market).

4.3 Short-run P2P rental market equilibrium

We now suppose that through some technological advance it becomes possible for the high-types to rent their entire excess capacity to the low-types, with no BTM costs. However, no one can revise their original ownership decision in light of this advance. Before the possibility of rental, owners were simply consuming α_H, leaving $1 - \alpha_H$ idle. If they had purchased the good, the low-types would consume α_L. However, with the new possibility of rental, each consumer's decision problem will change.

Posit a market rental rate of r. The owner's usage-optimization problem is now

$$\underset{x}{\operatorname{argmax}} \quad 2\alpha_H x - x^2 - p + \underbrace{(1-x)r}_{\text{Rental income}},$$

whereas the renter's optimization problem is

$$\underset{x}{\operatorname{argmax}} \quad 2\alpha_L x - x^2 - \underbrace{xr}_{\text{Rental cost}} .$$

Assuming an interior solution (which requires that $2\alpha_L > r$), both the renter and the owner choose to use

$$x^*(\alpha_i) = \alpha_i - r/2, \tag{3}$$

where α_i, $i \in \{H, L\}$, is their individual usage parameter value.

The P2P short-run equilibrium is characterized by a rental rate and a quantity rented. For the short-run P2P rental market to clear

$$\theta(1 - x_H(r)) = (1-\theta)x_L(r), \tag{4}$$

where $x_H(r)$ and $x_L(r)$ are the usage of the good for the owners and non-owners, respectively. Recall that θ is the fraction of high-types (and hence owners).

The market clearing rental rate is

$$r = 2\left[(1-\theta)\alpha_L - \theta(1-\alpha_H)\right]. \tag{5}$$

Note that the short-run equilibrium rental rate is proportional to the difference between what low-types would consume if they owned, $(1-\theta)\alpha_L$, and high-types would leave unused in the absence of the P2P rental market, $\theta(1-\alpha_H)$. As (5) shows, the rental rate increases in the valuation of either type (since higher valuation from low-types increases demand while higher valuation from high-types reduces supply) and declines with the fraction of high-types, as they provide the market supply. An increase in the relative number of owners decreases rental rates, as $\frac{\partial r}{\partial \theta} < 0$.

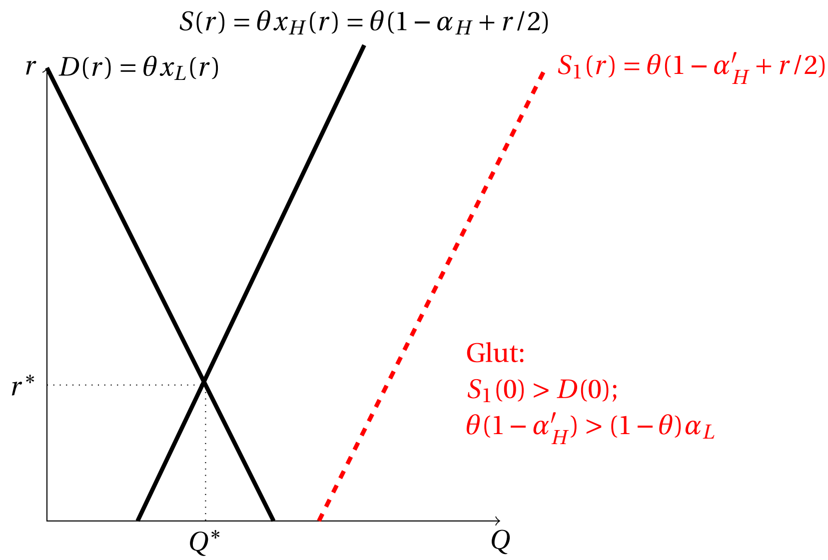
The quantity of the good exchanged is

$$Q = \theta(1-\theta)(1 - (\alpha_H - \alpha_L)). \tag{6}$$

Given this formulation, the quantity exchanged is largest when there are equal numbers of the two types. The quantity exchanged is increasing in the valuation of the low-types (since a higher valuation causes them to demand more of the good in the marketplace), but decreasing in the valuation of the high types (since for any rental rate, a higher valuation causes them to supply less of the good to the market).

From (5), we can see that it is possible for supply to exceed demand even when the rental rate is

Figure 3: Market clearing in the short-run peer-to-peer rental market



zero. This can arise when the owner's excess capacity in the absence of a rental market exceeds the non-owner's usage if he or she were to own. This glut condition occurs when the total usage if everyone owned the good, $\theta\alpha_H + (1-\theta)\alpha_L$, is lower than the actual stock of purchased goods.

Figure 3 illustrates market clearing with a positive rental rate, r^*, and the glut condition where the supply and demand curves do not intersect. When the valuation of the high-types goes down from α_H to α'_H, with $\alpha'_H < \alpha_H$, the supply curve shifts out (the dashed curve labeled $S_1(r)$), such that even at $r = 0$, the available supply, which would be $\theta(1-\alpha'_H)$, exceeds the demand from low-types, $(1-\theta)\alpha_L$, thereby creating a glut.

4.4 Social surplus in the short-run peer-to-peer rental market

The introduction of the P2P rental market changes outcomes in two ways: high-type consumption goes down (from $x_H = \alpha_H$ to $x_H = \alpha_H - r/2$) and low-type consumption goes up (from $x_L = 0$ to $x_L = \alpha_L - r/2$). The loss in utility for the high-type owners due to reduced consumption is

$$\begin{aligned} \Delta v_H &= \underbrace{\left[2\alpha_H(\alpha_H - r/2) - (\alpha_H - r/2)^2\right]}_{\text{New}} - \underbrace{\left[\alpha_H^2\right]}_{\text{Old}} \\ &= -\frac{r^2}{4}. \end{aligned} \tag{7}$$

As we would expect, the greater the rental rate, the greater the loss in this consumption utility, as a higher rental rate encourages owners to consume less. For the non-owners, the gain in utility from increased consumption is

$$\Delta v_L = \alpha_L^2 - \frac{r^2}{4}. \tag{8}$$

To calculate the total change in social surplus, we can ignore the rental income for both consumer types, as it is simply a transfer. The total change in surplus from the introduction of the P2P rental market is thus

$$\begin{aligned} \Delta V &= \theta \Delta v_H + (1-\theta)\Delta v_L \\ &= (1-\theta)\alpha_L^2 - r^2/4. \end{aligned} \tag{9}$$

This equation implies that the gain from the P2P rental market is the maximum surplus obtained by the non-owners consuming at their preferred levels of usage, minus a term capturing the reduction in consumption from both types required for the market to clear.[9] As we know the equilibrium rental rate from (5), we can write the total surplus as

$$\begin{aligned} V &= \theta \alpha_H^2 + (1-\theta)\alpha_L^2 - r^2/4 \\ &= \theta \alpha_H^2 + (1-\theta)\alpha_L^2 - [(1-\theta)\alpha_L - \theta(1-\alpha_H)]^2. \end{aligned} \tag{10}$$

This expression indicates that the total surplus is equal to the surplus obtainable when everyone consumes their preferred amount of the good when facing no marginal cost, minus the square of the difference between how much is demanded when the rental rate is zero, $(1-\theta)\alpha_L$, and how much would be supplied when the rental rate is zero, $\theta(1-\alpha_H)$. The greatest social surplus is "unlocked" by the emergence of the P2P rental market when non-owners are numerous and have relatively high valuations.

4.5 Bringing-to-market costs: labor, capital depreciation, and transaction costs

Our model thus far has assumed that owners can provide their unused quantities of the good to the market at no cost. Now, we assume that the owner of the good must pay a BTM cost. This could be the cost of labor for a good that requires a labor input, such as in the case of driving with Uber or cleaning up an apartment when hosting on Airbnb; it also includes depreciation from additional usage as well as the conventional transaction costs inherent in finding trading partners, coming to terms, executing payments, handing off the good, and so on.

