Peer-to-Peer Rental Markets: Some Thoughts on the "Sharing Economy"

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Abstract

Recent technological advances and entrepreneurial efforts have created a number of new peer-to-peer rental markets in which owners can rent out their durable goods. We consider the emergence of such a market and determine the market clearing rental rate, the patterns of trade and the surplus unlocked for different types of consumers. Our analysis considers both a short-run, before consumers can revise their ownership decisions and a long-run, in which they can. A survey of consumers finds broad support for the modeling conventions used—namely that ownership is determined by a forward-looking evaluation of planned usage. We also explore the factors that are permitting these new markets to flourish.

JEL J01, J24, J3

1 Introduction

Owners in rental markets have traditionally been firms that own assets for the specific purpose of renting them out. Some renting out by consumer-owners occurred, but it was confined largely to expensive, infrequently used goods, such as vacation homes and pleasure boats. More often, consumer-owned goods were shared among family and friends, without explicit payment. This characterization of rental markets is changing, as new technology focused companies create peer-to-peer (P2P) rental markets for much wider class of goods. These so-called "sharing economy" start-ups have created rental markets for houses, cars, boats, bicycles, tools, office space, cameras, parking spaces, and even clothes.

The most prominent example of this new kind of rental market is Airbnb, which allows individuals to rent out spare bedrooms, apartments or even entire homes. Airbnb and platforms like it have been

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heralded by many, as they they promise to expand access to goods, diversify individual consumption, increase efficiency by increasing asset utilization and provide income to owners (Sundararajan, 2013). Aside from the business interest in these platforms—Airbnb alone has attracted nearly $800 million in venture capital investment[1]—these companies have also attracted policy interest, much of it negative. Critics charge that the primary competitive advantage of these platforms is the ability to duck costly regulations—regulations that often are intended to keep costs from being imposed on third-parties.[2] This policy debate could benefit from an elucidation of what economic problem these markets address, why they are emerging and what their properties are likely to be in both the short- and long-runs. Providing this elucidation is the goal this paper.

We first explore the question of why P2P rental markets are flourishing now, given that the economic problem P2P rental markets are attempting to solve—underutilization of durable goods—is not new. We argue that although technological advances, such as the mass adoption of smart-phones and the falling cost of developing and running large web sites, while clearly important, are not the whole story. P2P rental markets rely heavily on the hard-won industrial experience in the design and management online marketplaces. In particular, recommender systems and reputation systems all emerged during the early days of electronic commerce and are now relied on extensivle in P2P rental markets. This knowledge allows P2P rental platforms to overcome—or at least ameliorate—market problems such as facilitating trust, lowering search costs and reducing moral hazard and adverse selection. We develop this argument in more depth and point out relevant works from the literature.

In addition to the question of why P2P rental markets emerge, another class of questions are their economic properties. For example, what determines the rental rate and the quantity exchanged in the P2P rental market? How much consumer surplus is "unlocked" by the P2P rental market and how is it distributed? How does the short-run rental rate—where existing owners rent to non-owners—differ from the long-run in which owners and non-owners alike can revise their ownership decision in light of the existence of a P2P rental market? Will total product market demand increase or decrease?

To address these questions, we develop a simple model in which consumers decide whether to purchase a good based on their expected usage, conditional upon purchase. We assume that there are two

[1] http://www.crunchbase.com/organization/airbnb

[2] See Horton (2014) for a discussion of the externalities imposed by Airbnb-style subletting in rented apartments.

consumer types that differ in their marginal utilty from usage. This difference in turn affects the purchase decision, with only the high-types owning the good initially. Even those that purchase the good do not use it 100% of the time. When the P2P rental market first emerges, the owners can rent to non-owners—as well as economize on their own usage to make more the good available for the rental market.

While we assume a purchase price that splits consumers into owners and non-owners, other configurations 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. It has to be low enough that the high-types own (i.e., there is a product market in the good) in order to provide the supply, but not so low that everyone simply owns the good, in which case there is no demand.[3]

The short-run rental market does not necessarily clear: if pre-P2P rental excess capacity exceeds demand, there is a glut. In practice, the inherent transaction cost of bringing excess capacity to the market would provide a price floor. Assuming a positive rental rate, both owners and non-owners use the good as if they were renting the good at the market-clearing rental rate. For renters the reason is that they do face that rental rate; for owners, they now face a marginal opportunity cost of usage, which is also the rental rate. The rental rate is increasing in the valuation of the high-types, which reduces supply, and the valuation of the low-types, which increases demand.

In addition to the short-run, we consider a long-run where owners and renters alike can revise their ownership decisions. If the short-run rental rate is below the purchase price, then ownership is less attractive, which will reduce *purchase* demand for product; likewise a rental rate above the purchase price increases ownership and hence purchase demand. In the long-run P2P equilibrium, the purchase price equals the rental rate. In the long-run P2P rental market, both high and low types receive the same utility from owning or renting, decoupling individual preferences from ownership. In practice, consumer risk-aversion would likely still cause higher-value consumers to be the owners, since a fall-off in market demand can be better absorbed by them though own-consumption.

The emergence of the P2P rental market is Pareto improving. The greatest gains are obtained when low-types have a valuation of the good close to that of the high-types. This suggests that the greatest surplus will come when differences in ownership are driven by income effects rather than, as in our

[3]Of course, in the long-run ownership decisions can be revised, but it would be difficult for a P2P rental market to take off for some class of goods were ownership was already universal.

model, tastes. 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.

In the model, we consider a single stylized, infinitely divisible, infinitely durable good. Actual goods have radically different patterns of usage that would strongly affect how amenable they are to "division" and hence renting. For example, goods with predictable usage are far easier to rent out with little lost utility to the owner. Similarly, goods that are used in large chunks of time—with no use in between—are more amenable to rental to goods that have usage broken up into many small chunks of time. Further, goods differ in their durability which should have a strong affect on what is rented and at what rate. In the last part of the paper, we rely on survey evidence to explore what kinds of goods are particularly amenable to P2P rental as well as assess some of the assumptions of the model.

Consumers were asked a series of questions about a single good (e.g., a BBQ grill) such as whether they own one, whether they have lent it out or borrowed it and, regardless of whether they own it, how much they would use it. If they do not own it, they were asked why. We also asked questions about how the good in question is characteristically used and how predictable that usage is. Finally, the respondent was asked for their household income.

For only a small number of goods (e.g., vacation homes) is income important in determining ownership. For other goods, planned usage was primary the driver, supporting our basic modeling framework. We find that with cars excluded, there is a strong negative relationship between ownership and rental. Given that P2P rental markets are nascent, respondents are presumably renting from conventional rental companies, but it still supports the modeling view that non-owner does not imply zero value from usage.

We conclude with some thoughts on how P2P rental markets might evolve. Our analysis has focused on a single homogeneous good, but a key advantage of P2P rental markets might be in facilitating greater consumption diversity. In addition to whatever 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, we also discuss how the producers of goods might do more than simply improve quality, but also explictly modify the goods to make them more or less amenable to rental, depending on

their own market power. One issue we have largely ignored, but which is potentially important, is that in many P2P rental markets owners also provide a labor input, such as on Uber and to a lesser extent, Airbnb. We discuss how this might be modeled and what the implications might be. We conclude by sketch out some promising areas for future research.

2 Factors in explaining the rise of peer-to-peer rental markets

The somewhat obvious economic rationale for P2P rental markets is that most durable goods are used by their owners far less than 100% of the time, and the excess capacity this under-utilization generates could be rented out. The demand side in such a market would be non-owners that still value usage of the good, but not enough to purchase it.[4] Given the obvious rationale for these markets, why are they only flourishing now?

