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Percentage Cost Discounts Always Beat Percentage Benefit Bonuses: Helping Consumers Evaluate Nominally Equivalent Percentage Changes

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ABSTRACT

Marketing offers that are framed as a "percentage change" in consumer cost vs. benefit can have highly non-linear impacts in terms of actual value for consumers. Even though two offers might appear identical, we show that consumers are better off choosing the offer framed as a percentage cost change over one framed as the opposite percentage benefit change, regardless of whether the net result is a gain (e.g., 50% less cost is better than 50% more benefit) or a loss (e.g., 50% less benefit is worse than 50% more cost) and regardless of whether costs or benefits are in the nominator or denominator of the standard rate (cost/benefit or benefit/cost). Three lab studies and one field experiment show that a majority of consumers (and particularly those with low numeracy) fail to accurately recognize the superiority of percentage cost changes over percentage benefit changes across various tasks and contexts. Even highly numerate consumers are prone to error. However, the provision of salient standard rates can reduce consumer error.

Keywords: Number cognition, Numeracy, Percentages, Ratios, bonus packs, Price discounts, Unit prices.

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MARKETING communications frequently contain percentage information about increases in consumer benefits (e.g., "15% more product per dollar," "20% more miles per gallon") or decreases in consumer costs ("15% lower price per package," "20% fewer gallons per mile"). We show that while consumers generally perceive nominally equivalent offers to be of equal value, in fact, a percentage cost decrease is always a better value for the consumer than a nominally equivalent benefit increase.

Consider, for example, a consumer who is looking to upgrade her car. The current car's engine gets a rate of 40 miles/gallon (MPG). There are two possible upgrade options. The first car's engine is described as "needing 50% fewer gallons per mile." This is a percentage reduction in "cost" since gallons are what the consumer must pay for. The second car's engine is described as "leading to 50% more miles driven per gallon." This is a percentage increase in "benefit," since miles driven are what the consumer gets in return for her expenses. These offers might seem identical at the outset because the nominal percentage change is the same. However, the percentage cost reduction (50% fewer gallons) is better for the consumer, resulting in a 100% improvement in terms of miles per gallon (from 40 MPG to 80 MPG). In contrast, the percentage benefit increase (50% more miles) leads to only a 50% improvement in miles per gallon (from 40 MPG to 60 MPG). It turns out that it is hard for consumers to see the superiority of cost reductions (Chen *et al.*, 2012), potentially to their great disadvantage.

In the current paper, we provide evidence as to why consumers have trouble perceiving the superiority of cost reductions, and we show how to address the issue to provide consumer protection. We begin by briefly demonstrating the generality of the cost reduction superiority, and by showing that it matters more in some circumstances than others. We then discuss the theoretical basis for consumers' failure to recognize the cost reduction superiority, and we suggest three important moderators of consumers' perceptions — the magnitude of the actual cost reduction superiority, the availability of underlying rate information, and the individual consumer's level of numeracy. Finally, we present four studies to test our hypotheses, across several contexts and in a task with real incentives.

Conceptual Framework

Percentage Change and the Superior Value of Cost Reductions

Before addressing the extent to which consumers detect the superior value of cost reductions over benefit increases, we must make a few notes about

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the superiority itself. First, even in the simple car engine example mentioned earlier, one may actually have to "do the math" to see that the 50% cost reduction leads to better fuel efficiency (80 MPG) than does the 50% benefit increase (60 MPG). In Table 1, we show the arithmetic for this example, and for several variations of it. The table shows that the cost reduction is better than a nominally equivalent benefit increase regardless of (a) whether one is considering benefit/cost (e.g., MPG) or cost/benefit (e.g., GPM, as recommended by Larrick and Soll (2008)), and (b) whether the nominal percentage change is large or small. The table also shows that the superiority of the cost reduction is much bigger in cases where the percentage changes are themselves large (i.e., 50% vs. 10%).

The superiority of cost reductions generalizes in one more way. The examples in Table 1 all deal with cases where the percentage change results in an improvement or a "gain" for the consumer. The fuel efficiency always gets better in these cases. But sometimes consumers have to consider cases when fuel efficiency gets worse. For example, a consumer may consider a powerful new car that uses 10% more fuel per mile driven or that drives 10% fewer miles per gallon of fuel used. Table 2 shows that in this loss domain as well, the consumer is always better off taking the cost change (in these cases a cost increase) over the nominally equivalent benefit change (in these cases a benefit decrease).

The focus of this paper will be the gain domain because it is percentage gains that are more commonly promoted to consumers, but it is important to note that what we have called the "superiority of cost reduction" (in the gain domain) is really a more general effect of "superiority of cost change" (generalizing to the loss domain as well).

In Figure 1, we show that the phenomenon generalizes beyond our engine example to any case where percentage changes in cost and benefits are compared. The figure shows graphically that percentage cost changes are always better than nominally equivalent percentage benefit changes, regardless of whether one is considering their cost/benefit or benefit/cost impact, and that their superiority rises hyperbolically with the magnitude percentage change itself. The caption below Figure 1 provides the mathematical reasoning to explain this relationship further.

Consumer Perceptions of Percentage Change Offers

We do not expect consumers to detect the superiority of cost changes when comparing nominally equivalent cost and benefit changes. Prior research has shown that consumers are often swayed by nominal versus actual values, in contexts ranging from inflation to exchange rates (Raghubir and Srivastava, 2002; Shafir *et al.*, 1997; Wertenbroch *et al.*, 2007). Consumers are particularly

Table 1: The table shows that for any two nominally equivalent percentage offers that are beneficial for the consumer (e.g., offer 1a and offer 1b), the cost reduction is always a better deal for the consumer than the benefit increase. This is true regardless of whether the offers are applied to a benefit/cost frame or to a cost/benefit frame. It is also true for both small percentage offers (10%) and for large percentage offers (50%), although the superiority of the cost reduction is larger when the percentage offer is larger.

Original framing	Original engine capability	Offer name	Offer description	Offer type	Arithmetic	New engine capability	Relative superiority of cost change for consumer
Benefit/ cost	40 Miles/ gallon	Offer 1 (cost)	"Use 10% Less fuel for each mile driven"	10% Less cost	$(40)/(1 \times 90\%)$	44.4 Miles/gallon	+0.4 Miles/gallon
		Offer 1 (benefit)	"Drive 10% more miles for each gallon of fuel"	10% More benefit	$(40 \times 110\%)/(1)$	44.0 Miles/gallon	
		Offer 2 (cost)	"Use 50% less fuel ..."	50% Less cost	$(40)/(1 \times 50\%)$	80.0 Miles/gallon	+20.0 Miles/gallon
		Offer 2 (benefit)	"Drive 50% more miles ..."	50% More benefit	$(40 \times 150\%)/(1)$	60.0 Miles/gallon	
Cost/ benefit	25 Gallons/ 1000 miles	Offer 3 (cost)	"Use 10% Less fuel ..."	10% less cost	$(25 \times 90\%)/(1000)$	22.5 Gallons/1000 miles	−0.2 Gallons/1000 miles
		Offer 3 (benefit)	"Drive 10% More miles ..."	10% more benefit	$(25)/(1000 \times 110\%)$	22.7 Gallons/1000 miles	
		Offer 4 (cost)	"Use 50% less fuel ..."	50% Less cost	$(25 \times 50\%)/(1000)$	12.5 Gallons/1000 miles	−4.2 Gallons/1000 miles
		Offer 4 (benefit)	"Drive 50% more miles ..."	50% More benefit	$(25)/(1000 \times 150\%)$	16.7 Gallons/1000 miles	

Table 2: The table shows that even in the domain of losses (i.e., where all of the percentage changes involve "offers" that leave the consumer worse off), the cost change is still superior to the benefit change.

Original framing	Original engine capability	Offer name	Offer description	Offer type	Arithmetic	New engine capability	Relative superiority of cost change for consumer
Benefit/ cost	40 Miles/ gallon	Offer 5 (cost)	"Use 10% more fuel for each mile driven"	10% More cost	$(40)/(1 \times 110\%)$	36.4 Miles/gallon	+0.4 Miles/gallon
		Offer 5 (benefit)	"Drive 10% less miles for each gallon of fuel"	10% Less benefit	$(40 \times 90\%)/(1)$	36.0 Miles/gallon	
		Offer 6 (cost)	"Use 50% more fuel . . . "	50% More cost	$(40)/(1 \times 150\%)$	26.7 Miles/gallon	+6.7 Miles/gallon
		Offer 6 (benefit)	"Drive 50% less miles . . . "	50% Less benefit	$(40 \times 50\%)/(1)$	20.0 Miles/gallon	
Cost/ benefit	25 Gallons/ 1000 miles	Offer 7 (cost)	"Use 10% more fuel . . . "	10% More cost	$(25 \times 110\%)/(1000)$	27.5 Gallons/1000 miles	−0.3 Gallons/1000 miles
		Offer 7 (benefit)	"Drive 10% less miles . . . "	10% Less benefit	$(25)/(1000 \times 90\%)$	27.8 Gallons/1000 miles	
		Offer 8 (cost)	"Use 50% less fuel . . . "	50% Less cost	$(25 \times 150\%)/(1000)$	37.5 Gallons/1000 miles	−2.5 Gallons/1000 miles
		Offer 8 (benefit)	"Drive 50% less miles . . . "	50% Less benefit	$(25)/(1000 \times 50\%)$	50.0 Gallons/1000 miles	