We will assume that the BTM cost is proportional to the amount brought to the market and is the same magnitude for all owners. Let that cost on a per-unit basis be γ.[10] The owner's return to renting on

[9] The ideal short-run P2P rental market is one where the excess capacity of the owners when they own equals the total demand of non-owners if they were to own the good. Under this scenario, the market clears with zero rental rate and both owners and non-owners get their preferred levels of usage.

[10] Our model considers a single good and hence a single γ. In Section 5 we discuss how this value is likely to differ across goods.

the P2P rental market is now just $r-\gamma$, and so $x_H(r) = \alpha_H - (r-\gamma)/2$. As we might intuit, this cost raises the rental rate and lowers the transaction volume.

Market clearing with BTM costs requires that

$$\theta(1-(\alpha_H-(r-\gamma)/2)) = (1-\theta)(\alpha_L - r/2). \tag{11}$$

The new market-clearing rental rate is simply the rental rate when there are no BTM costs (from (5)) plus the per-unit transaction cost scaled by the the size of supply side of the market, or

$$r_{BTM} = r_{\gamma=0} + \gamma\theta. \tag{12}$$

Note that there is an incomplete pass through of the costs, and while pass through increases in θ, the net effect on rental rates from a relative increase in owners is still negative.[11]

The quantity of the good exchanged is

$$Q_{BTM} = Q_{\gamma=0} - \frac{1}{2}\gamma\theta(1-\theta), \tag{13}$$

where $Q_{\gamma=0}$ is the equilibrium quantity when there are no BTM costs. This quantity is defined in (6).

4.6 Bringing-to-market costs and existence of the peer-to-peer rental market

If BTM costs are sufficiently high, then no P2P rental market will exist. The highest possible BTM cost that will still support a P2P rental market is

$$\bar{\gamma} = 2(1-\alpha_H+\alpha_L). \tag{14}$$

This condition comes from the requirement that $r < 2\alpha_L$; otherwise, the cost of consuming any of the good for a non-owner exceeds the marginal utility. As a check, note that from (13), when BTM costs are at the highest possible level, $\gamma = \bar{\gamma}$, $Q_{BTM} = 0$ (using the definition of Q from (6)). There is no P2P rental market when the reduced transaction volume from the BTM costs equals the amount that would be supplied in equilibrium in the absence of those costs.

4.7 Revised ownership without bringing-to-market costs

We now consider what happens in the long run, when owners and non-owners can revise their ownership decisions. For expositional ease, we will posit once again that BTM costs are zero. With this assumption, the long-run utility from owning is

$$v_i^{OWN} = 2\alpha_i x_i - x_i^2 + (1-x_i) r_{LR} - p, \tag{15}$$

[11] $\frac{\partial r_{BTM}}{\partial \theta} = -2(\alpha_L + (1-\alpha_H) + \gamma < 0$, as $2\alpha_L > \gamma$.

whereas the utility from renting is

$$v_i^{RENT} = 2\alpha_i x_i - x_i^2 - x_i r_{LR}, \tag{16}$$

where r_{LR} is the market-clearing long-run rental rate. The first order condition for either choice is $2\alpha_i - 2x_i - r_{LR} = 0$, and so $x_i^* = \alpha_i - r_{LR}/2$. Computing the indirect utility for both decisions, we have

$$v^{OWN} = \alpha_i^2 - p + \frac{r_{LR}^2}{4} + (1-\alpha_i) r_{LR} \quad \text{and} \quad v^{RENT} = \frac{1}{4}(r_{LR} - 2\alpha)^2. \tag{17}$$

Setting $v^{OWN} = v^{RENT}$ to find the conditions under which a user would be indifferent between renting and owning, the α_i term drops out, and we are left with the condition

$$p = r_{LR}. \tag{18}$$

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.

For the long-run market to clear, we have to determine what fraction of consumers would choose to own. Let f_{OWN} be the fraction of consumers that purchase the good in equilibrium. As ownership does not depend on valuation given that BTM costs are zero, we assume that both consumer types are equally likely to own. For the market to clear,

$$\left[\theta(1 - x_H(p)) + (1-\theta)(1 - x_L(p))\right] f_{OWN} = \left(\theta x_H(p) + (1-\theta) x_L(p)\right)(1 - f_{OWN}). \tag{19}$$

This expression simplifies to

$$\begin{aligned} f_{OWN} &= \theta x_H(p) + (1-\theta) x_L(p) \\ &= \theta \alpha_H + (1-\theta)\alpha_L - p/2, \end{aligned} \tag{20}$$

thus indicating the intuitive condition that the fraction of consumers owning in the long run is the average usage rate in the population.

Product demand in the long run is just the fraction of consumers owning the good, or

$$\begin{aligned} D_1(p) &= f_{OWN} \\ &= \theta \alpha_H + (1-\theta)\alpha_L - p/2. \end{aligned} \tag{21}$$

Before the P2P rental market emerged, there were "kinks" in the product market demand curve at α_H^2 and α_L^2. In contrast, in the long-run P2P rental equilibrium, product demand varies continuously over the range of prices when both consumer types participate.

One implication of $p = r_{LR}$ is that there are no profits from owning simply to rent out, as the purchase price is p and rental income from renting out all of the capacity is also p. In contrast, owners and non-owners that rent get an inframarginal surplus from their own consumption.

4.8 Product market demand in the long-run P2P rental market equilibrium

Many commentators on the “sharing economy” have assumed that the emergence of P2P rentals would reduce ownership. Their argument is that there is a fixed amount of consumption for some good, a “lump of consumption,” and that when idle goods are pulled into the market, demand can be met with a smaller total number of goods owned. Our model shows that reduced ownership does not necessarily follow, but the model does point to the condition under which total ownership would change, with no BTM costs. The condition is that ownership will increase in the long run when the short-run rental rate was above the purchase price, or that $r_{SR} > p$. Intuitively, if the short-run rental rate were above the purchase price, it would be attractive for individuals to buy the good purely to rent it out, as this would be profitable even if one did not use the good at all.

To see this more formally, when $r_{SR} > p$, it implies that

$$\begin{aligned} 2[(1-\theta)\alpha_L - \theta(1-\alpha_H)] - p &> 0 \\ (1-\theta)\alpha_L - \theta(1-\alpha_H) - p/2 &> 0 \\ \theta\alpha_H + (1-\theta)\alpha_L - p/2 &> \theta \\ D_1(p) &> D_0(p), \end{aligned} \tag{22}$$

where D_1 is the long-run product demand curve and D_0 is the pre-sharing demand curve. Recall that in the pre-sharing product market, $D_0(p) = \theta$ (for the range of prices where high-types purchased and low-types did not), as only the high-types purchased the good. This is likely to occur in situations where both consumer types have high valuations (making demand high and supply limited).[12]

A P2P rental market may lead to more or less ownership. However, it always increases the price at which there is non-zero demand for the good by owners. The highest possible price for the good that can support a market pre-P2P rental is $\bar{p}_0 = \alpha_H^2$. Recall that in the pre-P2P rental market with two consumer types, if $p > \alpha_H^2$, then no consumer buys the good (2). Let $p = \alpha_H^2$, with would-be owners breaking towards non-ownership rather than ownership, meaning $D_0(\alpha_H^2) = 0$. In the long-run P2P market, the rental rate would be $r = p = \alpha_H^2$; thus a high-type would demand $x_H = \alpha_H - \alpha_H^2/2$. As such, $x_H > 0$, meaning there would still be positive demand from high-types at a price that would foreclose the possibility of a non-P2P market, as $\alpha_H > \alpha_H^2$.

[12] One example of this kind of sharing-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 does not decrease the demand for season tickets. Belk (2014) also points out the possibility that sharing could expand, rather than contract, the market, giving the example of time-sharing condominiums expanding the second-home vacation market.