It is useful to consider what problems any putative P2P rental market creator would have to overcome. As with any market, there are the typical search costs, such as finding and evaluating trading partners and the Internet certainly makes this aspect easier (Bakos, 1997). Furthermore, there is now nearly 20 years of industrial experience in building online marketplaces and solving their characteristic problems. However, informational problems are not the sole obstacle in creating rental markets: 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] For P2P rental markets to draw in individual owners, the platform must fill in these gaps and give them firm-like resources. Because of both the lack of firm-like resources and the inherent information problems of rental markets, consumer-owned goods have historically just been truly shared been between family members and neighbors rather than strangers, except when the potential gains from trade are sufficiently large (such as in the example of vacation home and boat rentals).

[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.

P2P rental markets have emerged as entrepreneurs have taken advantage of technological advances to build facilitating platforms. The platforms lower transaction costs and provide individual owners tools previously only available to the firm. The maturation and increasing penetration of the Internet and the proliferation of smart phones, high resolution cameras and so on—were the technological shock that made these P2P rental markets feasible. However, 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 problems inherent to online market places.

Like all software companies, platforms have benefited from the rise of the Internet, which has radically increased the supply of potential users on both sides of the markets. They have also benefited from improving industrial knowledge about how to build and maintain large websites. The cost of creating such sites has also fallen dramatically.

A key challenge in all markets is facilitating trust among strangers, and this problem is even more acute in P2P rental markets, given the "opportunity" renters have to destroy or misuse the owner's capital. Facilitating trust is not a solved problem in online markets, but the experiences of early electronic commerce pioneers such as eBay provided2P rental market entrepreneurs a number of ready-made solutions to market problems related to trust. For example, every P2P rental market we are aware of uses some modified version of eBay's successful bi-lateral reputation system. The flaws in early versions of these systems—such as the ability for 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 the platform that parties can use in their decision-making.

Online markets in general lack many of the market-thickening coordination mechanisms available in offline markets such as time and geography. For example, 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 and is open Mondays from 8:00 a.m. - 6:00 p.m. The adaptation in the online world has been partially to create taxonomies and extensive classification of goods, but another approach has been to rely more on algorithmic innovations such as search algorithms and recommendation systems (Resnick and Varian, 1997; Adomavicius and Tuzhilin, 2005). These kids of approaches are particularly important

in P2P rental markets because the goods being rented are often highly differentiated, as our consumer preferences, making matching more important.

In addition to simply finding each other, would-be trading partners must asses the each other and the goods being traded. Verifiable measurements can often overcome some of the information problems in markets, and 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 smart-phone 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 built into smart-phones have similarly made it easier for parties to inspect goods ex ante (Airbnb in particular benefits from this innovation).

In terms of capacity, platforms do many of the things that individual owners would find costly. 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.

3 Model

Our model is built around the notion that goods can usefully be thought of as having an intensive margin of usage, which in turn drives the extensive margin decision, conditional upon price. This 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 is similar in spirit to Varian (2000). Varian in particular discusses—in the context of information goods—how planned usage affects the rent-versus-own decision.

3.1 Consumer decision about ownership based on expected usage

Every consumer has a unit of time to allocate to various activities, some of which involve the usage of a good. Consumers have to decide how much time, $x \in [0,1]$, to devote to using a particular good. There is

decreasing marginal utility from usage from a good: the consumer receives a benefit of $b(x) = 2\alpha x$, but as also a cost $c(x) = x^2$, where $\alpha \in (0,1)$ parametrizes their valuation of the good. The consumer's utility for a given x is

$$\begin{aligned} u(x) &= b(x) - c(x) \\ &= 2\alpha x - x^2, \end{aligned} \tag{1}$$

and so individual usage conditional upon owning the good is $x^* = \alpha$ and indirect utility is

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

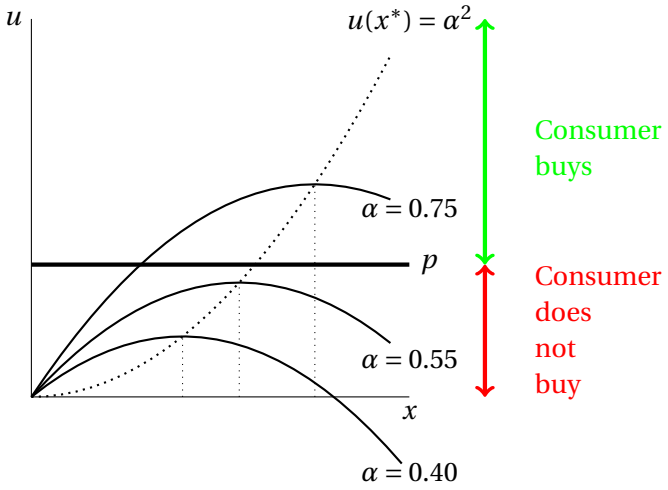
The purchase price of the good is p and so a consumer will buy the good only if $\alpha^2 > p$. Note that for all $\alpha^2 > p$, the consumer will have an amount of time $1 - x^*$ when they are not using the good. This unused capacity is what they will be able to rent out—plus however much more capacity becomes available when they economize their own usage in light of the market clearing rental rate—when the P2P rental market emerges.

Figure 1 illustrates the consumer problem, showing the utility from various levels of usage depending on consumers with different values of α. The usage solution for each consumer is their 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 price p determines who buys the good, with all those having $\alpha^2 > p$ deciding to own and those below choosing not to purchase the good.

3.2 Three consumption possibilities with two consumer types

Consider a marketplace with two consumer types: α_H and α_L with $\alpha_H > \alpha_L$. The fraction of high-types in the market is θ. For a given price p, there are three market possibilities: when $\alpha_L^2 > p$ everyone buys the good; when $\alpha_H^2 > p > \alpha_L^2$, high-types buy the good but low-types do not; when $\alpha_H^2 < p$ no one buys

Figure 1: Consumer purchase problem

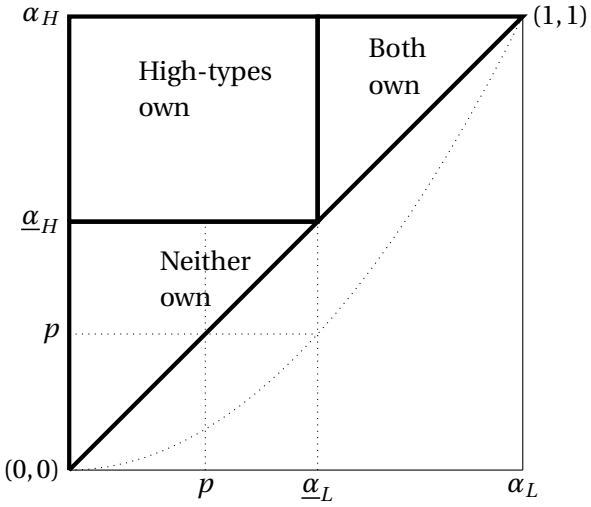


the good. This gives a market demand curve of

$$D(p) = \begin{cases} 0 & : p > \alpha_H^2 \\ \theta & : \alpha_H^2 \geq p > \alpha_L^2 \\ 1 & : p \leq \alpha_L^2 \end{cases} \tag{3}$$

The three market possibilities are shown in Figure 2. The figure shows the space defined by $\alpha_H \in [0,1] \times \alpha_L \in [0,1]$ when $p = \frac{1}{2}$. Since $\alpha_H > \alpha_L$ by definition, we only consider the space above the 45 degree line. The upper-right triangle labeled "Both buy" is the region where both consumer-types buy and the lower-left triangle where neither buy. This area is defined by $\alpha_L^2 > p$ and $\alpha_H^2 > p$. To show the geometry of the problem, the square of the valuation parameter is plotted in a faint dotted line; 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 upper left rectangle shows the region where the high-types buy but the low-types do not, while the lower left triangle shows the region where neither buy. We are particularly interested in the rectangle where high-types buy 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 trade exists between the two types, whereas in the other spaces a revision in the ownership decision is needed to support a P2P rental

Figure 2: Three consumer market possibilities in the absence of P2P rental with two consumer types



market.

