RATIONALITY & COMPETITION
CRC TRR 190

An Experimental Analysis of Overconfidence in Tariff Choice

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Discussion Paper No. 154

May 2, 2019

Collaborative Research Center Transregio 190 | www.rationality-and-competition.de
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Abstract

Digitalization has changed existing business models and enabled new ones. This development has been accompanied by the emergence of new pricing options and the possibility of applying established pricing models in new domains. Today, consumers can, for example, pay for accessing a product instead of buying it. Within such sharing services, consumers can usually choose between a flat-rate and a pay-per-use option. Prior work demonstrated that consumers' tariff choices are often systematically biased. Overconfidence was identified as one of the key drivers. Yet, prior research is non-experimental and focused on the so-called flat-rate bias. By contrast, we examine the effects of overconfidence on tariff choice experimentally. We show that overconfident consumers overestimate their ability to predict their future usage, which leads them to underestimate their actual usage, and eventually leads them to choose a pay-per-use (vs. a flat-rate) option more frequently. We discuss theoretical and managerial implications.

Keywords: overconfidence, tariff choice, pay-per-use, flat-rate, experiment.

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The authors would like to thank Dorothea Kübler and participants of the 5th CRC TRR meeting in Berlin for their helpful and constructive comments. The authors gratefully acknowledge financial support by the Deutsche Forschungsgemeinschaft through CRC TRR 190.

1 Introduction

Digitalization has changed existing business models and enabled new ones. This development has been accompanied by the emergence of new pricing options and the possibility of applying established pricing models in new domains (Fourie, 2018). A prime example are sharing services like WeWork (work space), Car2Go (cars), or Bagborroworsteal (luxury fashion items) that allow consumers to access products for a limited time instead of buying them (e.g., Schaefers, Lawson, & Kukar-Kinney, 2016). Sharing services typically offer consumers the choice between a flat-rate and a pay-per-use option. Even ride sharing services like Uber or Lyft that started with pay-per-use pricing only, now offer monthly flat-rates for reduced-cost rides (Hempel, 2018; Matousek, 2018). As a result, consumers are faced with an increasing number and frequency of tariff choice decisions across various product categories. Consequently, even small errors in individual tariff choices may add up to a substantial overall financial loss across all product categories. Therefore, better understanding the drivers of tariff choice is increasingly important. A good understanding of the drivers can help consumers make optimal decisions, can help (sharing) firms tackle pressing problems like platform switching or churn (Lambrecht & Skiera, 2006), and can inform public policy about how to assist consumers in making optimal tariff choice decisions.

Prior research has widely documented that consumers do not always make optimal (i.e., cost-minimizing) tariff choice decisions (e.g., DellaVigna & Malmendier, 2006; Lambrecht & Skiera, 2006). Such non-optimal choices can either be driven by behavioral biases or by consumers having a preference for the more expensive tariff. Belief-based biases are a prime candidate in the context of tariff choice decisions. Belief-based biases arise when uncertainty factors into decisions. Under uncertainty, decision-makers must form beliefs regarding potential outcomes or "states of the world" (DellaVigna, 2009; Rabin, 2002). In tariff choice decisions, consumers are faced with demand uncertainty at

the tariff choice stage, because of a time lag between the tariff choice decision and later usage decisions (Nunes, 2000). For example, when consumers want to sign up for a gym membership, they have to choose the tariff first, but only later decide on the individual trips to the gym. Therefore, it is likely that belief-based biases influence consumers' usage estimations and further their tariff choice decisions. Specifically, prior research proposed overconfidence as one of the main drivers of tariff choice (e.g., DellaVigna & Malmendier, 2006; Grubb, 2009). These studies often focus on overconfidence as a driver of flat-rate choice and flat-rate "bias", i.e., consumers choosing a flat-rate, although they would have saved money under a pay-per-use tariff. Moreover, they typically infer overconfidence from comparing contract choices to later usage by analyzing observational or survey data. Yet, causal evidence is lacking.

The goal of this paper is to extend prior research by experimentally testing whether and how overconfidence influences tariff choice decisions. We find that overconfidence (underconfidence) leads to an underestimation (overestimation) of actual usage and thereby to an increase in the choice of the pay-per-use (flat-rate) option. We thus show that estimated usage mediates the effect of overconfidence on tariff choice and we focus on both the flat-rate and the pay-per-use choice. Finally, we provide theoretical and managerial implications and avenues for future research.