One interesting aside is that if $p > 2\alpha_L$, then the long-run P2P equilibrium is one in which the high-types simply trade among themselves, creating a market demand of just $D(p) = \theta\alpha_H - p/2$. These parameter values suggest the possibility of a transitory short-run phase in which low-types get access that disappears once former-owners become renters and bid up the rental rate.

4.9 Long-run P2P rental market consumer surplus when both consumer types use the good

If both high- and low-types participate in the long-run P2P equilibrium, social surplus (assuming the price of the good remains p) is

$$V_{LR} = \frac{\theta}{4}(p - 2\alpha_H)^2 + \frac{1-\theta}{4}(p - 2\alpha_L)^2. \tag{23}$$

By contrast, in the pre-P2P rental market, surplus was $V_{NS} = \theta(\alpha_H^2 - p)$. The long-run gain in social surplus in the P2P rental market is

$$V_{LR} - V_{NS} = \frac{p\theta}{4}(4 + p - 4\alpha_H) + \frac{1-\theta}{4}(p - 2\alpha_L)^2. \tag{24}$$

The second term is clearly positive and the first term is as well, since $\alpha_H < 1$, and so the P2P rental market increases the social surplus in the long-run, positing no change in the price of the good, p.

4.10 Long-run P2P rental market equilibrium with bringing-to-market costs

Now we consider the same long-run outcome, but assume positive BTM costs. When we do this, the difference in the returns to owning versus renting for an individual with utility parameter α_i is

$$v^{OWN} - v^{RENT} = r - p - \frac{r\gamma}{2} + \gamma\left(\frac{\alpha_i - 1 - \gamma}{4}\right). \tag{25}$$

As we would expect, $v^{OWN} - v^{RENT} = r - p$ if $\gamma = 0$. Note, however, unlike in the case with no BTM costs, $v^{OWN} - v^{RENT}$ is larger for the high-types than the low-types because of the α_i term appearing in the difference. This implies that high-types would find ownership relatively more attractive. The economic intuition is that because a high-type wants to use the good more than a low-type, it is more attractive to use your own good rather than a rented good, as BTM costs are incorporated in the rental rate.

There are two possible long-run equilibria when BTM costs are positive: (1) some of the high-types choose to rent, or (2) some of the low-types choose to own. For the first equilibrium, total ownership goes down relative to the pre-P2P rental market case (as some owners are now renting), and vice versa for the second equilibrium.

First, we note that $r \leq p + \gamma$. Otherwise, someone could buy a good and then profitably rent all of it in the rental market. A natural question is whether the long-run equilibrium with the BTM costs included is analogous to the $p = r_{LR}$ result from (18); i.e., is $r_{LR} = p + \gamma$? In other words, do the BTM costs get fully incorporated into the rental rate? They do not, as was the case with the BTM costs in the short-run P2P rental market (recall (12)).

In Equilibrium (1), in which some of the high-types rent, if $r_{LR} = p + \gamma$, then high-type owners would consume $x = \alpha_H - p/2$ and high-type renters would choose $\alpha_H - (p+\gamma)/2$. The utility of the high-type owners would be $v_H^{OWN} = \frac{1}{4}(p - 2\alpha_H)^2$, while the utility of the high-type non-owners would be $v_H^{RENT} = \frac{1}{4}\left(p - 2\alpha_H + \gamma\right)^2$. Note that by assumption, $\alpha_H^2 > p$, which implies that $2\alpha_H > p$ (recall that $\alpha < 1$). As $\gamma > 0$, $(p - 2\alpha_H)^2 > (p - 2\alpha_H + \gamma)^2$ and so $v_H^{OWN} > v_H^{RENT}$ if $r = p + \gamma$. Thus, we conclude that for high-types to be indifferent, $r < p + \gamma$. In the presence of BTM costs, a firm that bought the good solely to rent would not merely earn no profits (as in the case with no BTM costs) but would instead suffer a loss.

Now consider Equilibrium (2), in which some of the low-types own. Recall that for low-types to demand any of the good in the P2P rental market, $2\alpha_L > r$. Then, $2\alpha_L > p + \gamma$, and thus $2\alpha_L > p$. If $r = p + \gamma$, then the utility of low-type owners would be $v_L^{OWN} = \frac{1}{4}(p - 2\alpha_L)^2$ and $v_L^{RENT} = \frac{1}{4}(p - 2\alpha_L + \gamma)^2$, and by the same argument from the Equilibrium (1) case, $v_L^{OWN} > v_L^{RENT}$.

The argument that the long-run P2P rental market rate does not fully pass through the BTM costs 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 elastic, the incidence of the tax will not fall wholly on the demand side (as would be the case if $r = p + \gamma$). On the question of elasticity, Cullen and Farronato (2014) use data from TaskRabbit to show that workers on this platform are highly elastic, with demand shocks met by large increases in hours worked. Although TaskRabbit is more of a pure labor platform than, say, UberX or Airbnb, if the suppliers in other P2P rental markets are similar, it suggests that the supply side of the market would be able to pass through most of their BTM costs.

4.11 More complex BTM cost structures

Although we have assumed that BTM costs are constant and proportional to the amount of the good rented, other possibilities are quite plausible. While we do not pursue the implications of these alternative possibilities formally, it is useful to consider the economic import of various types of cost structures. First, any fixed cost to renting would create an economy of scale that would favor those with lots of capacity to sell on the rental market. When there were no BTM costs, ownership did not matter; when we assumed BTM costs, ownership tilted towards those placing a high value on their own consumption. In the presence of significant fixed costs, ownership would tilt back towards those who do not value their own consumption, e.g., traditional rental firms.

We have assumed costs are homogeneous for all sellers in the P2P rental market. In practice, some sellers presumably have lower costs than others, and the 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 a surprisingly small number of hours relative to taxi drivers despite generally higher wages, suggesting that they face increasing marginal costs per shift.

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 of the good are pulled into the market.

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 above. At the equilibrium, every owner/supplier will be operating at the margin with BTM costs of γ. However, many of these owner/suppliers will be reaping inframarginal benefits because they have a range where their BTM costs are below those priced into the market.

4.12 The platform's incentives for reducing costs

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 of 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

$$\underset{\tau}{\operatorname{argmax}} \quad \tau \left[Q - \frac{1}{2}\tau(1-\theta)\theta \right] \tag{26}$$

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

$$\tau^* = \frac{Q}{(1-\theta)\theta}. \tag{27}$$

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).

4.13 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 greater than zero. 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 are several signs that Uber is securing market share at the expense of existing taxi firms, such as falling medallion prices and notable bankruptcies.[13] 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) give 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 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-lead efforts, there is now a burgeoning industry providing complementary services to Airbnb hosts and would-be UberX drivers. For example, a recently launched startup called Guesty aims to be a kind of property management company for Airbnb rentals.

5 The attributes of goods and the feasibility of renting

In the model, the purchase price, the valuation of owners and non-owners, the size of the pool of owners and non-owners, and the BTM costs of a good all affected whether a P2P rental market was possible. And if it was possible, these parameters affected the markets characteristics in both the short and long runs. In this section, we provide data on the attributes of some of these goods as a test of our modeling

[13] "Yellow cab to file for bankruptcy", San Francisco Examiner, January 6th, 2016. http://www.sfexaminer.com/yellow-cab-to-file-for-bankruptcy/.

assumptions and predictions.

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 p, broad-based appeal (meaning a large pool of non-owners with a non-zero α), and a sufficiently low BTM cost (low γ), relative to the rental rate.

The conditions necessary for the P2P rental market are similar, except that an equilibrium with rentals is only possible if there are stocks of both owners and non-owners. 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. 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. Other goods are expensive and durable but make poor candidates for P2P rental because they are used by their owners more or less continuously—consider prescription eyeglasses, wheelchairs, mobility scooters, furniture and so on.[14]

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.