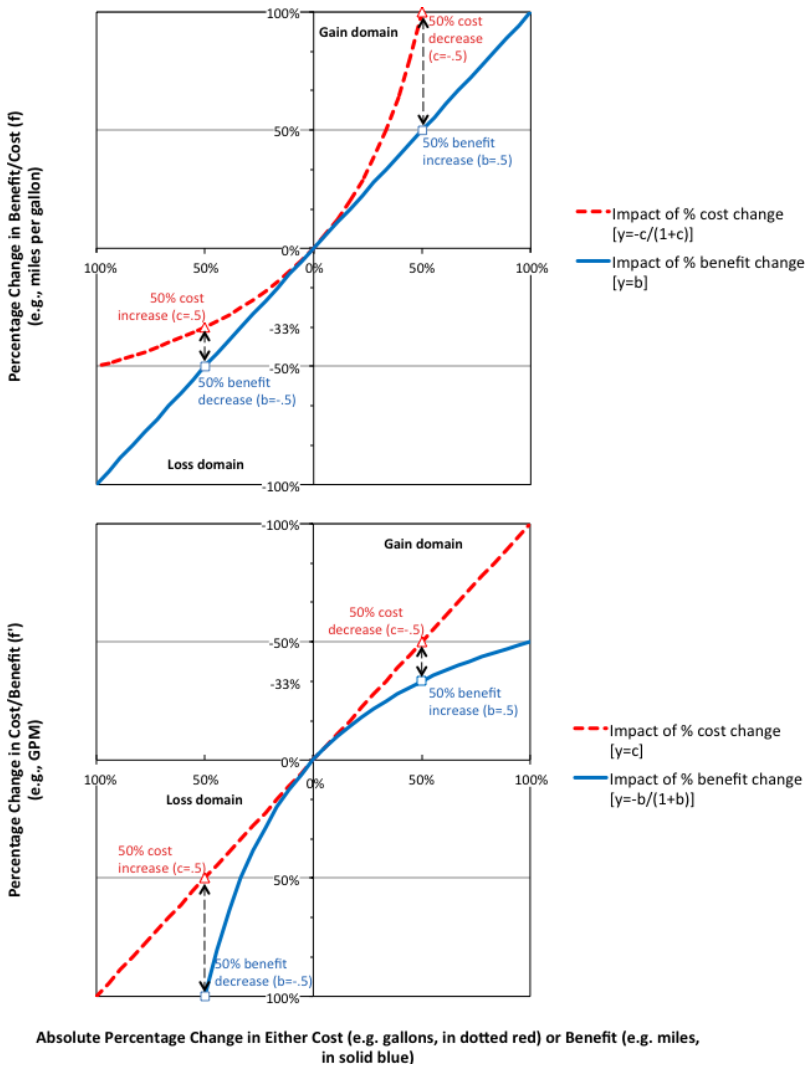

Figure 1: Effects of percentage changes in benefits and cost on percentage changes in benefit/cost (top) or cost/benefit (bottom). For any % change in cost or benefit, the dotted % cost change line is always above (i.e., more beneficial for the consumer) than the solid % change benefit line. As shown in the top chart, a b% change in benefit leads to the same b% change in benefit/cost whereas a $-c$% change in cost leads to a hyperbolic $[c/(1-c)]$% change in benefit/cost. If c and b are equal, $[c/(1-c)]$% is always larger than b%. Thus, the cost change is always better for the consumer because it leads to more benefit per unit of cost. The bottom chart shows that it is the same when rates are expressed as cost per unit of benefit. Finally, the cost change superiority grows larger as the outcome (cost/benefit or benefit/cost) becomes most positive, as indicated by the double arrows.

prone to these types of biases when assessing percentage promotions (Heath *et al.*, 1995; Chen and Rao, 2007; Kruger and Vargas, 2008). Chen *et al.* (2012) showed that consumers are typically indifferent toward nominally equivalent percentage changes in price and quantity (e.g., 50% off the base price of $10 vs. 50% more product on a base of 8 oz.) for familiar consumer goods, failing to recognize that 50% off is better than 50% more, provided that consumers can choose the quantity level that they desire.

This leads to our first two hypotheses, which extend and generalize prior work:

H1. Consumers erroneously believe that nominally equivalent percentage changes in cost and benefits are equally valuable. This will be true (a) whether the nominal percentage change is large or small, (b) whether the effect is considered for a cost/benefit rate or benefit/cost rate and (c) whether the changes result in an ultimate gain for the consumer or a loss for the consumer.

H2. The magnitude of the superiority of the percentage cost change will moderate the size of consumers' evaluation errors. Specifically, when the superiority of the percentage cost change is large, consumers will display the biggest errors in evaluating the relative value of cost changes and benefit changes.

Effects of Standard Rate Information Availability and Type on Perceptions of Cost Change Superiority

A ratio, which connotes the relationship between two measurements, is a construct that is easily understood, even by children (Sophian, 2000). A rate is a specialized ratio, a comparison of two measurements that have different units. Rates are often expressed in a standardized way with a consistent value for the denominator; we call this a "standard rate." For example, when printer companies advertise the speed of their products, rates are often framed in terms of pages printed per minute. Thus, consumers can compare varying levels of efficiency by comparing the numerators across standard rates for different printers. In some retail contexts, prices are translated into unit price, connoting price per unit of product. Indeed, such standard rates have been shown to ease cross-brand comparison of retail prices; as a result, they are mandatory in some brick and mortar shopping contexts (Manning *et al.*, 2003; Russo, 1977). Bagchi and Davis (2012) have shown that consumers are unlikely to compute standard rates if the computation is challenging.

Thus far, none of the existing studies of consumer response to offers framed as a percentage change have examined the effects of providing standardized rate information on perceptions of those percentage changes (Chen *et al.*, 2012;

Hardesty and Bearden, 2003; A. Mishra and H. Mishra, 2011). Table 1 showed the difficulty applying percentage cost and benefit change to rates without the help of a calculator. We therefore expect that providing standard rate information will help consumers recognize the superiority of percentage cost changes.

This leads to the following hypothesis:

H3. Consumers will be more likely to detect the superiority of percentage cost changes over percentage benefit changes when each percentage change is accompanied by a standard rate.

While we expect that providing rate information will reduce consumer error, there is one additional nuance in the relationship between rate frame and gains/losses that leads to an additional prediction. When we compare two nominally equivalent percentages — i.e., using 50% more fuel versus driving 50% fewer miles — the resulting rates can be framed as a cost/benefit (gallons/mile) or as a benefit/cost (miles/gallon). The choice of rate frame can make the superiority of a percentage cost change more salient. This is perhaps most easily seen with another look at Tables 1 and 2. As shown in Table 2, in the loss domain, the difference between 50% more cost and 50% less benefit offers is more apparent when framed as a cost/benefit rate (Offer 8: 37.5 gallons/1000 miles vs. 50 gallons/1000 miles) versus a benefit/cost rate (Offer 6: 26.7 miles/gallon vs. 20.0 miles/gallon). As shown in Table 1, this result is reversed in the gain domain: the difference between 50% less cost and 50% more benefit offers is more apparent when framed as a benefit/cost rate (Offer 2: 80 miles/gallon vs. 60 miles/gallon) versus a cost/benefit rate (Offer 4: 12.5 gallons/1000 miles vs. 16.7 gallons/1000 miles).

This example can be further generalized by looking at the gap between the dotted lines (cost changes) and the solid lines (benefit changes) in the top and bottom panels of Figure 1. The top chart shows that cost change superiority in the gain domain is particularly salient when the standard rate is framed as a benefit/cost. Choosing a 50% cost decrease over a 50% benefit increase magnifies the gain in terms of cost/benefit by a factor of 2 (from 50% to 100%). In contrast, the corresponding gain in terms of cost/benefit is only a factor of 1.5 (from −33% to −50%). The bottom chart shows that the opposite is true in the loss domain. There, cost change superiority is particularly salient when the standard rate is framed as a cost/benefit. In this case, choosing a 50% benefit decrease over the 50% cost increase magnifies the loss in terms of cost/benefit by a factor of 2 (from 50% to 100%) but magnifies the loss in terms of benefit/cost by a factor of 1.5 (from −33% to −50%).

We expect that consumers will find this pattern difficult to detect. Extending this analysis, we expect that the availability of a rate will be particularly helpful to consumers when the rate (cost/benefit or benefit/cost) makes the economic difference between nominally equivalent percentage changes as salient

(large) as possible (Miyazaki *et al.*, 2000; Pandelaere *et al.*, 2011; Russo, 1977). This leads to the following hypothesis:

H4a: In the gain domain, consumers will be better able to detect the superiority of percentage cost reductions (over benefit increases) when they are provided standard rate information in the benefit/cost frame than in the cost/benefit frame.

