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Remanufacturing, Third-Party Competition, and Consumers' Perceived Value of New Products

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In this paper, we investigate whether and how the presence of remanufactured products and the identity of the remanufacturer influence the perceived value of new products through a series of behavioral experiments. Our results demonstrate that the presence of products remanufactured and sold by the original equipment manufacturer (OEM) can reduce the perceived value of new products by up to 8%. However, the presence of third-party-remanufactured products can increase the perceived value of new products by up to 7%. These results suggest that deterring third-party competition via preemptive remanufacturing may reduce profits, whereas the presence of third-party competition may actually be beneficial for an OEM.

Keywords: remanufacturing; closed-loop supply chains; behavioral operations; competition
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1. Introduction

The residual value inherent in used products can make remanufacturing[1] a profitable activity for original equipment manufacturers (OEMs). The average profit margins from remanufacturing can exceed 20% (see Guide and Van Wassenhove 2001), which potentially explains the fact that production of remanufactured goods in the United States was at least $43 billion in 2011 (U.S. International Trade Commission 2012). However, despite these economic benefits, an OEM's decision to pursue remanufacturing is not a simple one because remanufactured products may cannibalize the demand for the OEM's new products. In fear of such cannibalization, many OEMs choose not to sell remanufactured products (e.g., Cisco; see Cheng 2009). At the same time, there may be third-parties that remanufacture products originally sold by the OEM. For example, Hewlett-Packard Company (HP) does not remanufacture printer cartridges and faces competition from third-parties who sell remanufactured HP printer cartridges (Hewlett-Packard 2014). Existing research in the closed-loop supply chain literature (see Atasu et al. 2008a, Guide and Van Wassenhove 2009, and Souza 2013 for recent overviews) has shown that such competition from third-party remanufacturers is detrimental for OEMs and that they may be better off remanufacturing or collecting cores to preempt third parties (Debo et al. 2005, Ferguson and Toktay 2006, Atasu et al. 2008b). However, it is implicitly assumed that the presence of remanufactured products does not influence the perceived value of an OEM's new products.

In this paper, we hypothesize that the presence of remanufactured products may influence the perceived value of new products. We propose that this may happen because a remanufactured product acts as a contextual reference point, shifting the consumer valuation of new products upward (contrast effect) or downward (assimilation effect) depending on the perceived similarity between new and remanufactured products (see Sherif et al. 1958; McKenna 1984; Mussweiler 2003, 2007). The presence of remanufactured products may also trigger quality concerns or act as a quality cue for the new product and, consequently, influence the perceived value of new products. In addition, we expect the magnitude and directionality of the shift in the perceived value of the new product to differ based on the identity of the remanufacturer,

[1] Remanufacturing is the process of repairing, replacing, or processing components of a used product to bring it to like-new condition.

that is whether it is an OEM versus a third-party remanufacturer.

To test these hypotheses, we employ a series of behavioral experiments. We use two different categories of consumer products, namely, MP3 players and consumer printers, whose remanufactured versions are commonly available in the market. Consistent with our hypotheses, the experimental results suggest the following.

1. The presence of remanufactured products influences the perceived value of new products. This effect is different based on whether products are remanufactured by an OEM or a third-party remanufacturer.

2. The presence of OEM-remanufactured products may have a negative effect on the perceived value of new products.

3. In contrast, the presence of third-party-remanufactured products has a positive effect on the perceived value of new products.

These experimental results have important implications for OEMs' remanufacturing and competitive strategies. While formulating these strategies, it is not sufficient to consider only the cannibalization of new product sales by remanufactured products. It is also important that the effect of remanufactured products on the perceived value of the new product is taken into account. In particular, remanufacturing may be detrimental for an OEM due to its negative effect on the perceived value of new products. However, the presence of third-party competition may be beneficial for an OEM even though third-party-remanufactured products may cannibalize the demand for new products.

The rest of this paper is structured as follows. In §2, we discuss the relevant literature and develop our hypotheses. Section 3 describes the experimental design and procedure for testing our hypotheses and discusses the results. In §4, we discuss the implications of our experimental results for an OEM's remanufacturing strategy and conclude by summarizing our insights and discussing the directions for future research.