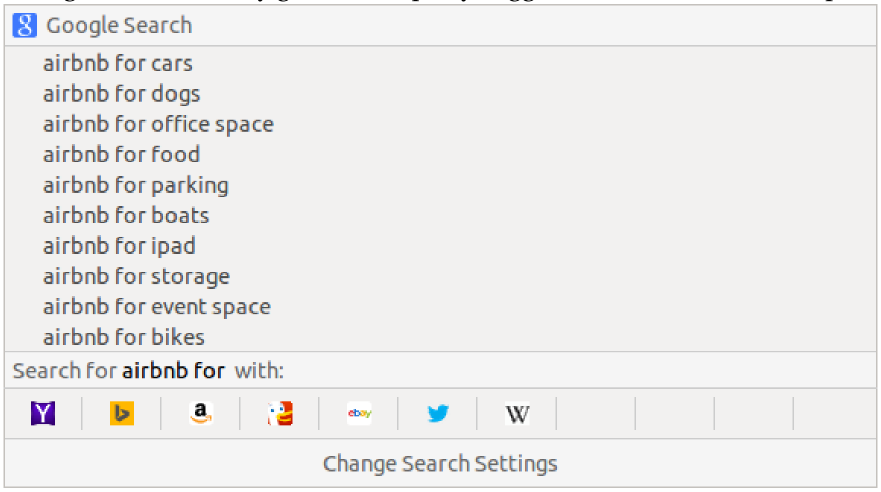
Another factor that would seem to affect suitability for rental is how much value a single session of usage offers and thus whether renting can overcome the inherent transaction costs. While amount of time rented is not necessarily proportional to the value created,[15] the time of use is almost always 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 vacation home in week-long chunks of time, her lawn-mower in hour-long chunks, and her toothbrush in minute-long chunks.

The attributes that make a good "shareable" get attention from Benkler (2004). He points out that some goods are "lumpy" in that you cannot buy less than some threshold amount, but once you own it, it invariably has excess capacity. Benkler provides the example of a PC, which cannot be purchased in fractional amounts, but once purchased, offers a certain amount of computation per unit of time, whether you want it or not. Benkler is seeking goods with "relatively wide-spread private ownership and [that] will systematically exhibit slack capacity relative to the demands of their owners." This notion of shareability as being related to the patterns of how goods are characteristically used also interests us (though we differ from Benkler in that in our approach, the ownership decision and the amount of slack capacity are not "givens" but rather economic decisions themselves).

[14] For some of these goods there are traditional rental firms, but much of this is because the expected duration of use is so short.

[15] 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.

Figure 4: Google automatically generated query suggestions for "Airbnb for " partial query



Notes: This screenshot shows the Google "auto-suggest" query completions for the phrase "airbnb for", which shows common queries entered by other users. This screenshot comes from the Google search toolbar in the Firefox browser, accessed on January 26th, 2016.

Predicting which goods are profitable candidates for P2P rental is a task best left to entrepreneurs whose judgments will ultimately be evaluated by the market. However, it is still useful to get a sense of where these markets might evolve by surveying consumers. One interesting source of market sentiment about P2P rental comes from Google, which will "auto-complete" partial queries, providing a proxy for what other Google users are searching for. Figure 4 shows the "auto-suggest" query completions from the Google search toolbar for the partial query "Airbnb for." Some of the queries are easy to understand: cars, office space, parking, boats, storage, event spaces, and bikes are all indeed goods for which there are already P2P rental markets. The phrase "airbnb for dogs" likely means kennel space and dog boarding, not rental dogs, while "airbnb for food" likely means services where chefs will come to your house to cook, ala KitchenSurfing.[16]

To move beyond the casual empiricism of considering which P2P rental markets might exist (or not) for various goods, we conducted a consumer survey on Amazon Mechanical Turk. The model and the survey complement each other in two ways. First, the survey helps justify some of the modeling conventions, such as making planned usage the primary explanation for the pattern of ownership rather than a taste for ownership or wealth. Second, the survey offers a partial decomposition of the BTM costs.

5.1 Main empirical results

We find strong evidence that respondents who predicted that they would use a good more are more likely to own that good. Increasing household income is associated with greater ownership, but even

[16]And "Airbnb for ipad" is presumably the result of individuals looking for that iPad application made by Airbnb.

when controlling for income, predicted usage helps to explain ownership. Among non-owners, planned usage was cited more often than a lack of income as the reason for non-ownership, with the exception of certain extremely expensive goods like vacation homes. It may be the case that P2P rental markets might create more welfare in developing countries, where individuals own fewer goods.

The predictability of usage and the size of usage sessions for a good tend to be positively correlated. In other words, goods that are used unpredictably tend to be used for relatively short periods. These kinds of goods are also more likely to be owned. When we inspect goods that are the "double opposite"—predictable usage that occurs in large chunks—we see goods that are often already rented in conventional markets. These are also the goods where P2P rental markets seem to have had the most success. Overall, we find that ownership and renting are gross substitutes, though there are notable outliers, such as the car, which is both widely owned and rented, presumably mostly because of trips that are initially taken by plane.

5.2 Design and administration of the survey

The survey focused on consumer decision making and usage patterns for a variety of goods. 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 willing—and has the incentive—to answer a tedious set of questions carefully. Workers on MTurk who have their work "rejected" by dissatisfied employers become ineligible for the best, highest-paying kinds of work on the marketplace and therefore are diligent. This respondent diligence makes it useful for certain kinds of questions. (For example, Kuziemko et al. (2015) used the MTurk population to study elasticities of demand for redistribution.)

We hired US-based "Master" workers to answer questions about a consumer good, e.g., BBQ grill, pick-up truck, men's suit, canoe, etc. 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. 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 actually 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 A for the full list of goods as well as the actual survey questions and answers. 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.

5.3 Ownership by an individual's planned usage

In the model, consumers considered how much they would use some good and then compared the resultant usage utility against the purchase price. The model predicts increasing ownership in estimated usage. Table 1 shows that individuals reporting greater expected usage are more likely to own the good. Furthermore, while higher household income predicts ownership, the strong association between expected usage and ownership persists even after taking income into account.

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. See Appendix A for the actual options.

Column (1) of Table 1 reports an OLS estimation of

$$\textsc{Own}_{ig} = \beta_0 + \beta_1 \log x_{ig} + c_g + \epsilon_g, \tag{28}$$

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. Standard errors are clustered at the level of the good. In Column (2), a control for the log of family income is included; in Column (3), a respondent fixed effect is added.

Table 1: Respondent estimates of the fraction of time spent using a good and whether they own that good