H4b: Conversely, in the loss domain, consumers will be better able to detect the superiority of percentage cost increases (over benefit decreases) when they are provided standard rate information in the cost/benefit frame than in the benefit/cost frame.

Individual Differences in Numeracy

Beyond the availability and type of rate information, we expect that numeracy will moderate people's ability to correctly choose between percentage cost and benefit offers. Numeracy is the ability to process basic probability and numerical concepts such as percentages (Lipkus *et al.*, 2001). Numeracy has been shown to affect performance on judgment and decision tasks across a wide variety of domains (Dickert *et al.*, 2011; Fagerlin *et al.*, 2007; Weller *et al.*, 2012). Highly numerate individuals are more able to avoid framing effects involving percentages; for instance, they are more likely to interpret a test score of "74% correct" as equivalent to a test score of "26% incorrect" than less numerate individuals (Peters *et al.*, 2006). We therefore predict that numeracy is negatively associated with the likelihood of focusing on the nominal percentage value rather than on cost–benefit rates. The cognitive reflection test (CRT, Frederick 2005) — a three question test which captures an individual's ability to engage in more effortful and deliberate mathematical computation and suppress the spontaneous and intuitive response — is highly correlated with other numeracy measures (Kelley, 2009; Weller *et al.*, 2012). Chen *et al.* (2012) found that people who know how to calculate compound interest make fewer mistakes when choosing between bonus packs and price discounts with the same percentage change value. However, they found no statistically significant effect for CRT in the two studies in which they measured it.

Given the theoretical support for expecting an effect of numeracy, and the always-present possibility of type-2 error in previous results, we re-examine the effects of numeracy across multiple studies. We expect a main effect of numeracy — as measured by both the three-item cognitive reflection test and the eight-item abbreviated numeracy scale — even after varying the types of cost and benefits (beyond quantity bonus vs. price discount), the valence of the outcome (gain vs. loss), task (choice vs. evaluation vs. ranking), and the product category.

This leads to the following hypothesis:

H5. Failure to detect the superiority of percentage cost changes will be moderated by consumer numeracy, such that consumers with better numeracy will be less prone to make errors in evaluation of percentage offers.

Overview of Studies

In study 1, we ask participants to estimate the impact of percentage changes in cost (fuel used) or benefit (miles driven) on an engine's efficiency (framed as either cost/benefit or benefit/cost). We find, as per H1, that consumers generally do not detect the superiority of percentage cost changes over nominally equivalent percentage benefit changes. We also find that consumers make larger errors when the difference between the percentage cost change and the percentage benefit change is larger, as per H2.

In study 2, we test H1 and H3 using percentages that are not nominally equivalent, a different task (ranking), and context (comparing printer speed). We ask participants to rank the efficiency of four printers after either a percentage change in cost (time needed to print a page) or a percentage change in benefit (pages printed for a unit of time). We find, as per H3, that the availability of standard rate information (pages/minute) can lead consumers to more accurately recognize the superiority of a percentage cost change over a percentage benefit change.

In study 3, we test H1, H3 and H4 by asking participants to choose between and then rate the difference between a percentage cost (price) and percentage benefit (minutes) change to a wireless internet provider's service. We find, as per H4, that rate information can work particularly well when framed in a way that makes the consequences of a percentage change more salient. Consumers are better able to detect the superiority of a percentage cost increase (over a benefit decrease) when they are provided standard rate information in the cost/benefit frame than in the benefit/cost frame.

In study 4, we test H1 and H3 in an incentive-compatible context. We pay Mechanical Turk workers a set wage per word found on a word search puzzle. We then give them the opportunity to complete a bonus puzzle for which they must choose between two nominally equivalent wage offers: a 50% benefit change (more pay per word found) or a 50% cost change (finding fewer words for the same pay). As per H1, we find that participants do not recognize that a percentage cost change is superior to a nominally equivalent percentage benefit change. We also find that participants are more likely to choose the superior cost change when provided a standard rate (wage/word), as per H3.

Finally, across all four studies, we examine how numeracy moderates our effects. We find, as per H5, that more numerate consumers are generally less likely to make errors when assessing a superior percentage cost change versus a percentage benefit change. Together, these findings allow us to examine practical solutions to help consumers better choose between percentage cost and benefit offers. They also offer novel implications from both the marketing and consumer protection perspectives.

Study 1: Assessing Consumer Ability to Evaluate the Actual Value of Varying Percentage Changes in Cost vs. Benefit

In this study, we quantify the errors consumers make when assessing the impact of percentage changes in the context of engine upgrades and fuel efficiency. We test Hypothesis 1, by measuring whether people accurately estimate the impact of nominally equivalent percentage changes. Participants estimate the impact of percentage changes that are both large and small, both in the domain of gains and losses, and expressed both as cost/benefit rates and benefit/cost rates. We test Hypothesis 2 by examining whether consumers make larger errors when the difference between the percentage cost change and the percentage benefit change is greater. Finally, by measuring participant numeracy, we also test whether more numerate consumers are less prone to error when assessing a superior percentage cost change or a percentage benefit change (Hypothesis 5).

Method

We asked 606 Americans recruited via an online panel to evaluate changes to a car engine. We used a 2 (outcome: loss vs. gain) by 2 (rate framing: cost/benefit vs. benefit/cost) by 2 (change type: cost vs. benefit) by 3 (percentage change level: 17% vs. 33% vs. 50%) mixed factorial design. While outcome valence, rate framing, and change type were all manipulated between subjects, percentage change level was manipulated within subjects. The specific instructions varied by condition, but as an example, participants who evaluated a cost change in the gain domain, with cost/benefit rate framing were told: "Imagine you own a car which currently uses 25 gallons per 1000 miles. Upgrading your engine will lead to 17% fewer gallons used per 1000 miles. By what percentage will your GPM (gallons per 1000 miles) decrease?" The response was selected on a sliding scale, from 1% to 100%. As another example, participants who evaluated a benefit change in the loss domain, with benefit/cost rate framing were told: "Imagine you own a car which currently gets 40 miles per gallon. A problem affecting your engine will lead to 17%

fewer miles driven per gallon. By what percentage will your MPG (miles per gallon) decrease?" using the same sliding scale from 1% to 100%.

Thus, participants solely assessed either the impact of a percentage reduction in costs (gallons) or a percentage increase in benefit (miles), and they did so either in the gain or loss domain and for either a cost/benefit (GPM) or benefit/cost (MPG) change. Each participant assessed changes at all 3 percentage change levels (17%, 33%, and 50%), in random order. Table 3 shows the exact instructions given in each condition, as well as the correct responses. The table reveals that the degree of cost change superiority depends on the percentage change level itself (e.g., it is lower for 17% than for 50%), the framing of the rate (as cost/benefit or benefit/cost), and the valence of the offer (a gain versus a loss).

In addition to completing the estimation task, all participants also completed both the 3 question cognitive reflection test (Frederick, 2005), as well as the 8 question abbreviated numeracy scale (Weller *et al.*, 2012).

Results

We had predicted that the superiority of percentage cost changes over nominally equivalent percentage benefit changes would not be detected by consumers, as per Hypothesis 1. To better visualize our data, we plotted the average participant guess relative to the actual percentage cost reduction or benefit increase (see Figure 2). The figure shows that participants generally (and erroneously) estimated that the nominal percentage of the offer would be its actual impact on MPG (miles per gallon) or GPM (gallons per 1000 miles), thus, in aggregate, failing to detect the superiority of the cost change, consistent with Hypothesis 1.

To test our hypotheses more directly, we coded our data to capture the extent to which the percentage cost change was superior to the nominally equivalent percentage benefit change. To test hypothesis 1, we first coded whether participants were in one of the four between-subjects conditions where the correct response was not the percentage of the offer (see Table 3). For instance, using 17% less gas for every 1000 miles actually leads to a 20% improvement in miles driven per gallon. In this example, there is a discrepancy between the percentage mentioned in the offer (17%) and its actual impact (20%).

To test Hypothesis 2, we coded whether participants were in one of the four between-subjects conditions where the superiority of the percentage cost change appears especially large compared to the nominally equivalent percentage benefit change (see Table 3). As discussed in the Introduction, the degree of cost change superiority depends upon the percentage change level, framing of the rate (as cost/benefit or benefit/cost), and the valence of the offer (a gain versus a loss). This can also be seen in the current context in

Table 3: Study 1 stimuli summary, with correct responses and coding.