2 Conceptual framework

One can distinguish two broad streams of literature in tariff research. One stream of literature analyzes drivers of tariff choice (e.g., DellaVigna & Malmendier, 2006; Uhrich, Schumann, & Wangenheim, 2013). The other stream of literature studies consumer behavior given a chosen tariff (e.g., Iyengar, Jedidi, Essegaier, & Danaher, 2011; Leider & Şahin, 2014). Focusing on tariff choice, several studies showed that consumers do not always pick the tariff that minimizes their billing rate (e.g., DellaVigna & Malmendier,

2006; Lambrecht & Skiera, 2006; Train, McFadden, & Ben-Akiva, 1987; Uhrich et al., 2013). The majority of these studies finds mostly flat-rate choices and a flat-rate bias (DellaVigna & Malmendier, 2006; Lambrecht & Skiera, 2006; Uhrich et al., 2013). DellaVigna and Malmendier (2006), for example, found that consumers chose the flat-rate tariff too often in a gym setting and Lambrecht and Skiera (2006) showed that consumers primarily had a flat-rate bias in the context of Internet access. A few studies also analyzed the pay-per-use choice and pay-per-use bias (e.g., Lambrecht & Skiera, 2006; Miravete, 2002). Lambrecht and Skiera (2006), for example, demonstrate that the pay-per-use bias (in contrast to the flat-rate bias) only occurs irregularly and that it seems to lead to higher churn. For both tariffs, most studies identify drivers of tariff choice based on findings from observational or survey data.

Two explanations for non-optimal tariff choice decisions have been proposed. First, consumers are inherently prone to biases, leading them to commit errors. It is, for example, likely that belief-based biases influence tariff choice decisions. Before making a tariff choice, consumers need to estimate their future usage (Nunes, 2000). Often, consumers face a time lag between their tariff choice decision and their usage decisions. As a result, consumers are uncertain about their usage at the tariff choice stage (Narayanan, Chintagunta, & Miravete, 2007). Therefore, consumers are likely to form incorrect beliefs about their future usage, resulting in misforecasting and non-optimal tariff choice decisions. The second explanation is that consumers have a preference for a respective tariff and deliberately choose the more expensive tariff. Lambrecht and Skiera (2006) analyze causes of such tariff-specific preferences. They demonstrate that the so-called insurance effect (i.e., avoidance against monthly variations in bill amounts) and taxi-meter effect (i.e., when the ticking taxi meter lowers the consumption enjoyment) lead to a flat-rate bias. Uhrich et al. (2013) replicate these findings and demonstrate that consumers with

a more hedonic (rather than utilitarian) consumption goal exhibit a stronger preference for the flat-rate.

With regard to possible biases influencing tariff choice, previous research proposed overconfidence as one of the main drivers (e.g., DellaVigna & Malmendier, 2006; Grubb, 2015; Grubb & Osborne, 2015). DellaVigna and Malmendier (2006), for example, propose that overconfidence about future self-control is a main driver of the substantial flat-rate bias they observe. Grubb and Osborne (2015) argue that consumers are overconfident in the sense that they underestimate the variance of their future consumption and thereby choose overly risky plans (in the context of a cellular service). Grubb (2015) further suggests that naive inattention may explain the presence of overconfidence that Grubb and Osborne (2015) estimate. He shows that overconfidence leads naively inattentive customers to underestimate the probability of paying surprise penalty fees. Overall, overconfidence has been proposed as a key driver of tariff choice across multiple industries (e.g., gym memberships, Internet access, or optional calling plans) and methods (observational data: e.g., DellaVigna & Malmendier, 2006 or analytical modeling: e.g., Grubb, 2015). However, to the best of our knowledge, no study has yet experimentally studied the effect of overconfidence on tariff choice.

We contribute to prior research by showing experimentally whether and how overconfidence influences tariff choice. We propose a possible mechanism behind this effect, namely that estimated usage mediates the effect of overconfidence on tariff choice. As prior research shows, overconfidence leads consumers to overestimate their abilities (e.g., driving ability; DellaVigna, 2009). In the context of tariff choice decisions, we suggest that consumers overestimate their ability to accurately predict their future usage. As a result, we propose that overconfident consumers underestimate their actual usage, related to the argument by Grubb and Osborne (2015), who suggest that overconfident

consumers underestimate the variance of their future consumption. Next, having underestimated their usage, we predict that overconfident consumers are more likely to choose a pay-per-use (vs. a flat-rate) option. We expect the opposite effect for underconfident consumers. Thus, we predict that estimated usage mediates the effect of overconfidence on tariff choice. We illustrate our prediction in Fig. 1.

--- INSERT FIG. 1 HERE ---

3 Method

3.1 Participants

We recruited 411 US-based participants (48.91% female, M_{age} = 38.07 years, SD = 11.31 years) from an online crowdsourcing platform for human intelligence tasks (HITs), i.e., Amazon Mechanical Turk. Participants completed the experiment through the web-based survey software Qualtrics in exchange for a fixed fee and an additional bonus payment that depended on participants' behavior in the experiment.

3.2 Design and procedure

The study consisted of three parts (see Fig. 2): (1) the treatment phase (manipulation of overconfidence), (2) a second part including estimation of usage, tariff choice, and completion of a usage task, and (3) a third part consisting of process and belief measures.