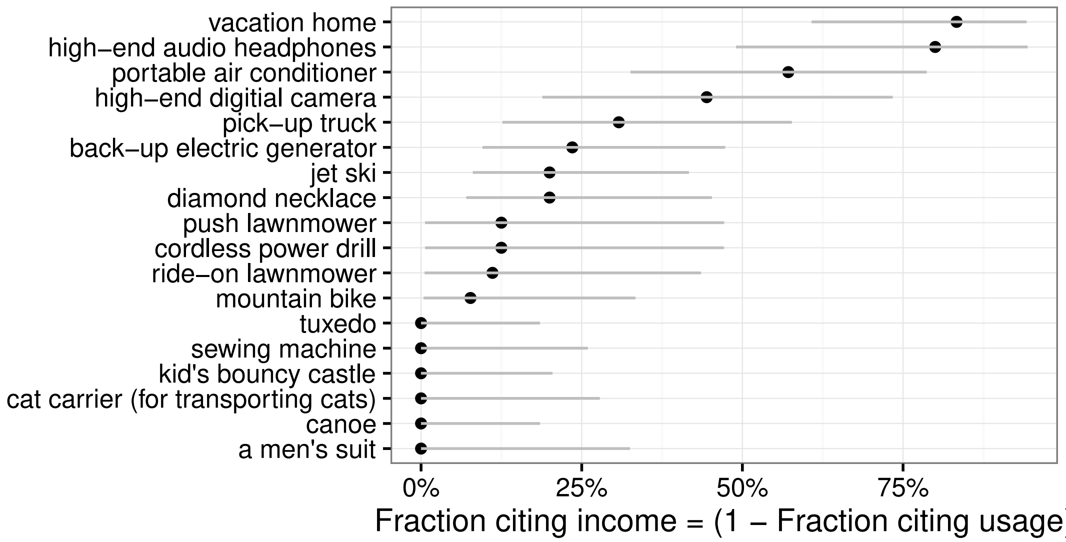
	Dependent variable:		
	Respondent owns the item?, ($\textsc{Own}_{ig} = 1$)		
	(1)	(2)	(3)
Log estimated usage, $\log x_{ig}$	0.0262**	0.0259**	0.0264**
	(0.0111)	(0.0109)	(0.0110)
Log household income, $\log y_i$		0.1019***	
		(0.0254)	
Good FE	Y	Y	Y
Respondent FE	N	N	Y
Observations	411	411	411
R^2	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 what fraction of time he or she would spend using that good (in logs). In Column (2), a regressor for the log of the respondent's self-reported household income is added to the Column (1) specification. Column (3) uses the same specification as Column (1), but a respondent-specific fixed effect is added. The sample is restricted to respondents who report some positive amount of 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 $p \leq .001 : ***$.

As the model predicts, higher estimated usage is positively associated with ownership. The coefficient on the estimated usage regressor in Column (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.[17] In Column (2), the coefficient on the usage

[17] Assuming log points are approximately equal to percentage changes.

Figure 5: Fraction of non-owners citing income as the reason (rather than usage) 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. Only 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).

regressor is the same magnitude, despite the inclusion of the log of self-reported household income (in thousands) in the specification.[18] 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 primarily the result of higher income respondents being more likely to own and report greater expected usage generally (perhaps because of greater leisure time). In Column (3), we re-estimate Column (1) but include respondent-specific fixed effects as well. As with the other specifications, the strong positive relationship between expected usage and ownership persists.

5.4 Self-reported reasons for non-ownership

The regression results in Table 1 suggest that both income and predicted usage are important for explaining the ownership decision. These two factors are presumably more or less important for different kinds of goods. Figure 5 shows that there is substantial good-level heterogeneity in the reported reasons of non-owners. However, for the goods we surveyed, explanations for non-ownership are strongly tilted towards usage considerations rather than toward income considerations.

[18] Household incomes 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. See Appendix A for the actual income bands respondents could select from.

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."). 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). By construction, the fraction citing income is 1 minus the fraction citing usage. The sample is limited to goods that had seven or more non-owners. There are some goods for which income was not cited at all (e.g., sewing machine, tuxedo, canoe), and several others where usage was overwhelmingly more likely to be cited. The only goods where a larger fraction of respondents cited income rather than usage were high-end headphones and vacation homes.

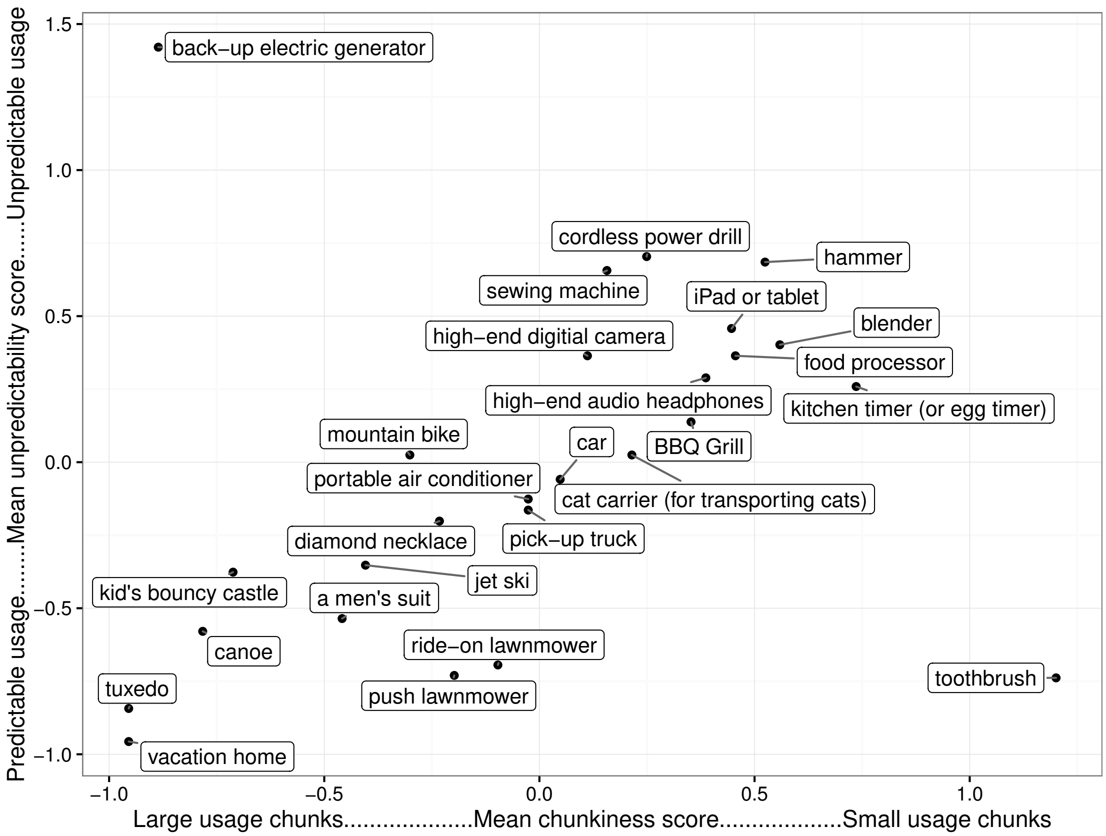
5.5 Aggregate usage chunkiness and predictability

Two major practical determinants of the feasibility of a P2P rental market are the predictability and size of usage sessions. Goods for which it is easy to predict when they will be needed (perhaps because it is easy for the owner to choose when to use the good with little loss in utility) would be easier to rent (or lend out). In contrast, goods that have inherently unpredictable usage or goods where there is little flexibility in when they are used would be difficult to rent out without substantial utility loss to the owner. Similarly, for goods that are used in numerous small sessions, renting or lending out the good to others would create high transactions costs. We asked subjects about the predictability and chunkiness of their usage for the goods and found that these measures strongly covary (with some exceptions, which we will discuss): that is, the smaller the chunk of typical usage, the more unpredictable is the usage. For example, respondents rated a hammer as being used in small chunks of time (say, when hanging a picture), and this usage is unpredictable. In contrast, a tuxedo scores low on both measures—when used it is used for a substantial amount of time (say, when attending a wedding), and that usage can be predicted far in advance.

For each good, respondents were asked to rate the unpredictability of usage on a 1-5 scale (1 was highly predictable and 5 was highly unpredictable) as well as chunkiness (1 was one big chunk— and 5 was low chunkiness—lots of little chunks). We then normalized responses across all goods to create unpredictability and chunkiness scores to have a meaningful 0. Figure 6 plots the mean unpredictability score against the mean chunkiness score. It shows a strong relationship between chunkiness and predictability, with two notable outliers: the toothbrush and the generator. A toothbrush is used in small chunks (2 minutes according to the ADA) and its usage 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. These common-sense answers are not particularly illuminating, but they do show subjects were paying attention and offering reasonable answers.