					Actual rate impact			Statistical coding	
Starting rate	Outcome	Type	Context	Question	$x = 17\%$	$x = 33\%$	$x = 50\%$	Nominal discrepancy	Large % cost superiority
Cost/benefit	Gain	Cost	Upgrading your engine will lead to $X\%$ fewer gallons needed per 1000 miles.	By what percentage will your GPM (gallons per 1000 miles) decrease?	17%	33%	50%	No	No
(Imagine you own a car which currently uses 25 gallons per 1,000 miles)	Gain	Benefit	Upgrading your engine will lead to $X\%$ more miles per gallon.		14%	25%	33%	Yes	No
	Loss	Cost	A problem affecting your engine leads to $X\%$ more gallons needed per 1000 miles.		17%	33%	50%	No	Yes
	Loss	Benefit	A problem affecting your engine leads to $X\%$ fewer miles per gallon.	By what percentage will your GPM (gallons per 1000 miles) increase?	20%	50%	100%	Yes	Yes

(*Continued*)

Table 3: (*Continued*)

					Actual rate impact			Statistical coding	
Starting rate	Outcome	Type	Context	Question	$x = 17\%$	$x = 33\%$	$x = 50\%$	Nominal discrepancy	Large % cost superiority
Benefit/cost	Gain	Cost	Upgrading your engine will lead to $X\%$ fewer gallons needed per 1000 miles.	By what percentage will your MPG	20%	50%	100%	Yes	Yes
(Imagine you own a car which currently gets 40 miles per gallon)	Gain	Benefit	Upgrading your engine will lead to $X\%$ more miles driven per gallon.	(miles per gallon) increase?	17%	33%	50%	No	Yes
	Loss	Cost	A problem affecting your engine leads to $X\%$ more gallons needed per 1000 miles.	By what percentage will your MPG	14%	25%	33%	Yes	No
	Loss	Benefit	A problem affecting your engine leads to $X\%$ fewer miles driven per gallon	(miles per gallon) decrease?	17%	33%	50%	No	No

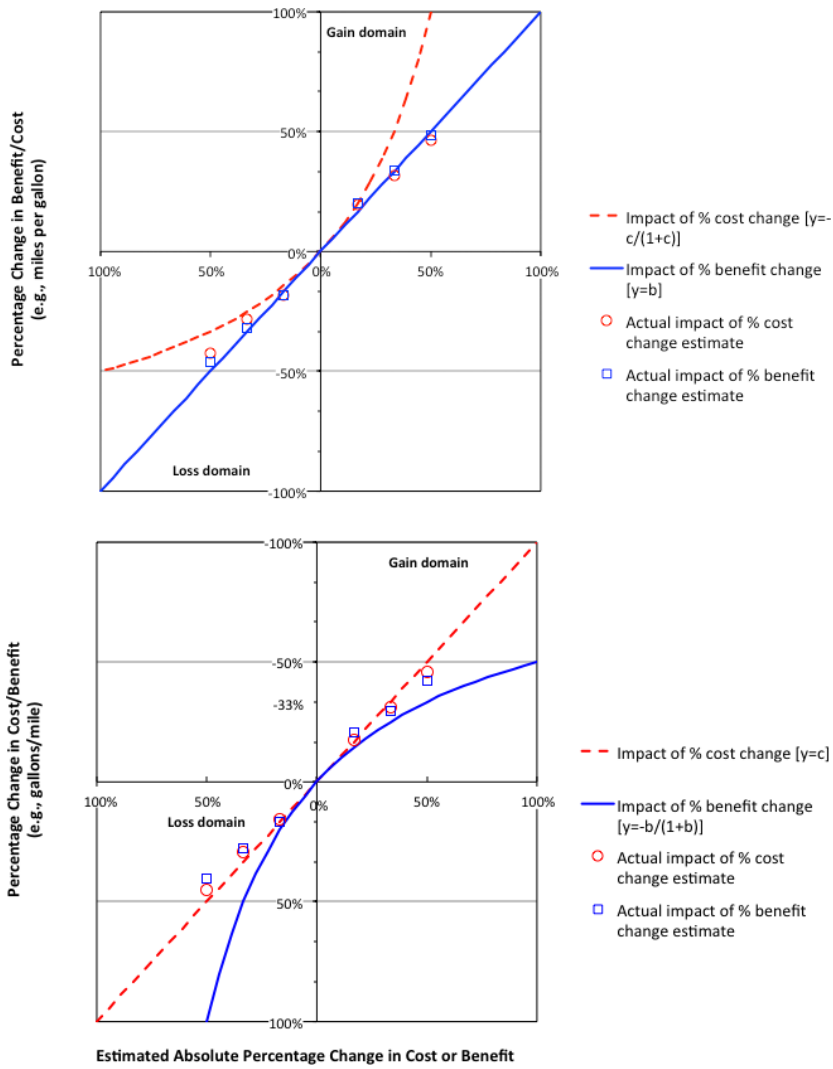

Figure 2: Study 1: actual and estimated impact of 17%, 33%, and 50% changes in cost (gallons consumed) and benefit (miles driven). Participants failed to recognize the non-linear effects of some of the changes and hence did not infer the superiority of the percentage cost change over the nominally equivalent percentage benefit change. The magnitude of their errors increased with the size of the change.

Table 3. This coding allowed us to test for whether the size of the superiority of the percentage cost change would moderate the size of consumers' evaluation errors.

We conducted a 2 (nominal discrepancy: yes vs. no) by 2 (large cost change superiority: yes vs. no) by 2 (outcome valence: loss vs. gain) by 2 (rate framing: cost/benefit vs. benefit/cost) by 2 (percentage change type: cost vs. benefit) by 3 (percentage change level: 17% vs. 33% vs. 50%) mixed ANOVA, with participant accuracy as the dependent variable. To capture participant accuracy, we subtracted each participant estimate from the correct value and used the absolute value as the dependent variable.

We first examined the between-subjects effects. We found a significant main effect on accuracy of whether the nominal percentage change was correct, $F(1, 594) = 69.64$, $p < 0.01$. Thus, as per Hypothesis 1, consumers did not detect the difference between nominally equivalent percentage changes. With respect to Hypothesis 2, we also found a significant main effect of large cost change superiority on accuracy $F(1, 594) = 24.98$, $p < 0.01$. The interaction between the two was also significant $F(1, 594) = 30.86$, $p < 0.01$. Thus, the size of the superiority of the percentage cost change moderated the size of consumers' evaluation errors.

Examining the multivariate tests, we also found a significant within-subjects main effect of the percentage change level on accuracy, $F(2,596) = 72.19$, $p < 0.01$. Participants had a higher average error at the 50% level ($M = 20.52$, SE = 1.06) than at the 17% level ($M = 6.22$, SE = 0.44). This also supports Hypothesis 2, that consumer errors will be bigger in cases where the superiority of the cost change is bigger.

We found no significant main effect of outcome valence (gain versus loss), rate framing (MPG versus GPM), or percentage change type (change in miles travelled versus change in gallons used), in all cases, $p > 0.14$. This indicates that none of these manipulations had any effect on participants' accuracy beyond their hypothesized effects. For example, it did not matter whether the offer was a gain or a loss or whether people were asked to consider MPG or gallons per 1,000 miles. What mattered for accuracy was whether the actual impact of the offer was the nominal rate or not (in which case they were wrong), the size of the percentage, and the magnitude of the gap between the nominal and the actual impact.

Finally, we examined the effects of numeracy. When we included our measure of numeracy in our model as a covariate, we found a significant main effect of the 8-measure abbreviated numeracy score, $F(1,597) = 76.217$. When we instead included CRT in our model as the measure of numeracy, the effect was also significant, $F(1, 595) = 36.21$. Participants' score on the 8-measure numeracy test and the 3-measure CRT measure were highly correlated ($r = 0.74$, $p < 0.01$). We dichotomized participants between those who answered all three CRT questions incorrectly and those who had at least

one correct answer. The average error of those with a CRT score of zero ($M = 26.33$, SE $= 2.25$) was higher than those with a CRT score above zero ($M = 18.52$, SE $= 1.17$). All of these results support Hypothesis 5.

Discussion

In Study 1, we find that consumers make large errors when assessing nominally equivalent percentage changes in cost and benefit because they assume that the nominal percentage change offered always corresponds to the actual effect on value, whereas this is true in only some conditions. As per Hypothesis 1, these errors exist even after controlling for whether the effect is considered for a cost/benefit or benefit/cost rate, or whether or not the percentage changes lead to gains or to losses for the consumer. Consistent with Hypothesis 2, these errors increase with the size of the cost change. Specifically, when the superiority of the cost reduction is large, consumers display the biggest errors in evaluating the relative value of cost changes versus benefit changes. Finally, as per Hypothesis 5, more numerate consumers are less prone to error, regardless of the numeracy measure used.

In the next study, we examine how participants assess percentage changes in costs versus benefits which are not necessary nominally equivalent (e.g., a 35% cost reduction vs. a 50% benefit increase). We test our third hypothesis, which is that the availability of standard rate information can lead consumers to more accurately recognize the superiority of a percentage cost change over a percentage benefit change. We also again examine whether individual differences in numeracy can moderate the propensity to make errors.

Study 2: Effects of Cost vs. Benefit Framing, Rate Availability, Outcome Valence, and Cognitive Reflection on Ranking Printers' Speed

In this study, we test Hypothesis 3 and examine whether standard rate information can moderate the propensity to make errors assessing nominal percentage changes. A cost change can be even more beneficial to a consumer than a benefit change with a higher nominal value (e.g., a 35% cost reduction leads to a better price per unit than a 50% increase in benefit). For instance, Chen *et al.* (2012) showed that consumers prefer nominally higher but economically inferior percentage changes (e.g., 50% more quantity over 40% less price) and that these errors occur regardless of whether consumers are comparing two gains or two losses. We test whether consumers are more likely to detect the superiority of percentage cost changes over percentage benefit changes when each percentage change is accompanied by a "standard rate" (in this case, pages/minute), as per Hypothesis 3. We therefore build upon prior research

on the effects of information availability in shopping contexts, such as the provision of rate information in the form of unit price (Manning *et al.*, 2003; Russo, 1977).