--- INSERT FIG. 2 HERE ---

We conducted a context-free experiment with behavioral consequences using a between-subjects design. In the treatment phase, we randomly assigned participants to one of two treatments: **under**confidence and **over**confidence. In both treatments, participants had to solve a real-effort task. In the **under** treatment, participants had to solve 6 logic questions taken from IQ tests (see Appendix 1). This task was difficult for participants as there was no clear technique that could be applied to answer the questions and we expected them to answer only a small number of the questions correctly (Dargnies, Hakimov, & Kübler, 2016). In the **over**confidence treatment, participants had to solve 12 easy additions (see

Appendix 1). This task was easy for participants because they knew directly what they had to do and we expected them to answer a large number of the questions correctly (Dargnies et al., 2016; Niederle & Vesterlund, 2007).[2] We presented the questions sequentially. Participants received feedback on whether they had answered a question correctly or not after each question. The aim of this manipulation was to induce relative **under**confidence in the **under** treatment with the difficult task and relative **over**confidence in the **over** treatment with the easy task (Cain, Moore, & Haran, 2015; Dargnies et al., 2016; Niederle & Vesterlund, 2007). After they completed the real-effort tasks, we asked participants to state what percentage of other participants they thought answered more questions correctly than they did (i.e., a better-than-average measure; Alicke & Govorun, 2005).

In the second part of the study, we asked participants to estimate their usage for a so-called usage task, to make a choice between a flat-rate and a pay-per-use option for this task, and then to complete the task (see Fig. 2). These three steps were designed to reflect the real-world situation of tariff choice decisions including the prediction of one's usage, the choice of the corresponding tariff, and finally using/consuming the product. We operationalized the usage task as a memory game.

Prior research often used trivia quizzes as usage tasks (often referred to as estimation tasks; e.g., Cain et al., 2015). Usage tasks in the form of trivia quizzes followed the following procedure: after answering a set of trivia questions, participants had to estimate how many questions they answered correctly, and they had then to make a choice. However, the order of the different steps using trivia quizzes did not seem to match the steps in tariff choice decisions. In the context of tariff choice decisions, the order is estimation – choice – task completion. In trivia quizzes, by contrast, the order is task completion – estimation –

[2] In a pilot study, we observed that participants in the **under** treatment needed more time to answer the questions than the participants in the **over** treatment. Therefore, we increased the number of questions in the **over** treatment to achieve approximately the same average duration for the real-effort task in both treatments.

choice. Therefore, we developed an online memory game as our usage task, which enabled us to mirror the sequence of steps in tariff choice decisions. Moreover, our memory game had the advantage that participants most likely already had some experience with the game. Therefore, they could approximate how many clicks they might need, while a moderate level of uncertainty about their estimated usage remained – as one would expect in a real-world tariff choice situation.

To illustrate the type of tariff choice situation that we aim to mimic, consider the following example. In a car sharing context, consumers regularly have to decide between a flat-rate option (e.g., 3-hour package) and a pay-per-use option (e.g., price per minute). Under the flat-rate option, consumers pay an up-front fee and can drive as much as they wish within the 3-hour window. Under the pay-per-use option, consumers drive a certain amount of minutes and are charged by the minute at the end of the trip. Similarly, in our memory task, participants receive a fixed bonus under the flat-rate option and they can consume as many clicks as they wish in the memory task. Under they pay-per-use option, a per-usage cost is subtracted from an initial endowment for each click participants need in the memory game. In both situations (the car sharing example and our memory task), the payment/bonus is decoupled from the "usage" under the flat-rate option, but is dependent on the "usage" under the pay-per-use option. Since each unit of "usage" is costly under the pay-per-use option, we would expect individuals striving to minimize "usage" and thereby total cost in both situations.

We showed participants the memory game consisting of 16 tiles with food icons, as depicted in Appendix 2. Moreover, we told them that participants needed on average 32 clicks to solve the memory game, which we learned in a pilot study (N = 45). Thereafter, we asked participants to state their estimate of how many clicks they thought they would need to solve the memory game and to state their confidence with regard to this estimate.

Next, participants were presented with the choice between a flat-rate option and a pay-per-use option (called pay-per-click option). In order to make the choice consequential for participants, they could receive a bonus payment depending on their chosen option. Under the flat-rate option, participants received a fixed bonus of $0.80, regardless of the number of clicks they needed to solve the memory game. Under the pay-per-use option, participants received a bonus between $0 and $1.60, depending on the number of clicks they needed to solve the memory game (a cost per click of $0.05 was subtracted from $2.40, see Appendix 3). We used the average of 32 clicks from the pilot study to parameterize the two tariff options such that the expected value of the bonus was the same for the two options ($0.80). Next, participants proceeded to the actual tariff choice and then completed the memory game. Upon completion of the memory game, we told participants how many clicks they actually needed to solve it and what their bonus payment and total payout was.

In the last part of the study, we asked participants to answer process and belief measures. These measures included questions and scales regarding satisfaction with their chosen tariff, attitude towards risk, tariff-specific preferences, and demographics.