3.3 Short-run P2P rental market equilibrium

We now suppose that through some technological advance, it becomes possible for the high-types to costlessly rent their entire excess capacity to the low-types. As first, we will assume that no one can revise their original ownership decisions in light of this advance. Call the resulting equilibrium the "short-run." Before the possibility of rental, the high-types were simply consuming α_H, giving $1-\alpha_H$ to rent out. 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 has changed. The new owner optimization problem is

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

whereas the renter optimization problem is

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

where r is the taken-as-given rental rate. Assuming an interior solution (which requires that $2\alpha_L > r$), both decision problems yield the same usage decision,

$$x^*(\alpha_i) = \alpha_i - r/2, \tag{4}$$

where i indexes consumer type. Let $x_H = x^*(\alpha_H)$ and $x_L = x^*(\alpha_L)$. For the rental market to clear

$$\theta(1 - x_H(r)) = (1-\theta)x_L(r). \tag{5}$$

The market clearing rental rate is

$$r = 2\left[(1-\theta)\alpha_L - (1-\alpha_H)\theta\right]. \tag{6}$$

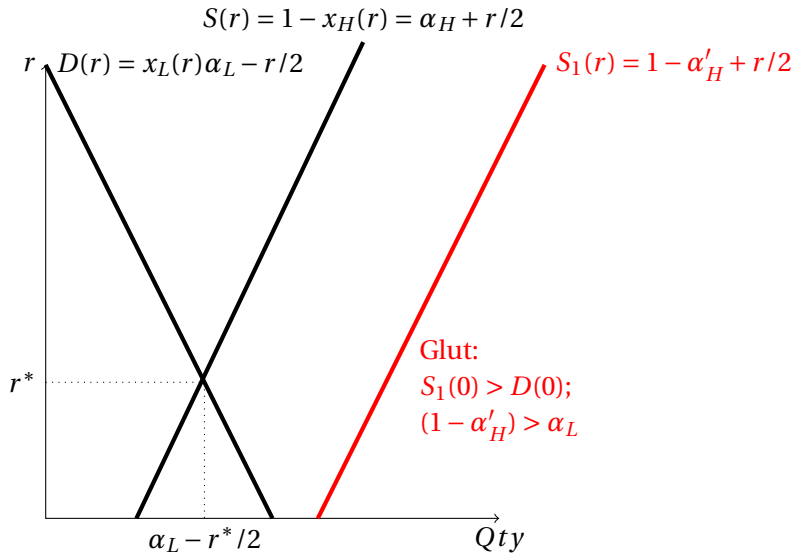
, which is proportional to the difference in the total amount both types would consume if facing no marginal cost (i.e., what they would do if they owned the good). As expected, rental rates are increasing in the valuations of either type (since higher valuation from low types increases demand while higher valuation from high types reduces supply) and declining the fraction of high types, as they provide the market supply. The quantity of the good exchanged is

$$Q = \theta(1-\theta)\left(1 - \alpha_H + \alpha_L\right). \tag{7}$$

All else equal, the quantity exchanged is largest when there are equal numbers of both 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 a higher valuation causes them to be willing to supply less of the good to the market).

From Equation 6, we can see that a negative rental rate is possible. This can arise when the owner's excess capacity in the absence of a rental market exceeds the non-owner's usage if given the good for free. If all consumers were allocated the good and their cumulative usage, $\alpha_H + \alpha_L$, exceeds the capacity of the actual stock of purchased goods, then a positive rental rate is needed to clear the market. Figure 3 illustrates market clearing with a positive rental rate and the glut condition. The rental market demand

Figure 3: Market clearing with two consumer types in a P2P rental market



is simply $x_L(r)$, whereas supply is $1 - x_H(r)$. The market-clearing quantity is the optimal consumption of the low-types, $\alpha_L - r/2$. We add a supply curve with a lower α_H value (which moves out the supply curve, in red) such that the offered supply at $r = 0$ exceeds demand, creating a glut. It is also clear from the figure that if the valuation parameter of either type rises, short-run rental rates increase, as increases in valuation lower supply and increase demand.

3.4 Social surplus in the short-run P2P rental market

With the introduction of the P2P rental market there are several welfare-affecting changes: 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 $x_L = \alpha_L - r/2$). Change in utility for the high-types from reduced consumption is

$$\begin{aligned} \Delta v_H &= \underbrace{\left[2\alpha_H(\alpha_H - r/2) - (\alpha_H - r/2)^2\right]}_{\text{New}} - \underbrace{\left[\alpha_H^2\right]}_{\text{Old}} \\ &= -\frac{r^2}{4}. \end{aligned} \tag{8}$$

As we would expect, the greater the rental rate, the greater the loss in utility from reduced consumption, since a higher rental rate encourage more economization of usage by the high-types. For the low-types, the change in utility from increased consumption is

$$\Delta v_L = \alpha_L^2 - \frac{r^2}{4}. \tag{9}$$

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

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

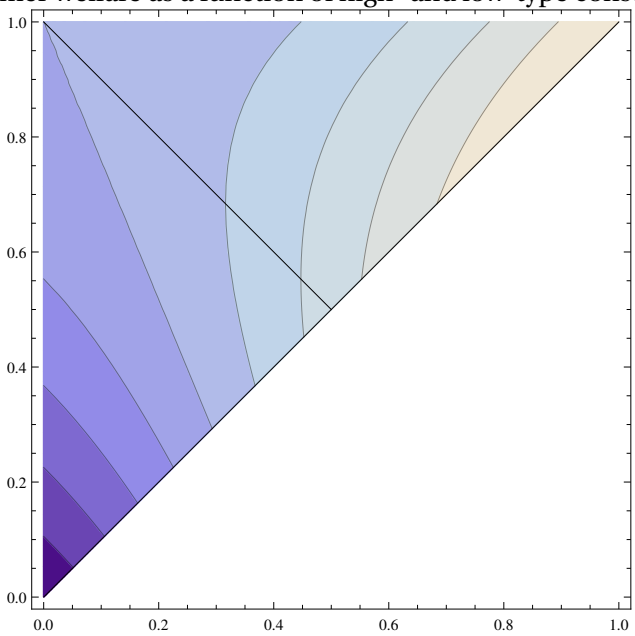
This equation implies that the gains from the P2P rental market is the maximum surplus obtained by the low-types consuming at their preferred usage point, minus a term capturing the amount of reduction in consumption required of both types for the market to clear. The ideal short-run P2P rental market is one where the excess capacity of the high-types when they own equals the total demand of low-types if they were to own the good. Under this scenario, the market clears with zero rental rate and both the low and high-types get their preferred level of usage.