2. Related Literature and Hypotheses Development

This paper contributes to the streams of literature in operations management that analyze an OEM's remanufacturing strategies (Debo et al. 2005, Ferguson and Toktay 2006, Ferrer and Swaminathan 2006, Atasu et al. 2008b, Agrawal et al. 2009) and empirically investigate the drivers of consumer valuations of remanufactured products (Guide and Li 2010, Ovchinnikov 2011, Subramanian and Subramanyam 2012). Both of these streams implicitly assume that the presence of remanufactured products has no effect on the perceived value of the new product. In this paper, we analyze whether and how the presence of remanufactured products influences the perceived value of the new product.

A stream of literature in marketing has discussed how the introduction of a downward vertical product-line extension may influence consumer valuations of existing products (Randall et al. 1998, Kim et al. 2001). It could be argued that a remanufactured product resembles a downward vertical product-line extension because it is perceived to be of lower value. However, a remanufactured product differs from a low-end extension in two key dimensions: First, although low-end extensions may have lower functionality and different components, product architecture, and configurations than high-end products, remanufactured products are identical to new products with respect to these aspects. Second, although a low-end extension is typically sold by the same firm as the original product, a remanufactured product can be sold by an OEM or an independent third-party remanufacturer. Therefore, an examination of the effect of remanufactured products on the perceived value of new products needs to take these characteristics into account and distinguish between OEM-remanufactured and third-party-remanufactured products. This is the main research question we address in this paper.

We next develop our hypotheses by proposing that two complementary mechanisms influence how the presence of remanufactured products affects the perceived value of new products. First, a remanufactured product may act as a contextual reference point. The introduction of such a reference point can change the valuation of an existing option because of well-established contrast and assimilation effects (see Sherif et al. 1958, McKenna 1984, Mussweiler 2003). An assimilation effect is a shift in the valuation of the existing option toward the contextual reference point, whereas a contrast effect is a shift away from the reference point. Therefore, if the remanufactured product acts as a contextual reference point, the perceived value of the new product can shift downward toward that of the remanufactured product (assimilation effect) or upward away from it (contrast effect). The directionality of this shift depends on the overall similarity of remanufactured and new products, which is the extent to which they are considered to be objectively and subjectively identical (see Mussweiler 2007). Second, it is well established that consumers often rely on cues or signals (Nelson 1970, Kirmani and Rao 2000) such as product variety (Berger et al. 2007), market share (Hellofs and Jacobson 1999), seller reputation (Purohit and Srivastava 2001), or resale value (Pierce 2012), when evaluating the quality of a product. Similarly, the presence of remanufactured products may be perceived as a signal regarding the

quality of the new product. The directionality of these two effects may depend on who offers the remanufactured product, as we elaborate in detail below.

First, consider a situation where an OEM remanufactures its own products. In this case, we expect that the OEM-remanufactured product will be perceived to be similar to the new product. There are three reasons for this. First, new and remanufactured products have the same functionality and product architecture. Second, consumers will perceive them to be similar because the OEM is well equipped with qualified processes, knowledge, and technologies to ensure that the remanufactured products conform to the defined specifications of the new products (see Subramanian and Subramanyam 2012). Third, the mere fact that the same firm (i.e., the OEM) offers both new and remanufactured products will increase their perceived similarity. Because OEM-remanufactured and new products are perceived to be similar, an assimilation effect will take place, shifting the perceived value of the new product downward, toward that of the OEM-remanufactured product. In addition, the presence of OEM-remanufactured products may trigger quality concerns for the new product; e.g., consumers may believe that the OEM is receiving failure or warranty returns, providing it with a supply of cores that can be remanufactured and sold. Therefore, the presence of these products may act as a negative quality signal for the new product. Consequently, both the assimilation effect and the possible negative quality signal suggest that the presence of OEM-remanufactured products will lead to a decrease in the perceived value of new products, which forms the basis for our first hypothesis. Throughout this paper, we use consumer willingness to pay (WTP) as a measure for the perceived value of the new product.

Hypothesis 1. *The presence of OEM-remanufactured products has a negative effect on the WTP for the new product*.