3.3 Measures

This section summarizes all measures we elicited throughout the study. After the manipulation of overconfidence, we asked participants to answer two manipulation checks. We asked them to rate the perceived task difficulty (7-point scale; 1 = *not difficult at all* – 7 = *very difficult*) and to indicate the percentage of other participants that they believed had answered more questions correctly then they had (i.e., the better-than-average measure; 0% – 100%[3]; Alicke & Govorun, 2005). After illustrating and explaining the memory game, we asked participants to estimate the number of clicks they would need to solve the

[3] We calculate the better-than-average measure as (50 – answer)/50, following Glaser and Weber (2007).

memory game and to rate their confidence with regard to this estimation (7-point scale; 1 = *not confident at all* – 7 = *very confident*). Apart from the absolute number of estimated clicks, we also calculated an overestimation measure (= estimated clicks – actual clicks; Cain et al., 2015). Next, participants made their choice between the two tariff options (0 = *pay-per-use*; 1 = *flat-rate*). After their choice, we asked participants to rate their satisfaction with the chosen tariff (7-point scale; 1 = *not satisfied at all* – 7 = *very satisfied*; Novemsky & Schweitzer, 2004). In the last part of the study, we asked participants to rate their willingness to take risks (7-point scale; 1 = *completely unwilling to take risks* – 7 = *completely willing to take risks*; Dohmen et al., 2011), to complete Lambrecht and Skiera's (2006) scales regarding tariff-specific preferences – insurance, taxi meter, and convenience effects – (for all constructs: 7-point scale; 0 = *strongly disagree* – 7 = *strongly agree*), and to provide demographic information: age, sex (0 = *female*; 1 = *male*), income, and employment status. We provide a detailed overview of all measures in Appendix 4.

4 Results

Manipulation checks. We conducted Mann-Whitney-U tests for task difficulty and the better-than-average measure, as the distributions were not normally distributed. In terms of task difficulty, the results confirmed that participants in the **under** treatment perceived their questions to be more difficult than the participants in the **over** treatment (M_{under} = 6.46, M_{over} = 1.45, $z_{\text{Mann-Whitney-U}}$ = 17.94, $p < .001$). Comparing the better-than-average measure between treatments showed that participants in the **under** treatment were more underconfident and participants in the **over** treatment more overconfident (M_{under} = -.22, M_{over} = .39, $z_{\text{Mann-Whitney-U}}$ = -8.07, $p < .001$). Regarding task performance, as expected, the majority of participants in the **under** treatment only answered *very few* questions correctly (mostly 0-1 out of 6). Yet, participants in the **over** treatment answered *the majority* of questions correctly (mostly 11-12 out of 12).

Estimated and actual number of clicks. We found that **over**confident participants underestimated their actual usage, while **under**confident consumers overestimated their actual usage (see Table 1). Mann-Whitney-U tests showed that the estimated number of clicks was significantly different between treatments (M_{under} = 33.65, M_{over} = 30.91, $z_{Mann\text{-}Whitney\text{-}U}$ = 3.44, $p < .001$). We found no statistically significant difference in the actual number of clicks, but the overestimation measure was again significantly different between treatments (M_{under} = 2.66, M_{over} = -1.25, $z_{Mann\text{-}Whitney\text{-}U}$ = 2.80, $p < .005$).

Table 1 Estimated and actual number of clicks

Treatment	N	Estimated clicks (mean) (1)	Actual clicks (mean) (2)	Overestimation measure (3) = (1) – (2)
Under	201	33.65	30.99	2.66
Over	210	30.91	32.16	-1.25

Choice. Overall, 39.66% of participants chose the flat-rate option and 60.34% chose the pay-per-use option. In absolute terms, the majority of participants chose the pay-per-use option in both treatment groups, as can be seen in Fig. 3. However, there are significant relative differences between treatments. We found that participants in the **over** treatment chose the pay-per-use (vs. the flat-rate) option relatively more often than participants in the **under** treatment (M_{under} = .55, M_{over} = .65, $z_{Mann\text{-}Whitney\text{-}U}$ = -2.07, $p = .038$). Participants in the **under** treatment chose in turn the flat-rate (vs. the pay-per-use) option relatively more often than participants in the **over** treatment.

--- INSERT FIG. 3 HERE ---

In addition, we analyzed the consistency of participants' tariff choices. We compared whether the chosen tariff was coherent with their stated estimate of clicks. More specifically, if participants estimated that they needed less than 32 clicks, they should have taken the pay-per-use option to maximize their payout, yet if they had estimated that they needed more than 32 clicks, they should have taken the flat-rate option. However, we found that 27% of participants did not choose the tariff option that would have matched

their estimate. We did not observe any systematic differences in terms of the chosen tariff, as the non-consistent choices comprised 52% pay-per-use and 48% flat-rate. In line with previous research, this result suggests that at least some of these participants had a preference for a specific tariff and therefore deliberatively chose the more expensive tariff. Consistent with this argument, results of a Mann-Whitney-U test indeed showed that participants with non-consistent choices scored higher on the scales for tariff-specific preferences than participants with a consistent choice (using an index of tariff-specific preferences[4]: $M_{consistent} = 13.19$, $M_{not\ consistent} = 14.16$, $z_{Mann\text{-}Whitney\text{-}U} = 2.34$, $p = .019$).