Examining goods near the origin, we see goods well suited to rental in that they have predictable usage that occurs in large chunks. Not surprisingly, these are often goods for which conventional rental

Figure 6: Usage predictability versus chunkiness



Notes: This figure plots each good's mean unpredictability score versus that same good's mean chunkiness score. These scores are calculated by normalizing the 1-5 scores across all goods and all respondents. A lower chunkiness score (near the origin) implies that good is characteristically used in large chunks, whereas a higher chunkiness score indicates the opposite. On the y-axis, goods with a high unpredictability score have unpredictable usage patterns (i.e., consumers do not know in advance when they will need the good).

markets already exist—formal wear (tuxedos), vacation homes, bikes, sporting equipment (canoes and jet skis for rent at lakes), and so on. As we move a bit further from the origin, we see goods for which there is not much of a rental market (lawnmowers and jewelry) but which would seem to have the attributes necessary to support such a market, assuming there are in fact enough non-owners to support it.

5.6 Predictability, chunkiness, and ownership

We now test whether the predictability and chunkiness measures are related to individual ownership. Table 2 shows that they are, in the expected direction: goods with unpredictable usage that occurs in small chunks are substantially more likely to be owned. Furthermore, these two measures are not simply capturing some single latent "rentability" measure, as each seems to have an independent effect on the probability of ownership.

Table 2: Unpredictability and chunkiness of good usage and their association 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 regressions of an indicator for whether the respondent owns a good on that same respondent's estimates of the unpredictability and granularity of usage for that good. The two indices are normalized responses to the 1-5 scale questions on usage chunkiness and unpredictability, pooled over all respondents and goods. Toothbrushes and backup generators are excluded from the sample. See Appendix A for the actual survey language and responses. In each regression, a respondent-specific fixed effect is included. Standard errors are clustered at the level of the individual respondent. Significance indicators: $p \le 0.05 : *$, $p \le 0.01 : **$, and $p \le .001 : ***$.

Column (1) of Table 2 reports an estimate of

$$\text{Own}_{ig} = \beta_0 + \beta_1 \textsc{UnpredictabilityScore}_{ig} + c_i + \epsilon_i, \tag{29}$$

where $\textsc{UnpredictabilityScore}_{ig}$ is the normalized unpredictability score by respondent i for good g. The coefficient on the unpredictability score is positive and highly significant. A one standard deviation decrease in predictability increases the probability of ownership by about 14 percentage points. In Column (2), we instead use the chunkiness measure as the predictor and also find a positive and highly significant effect of about the same magnitude. In Column (3), we interact the chunkiness and predictability measures. 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.

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. In Column (4), we use the same specification as Column (3) but include 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 really are driven by the nature of the good.

5.7 Aggregate ownership and renting patterns at the level of the good

This paper was motivated in part by the recent flourishing of P2P rental markets. Thus, asking respondents whether they have rented a particular good in a P2P rental market would likely yield few results, given how new these markets are. However, the 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. As Figure 7 will show, renting and owning are gross substitutes in the data, when cars are excluded. Cars show a high level of both ownership and rental.

In Figure 7, the fraction owning is plotted on the x-axis and the fraction renting on the y-axis. Both axes are on a square root scale to better show the data. Some notable goods are labeled—see Appendix B for the precise by-good fractions for every good.

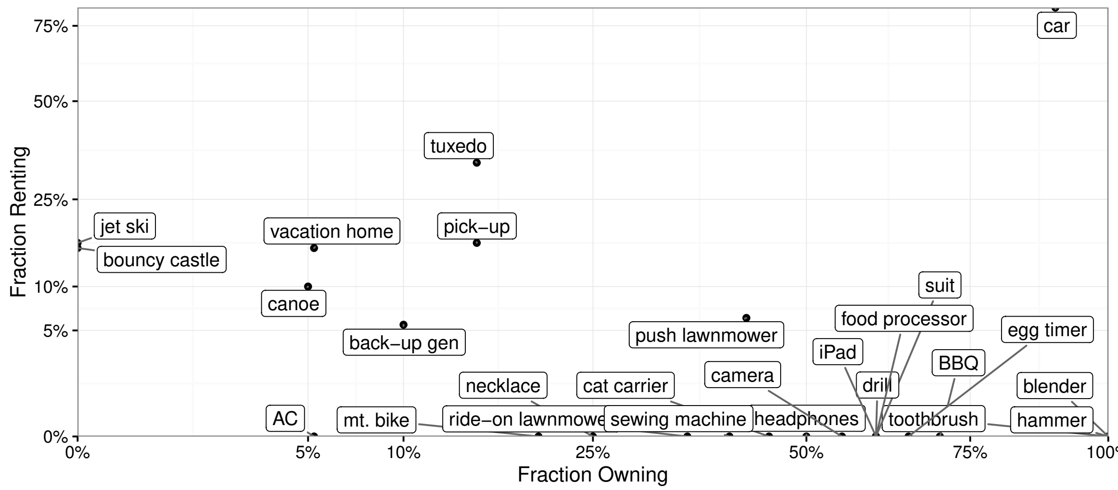
Unsurprisingly, goods that are nearly universally owned show little renting. There are a number of goods that show medium ownership levels (e.g., around 50%) and yet zero recorded instances of renting, which could indicate potential P2P rental market candidates. Goods that are used during special occasions like 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

$$\textsc{FracRent}_g = \beta_0 + \beta_1 \textsc{FracOwn}_g + \epsilon, \tag{30}$$

where $\textsc{FracRent}_g$ is the fraction claiming to have rented good g and $\textsc{FracOwn}_g$ is the fraction of respondents reporting to own 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

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



Notes: This figure plots the fraction of respondents reporting ever having renting the good in question 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: The unit of observation for the regressions in this table is the individual good. The dependent variable is the fraction of respondents reporting having rented that good, while 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 A. Significance indicators: $p \leq 0.05: *$, $p \leq 0.01: **$, and $p \leq .001: ***$.

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.

6 Conclusion

The sharing economy has dramatically impacted several important markets in just a few years, notably those for ride services and for very short-term apartment rentals. 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 consumed. 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.com 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.[19] The reason for this pattern in the language of this model is clear: a consumer's 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. Even if the blender example seems implausible, we should consider that very few consumers try to rent the car that they normally drive in their hometown when on vacation. Presumably, they diversify consumption in these cases precisely because it is easy to do so.

One long-term reaction to the rise of P2P rental markets is that firms might 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 to where they are needed might be substantially diminished.[20] 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.

Our model makes several predictions that are—or should become—testable over time as P2P rental markets grow. Some obvious candidates include examining whether the emergence of P2P rental markets increases access by non-owners, change ownership decisions, and affects rental rates.

[19] As of October 8th, 2014.

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

References

Adomavicius, Gediminas and Alexander Tuzhilin, "Toward the Next Generation of Recommender Systems: A Survey of the State-of-the-art and Possible Extensions," *IEEE Transactions on Knowledge and Data Engineering*, 2005, *17* (6), 734–749.

Avital, Michel, John M Carroll, Anders Hjalmarsson, Natalia Levina, Arvind Malhotra, and Arun Sundararajan, "The Sharing Economy: Friend or Foe?," in "Proceedings of the 2015 International Conference on Information Systems" 2015.

Bakos, J Yannis, "Reducing Buyer Search Costs: Implications for Electronic Marketplaces," *Management Science*, 1997, *43* (12), 1676–1692.

Becker, Gary S, "A Theory of the Allocation of Time," *Economic Journal*, 1965, *75* (299), 493–517.

Belk, Russell, "You Are What You Can Access: Sharing and Collaborative Consumption Online," *Journal of Business Research*, 2014, *67* (8), 1595–1600.

Benjaafar, Saif, Guangwen Crystal Kong, Xiang Li, and Costas Courcoubetis, "Peer-to-Peer Product Sharing: Implications for Ownership, Usage and Social Welfare in the Sharing Economy," *Working Paper*, 2015.