Method

We used a 2 (outcome valence: loss vs. gain) by 2 (standard rate information: present vs. absent) between subjects design. We recruited 400 American adults via an online panel to rank printers by speed but excluded 5 of them due to duplicate IP addresses. We told participants to imagine that they must purchase a new printer to replace their previous one, which printed 25 pages per minute (ppm). We manipulated outcome valence by telling participants that all the printers available were either slower (loss condition) or faster (gain condition) than their previous one. We then asked them to rank the four printers in order of speed and to complete the three-question cognitive reflection test (Frederick, 2005).

We chose this printer scenario for a specific reason; as in the fuel context, there is a normatively correct response. With some products (specifically packaged goods) consumers may not only seek to get the best rate (e.g., price per unit), but also prefer a particular package size (e.g., 8 ounce jar of pasta sauce) or a specific price point (e.g., nothing more than $6). With printers, however, people can print as many pages as they want; there is no downside to printing more pages per minute or taking less time to print a page.

As shown in Table 4, the change in printing efficiency was described as the percentage change in the number of pages printed per minute (benefit change) for two of the printers and as the percentage change in the time needed to print one page (cost change) for the other two printers. In the rate information present condition, a standard rate was also included alongside the percentage changes. The standard rate comprised speed described in pages per minute (ppm).

Results

We analyzed whether or not participants correctly ranked the four printers with a binomial logistic regression with standard rate availability and outcome valence as categorical factors, CRT as a continuous variable, and all interactions. Consistent with Hypothesis 3, the effect of providing standard rate information was strongly significant ($\beta = 3.23$, SE $= 0.41$, $p < 0.001$). When rate information was present, 57% of the participants provided the correct ranking (see Figure 3). When standard rate information was absent, only 8% of the participants ranked the printers accurately, which is not statistically higher than chance (given the 24 possible rankings, $M_{\text{random}} = 1/24 = 4.2\%$, $z = -1.45$, $p = 0.15$). This supports Hypothesis 3, that consumers are more

Table 4: Study 2: Stimuli description.

Naïve speed rank (based on nominal percentage value)	Actual speed rank (based on rate)	Gain condition	Loss condition
1	3	Printer 1: Prints 50% more pages per minute than your previous printer (37.5 ppm).	Printer 1: Prints 33% fewer pages per minute than your previous printer (16.8 ppm).
2	1	Printer 2: Takes 45% less time to print each page than your previous printer (45.5 ppm).	Printer 2: Takes 35% more time to print each page than your previous printer (18.5 ppm).
3	4	Printer 3: Prints 40% more pages per minute than your previous printer (35 ppm).	Printer 3: Prints 38% fewer pages per minute than your previous printer (15.5 ppm).
4	2	Printer 4: Takes 35% less time to print each page than your previous printer (38.5 ppm).	Printer 4: Takes 40% more time to print each page than your previous printer (17.8 ppm).

Note: Speed rate (in pages per minutes) was only provided in the rate information present condition.

likely to detect the superiority of percentage cost changes over percentage benefit changes when each percentage change is accompanied by a standard rate. The main effect of outcome valence was not statistically significant ($\beta = 0.43$, SE $= 0.41$, $p = 0.30$), replicating the effects of Study 1 and the general findings of Chen *et al.* (2012) that outcome valence on its own does not affect accuracy.

We also measured the effects of numeracy. As in Study 1, CRT was strongly associated with accuracy ($\beta = 0.59$, SE $= 0.16$, $p < 0.001$). To provide a more intuitive understanding of the effects of numeracy, we dichotomized in Figure 3 participants into two groups: those who answered all three CRT questions incorrectly and those who had at least one correct answer. A total of 21% of the participants with a zero CRT score found the correct order vs. 41% among those with a nonzero score. None of the interactions were

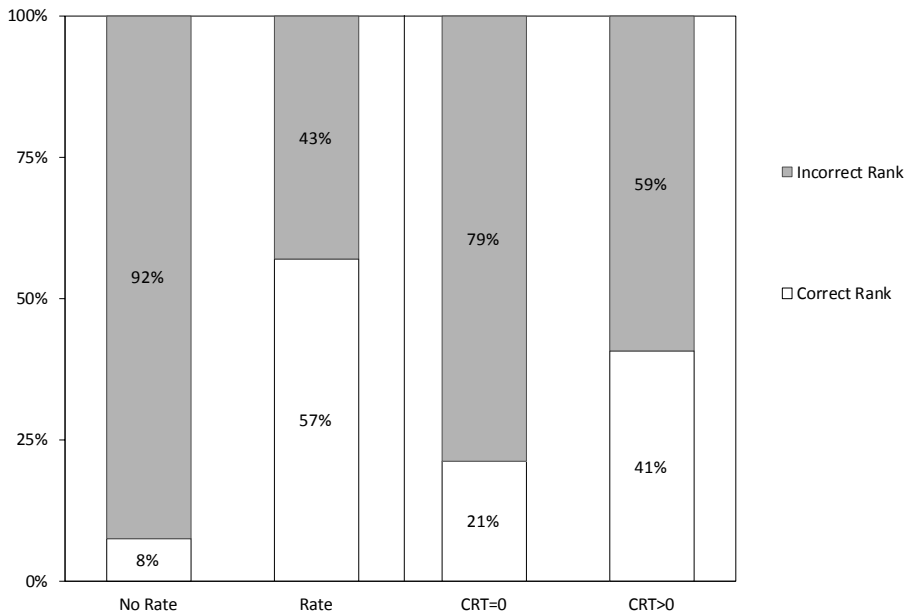

Figure 3: Study 2: rate information and cognitive ability improve the odds of correctly ranking four printers by order of speed, when their speed is described either in terms of percentage changes in benefits (e.g., "50% more pages per minute") or in cost (e.g., "35% less time to print each page") over a benchmark printer. Rate information was provided as pages per minute. CRT, cognitive reflection test.

statistically significant (p's > 0.10), including the interaction between CRT and rate information ($\beta = -0.33$, SE $= 0.31$, $p = 0.29$), indicating that providing rate information helped participants regardless of their cognitive ability. Thus, our results supported Hypothesis 5, that consumers with better numeric abilities are less prone to error.

Choice of fastest printer. For a more generalized analysis of accuracy, we examined which printer was identified as the fastest printer. The majority (66%) of participants incorrectly chose the printer with the best nominal percentage change (printer #1: described as "prints 50% more pages per minute"). Only 19% of the participants chose printer #2 (described as "takes 45% less time to print each page"), which was the fastest but whose speed was measured with a nominally lower percentage cost change. The rest chose one of the two dominated, inferior printers, thus providing additional support for our prediction in Hypothesis 1 that consumers misinterpret the nominal value of percentages. As in the ranking results, rate information significantly increased the proportion of participants choosing the correct printer (respectively, from 19% to 65%, $\chi^2\ (1, 395) = 83$, $p < 0.001$), consistent with Hypothesis 3.

Moreover, as per Hypothesis 5, numeracy reduced consumer error, which was 30% among participants with a zero CRT score vs. 51% among those with a nonzero score, $\chi^2(1, 395) = 17$, $p < 0.001$).

Discussion

Study 2 showed that a majority of people focused on nominal percentage information when assessing printer speed and therefore erroneously chose the option described in terms of percentage benefit change instead of the better option described in terms of percentage cost change, as per Hypothesis 1. Most importantly, as per Hypothesis 3, providing standard rate information (in this case, a benefit/cost rate) helped correct consumer errors, regardless of their numeracy. The availability of standard rate information (framed as pages/minute) led the majority of consumers to more accurately recognize the superiority of a percentage cost change over a percentage benefit change, though some participants disregarded the rate information. Study 2 also demonstrated once again that more numerate consumers, as measured by cognitive reflection ability, are generally more accurate (consistent with Hypothesis 5).

In the next study, we further test our hypotheses by looking at a task that ought to be easier for consumers, compared to the task they did in studies 1 and 2. In this study, participants are simply asked to choose between two nominally equivalent percentage changes (vs. rate individual percentage changes or rank four changes). We examine their choices in a context that is frequently encountered by consumers — a context where price is the cost and service quantity the benefit (specifically, we ask them to choose between differently priced internet access plans). In addition to testing Hypotheses 1, 2, 3, and 5, this study also allows a clean test of Hypothesis 4: specifically we can test whether standard rate information can work particularly well when framed in a way that makes the consequences of a percentage change more salient. We specifically manipulate the salience of standard rate information by manipulating the framing as cost/benefit vs. benefit/cost.