Regression. To adjust for additional drivers of tariff choice, we ran a logistic regression model with overconfidence (0 = ***under****confidence*; 1 = ***over****confidence*), attitude towards risk (7-point scale; 1 = *completely unwilling to take risks* – 7 = *completely willing to take risks*), an index of tariff-specific preferences, age, sex (0 = *female*; 1 = *male*), and income as the independent variables and choice (0 = *pay-per-use*; 1 = *flat-rate*) as the dependent variable. As Table 2 shows, the results corroborate that overconfidence has a significant effect on tariff choice, even when adjusting for tariff-specific preferences and demographics (model 1). Thus, **over**confident participants were more likely to choose the pay-per-use option. Moreover, we replicate previous research by demonstrating that the higher the index for tariff-specific preferences, the more likely participants were to choose the flat-rate option. These results also hold when including a measure of risk preferences, although the effect of overconfidence is then only marginally significant ($p = .055$, model 2). In line with previous research, risk-seeking participants were also more likely to choose the pay-per-use option and risk-averse participants were more likely to choose the flat-rate option (Grubb, 2009; Lambrecht & Skiera, 2006).

[4] Since the tariff-specific preferences (insurance effect, taximeter effect, and convenience effect) according to Lambrecht and Skiera (2006) were highly correlated, we included an index of the three effects in the regressions, calculated as the sum of the scores of the three effects. Cronbach's α for the individual effects are: insurance effect (α = 0.84), taximeter effect (α = 0.86), and convenience effect (α = 0.81).

Table 2 Logistic regression analysis

Tariff Choice: 0 = Pay-per-use 1 = Flat-rate	*Model 1*		*Model 2*	
Treatment dummy (0 = *under*; 1 = *over*)	-0.464**	(0.212)	-0.419*	(0.218)
Attitude towards risk			-0.311***	(0.068)
Tariff preferences index	0.164***	(0.032)	0.178***	(0.034)
Age	-0.2×10^{-3}	(0.010)	-0.4×10^{-2}	(0.010)
Sex	0.190	(0.214)	0.393*	(0.226)
Income	0.188*	(0.105)	0.207*	(0.107)
Constant	-3.091***	(0.679)	-2.036***	(0.722)
Observations	411		411	

Note: Standard errors in parentheses.
*** p < .01, ** p < .05, * p < 0.1

Mediation analysis. We conducted a mediation analysis (Hayes, 2013; Model 4) to provide further evidence for the behavioral mechanism proposed in our conceptual model. We used overconfidence (i.e., the treatment) as the independent variable (0 = ***under****confidence*; 1 = ***over****confidence*), estimated usage as the mediator, and tariff choice as the dependent variable (0 = *pay-per-use*; 1 = *flat-rate*). The results support the hypothesized model: overconfidence had a significant negative effect on estimated usage (b = -2.74; SE = .94; p = .004). Estimated usage had in turn a significant positive effect on tariff choice (b = .07; SE = .02; p < .001). Importantly, in support of our prediction, the overall indirect effect was significant, thus estimated usage significantly mediated the effect of overconfidence on tariff choice (*b* = -.19; CI -.39 – -.07). Thus, **over**confident participants underestimated their usage and were relatively more likely to choose the pay-per-use option. The opposite effect holds for **under**confident participants. The direct effect of overconfidence on tariff choice was not significant (*b* = -.27; CI -.68 – .14).

5 Discussion and conclusion

This study examines the effects of overconfidence on tariff choice in an experimental setting. The results suggest that overconfidence leads to an underestimation of usage and as

a result to a relative increase in the choice of a pay-per-use (vs. flat-rate) option. We observe the opposite effect for underconfident participants. These findings are in line with many studies in both marketing and economics that proposed overconfidence as a key driver of tariff choice (e.g., DellaVigna & Malmendier, 2006; Grubb, 2009, 2015; Lambrecht & Skiera, 2006). We extend prior research by establishing a causal relationship between overconfidence and tariff choice as well as by proposing and analyzing a behavioral mechanism behind this relationship.

Theoretical implications

This research contributes to the literature on tariff choice and overconfidence. First, we contribute to the tariff choice literature by experimentally showing that and how overconfidence influences tariff choice decisions. We demonstrate that estimated usage mediates the effect of overconfidence on tariff choice for both flat-rate and pay-per-use choices. Whereas prior research has typically inferred overconfidence from observational or survey data, we can establish a causal relationship between overconfidence and tariff choice.