Benkler, Yochai, "Sharing Nicely: On Shareable Goods and the Emergence of Sharing as a Modality of Economic Production," *Yale Law Journal*, 2004, pp. 273–358.

Bolton, Gary, Ben Greiner, and Axel Ockenfels, "Engineering Trust: Reciprocity in the Production of Reputation Information," *Management Science*, 2013, *59* (2), 265–285.

Botsman, Rachel and Roo Rogers, *What's Mine is Yours: The Rise of Collaborative Consumption*, HarperBusiness, 2010.

Bronnenberg, Bart J, Jean-Pierre Dubé, Matthew Gentzkow, and Jesse M Shapiro, "Do Pharmacists Buy Bayer? Informed Shoppers and the Brand Premium," *Working Paper*, 2014.

Byers, John W, Davide Proserpio, and Georgios Zervas, "The Rise of the Sharing Economy: Estimating the Impact of Airbnb on the Hotel Industry," *Working Paper*, 2013.

Cabral, Luis and Ali Hortaçsu, "The Dynamics of Seller Reputation: Evidence from eBay," *The Journal of Industrial Economics*, 2010, *58* (1), 54–78.

Cannon, Sarah and Lawrence H Summers, "How Uber and the Sharing Economy Can Win Over Regulators," *Harvard Business Review*, 2014, *13.*

Cullen, Zoë and Chiara Farronato, "Outsourcing Tasks Online: Matching Supply and Demand on Peer-to-Peer Internet Platforms," *Working Paper*, 2014.

De los Santos, Babur, Ali Hortaçsu, and Matthijs R Wildenbeest, "Testing Models of Consumer Search using Data on Web Browsing and Purchasing Behavior," *The American Economic Review*, 2012, *102* (6), 2955–2980.

Dellarocas, Chrysanthos, "The Digitization of Word of Mouth: Promise and Challenges of Online Feedback Mechanisms," *Management Science*, 2003, *49* (10), 1407–1424.

Dinerstein, Michael, Liran Einav, Jonathan Levin, and Neel Sundaresan, "Consumer Price Search and Platform Design in Internet Commerce," *Working Paper*, 2014.

Edelman, Benjamin G and Damien Geradin, "Efficiencies and Regulatory Shortcuts: How Should We Regulate Companies like Airbnb and Uber?," *Working Paper*, 2015, (16-026).

Einav, Liran, Chiara Farronato, and Jonathan Levin, "Peer-to-Peer Markets," *Working Paper*, 2015.

Eisenmann, Thomas, Geoffrey Parker, and Marshall W Van Alstyne, "Strategies for Two-sided Markets," *Harvard Business Review*, 2006, *84* (10), 92.

Fradkin, Andrey, "Do Online Marketplaces Become More Efficient Over Time?," *Working Paper*, 2012.

—, "Search Frictions and the Design of Online Marketplaces," *Working Paper*, 2013.

—, Elena Grewal, Dave Holtz, and Matthew Pearson, "Bias and Reciprocity in Online Reviews: Evidence From Field Experiments on Airbnb," in "Proceedings of the Sixteenth ACM Conference on Economics and Computation" ACM 2015, pp. 641–641.

Fraiberger, Samuel P. and Arun Sundararajan, "Peer-to-Peer Rental Markets in the Sharing Economy," *Working Paper*, 2015.

Hagiu, Andrei, "Strategic Decisions for Multisided Platforms," *MIT Sloan Management Review*, 2014, *55* (2), 71.

— and Julian Wright, "Marketplace or Reseller?," *Management Science*, 2014, *61* (1), 184–203.

Hall, Jonathan V and Alan B Krueger, "An Analysis of the Labor Market for Uber's Driver-Partners in the United States," *Working Paper*, 2015.

Hampshire, Robert and Craig Gaites, "Peer-to-Peer Carsharing: Market Analysis and Potential Growth," *Transportation Research Record: Journal of the Transportation Research Board*, 2011, (2217), 119–126.

Hitsch, Günter J, Ali Hortaçsu, and Dan Ariely, "Matching and Sorting in Online Dating," *The American Economic Review*, 2010, pp. 130–163.

Horton, John J, "Misdirected search effort in a matching market: Causes, consequences and a partial solution," in "Proceedings of the fifteenth ACM conference on Economics and computation" ACM 2014, pp. 357–357.

__ , “The Tragedy of Your Upstairs Neighbors: Is the Airbnb Negative Externality Internalized?,” *Working Paper*, 2014.

__ **and Joseph M Golden**, “Reputation Inflation: Evidence from an Online Labor Market,” 2015.

Hui, Xiang, Maryam Saeedi, Zeqian Shen, and Neel Sundaresan, “From Lemon Markets to Managed Markets: the Evolution of eBay’s Reputation System,” *Working Paper*, 2014.

Koopman, Christopher, Matthew D Mitchell, and Adam D Thierer, “The Sharing Economy and Consumer Protection Regulation: The Case for Policy Change,” *Working Paper*, 2014.

Kuziemko, Ilyana, Michael I. Norton, Emmanuel Saez, and Stefanie Stantcheva, “How Elastic Are Preferences for Redistribution? Evidence from Randomized Survey Experiments,” *American Economic Review*, 2015, *105* (4), 1478–1508.

Malhotra, Arvind and Marshall Van Alstyne, “The Dark Side of the Sharing Economy ldots and How to Lighten It,” *Communications of the ACM*, 2014, *57* (11), 24–27.

Neeser, Dâvid, Martin Peitz, and Jan Stuhler, “Does Airbnb Hurt Hotel Business: Evidence from the Nordic Countries,” *Working Paper*, 2015.

Nosko, Chris and Steven Tadelis, “The Limits of Reputation in Platform Markets: An Empirical Analysis and Field Experiment,” *Working Paper*, 2015.

Resnick, Paul and Hal R. Varian, “Recommender Systems,” *Communications of the ACM*, 1997, *40* (3), 56–58.

__ **and Richard Zeckhauser**, “Trust Among Strangers in Internet Transactions: Empirical Analysis of eBay’s Reputation System,” *The Economics of the Internet and E-commerce*, 2002, *11* (2), 23–25.

__ **, Ko Kuwabara, Richard Zeckhauser, and Eric Friedman**, “Reputation Systems,” *Communications of the ACM*, 2000, *43* (12), 45–48.

Rochet, Jean-Charles and Jean Tirole, “Platform Competition in Two-sided Markets,” *Journal of the European Economic Association*, 2003, pp. 990–1029.

__ **and** __ , “Two-sided Markets: A Progress Report,” *The RAND Journal of Economics*, 2006, *37* (3), 645–667.

Slee, Tom, *What’s Yours is Mine: Against the Sharing Economy*, OR Books, 2015.

Sundararajan, Arun, “From Zipcar to the Sharing Economy,” *Harvard Business Review*, 2013.

Varian, Hal R., “Buying, Sharing and Renting Information Goods,” *The Journal of Industrial Economics*, 2000, *48* (4), 473–488.

— , "Computer Mediated Transactions," *American Economic Review*, 2010, *100* (2), 1–10.

Wallsten, Scott, "Has Uber Forced Taxi Drivers to Step Up Their Game?," *Working Paper*, 2015.

Wilson, Edwin B., "Probable Inference, the Law of Succession, and Statistical Inference," *Journal of the American Statistical Association*, 1927, *22* (158), 209–212.

A Survey Questions

The actual goods 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 digitial [sic] camera
- iPad or tablet
- jet ski
- kid's boucy [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
- Does your household own a **good**?
  - Yes
  - No
- Have you ever lent your **good** to someone else?
  - Yes
  - No
  - NA - we do not own one.
- Have you ever borrowed a **good** from someone else?
  - Yes
  - No
  - NA - we own one.
- Have you ever rented a **good**?
  - Yes
  - No
  - NA - we own one.
- 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)

- 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

- 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.