Study 3: Effects of Availability and Type of Rate Information when Evaluating Nominally-Equivalent Percentage Changes in Price vs. Duration of Internet Access Plans

In this study, we first ask consumers to evaluate the superiority of a percentage cost change relative to a percentage benefit change. We test Hypothesis 4 by measuring whether framing a standard rate as a cost/benefit versus a benefit/cost better enables consumers to detect the superiority of a percentage cost increase over a nominally equivalent percentage benefit decrease. To better understand the implications of rate framing, we examine

the interaction between outcome valence (gain vs. loss) and the type of standard rate provided (cost/benefit vs. benefit/cost). Specifically, we examine whether, in the gain domain, consumers will be better able to detect the superiority of percentage cost reductions (over benefit increases) when they are provided standard rate information in the benefit/cost frame than in the cost/benefit frame. Conversely, in the loss domain, we examine whether consumers will be better able to detect the superiority of percentage cost increases (over benefit decreases) when they are provided standard rate information in the cost/benefit frame than in the benefit/cost frame.

It is also important to note that in study 3, we use a scenario where the cost and benefit associated with a service (wireless internet access) have identical numerical values. Chen *et al.* (2012) suggest that errors occur because people neglect the differences in base values — i.e., price and quantity — associated with percentages. We suggest that neglecting rate information (comprised of a cost/benefit or benefit/cost ratio) matters more to consumers than neglecting the base value differences associated with a percentage. Consider, for example, the case of identical base values for the cost and benefit associated with a service. If "pay as you go" internet access costs 100 cents for 100 seconds, the base values associated with the cost and benefit are both 100. In this case, we expect that even consumers who consider base values will be incorrectly indifferent between a given percentage cost change (e.g., "50% price off for the same time online") and the opposite percentage benefit change ("50% more time online for the same price"). This would occur due to a failure to notice that these promotions lead to different benefit/cost rates: 200 minutes per 100 cents for the cost change (50% less cost) vs. 150 minutes per 100 cents for the benefit change (50% more benefit). The same promotions can be framed as a cost/benefit rate as well: 50 cents/100 seconds (50% less cost) versus 67 cents/100 seconds (50% more benefit). Finally, we again measure CRT, to examine how numeracy moderates our effects as per Hypothesis 5.

Method

We used a 2 (outcome valence: loss vs. gain) by 3 (standard rate availability: none vs. cost/benefit vs. benefit/cost) between-subjects design. We asked 606 American adults recruited via an online panel to evaluate wireless internet service providers (we excluded one participant who did not answer all the questions). We told participants to imagine that they had used an airport's wireless internet provider while waiting for a plane delay and asked them to choose between two "pay as you go" wireless providers or to indicate that the offers were equivalent. Table 4 provides the full stimuli descriptions. Those who chose one of the two providers were then asked to rate the difference between the two offers on a 5 point scale ranging from 'no difference' to a

'very big difference.' We used participant ratings of the cost or benefit offer to create a continuous scale from −4 to 4. Those who stated that the offers were equivalent were coded as a zero. Those who stated that the percentage benefit change was better had negative values (up to −4). Those who stated that the percentage cost change was better had positive values (up to +4). Thus, positive values were more accurate than negative values. This rendering of the evaluation data allowed us to subsequently test how the availability and type of standard rate information influenced whether participants detected the superiority of the percentage cost change.

Our standard rates were framed as either cents/100 seconds or seconds/100 cents. In the loss condition, as per Figure 1, the superiority of the 50% percentage cost change is more salient when the standard rate is framed as a cost/benefit rate (150 cents/100 seconds vs. 200 cents/100 seconds) versus a benefit/cost rate (50 seconds online/100 cents vs. 67 seconds online/100 cents). Choosing a 50% benefit decrease over the 50% cost increase magnifies the loss in terms of cost/benefit by a factor of 2. As shown in Table 5, the opposite is true in the gain condition. Participants finally completed the cognitive reflection test.

Table 5: Study 3: Stimuli description.

Rate condition	Wireless internet provider	Loss condition	Gain condition
Control (no rate information)	Initial provider	Spent $6.00 in 10 minutes with the initial provider's introductory rate.	Spent $6.00 in 10 minutes with the initial provider.
	Provider *Y* (percentage benefit change)	Costs 50% more for the same time online compared to the initial provider.	Costs 50% less for the same time online compared to the initial provider.
	Provider *X* (percentage cost change)	Offers 50% less time online for the same price compared to the initial provider.	Offers 50% more time online for the same price compared to the initial provider.
Cost/benefit rate information	Initial provider	Spent $6.00 in 10 minutes with the initial provider's introductory rate of 100 cents/100 seconds online.	Spent $6.00 in 10 minutes with the initial provider (rate of 100 cents/100 seconds online).

(*Continued*)

Table 5: (*Continued*)

Rate condition	Wireless internet provider	Loss condition	Gain condition
	Provider *Y* (percentage benefit change)	Costs 50% more for the same time online compared to the initial provider (rate of 150 cents/100 seconds online).	Costs 50% less for the same time online compared to the initial provider (rate of 50 cents/100 seconds online).
	Provider *X* (percentage cost change)	Offers 50% less time online for the same price compared to the initial provider (rate of 200 cents/100 seconds online).	Offers 50% more time online for the same price compared to the initial provider (rate of 67 cents/100 seconds online).
Benefit/cost rate information	Initial provider	Spent \$6.00 in 10 minutes with the initial provider's introductory rate of 100 seconds online/100 cents.	Spent \$6.00 in 10 minutes with the initial provider (rate of 100 seconds online/100 cents).
	Provider *Y* (percentage benefit change)	Costs 50% more for the same time online compared to the initial provider (rate of 67 seconds online/100 cents).	Costs 50% less for the same time online compared to the initial provider (rate of 200 seconds online/100 cents).
	Provider *X* (percentage cost change)	Offers 50% less time online for the same price compared to the initial provider (rate of 50 seconds online/100 cents).	Offers 50% more time online for the same price compared to the initial provider (rate of 150 seconds online/100 cents).

Results

The evaluation data were regressed on rate condition, outcome valence, CRT, and all interactions. To test Hypotheses 3 and 4, and examine the effects of the three-level rate intervention (no rate, benefit/cost rate, cost/benefit rate), we created two binary variables via Helmert coding and conducted a regression of the evaluation data on these two binary variables, outcome valence, CRT, and all interactions. This allowed us to estimate the effects

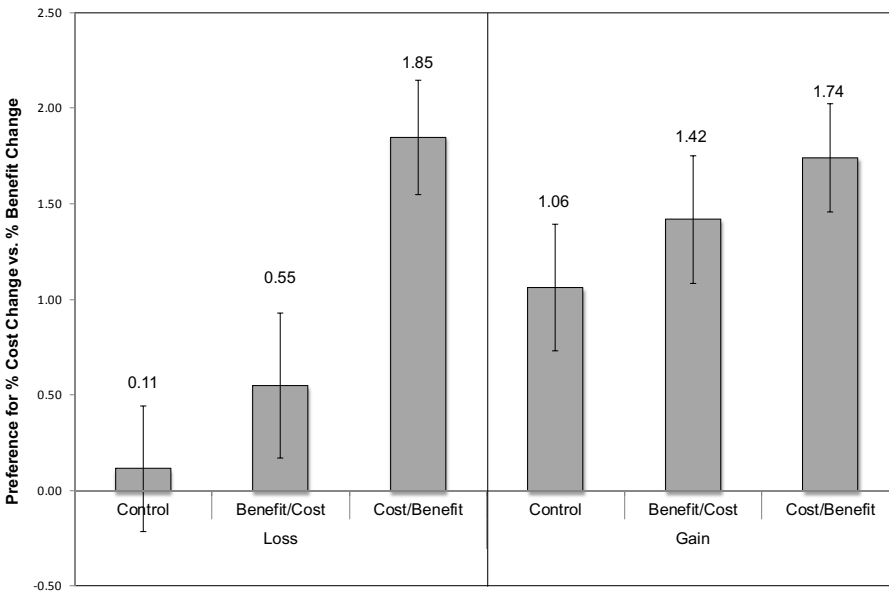

Figure 4: Study 3: rate information most improves the evaluation of the most cost-efficient "percentage cost" offer, especially in the loss condition. Cost/benefit rate information is more effective than benefit/cost information in the loss than in the gain condition. More positive values on the Y-axis indicate a positive evaluation of a cost change of 50% as opposed to the opposite benefit change of 50%.

of providing any standard rate information (vs. no rate) and the difference between the two rate types.