Second, we contribute to the overconfidence literature. While multiple prior studies model overconfidence (e.g., Grubb, 2009, 2015) or rely on measurements of overconfidence (e.g., Glaser & Weber, 2007; Ren & Croson, 2013), we successfully manipulate participants' overconfidence and add causal evidence. Moreover, we provide an example of how a study analyzing the effect of overconfidence can be conducted online in an incentive-compatible way.

In addition, our results can help explain phenomena and findings in the Sharing Economy. Although context-free, our experimental setting seems to align well with a sharing context. Participants in our study exhibited a relatively large share of pay-per-use choice (60.34%), which is typical for sharing services, in which the pay-per-use option is often the default option (e.g., in car sharing services; Dowling, Spann, & Manchanda, 2018). Beyond the

application of our findings to tariff choice *within* sharing services, the choice between a flat-rate and a pay-per-use tariff could in a broader sense be seen as an analogy for the choice between ownership (buying) and access (using a sharing service). In both cases, our findings regarding overconfidence as a key driver of tariff choice could be transferred to a sharing context. This may broaden our understanding of tariff choice in a sharing context and more generally help explain drivers of sharing participation beyond the motives already analyzed, such as economic benefits or flexibility (e.g., Lamberton & Rose, 2012).

Managerial implications

Understanding drivers of tariff choice is essential for firms, as tariff choice and tariff characteristics can determine the satisfaction and thereby retention of customers (Becker, Spann, & Schulze, 2015). If customers are not satisfied with service quality, they are more likely to churn, which can be very costly and threatening to the viability of business models and the survival of firms like sharing services. Not surprisingly, our data also shows that participants who did not choose the optimal tariff (i.e., committed a flat-rate or pay-per-use error) were less satisfied with their choice ($M_{no\ error}$ = 6.31, M_{error} = 4.93, $z_{\text{Mann-Whitney-U}}$ = 6.80, $p < .001$). In our case, firms could try to diminish the overconfidence of their customers by offering them decision aids to better estimate their usage or by proactively offering them the cost-minimizing tariff to invest in their satisfaction and thus in a long-term relationship. In addition, this study can inform policy makers on how to design regulations that help consumers to avoid biased decisions, e.g., by prescribing decision aids for tariff choice decisions. Moreover, mandating service providers to disclose more information on average monthly bills across all existing customers or to make information about a customer's own past usage levels more salient, could reduce misforecasting and potentially overconfidence. In this respect, our study showed that overconfidence is not only associated with an excessive flat-rate choice (e.g., see DellaVigna & Malmendier, 2006), but that overconfidence also drives the pay-per-use

choice and potentially bias. Since consumers frequently choose the pay-per-use option in new business models like sharing services, public policy needs to adapt their measures accordingly.

Limitations and future research

We acknowledge some limitations that provide avenues for future research. First, several studies have shown that biases may diminish over time through learning (e.g., Grubb & Osborne, 2015; Miravete, 2002). Since we analyze a single tariff choice decision, we cannot observe the long-term effect of overconfidence on tariff choice, which could be explored in future research. Further, we conducted the experiment in a context-free setting. Future research could explore whether the effects hold in specific contexts (e.g., car sharing) and whether context-specific differences exist. For example, since the study was conducted online, future research could analyze these effects in the field.

Appendix 1 Manipulation of overconfidence

Treatment	**Under**confidence	**Over**confidence
Instructions	Please provide the number or letter that logically follows next in the series of numbers or letters.	Please provide the answer to the additions.
Question 1	8, 2, 6, 4, 7, 3, 5, ?	29 + 55 =
Question 2	7, 7, 15, 21, 37, 57, ?	71 + 15 =
Question 3	1, 2, 3, 5, 7, 11, 15, ?	31 + 63 =
Question 4	1, 3, 5, 11, 21, 43, ?	13 + 51 =
Question 5	a, d, h, m, ?	47 + 44 =
Question 6	2, 4, 6, 10, 16, ?	60 + 39 =
Question 7		11 + 40 =
Question 8		43 + 14 =
Question 9		35 + 40 =
Question 10		32 + 23 =
Question 11		40 + 7 =
Question 12		50 + 11 =