- 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

- 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

B Additional empirical results

Figure 8 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 a blender; no one reported owning a jet ski, and only one respondent reported owning a vacation home. Figure 9 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 10 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 lawn-mowers). 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 11 shows the mean chunkiness index per good. There appears to be some similarity in high 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 owning various goods

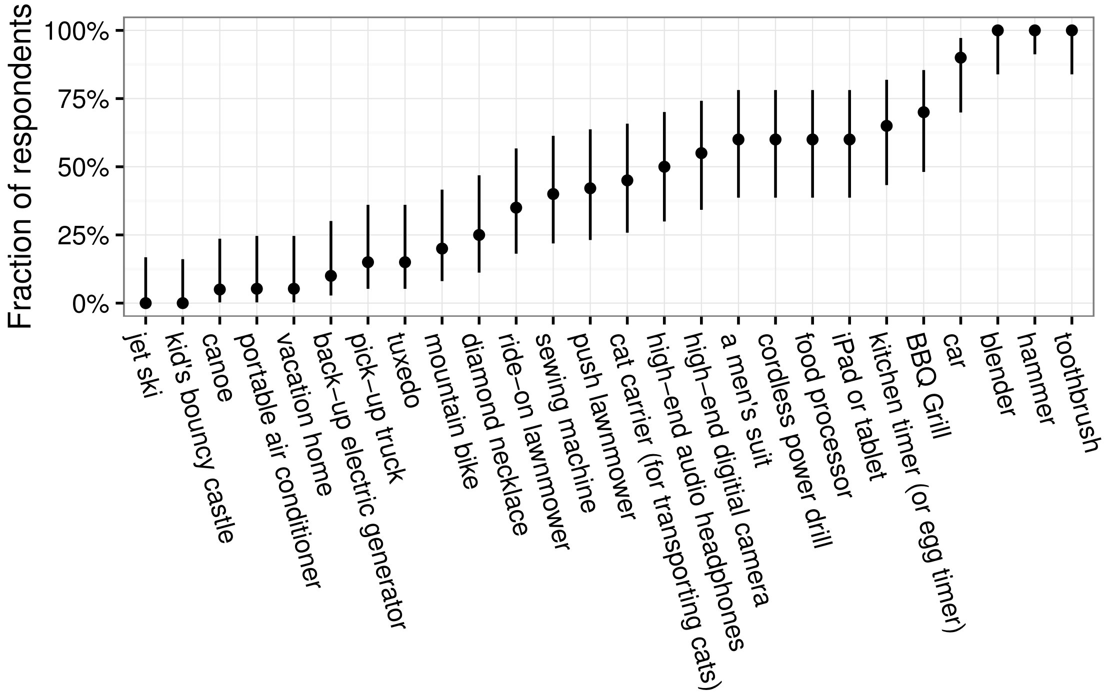


Figure 9: Fraction of respondents reporting having rented various goods

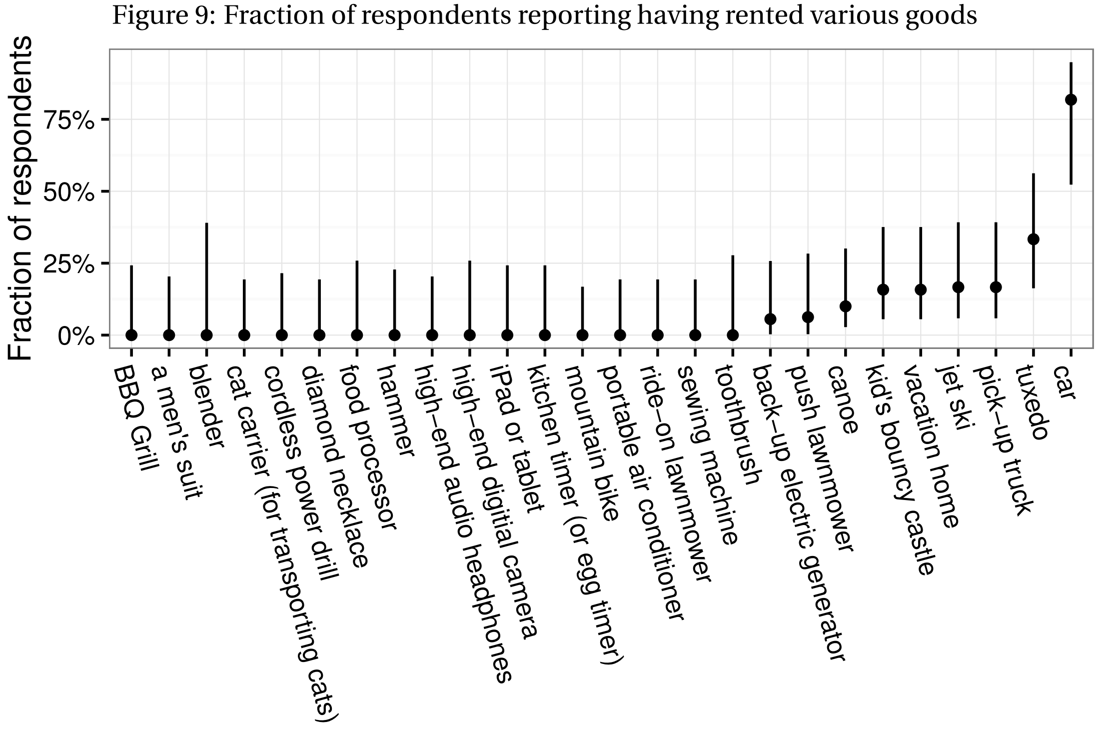


Figure 10: Mean unpredictability index by good

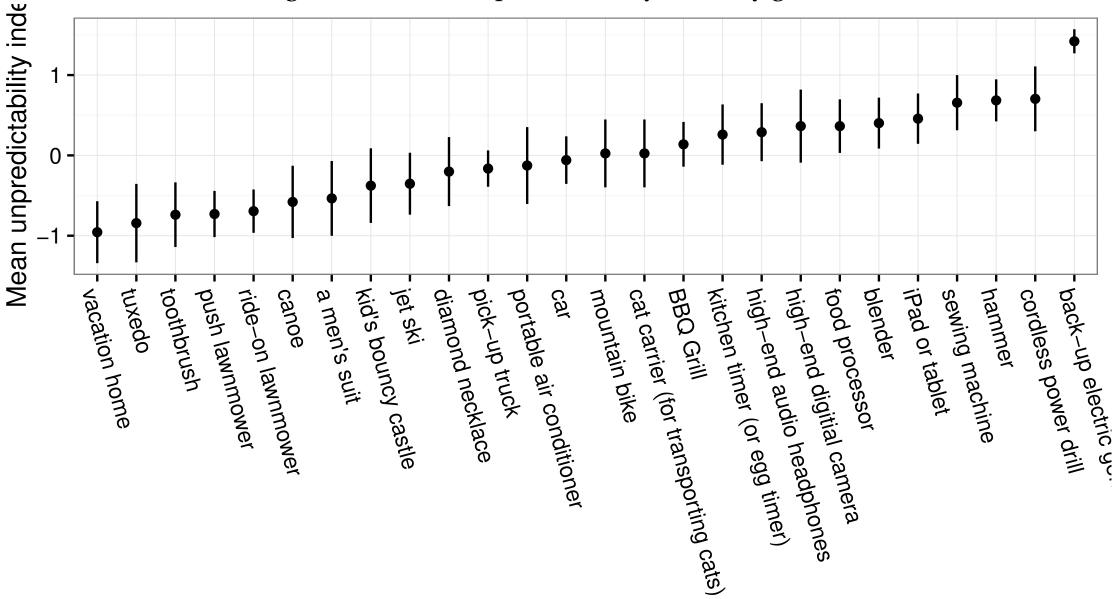


Figure 11: Mean chunkiness index by good