Figure 4 is a contour plot of change in social surplus from the emergence of the P2P rental market for the space of possible valuation parameters. The figure shows that higher values of α_L increase the gain in social surplus. Indeed, $\partial \Delta S / \partial \alpha_L = 1 - \alpha_H + \alpha_L > 0$ since $\alpha_H < 1$ and $\alpha_L > 0$. The more the non-owners value the good, the greater the increase in social surplus from the emergence of P2P rental markets. The case of α_H is more complex. Recall that a positive rental rate only occurs when $\alpha_H + \alpha_L > 1$. As such, an increase in the valuation of the high-types reduces social surplus from P2P rental markets in non-glut P2P rental scenarios:

$$\frac{\partial \Delta S}{\partial \alpha_H} = 1 - (\alpha_H + \alpha_L) < 0. \tag{11}$$

In Figure 4 the line stretching from $(1,0)$ to $(1/2,1/2)$ indicates the glut/non-glut boundary. For all points

Figure 4: Consumer welfare as a function of high- and low-type consumer valuations



Notes: This contour plot shows the level of social surplus created by a P2P rental market at different valuation parameters for the low-type (on the x-axis) and the high-type (on the y-axis). Lighter shading indicates a higher value.

to the right of that line, a higher α_H valuation reduces social surplus. As, such the greatest social surplus is "unlocked" by the emergence of the P2P rental market when both purchasers and non-purchasers have similar, high valuations. In terms of the figure, the highest obtainable social surplus values for a fixed $\alpha_H + \alpha_L$ run along the 45 degree line that indicates $\alpha_H \approx \alpha_L$.

For simplicity, we have ignored income effects as a cause of the pattern of ownership. However, for goods where income effects are important in the consumer's ownership decision problem, the $\alpha_H > \alpha_L$ requirement would no longer hold and potentially larger gains in social surplus would be unlocked by the P2P rental market emergence.

3.5 Long-run P2P rental equilibrium

In the long-run equilibrium, all parties can revise their ownership decisions. The utility from owning is

$$v_i^{OWN} = 2\alpha_i x_i - x_i^2 + (1 - x_i) r_{LR} - p \tag{12}$$

whereas the utility from renting is

$$v_i^{RENT} = 2\alpha_i x_i - x_i^2 - x_i r_{LR}, \tag{13}$$

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

$$v^{OWN} = \alpha_i^2 - p + \frac{r_{LR}^2}{4} + (1 - \alpha_i) r_{LR} \quad \text{and} \quad v^{RENT} = \frac{1}{4}(r_{LR} - 2\alpha)^2. \tag{14}$$

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

$$p = r_{LR}. \tag{15}$$

In the long-run P2P rental equilibrium, the rental rate equals the product market purchase price and ownership does not depend on usage patterns or valuation.

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

$$\left[(1 - x_H(p)) + (1 - x_L(p))\right] f_{OWN} = \left(x_H(p) + x_L(p)\right)(1 - f_{OWN}) \tag{16}$$

which simplifies to

$$f_{OWN} = \frac{x_H(p) + x_L(p)}{2}. \tag{17}$$

The fraction of consumers owning in the long-run is the average usage rate in the population. In this long-run P2P rental equilibrium, even though both types own, we might expect in that even with the indifference condition, higher-valuation types to be the ones to own, as they can better bear the risk in the rental rate, ala Sinai and Souleles (2005).

In the long-run P2P rental market equilibrium, there are no profits from owning to simply 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 a surplus from their own consumption. This suggests that firms that derive no consumption value from the good can not compete in a competitive P2P rental market unless they have some other cost advantage. because the consumer has excess capacity after satisfying their own consumption, they can "profitably" sell their excess capacity at any price and still have positive utility; a firm owning simply to rent would make zero profit. There is already perhaps some evidence that P2P rental markets are adversely affecting traditional firms: Byers et al. (2013) find that Airbnb is already winning customers from hotels catering to the lower-end of the market. Firms do have other advantages over consumers, such as economies of scale or expertise in minimizing transaction costs. However, this firm-level expertise might simply be offered to consumers without the firm taking ownership.[6]

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

Most commentators considering the sharing economy assume that sharing economy platforms reduce ownership. The intuitive idea is that there is a fixed amount demand 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. This is not the case: ownership increases if the product market price is below the short-run rental rate. Intuitively, when the short-run rental rate is greater than the purchase price, a consumer could buy the good at p and rent out the entire capacity for r and since $r > p$, earn a profit.

To see this algebraically, first consider that in the long-run P2P equilibrium, the new product market

[6] A recently launched start-up called Guesty aims to be a kind of property management company for Airbnb rentals.

demand curve, D_1, is

$$\begin{aligned} D_1(p) &= 2f \\ &= x_H(p) + x_L(p) \\ &= \alpha_H + \alpha_L - p. \end{aligned} \tag{18}$$

In the pre-sharing product market, $D_0(p) = 1$ since only the high-types purchased the good. Let r_{SR} be the short-run rental rate, which we recall from Equation 6 is just $\alpha_H + \alpha_L - 1$. If demand is higher after the long-run P2P equilibrium emerges, then

$$\begin{aligned} D_1(p) &> D_0(p) \\ \alpha_H + \alpha_L - p &> 1 \\ \alpha_H + \alpha_L - 1 &> p \\ r_{SR} &> p. \end{aligned} \tag{19}$$

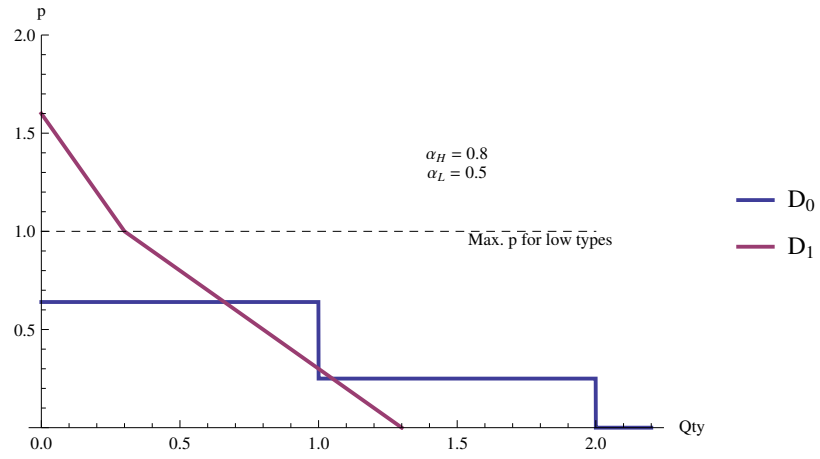
If the market-clearing short-run rental rate is above the purchase price, ownership will increase. This is likely to occur in situations where there are high valuations from both consumer types (making demand high and supply tight) as well as relatively low purchase prices.

3.7 Long-run P2P equilibrium product market demand versus the original "no sharing" demand

Previously, there were "kinks" in the product market demand curve at α_H^2 and α_L^2. In the long-run P2P rental equilibrium, product demand varies continuously, with $D(p) = x_H(p) + x_L(p) = \alpha_H + \alpha_L - p$ when both consumer-types participate. Figure 5 illustrates the new product market demand curve, with the pre-P2P rental market curve indicated as D_0 and the post-P2P rental market by D_1.

Recall that in the pre-P2P rental market with two consumer types, if $p > \alpha_H^2$, then no consumer bought the good. Figure 5 shows this and it shows that with the P2P rental market in long-run equilibrium, demand can be non-zero above this point. Intuitively, if a would-be owner can earn rental income

Figure 5: Product market demand pre-P2P rental market and post-P2P rental market (long-run)



from their unused capacity, it seems likely that a higher product market price is supportable. The highest possible price that can support a market pre-P2P rental is $\bar{p}_0 = \alpha_H^2$. In the long-run P2P market, $D(p) = \alpha_H + \alpha_L - p$, and so $\bar{p}_1 = \alpha_H + \alpha_L$. Since $\alpha_H > \alpha_H^2$ and $\alpha_L > 0$, $\bar{p}_1 > \bar{p}_0$: the existence of a P2P rental market can support a higher product market price.