As shown in Figure 4, rate information significantly increased the evaluation of percentage cost change superiority ($\beta = 0.80$, SE $= 0.14$, $p < 0.001$), consistent with Hypothesis 3. Moreover, as per Hypothesis 4, we found the expected interaction between outcome valence and ratio type ($\beta = 0.97$, SE $= 0.34$, $p < 0.01$), indicating that the cost/benefit rate was more effective than the benefit/cost rate in the loss condition than in the gain condition. Finally, the main effect of CRT was statistically significant ($\beta = 0.13$, SE $= 0.06$, $p = 0.02$); people with a higher CRT evaluated the percentage cost change more positively than the percentage benefit change option, consistent with Hypothesis 5. None of the other 2-way or 3-way interactions (between ratio, outcome valence and CRT) were significant ($p > 0.20$). There were also several additional effects that are tangential to our hypotheses.[1]

[1]As shown in Figure 4, participants were more correct in the gain condition, rating the impact of the price-decrease more highly than the time-increase. Thus, the main effect of outcome valence ($\beta = 0.54$, SE $= 0.14$, $p < 0.001$) was statistically significant, and providing rate information was more impactful for the loss condition than the gain condition ($\beta = 0.57$,

Discussion

Study 3 demonstrates the robustness of the effects of standard rate information availability and cognitive ability, even for the simpler task of comparing two nominally equivalent percentages when the base rates (100 cents or 100 seconds) are identical, providing support for Hypotheses 3 and 5. The study also provides support for Hypothesis 4, and demonstrates that standard rates framed using a cost/benefit format can be particularly effective in the loss domain, when people erroneously prefer a quantity decrease to the more efficient, but more aversive, monetary cost increase. Thus, we find partial support for Hypothesis 4: the framing of a standard rate as a cost/benefit versus a benefit/cost better enable consumers to detect the superiority of a percentage cost increase over a nominally equivalent percentage benefit decrease.

However, we do not show the opposite in the gain domain, that consumers will be better able to detect the superiority of percentage cost reductions (over benefit increases) when they are provided standard rate information in the benefit/cost frame than in the cost/benefit frame. Participants appeared to have a general inclination for choosing decreases in price over increases in time, and a preference for highlighting money over time in the numerator. Research has shown that people are more sensitive for changes in money than for changes in time (Chandran and Morwitz, 2006; Leclerc *et al.*, 1995; Okada and Hoch, 2004; Prelec and Loewenstein, 1998; Shampanier *et al.*, 2007). This suggests that percentage changes in time and money may not be psychologically identical, even if the results are economically equivalent. Since this does not replicate the results of study 2 and those of Chen *et al.* (2012), who found no effect of outcome valence on the assessment of percentage changes, these effects can be more carefully examined in future research.

In our next study, we test whether a standard rate can help work and wage decisions in an incentive-compatible field experiment.

Study 4: Effects of Cost vs. Benefit Framing, Rate Information Availability, and Cognitive Reflection on Work Choices (Field Experiment)

In this study, we examine both the propensity to make errors as well as the effectiveness of standard rate information in an incentive-compatible context. We shift our focus to a new real world context: the framing of bonuses and incentives. We ask Mechanical Turk workers to complete a job (a word search

SE = 0.29, $p < 0.05$). Moreover, evaluations were more correct when price was in the numerator of the standard rate ($\beta = -0.78$, SE = 0.17, $p < 0.001$). As we suggest in the Discussion section, these results were possibly driven by the specific cost and benefit (time vs. money) that we used in this study.

puzzle). They are subsequently paid a wage for every task completed (every word found). We then give them the opportunity to complete a second job, and choose between two nominally equivalent 'bonus structures': a 50% "benefit" change (more pay per word found), or a 50% "cost" change (finding fewer words for the same pay), thereby testing Hypothesis 1. Finally, we examine how providing a standard rate (wage/task) and individual differences in numeracy moderate our findings, thereby testing Hypotheses 3 and 5.

Method

We hired 150 workers from Mechanical Turk and paid them 6 cents for each word with at least three letters that they could find in less than one minute in an 8 by 8 letter word search puzzle. After completing the first puzzle, we gave them the option to earn more money by solving an additional word search puzzle. If they decided to continue, they had to choose between two payment options, one framed as a benefit increase and the other as a cost decrease.

Participants were then randomly assigned to one of two conditions (rate information: present vs. absent). In the rate information present condition, the benefit increase option was described as "you will make 50% more money per correct word that you find (this means that you will be paid 9 cents per word)" and the cost decrease option was described as "you will need to find 50% fewer correct words to make as much money as you earned in the first task (this means that you will be paid 12 cents per word)." Note that, in this study, cents per word is a benefit/cost rate. The information in parentheses was omitted in the rate information absent condition. In both conditions, the instructions stated "as in the first word search game, your goal will be to find as many words as possible in 1 minute," thus indicating that consumers would be paid for every word found. This wording was included to ensure that those who chose to find 50% fewer correct words to make as much money did not curtail their effort. Thus, participants were able to choose both their workload and wage. Participants finally completed the cognitive reflection test (Frederick, 2005).

Results

We excluded two participants because of duplicate IP addresses. In the first puzzle, participants found on average 4 words and were paid \$0.24. Of the 148 participants who chose to do the bonus puzzle, only 7% chose the more advantageous percentage cost decrease payment scheme (fewer words) when rate information was absent vs. 49% when rate information was present ($\chi^2(1,144) = 31.2$, $p < 0.001$). Thus, as per Hypothesis 1, participants did not detect the superiority of a percentage cost change over the nominally equivalent percentage benefit change. However, as per Hypothesis 3, participants were

more likely to detect the superiority of percentage cost changes over percentage benefit changes when each percentage change was accompanied by a standard rate.

Participants worked equally hard on the bonus puzzle regardless of their payment scheme choice ($M_{\text{Benefit}} = 6.17$, SE $= 0.19$ vs. $M_{\text{Cost}} = 5.73$, SE $= 0.37$, $t(254) = 1.6$, $p = 0.11$). Thus, participants did not work harder on the second puzzle as a function of choosing the superior cost change payment scheme. This also indicates that those who chose the inferior percentage benefit change did not curtail their effort as a result of question wording. As a result, participants who chose the percentage cost change offer earned a bonus of \$0.69 each, a 23% premium for doing the same amount of work over those who chose the percentage benefit change. Because there were no differences in the total number of words that were found across the two conditions, this higher wage was entirely driven by the choice of the correct payment scheme.

Finally, the proportion of participants choosing the more advantageous cost payment scheme rose from 23% among participants who missed all three CRT questions to 39% for those who answered all three questions correctly ($\chi^2(3, 144) = 6.9$, $p = 0.07$), providing further evidence for Hypothesis 5.

Discussion

Overall, study 4 replicated our findings in an incentive-compatible field experiment involving work choices, providing additional support for Hypotheses 1, 3 and 5. In the absence of a standard rate, most participants chose the percentage benefit change over the superior percentage cost change. Providing standard rate information led to significantly more participants choosing the percentage change in cost (words) versus benefit (wage). Participants worked equally hard, regardless of the bonus payment scheme chosen. Some participants might have had a hard time understanding the cost payment scheme. Working 50% less for the same amount of money is not a typical way of offering bonus payments, and the description could have come across as disfluent. Thus, particular framings may be more natural to certain contexts, and this could skew preferences. In our field study, we also had a marginally significant effect of cognitive reflection, providing further evidence to support Hypothesis 5. Participants with higher cognitive reflective abilities were more likely to choose the percentage cost change over the percentage benefit change.

General Discussion

Findings from three laboratory studies and one incentive-compatible field experiment show that most consumers cannot correctly evaluate marketing offers communicated as a percentage change in cost or in benefit because they

assume that the nominal value of percentages represents their true impact on value. This result replicates across a variety of tasks and domains. We show that providing standard rates can help correct these errors and lead the majority of consumers from making the wrong choice to making the correct one. This occurs because consumers fail to consider the impact of percentages in terms of cost/benefit (or benefit/cost).

Implications for Consumers

We find that rate information helps all groups of consumers equally but that some, particularly those with low cognitive ability, persist in choosing the wrong percentage benefit option even after being provided with a rate. For instance, even after providing rate information to participants in study 4, 51% of the online workers still did not choose the superior cost change over the benefit change. Similarly, even after providing standard rate information in study 2, 43% of consumers still did not rank printers correctly. Future work could more systematically explore how different types of costs versus benefits affect how consumers assess percentages.

Moreover, future research could examine whether less numerate people with a low CRT score disregard rate information or if they are just unable to process even simple ratios (Viswanathan *et al.*, 2005). In most retail contexts, rate information resulting from a percentage promotion is not calculated out for consumers. At the moment, unit prices are not mandatory for retail distribution in the majority of US states, and are never mandatory when accompanying percentage promotions or for consumers shopping online (U.S. Department of Commerce, 2013). Thus, in the absence of a unit ratio provided by a retailer, consumers would need to calculate the resulting rate from a promotion themselves. Thus, future research could examine whether other aids — such as the provision of a calculator — would help consumers derive rates and assess percentages more accurately.

We also show in study 3 that price/minute rate information is relatively more effective than minute/price information to help consumers make correct decisions in the loss domain. Future research is necessary to determine whether this result would hold for benefits and costs other than time and money.

Implications for Marketers

Unlike a consumer, a marketer would likely seek to maximize the cost/benefit ratio resulting from a sale (or conversely, minimize the benefit/cost given to the consumer). Thus, from the marketer's perspective, cost or benefit changes should always be framed as a percentage change in benefit as opposed to a percentage change in cost. Marketers should frame their offers as a percentage benefit change, which produces the largest nominal percentage, rather than

by the equivalent percentage cost change. From a profit-focused perspective, marketers would be better off framing a promotion as a 40% bonus pack as opposed to a 40% price discount, because they will receive a higher price per unit sold.