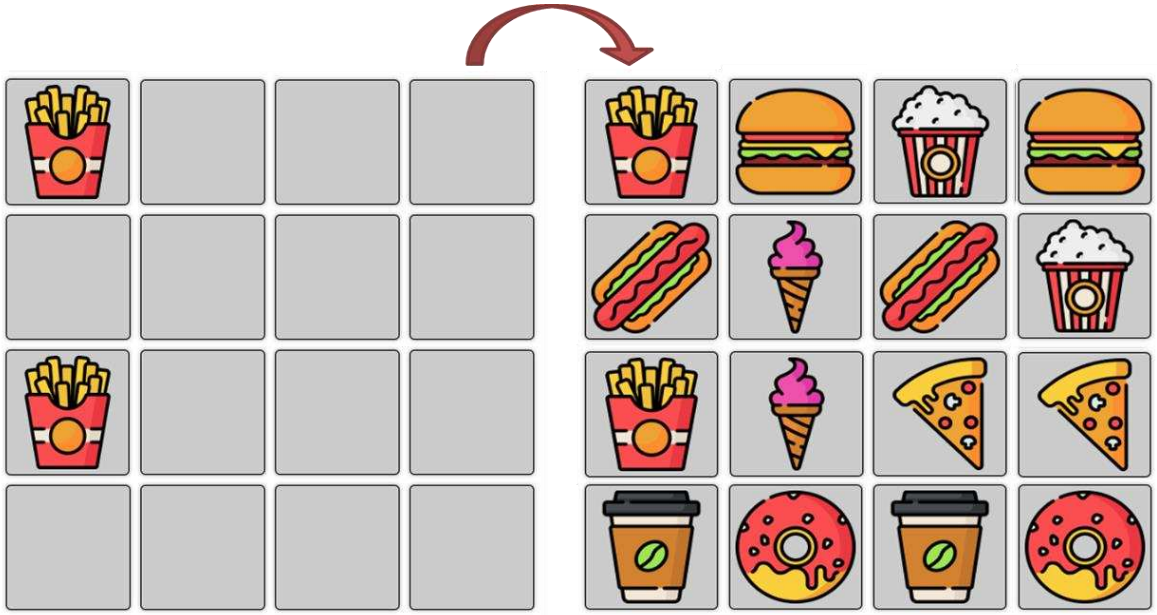
Source: Own Illustration

Appendix 2 Usage task

In a memory game you need to match pairs of tiles. You turn over one tile and then try to find a matching tile.

You are going to **solve the memory game below (in a different order)**, for which you can receive a **bonus payment.**

Example:



Source: Own Illustration

Appendix 3 Tariff choice options

Flat-rate Option	Pay-per-Click Option
Bonus: $0.80 ▪ Cost per click = $0 ▪ Bonus = $0.80 Your bonus is $0.80 regardless of the number of clicks you need to solve the memory game.	**Bonus:** between **$0** and **$1.60** ▪ Cost per click = $0.05 ▪ Bonus = $2.40 – $0.05 x number of clicks The fewer clicks you need to solve the memory game, the higher is your bonus. You need at least 16 clicks. Therefore, your maximum bonus is $1.60.

Source: Own Illustration

Appendix 4 Scales and items

Construct	Items	Scale	Source
Task difficulty	How difficult was it to solve the previous logic/calculation tasks?	7-point scale; 1 = *not difficult at all* – 7 = *very difficult*	-
Better-than-average measure	What do you think, how many other participants in this study answered more tasks correctly than you?	0% – 100%	Alicke and Govorun (2005)
Estimation of clicks	What do you think, how many clicks will you need to solve this memory game?	___ clicks	-
Confidence with regard to estimation	How confident are you that this is the actual number of clicks you will need to solve the memory game?	7-point scale; 1 = *not confident at all* – 7 = *very confident*	-
Overestimation measure	*Calculated as: estimated clicks – actual clicks*	-	Cain et al. (2015)
Tariff choice	Now please choose one of the following options.	0 = *pay-per-use*; 1 = *flat-rate*	-
Satisfaction	Overall, how satisfied are you with your choice of the Flat-rate option/Pay-per-use option?	7-point scale; 1 = *not satisfied at all* – 7 = *very satisfied*	Novemsky and Schweitzer (2004)
Attitude towards risk	How do you see yourself: Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?	7-point scale; 1 = *completely unwilling to take risks* – 7 = *completely willing to take risks*	Dohmen et al. (2011)
Honesty	In all honesty, how seriously did you take this study? Your response to this question will not affect your payment for this study.	7-point scale; 0 = *not seriously at all* – 7 = *very seriously*	-
Comprehension Questions (bold indicates correct answer)			
Comprehension question 1	Your bonus payment for solving the memory game depends on your choice between a flat-rate and a pay-per-click option.	• **True** • False	-
Comprehension question 2	If you choose the flat-rate option, you can have as many clicks as you want to solve the memory game without reducing your bonus payment.	• **True** • False	-
Comprehension question 3	If you choose the flat-rate option, what is your bonus payment?	• $0.00 • $0.40 • **$0.80** • $1.20 • $1.60	-
Comprehension question 4	If you choose the pay-per-click option, the fewer clicks you need to solve the memory game, the higher your bonus payment.	• **True** • False	-