In this high-price range, the D_1 curve is kinked at $p = 2\alpha_L$. The reason for this kink is that if $2\alpha_L < p$, the low-types do not use the good in the long-run P2P equilibrium. The reason is simple: if $p > 2\alpha_L$, usage of the good offers negative utility from any amount of usage and so the low-types use none. If $p > 2\alpha_L$, then the long-run P2P equilibrium is one in which the high-types simply trade with themselves, creating a market demand of just $D(p) = \alpha_H - p/2$. The model suggests the possibility of a transitory short-run phase in which low-types get access that disappears once former-owners become renters and bid up rental rates.

3.8 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 no price changes in the product market) is

$$\begin{aligned} S_1 &= \frac{1}{4}(p - 2\alpha_H)^2 + \frac{1}{4}(p - 2\alpha_L)^2 \\ &= \alpha_H^2 + \alpha_L^2 - p(\alpha_H + \alpha_L) + \frac{p^2}{2} \end{aligned}$$

whereas in the pre-P2P rental market, surplus was $S_0 = \alpha_H^2 - p$. The long-run social surplus from the introduction of the P2P rental market is

$$\Delta S = S_1 - S_0 = \alpha_L^2 + (1 - \alpha_L - \alpha_H)p + p^2/2. \tag{20}$$

From the requirement that $\alpha_L^2 < p < \alpha_H^2$ and the assumption that the low-types use some of the good in equilibrium ($2\alpha_L > p$), we can show that $\Delta S > 0$. We can also show that social surplus from the long-run P2P rental market is increasing the low-type valuation, or $\Delta S'(\alpha_L) > 0$, again because $2\alpha_L > p$. For the high-types, $\Delta S'(\alpha_H) = -p < 0$, and so the social surplus from sharing is reduced when the high-types have a higher valuation (as was the case in the short-run).

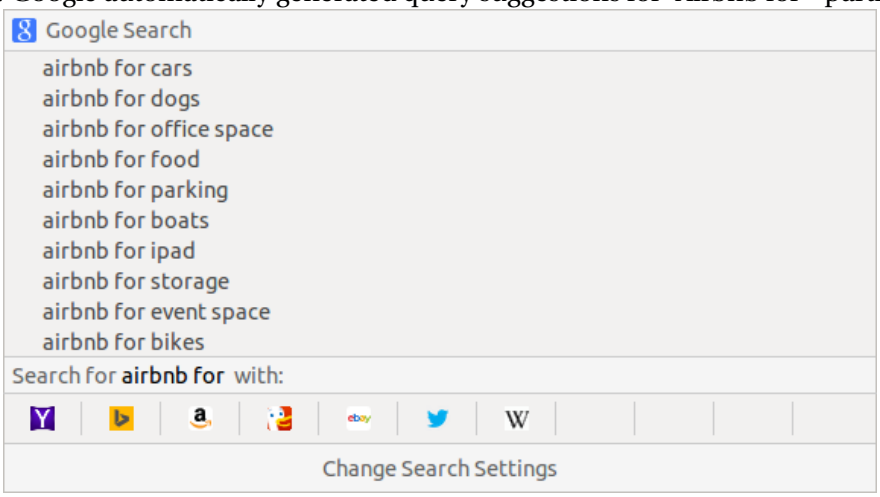
4 The attributes of goods and the feasibility of renting

In the model, a good is described by several parameters: the purchase price, p, the usage valuation, α, and, if we consider transaction costs, c. If we look to what goods are currently commonly rented now, we get a sense of what makes something amenable to renting: relatively low α, high p and low c, or expensive goods that are used infrequently but predictably and are not wholly consumed by usage. Examples include cars and hotels in distant cities, tuxedos, certain kinds of specialty tools (e.g., rototillers, carpet shampooers) and so on. The conditions necessary for the P2P rental market are similar, except that we also need a stock of owners and non-owners.

When product market prices are so low that nearly everyone buys the product, no P2P rental market can exist even when total usage is low. For example, there is no rental market in kitchen timers—although they are used infrequently and quite durable, there is neither supply (owning consumers would not find it worth the hassle to rent them out) nor demand (if a consumer wants one, they go to the product market and buy one). Other goods are expensive, but there is no excess capacity, as they are used more or less continuously, giving no spare capacity: this is why there is no P2P rental market in prescription eyeglasses.

Even at constant total amounts of usage, goods differ in the granularity of typical usage: a person might use their vacation home in week-long chunks of time, their lawn-mower in hour-long chunks and

Figure 6: Google automatically generated query suggestions for "Airbnb for " partial query



Notes: This screenshot shows the Google "auto-suggest" query completions 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 May 12, 2015.

their tooth brush in minute-long chunks. These usage chunks also differ in their predictability. 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 pattern of usage—the need for a back-up electric generator is almost always a surprise. It seems likely that goods with predictable (and easily adjustable), "large chunk" usage patterns should be more amenable to P2P rental markets than goods with unpredictable, granular usage patterns.

Predicting what goods are profitably amenable to P2P rental is a task best left to entrepreneurs. 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 search for. Figure 6 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 space 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. And "Airbnb for ipad" is presumably the result of individuals looking for that iPad application made by Airbnb.

To move beyond the casual empiricism of considering what P2P rental markets might exist (or not) for various goods, we conducted a consumer survey on Amazon Mechanical Turk. The model and the survey are designed to complement each other in two ways. First, the survey provides justification for some of the modeling conventions, such as making planned usage the primary explanation for the pattern of ownership rather than "taste" or income. Second, the survey offers a partial decomposition of the non-specific "costs" that would make a good difficult or easy to share. P2P rental markets are now possible in part because technology has reduced transaction costs, but such markets have not emerged for all goods. The survey results suggest that those goods with unpredictable and highly granular usage might not support a P2P rental market even if the total usage is small. However, it also suggests that innovations that make usage more predictable might change this characterization.

4.1 Main empirical results

We find strong evidence that respondents who predicted they would use a good more are more likely to own that good. Increasing household income is associated with greater ownership, but even when controlling for income, predicted usage helps 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 high-end goods like vacation homes. It may be the case that P2P rental markets might have larger welfare effects in countries were more goods are not owned because of income.

We find strong evidence that the predictability and granularity of usage for a good tend to be positively correlated and that goods with unpredictable and more granular usage patterns are more likely to be owned. When we inspect goods that are the "opposite"—predictable usage that occurss in large chunks—we see goods that are very often already rented in conventional markets. Not surprisingly, these are also the goods where P2P rental markets are emergent. 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 widely rented, presumably because of long-distance travel.

4.2 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 no strong reason to think they would have highly idiosyncratic consumption patterns. Furthermore, for our purposes, the MTurk population is useful for two reasons. First, because it is easy to pay for small amounts of work, it is easy to keep incentives high for even a very long survey. Second, because the MTurk population is willing—and has incentives to—carefully answer a tedious set of questions, they are less likely to quickly and carelessly complete the survey; 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 as such show a high level of diligence. This respondent diligence makes it useful for certain kinds of questions (for example, Kuziemko et al. (2013) used the MTurk population to study elasticities of demand for redistribution).