While potentially beneficial to businesses, framing offers as a percentage benefit change rather than a percentage cost change could lead consumers to sub-optimal choices, where they might be unknowingly paying more for a unit of a good than expected. Future work could further explore the tension between the marketer and consumer perspectives, and how each party could benefit from greater transparency around percentage promotions.

Our results suggest that if a firm intends to be truly transparent, marketing offers promoting a percentage change in cost or benefit should focus on how the underlying rate changes, taking into account any local conventions. This means, for example, that percent increases in fuel efficiency should be described as increases in MPG in the United States and as decreases in GPM (or, rather, liters per 100 kilometers) in other parts of the world.

However, there might be scenarios where both marketers and consumers would benefit from the actual percentage change in cost or benefit being highlighted. Consider, for example, a new technology, which leads to a 33% improvement in terms of liters per 100 km. Our results show that it would be more effective to frame this improvement as "50% more km driven per liter" than "33% fewer liters needed per 100 km." Thus, building on prior work by Larrick and Soll (2008), our results suggest that for countries around the world that rate fuel efficiency in liters per 100 km driven (the vast majority), fuel efficiency improvements should be framed as a percent benefit increase rather than the nominally lower percent cost decrease.

In certain retail shopping contexts, government intervention might help further mandate and standardize how percentage and rate information is presented to consumers, since these laws vary by state and channel (U.S. Department of Commerce, 2013). Although less frequent than promotional offers, marketing communication can also convey percentage losses to the consumer, such as cost increases or benefit decreases. In Brazil, for example, consumer protection laws mandate that percentage reductions in product quantity due to downsizing be displayed on the front of packages (Neves and Itacarambi, 2008). However, our research suggests that a percentage reduction of a package might be difficult to interpret without an accompanying unit price ratio. Thus, our findings have important implications for public policy. They affirm the effectiveness of providing unit price information in conjunction with percentage promotions, and support the case that rate information should be made mandatory across different retail domains.

Of course, the tension between the perspective of the consumer and the perspective of the marketer would only exist if marketers know that the highest

nominal framing is best for them, but do they? In a short follow-up study, we distributed a questionnaire to 75 MBA students at a top business school (average GMAT score = 703). All participants were asked to assess a question from the marketer perspective: "Marketing offers often feature a percentage. Percentage offers can be framed as a benefit change ('X% more product', 'X% more miles per gallon') or as a cost change ('X% lower price', 'X% fewer gallons per mile'). These offers can both be gains for the consumer; for example, 20% more products vs. 20% less price. They can also both be losses for the consumer; for example, 40% fewer miles per gallon vs. 40% more gallons per mile. Imagine marketers are seeking to maximize their unit margin. From the marketer's perspective, which of these sentences is true?

Participants were given two minutes to answer the question and the order of the five choices was randomized.

(1) An 'X% cost change' is always better than a '–X% benefit change'.

(2) An 'X% benefit change' is always better than a '–X% cost change'.

(3) An 'X% cost change' is as valuable as a '–X% benefit change'.

(4) The best offer depends on whether we are dealing with gains or losses to the consumer.

(5) There is no general solution. You have to do the math depending on the value of X.

We found that only 34% of participants chose the correct response (2). However, this proportion was only marginally statistically superior from the chance level ($M = 20\%$, $z = -1.8$, $p = 0.08$). Thus, even highly trained MBA students could not identify the normative solution from the marketer's perspective. This suggests that many marketers may not even recognize consumers' misperceptions of percentage offers.

References

Chandran, Sucharita and Vicki G. Morwitz (2006), "The Price of "Free"-dom: Consumer Sensitivity to Promotions with Negative Contextual Influences," *Journal of Consumer Research*, 33(3), 384–392.

Chen, Haipeng (Allan), Howard Marmorstein, Michael Tsiros, and Akshay R. Rao (2012), "When More Is Less: The Impact of Base Value Neglect on Consumer Preferences for Bonus Packs over Price Discounts," *Journal of Marketing*, 76(4), 64–77.

Dickert, Stephan, Janet Kleber, Ellen Peter, and Paul Slovic (2011), "Numeracy as a Precursor to Pro-social Behavior: The Impact of Numeracy and Presentation Format on the Cognitive Mechanisms Underlying Donation Decisions," *Judgment and Decision Making*, 6(7), 638–650.

Fagerlin, Angela, Brian J. Zikmund-Fisher, Peter A. Ubel, Aleksandra Jankovic, Holly A. Derry, and Dylan M. Smith (2007), "Measuring Numeracy without a Math Test: Development of the Subjective Numeracy Scale," *Medical Decision Making*, 27(5), 672–680.

Frederick, Shane (2005), "Cognitive Reflection and Decision Making," *Journal of Economic Perspectives*, 19(4), 25–42.

Hardesty, David M. and William O. Bearden (2003), "Consumer Evaluations of Different Promotion Types and Price Presentations: The Moderating Role of Promotional Benefit Level," *Journal of Retailing*, 79(1), 17–25.

Heath, Timothy B., Subimal Chatterjee, and Karen Russo France (1995), "Mental Accounting and Changes in Price: The Frame Dependence of Reference Dependence," *Journal of Consumer Research*, 90–97.

Kelley, Colleen M. (2009), "Cognitive Abilities and Superior Decision Making Under Risk: A Protocol Analysis and Process Model Evaluation Edward T. Cokely Max Planck Institute for Human Development Center for Adaptive Behavior and Cognition," *Judgment and Decision Making*, 4(1), 20–33.

Larrick, Richard P. and Jack B. Soll (2008), "Economics — The MPG Illusion," *Science*, 320(5883), 1593–1594.

Leclerc, France, Bernd H. Schmitt, and Laurette Dubé (1995), "Waiting Time and Decision Making: Is Time like Money?" *Journal of Consumer Research*, 22(1), 110–119.

Lipkus, Isaac M., Greg Samsa, and Barbara K. Rimer (2001), "General Performance on a Numeracy Scale Among Highly Educated Samples," *Medical Decision Making*, 21(1), 37–44.

Manning, Kenneth C., David E. Sprott, and Anthony D. Miyazaki (2003), "Unit Price Usage Knowledge: Conceptualization and Empirical Assessment," *Journal of Business Research*, 56(5), 367–377.

Mishra, Arul and Himanshu Mishra (2011), "The Influence of Price Discount Versus Bonus Pack on the Preference for Virtue and Vice Foods," *Journal of Marketing Research*, 48(1), 196–206.

Miyazaki, Arul, David F. Sprott, and Kenneth C. Manning (2000), "Unit Prices on Retail Shelf Labels: An Assessment of Information Prominence," *Journal of Retailing*, 76(1), 93–102.

Neves, Felipe and Francisco Itacarambi (2008), "Não vale o quanto pesa," *Revista Procon*, 9(March–April), 16–21.

Okada, Erica Mina and Stephen J. Hoch (2004), "Spending Time versus Spending Money," *Journal of Consumer Research*, 31(2), 313–323.

Pandelaere, Mario, Barbara Briers, and Christophe Lembregts (2011), "How to Make a 29% Increase Look Bigger: The Unit Effect in Option Comparisons," *Journal of Consumer Research*, 38(2), 308–322.

Peters, Ellen, Daniel Västfjäll, Paul Slovic, C. K. Mertz, Ketti Mazzocco, and Stephan Dickert (2006), "Numeracy and Decision Making," *Psychological Science*, 17(5), 407–413.

Prelec, Drazen and George Loewenstein (1998), "The Red and the Black: Mental Accounting of Savings and Debt," *Marketing Science*, 17(1), 4–28.

Raghubir, Priya and Joydeep Srivastava (2002), "Effect of Face Value on Product Valuation in Foreign Currencies," *Journal of Consumer Research*, 29(3), 335–347.

Russo, J. Edward (1977), "The Value of Unit Price Information," *Journal of Marketing Research*, 14(2), 193–201.

Shafir, Eldar, Peter Diamond, and Amos Tversky (1997), "Money Illusion," *The Quarterly Journal of Economics*, 341–374.

Shampanier, Kristina, Nina Mazar, and Dan Ariely (2007), "Zero as a Special Price: The True Value of Free Products," *Marketing Science*, 26(6), 742–757.

Sophian, Catherine (2000), "Perceptions of Proportionality in Young Children: Matching Spatial Ratios," *Cognition*, 75(2), 145–170.

U.S. Department of Commerce (2013), "National Institute of Standards and Technology Handbook 130," http://www.nist.gov/pml/wmd/pubs/hb130-13.cfm.

Viswanathan, Madhubalan, José Antonio Rosa, and James Edwin Harris (2005), "Decision Making and Coping of Functionally Illiterate Consumers and Some Implications for Marketing Management," *Journal of Marketing*, 69(January), 15–31.

Weller, Joshua A., Nathan F. Dieckmann, Martin Tusler, C. K. Mertz, William J. Burns, and Ellen Peters (2012), "Development and Testing of an Abbreviated Numeracy Scale: A Rasch Analysis Approach," *Journal of Behavioral Decision Making*.

Wertenbroch, Klaus, Dilip Soman, and Amitava Chattopadhyay (2007), "On the Perceived Value of Money: The Reference Dependence of Currency Numerosity Effects," *Journal of Consumer Research*, 34(1), 1–10.