Tariff-specific Preferences			
Insurance effect	• For the security of knowing that my monthly invoice will never go above the amount agreed upon, I'm willing to pay a little more than average. • Even if a flat-rate is somewhat more expensive for me than a usage-driven rate, I'm happy because my costs won't exceed the fixed amount.	7-point scale; 0 = *strongly disagree* – 7 = *strongly agree*	Lambrecht and Skiera (2006)
Taximeter effect	• The flat-rate is great because I don't have to worry about the costs. • When I'm paying a flat-rate, I feel much freer and more relaxed than with a variable rate.	7-point scale; 0 = *strongly disagree* – 7 = *strongly agree*	Lambrecht and Skiera (2006)
Convenience effect	• It takes so long to figure out which rate is better that the effort normally isn't worth it. • The money you can save by picking a better rate than the one you have now doesn't make up for the time and effort involved.	7-point scale; 0 = *strongly disagree* – 7 = *strongly agree*	Lambrecht and Skiera (2006)
Demographics			
Age	What is your age?	___ years	-
Sex	What is your sex?	• Male • Female	-
Income	What was your total household income before taxes last month?	• Up to $1,000 • $1,001 - $2,000 • $2,001 - $3,000 • $3,001 or above	-
Employment status	Employment Status: Are you currently...?	• A student • Employed for wages • Self-employed • Out of work and looking for work • Out of work, but not currently looking for work • A homemaker • Other	-

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Figures

Fig. 1 Conceptual model

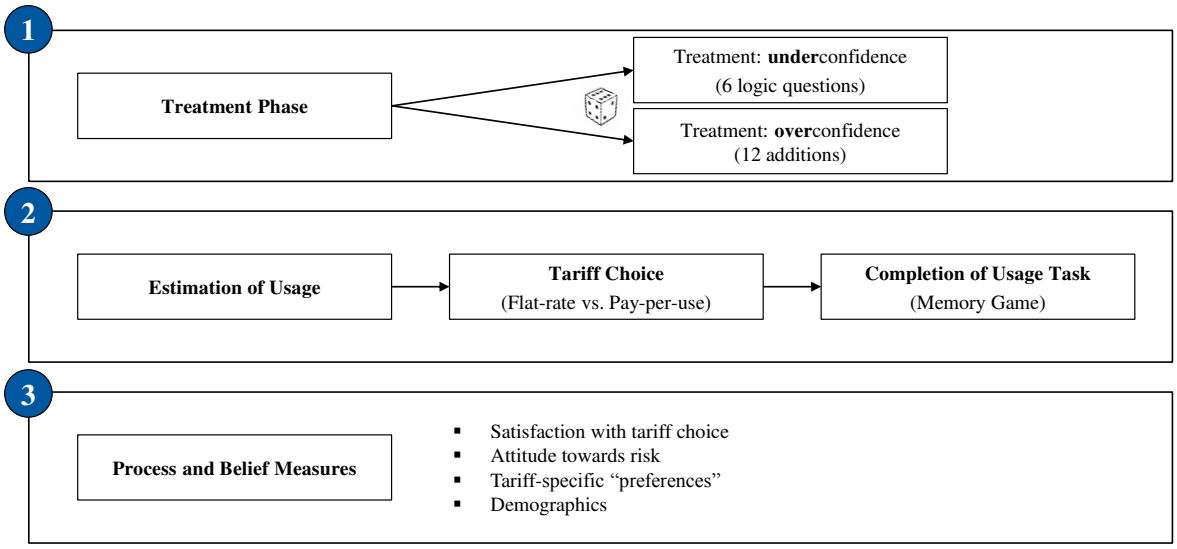

Fig. 2 Overview of the three parts of the study

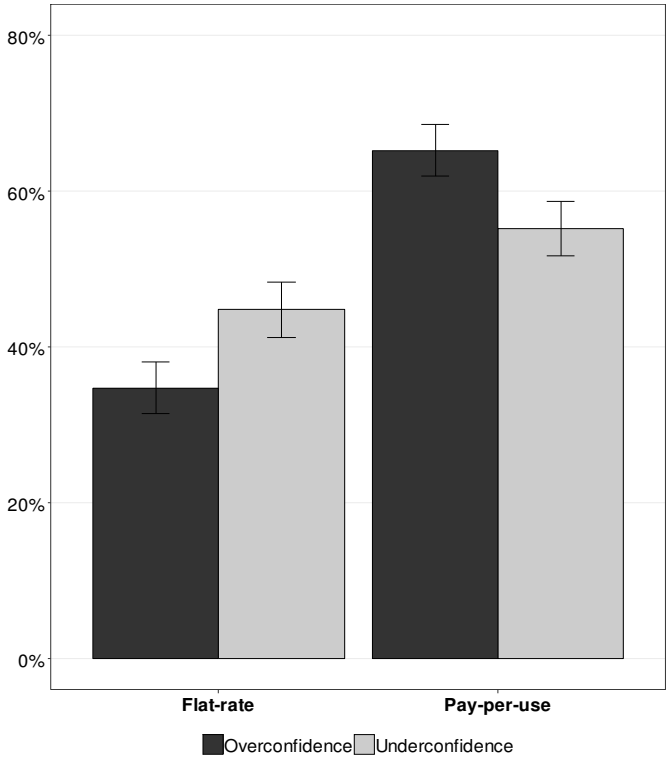

Fig. 3 Choice of flat-rate and pay-per-use options between treatments