We hired US-based "Master" workers to answer a 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 had some variation in purpose (e.g., recreation, home improvement, cooking and so on), purchase price, predictability and granularity. We asked them: 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 many small chunks; whether usage was predictable; why they did not own the good; and finally, what was 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 was a total of eight questions about one particular good, with one question about family income. Workers were allowed to answer for each of the 20 goods.

4.3 Ownership and usage by individual 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 houshold income predicts ownership, the strong association between ex-

pected usage and ownership persists. At least some of the variation in ownership is not solely explained by differences in income but also by differences in taste.

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., 1 hour a week, 1 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 choices options and language.

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

$$\text{OWN}_{ig} = \beta_0 + \beta_1 \log x_{ig} + c_g + \epsilon_g, \tag{21}$$

where OWN_{ig} is indicator for whether respondent i reported owning good g, x_{ig} is their 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.

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?, ($\text{OWN}_{ig} = 1$)		
	(1)	(2)	(3)
Log estimated usage, $\log x_{ig}$	0.026^{**}	0.026^{**}	0.026^{**}
	(0.011)	(0.011)	(0.011)
Log household income, $\log y_i$		0.102^{***}	
		(0.025)	
Good FE	Y	Y	Y
Respondent FE	N	N	Y
Observations	411	411	411
R^2	0.445	0.465	0.567

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 their time they 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 reports 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 predicts ownership. To give a sense of magnitudes, the

Column (1) regression 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 probability of ownership. In Column (2) we add the log of self-reported household income (in thousands) to the specification.[7] 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. The coefficient on the usage regressor remains unchanged, suggesting that the pattern found in Column (1) is not simply the result of say, higher income respondents being more likely to own and to report greater expected usage generally (say because of greater leisure time). In Column (3) we re-estimate Column (1) but include respondent-specific FEs as well. As with the other specifcations, the the strong positive relationship between expected usage and ownership persists.

4.4 Self-reported reasons for non-ownership

The regression results from the previous section 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. As we will see in Figure 7, there is in fact 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 income considerations.

Non-owners were asked for the primary reason for not-owning and 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."). Space was not frequently cited and so in Figure 7 we plot the per-good fractions citing usage versus income, among those that cited either income or usage and for which the good in question 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 overwhelming more likely to be cited. The only goods where a larger fraction of respondents cited income than cited usage was high-end headphones and vacation homes.

[7] Household incomes imputed by taking the midpoint of the range associated with each bin (i.e., a respondent's selecting $10,000-$19,999 are imputed to have a $15K family income). There was only one top-coded respondent and they were given an inputed income of 1.5 times the censoring threshold. See Appendix A for the actual income bands respondents could select from.

Figure 7: Fraction of non-owners citing usage versus fraction citing income as the reason for ownership decision

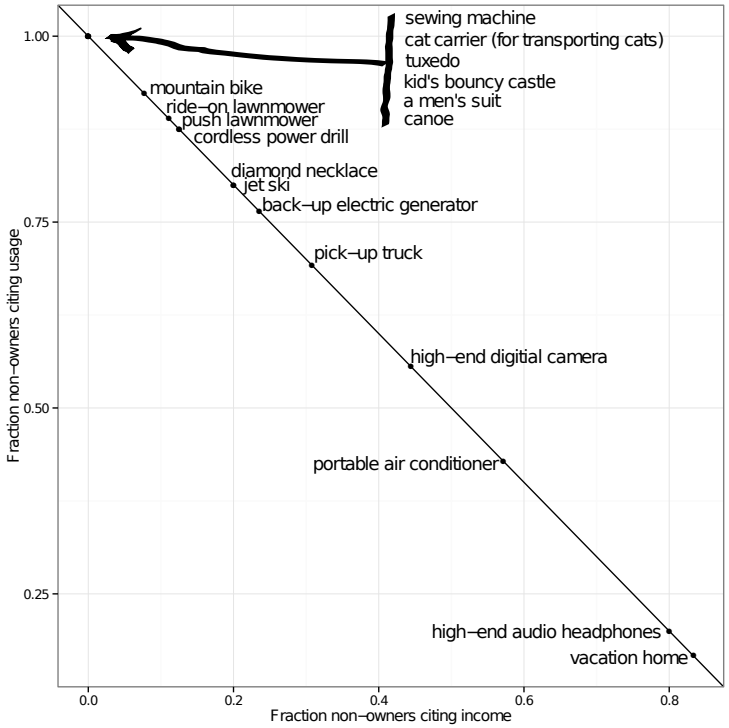
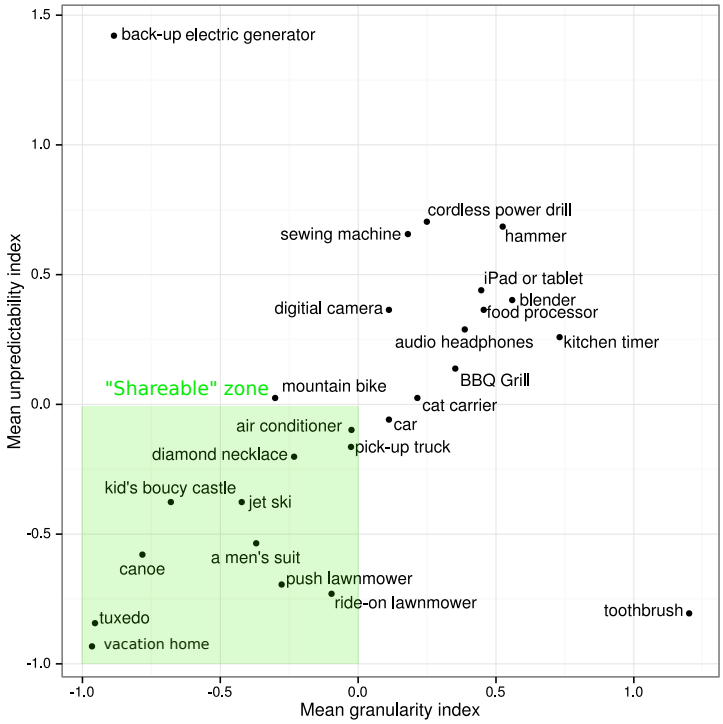


Figure 8: Usage predictability versus granularity



4.5 Aggregate usage granularity and predictability

A large practical determinant of how feasible a rental market is for a good is how predictable usage is and how granular it is. Goods with highly predictable usage patterns would be easier to rent (or lend out), whereas goods that have unpredictable usage patterns 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 transaction costs.

We asked subjects about the predictability and granularity of usage for the goods and found that they strongly covary, with some notable exceptions: the smaller chunk of typical usage, the more unpredictable the usage is. For example, respondents rated a hammer as having high granularity (it is used for a short amount of time, say when hanging a picture) and high unpredictability (it is difficult to predict when it will be needed). In contrast, a tuxedo scores low on both measures—it is used for a substantial amount of time (say when attenting 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 granularity (1 was low granularity—one big chunk— and 5 was high granularity—lots of little chunks). Figure 8 plots the mean unpredictability score against the mean granularity score. We can see a strong positive relationship between granularity and unpredictability, with two notable outliers: the toothbrush and the generator. A toothbrush has a highly granular usage pattern (2 minutes according to the ADA) and its usage is highly predictable (after every meal, according to the ADA). 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.

If we examine goods near the origin (shaded green in the figure), we see goods highly amenable to rental, in that they have predictable usage that occurs in large chunks. Not surprisingly, these are often goods for which conventional rental markets already exist—formal wear (tuxedos), vacation homes, 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 that there is not much of a rental market (bikes, lawnmowers, jewlrey) but would seem to have the attributes necessary to support such a market, assuming there are in fact enough non-owners to support such a market.

4.6 Granularity, predictability and ownership

We test whether the unpredictability and granularity measures are related to individual ownership. Table 2 shows that they are, in the expected direction: goods with unpredictable and highly granular usage are substantially more likely to be owned. Furthermore, it is not the case that these two measures are simply capturing some single latent "rentability" measure, as both seem to have an independent effect on the probability of ownership.

Column (1) of Table 2 reports an estimate of

$$\text{Own}_{ig} = \beta_0 + \beta_1 \text{UNPREDICTABILITYSCORE}_{ig} + c_i + \epsilon_i \tag{22}$$

where $\text{UNPREDICTABILITYSCORE}_{ig}$ is the normalized predictability score for good g by respondent i. The coefficient on the unpredictability score is positive and highly significant, with a one standard deviation

Table 2: Good usage unpredictibility and granularity and their association with good ownership.

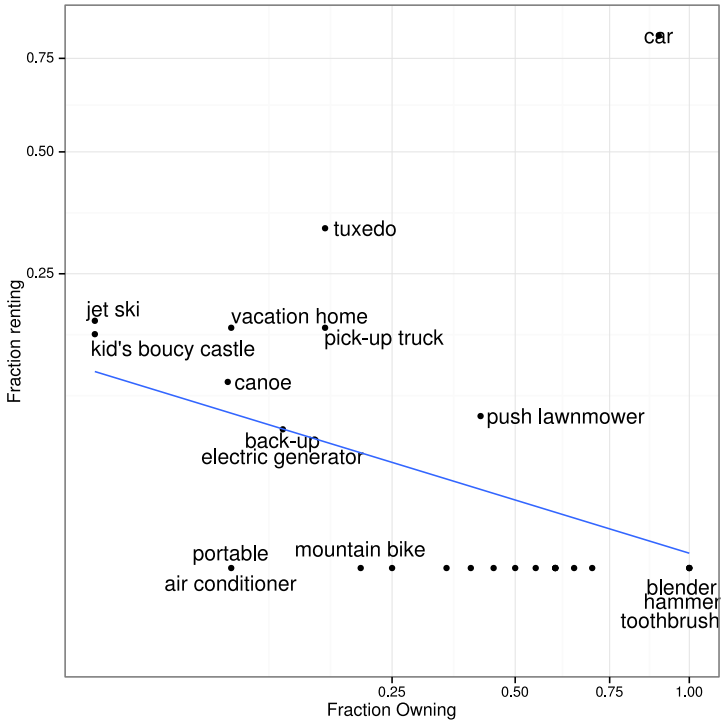
	Dependent variable:			
	Item is owned			
	(1)	(2)	(3)	(4)
Unpredictability index (UI)	0.139^{***}		0.095^{***}	0.003
	(0.030)		(0.034)	(0.034)
Granularity index (GI)		0.135^{***}	0.091^{***}	−0.018
		(0.025)	(0.029)	(0.025)
UI x GI			−0.009	0.006
			(0.018)	(0.018)
Respondent FE	Y	Y	Y	Y
Good FE	N	N	N	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 granularity 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: $p \leq 0.05 : *$, $p \leq 0.01 : **$ and $p \leq .001 : ***$.

increase in unpredicability increasing the probability of ownership by about 14 percentage points. In Column (2) we instead use granularity as the predictor and also find a positive and highly significant effect of about the same magnitude. In Column (3) we interact the the granularity and predictability measures. Each measure has a slighly smaller effect (though a formal hypothesis test would fail to reject a difference relative to the estimate when each measure appeared alone) and while the interaction term is negative, it is small and far from significant.

One concern with our approach might be that respondents prone to reporting high or low granularity and unpredictability measures might be idiosyncratically more or less likely to own the good. In other words, the patterns from Columns (1) through (3) 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 all regressors become close to zero, which supports the notion that the patterns in the previous regressions really are driven by the nature of the good.

Figure 9: Fraction renting versus fraction owning



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

This paper was motivated by the fact that P2P rental markets are *begining* to flourish. As such, asking respondents whether they have rented a particular good in a P2P rental market would likely yield uninteresting results, given how new they are. However, the existing P2P rental markets seem to be focusing on sectors whether rental markets already existed, and so asking respondents if they have ever rented a good at all might be a reasonably 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 9 will show, renting and owning are gross substitutes in data, when cars are excluded, as cars show a high level of both ownership and rental.

In Figure 9, the fraction owning is plotted on the x-axis and the fraction renting on the y-axis. Some notable goods are labeled—see Appendix B for the precise by-good fractions for every good. The plot shows that there is generally a negative relationship between owning and renting, with the notable exception of cars.

Unsurprisingly, goods with nearly universal ownership show little renting with the notable exception of cars, which are both owned and rented at high rates. There are a number of goods (not all labeled) 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, bouncy castles. There may also be some evidence of expensive tools useful for one-off jobs being rented, such as an electric generator and a pick-up truck.

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 indendent 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 langugage, see Appendix A. Significance indicators: $p \leq 0.05 : *$, $p \leq 0.01 : **$ and $p \leq .001 : ***$.

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

$$\text{FRACRENT}_g = \beta_0 + \beta_1 \text{FRACOWN}_g + \epsilon, \tag{23}$$

where FRACOWN_g is the fraction of respondents claiming to own good g and FRACRENT_g is the faction claiming to have rented good g. Column (1) reports the estimated regression of this equation with cars, while in Column (2), cars are excluded. If we exclude cars, there is a strong negative relationship between owning and renting, with a 10% increase in the fraction owning reduces the fraction of households reporting renting by a little more than 1.5 percentage points.

5 Conclusion

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 between "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, with most owning one or none.[8] 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 and so another blender is not purchased. However, if a rental market existed for both blender types, consumers could act upon their taste for diversity without owning a dozen blenders. Even if the blender example seems implausible, we should consider that very few consumers try to rent the car they normally drive or vacation in their hometown: presumably they diversify consumption in these cases precisely because they can.

One long-term reaction to the rising 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 more attractive for 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 trade automatically. 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 are computer-mediated, platforms will use this information to verify the identify and reputation of buyers and sellers, further mitigating moral hazard and adverse selection.

One area not considered by this paper how many of these P2P rental markets also have an inherent labor input. For normal goods, we might expect owners to have higher opportunity costs of time, which would tend to reduce the supply given their higher labor costs. We might also see more platforms where the labor input is provided by a firm (or even the P2P rental market platform itself) but the capital is still provided by the good owner; this would be similar to the property manager role common in real estate.

[8] As of October 8th, 2014.

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 increase access by non-owners, changes the ownership decision and affects rental rates. A cursory look at some certain prices suggest sharing economy platforms with large penetration are having substantial effects: the price of NYC taxi medallion has falled from $1.3 million in April 2013 to $840,000 by March 2015—the first observed fall in price for a medallion—and this fall is widely attributed to the rise of Uber (though during this same period outer-borough green taxis were also introduced, so even here, causal claims require care).[9] Given the substantial legal and regulatory obstacles many sharing economy companies face—including being banned in some places at certain periods of time—might make credible quasi-experimental designs feasible.

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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**?

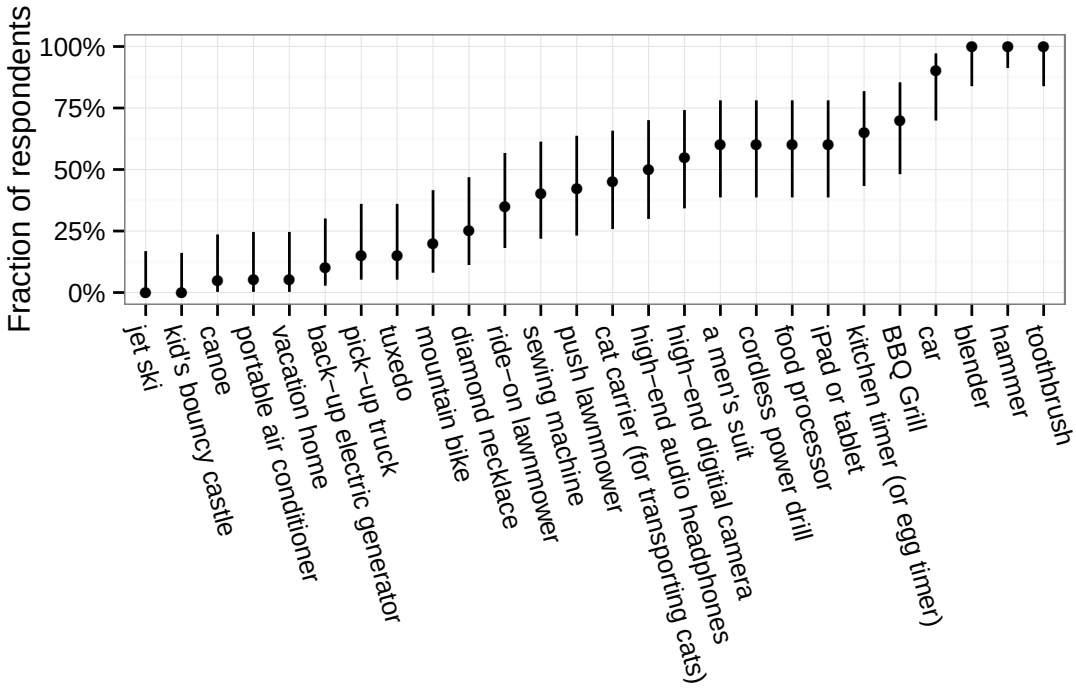
  - Yes
  - No
  - NA - we own one.

- 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

Figure 10: Fraction of respondents owning various goods



– $100,000-$149,000

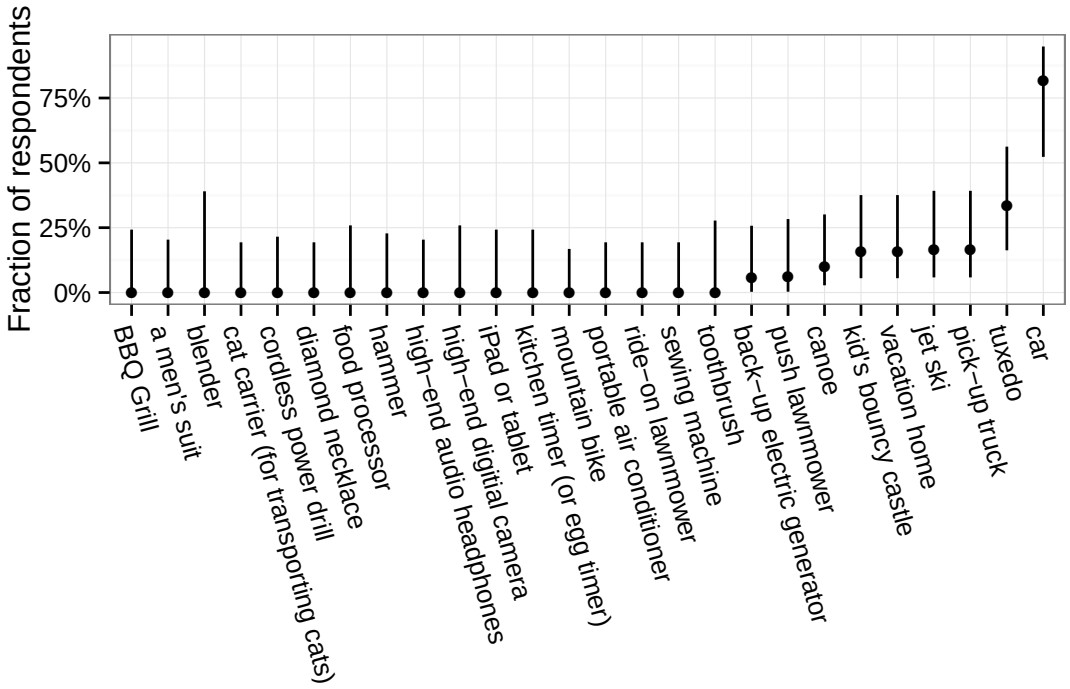
– More than $150,000

B Additional empirical results

Figure 10 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 11 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 12 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-

Figure 11: Fraction of respondents reporting having rented various goods



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 13 shows the mean granularity index per good. There appears to be some similarity in high predictable usage, but some goods with very granular usage also appear to have highly predictable usage—namely the toothbrush. To make this relationship explicit, in Figure 8 the granularity and unpredictability indices are plotted against each other. With the exception of two goods—the toothbrush and back-up generator—unpredictability and granularity are strongly positively correlated.

Figure 12: Mean unpredictability index by good

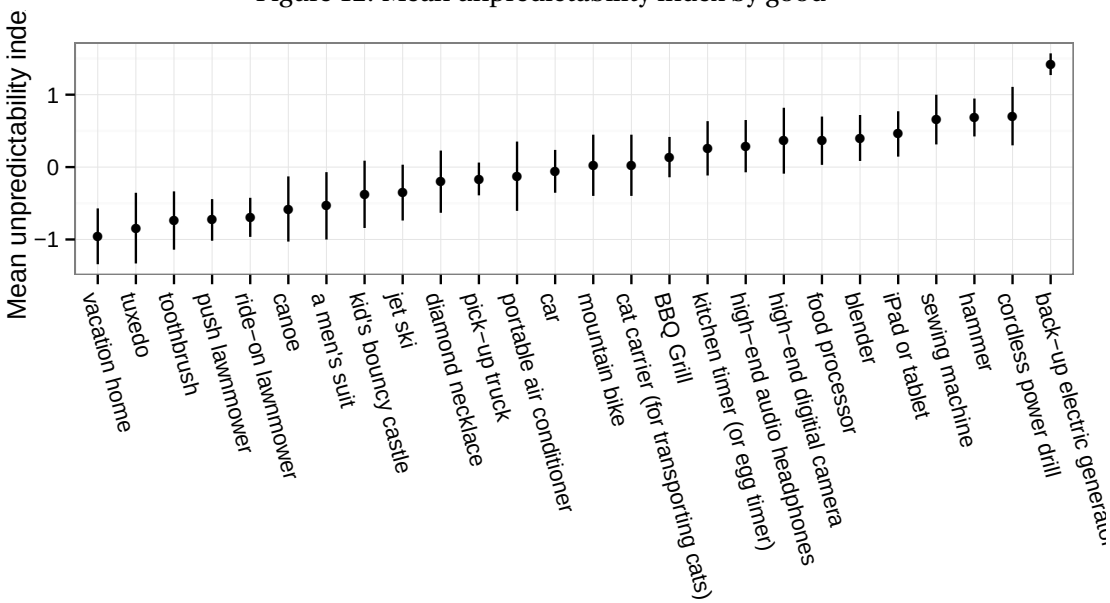


Figure 13: Mean granularity index by good