Next, consider a situation where third parties collect and remanufacture products originally sold by the OEM. We expect the effect of third-party-remanufactured products on the perceived value of the new product to be different from that of OEM-remanufactured products. In particular, we propose that the effect of a third-party-remanufactured product as a contextual reference point for the new product will be different than the effect of an OEM-remanufactured product. This is because consumers may perceive a weak association between new and third-party-remanufactured products (see the literature on horizontal extensions for a similar argument, e.g., Loken and John 1993, John et al. 1998). Consumers may consider a third-party remanufacturer as lacking the expertise of the OEM in ensuring that remanufactured products conform to defined specifications and functionality of new products offered by the OEM. This suggests that the perceived similarity between new and third-party-remanufactured products will be lower than that between new and OEM-remanufactured products. The magnitude of this difference in similarity, however, is critical in determining the directionality of the contextual reference-point effect of the third-party-remanufactured product. If the difference is small, the presence of the third-party-remanufactured product will lead to a weaker assimilation effect (relative to the OEM-remanufactured product), reducing the perceived value of new products. On the other hand, if the difference is large enough that the new and third-party-remanufactured products are perceived to be relatively dissimilar, the presence of the third-party-remanufactured product will lead to a contrast effect. This would result in an upward shift in the perceived value of the new product, away from that of the third-party-remanufactured product.

We expect a similar difference between the quality signals for the new product from third-party versus OEM remanufacturing. Although third-party-remanufactured products may also trigger quality concerns, we expect consumers to be less likely to attribute their presence to defects or quality concerns with new products, because they are offered by an independent third party. On the contrary, their presence may even serve as a positive quality signal for the new product. Similar to the assumptions in the durable goods literature, the presence of a market for remanufactured products may lead to a higher valuation for the new product (Desai and Purohit 1998, Waldman 2003, Pierce 2012). Consumers may also interpret the presence of independent third parties establishing a business based on remanufactured versions of the OEM's new products to imply that the new product is of high quality, increasing their perceived value. In sum, the presence of third-party-remanufactured products may result in a weaker negative or a positive quality signal for the new product.

Based on the above discussion, we expect that the presence of third-party-remanufactured products will have a different effect on perceived value of the new product than the presence of OEM-remanufactured products. The effect of third-party-remanufactured products may be in the form of a shift in directionality (an increase in perceived value) or magnitude (a smaller reduction in perceived value). Both of these imply that the perceived value of the new product will be higher in the presence of third-party-remanufactured products than in the presence of OEM-remanufactured products. We formally state this

as Hypothesis 2A below. In Hypothesis 2B, following the expectation from the contextual reference-point mechanism, we hypothesize that the effect of third-party-remanufactured products is in the form of a shift in directionality; i.e., the presence of third-party-remanufactured products will lead to an increase in the perceived value of the new product.

Hypothesis 2A. *The WTP for the new product will be higher in the presence of third-party-remanufactured products than in the presence of OEM-remanufactured products.*

Hypothesis 2B. *The presence of third-party-remanufactured products has a positive effect on the WTP for the new product.*

3. Experiments

We begin by discussing our first experiment, which utilizes Apple MP3 players as the product stimulus, in §3.1. Section 3.2 provides three additional experiments that test our hypotheses for Sansa MP3 players to examine potential brand effects, for HP printers to investigate possible product-category effects, and with additional conditions that include a non-remanufactured inferior product to examine whether our main results are specific to remanufacturing.

3.1. Experiment 1

3.1.1. Design and Procedure. *Participants and Stimuli.* The experiment was conducted by using the Mechanical Turk online panel offered by Amazon.[2] The experiment was restricted to participants based in the United States and each participant was paid \$1.[3] Responses were obtained from 777 participants, with an average age of 31.01 years, 45.6% of whom were female. We used MP3 players, namely, Apple iPod Nanos, as the product stimulus in this experiment (see Ding 2007 for a similar product stimulus).

Experimental Procedure. In our experiment, each participant took part in two tasks. They first performed a choice task, which allowed us to estimate their WTP the new product. Subsequently, they performed a follow-up task, where we obtained different measures regarding the perceived similarity between new and remanufactured products and beliefs regarding the quality signal from remanufacturing. Before beginning the choice task, participants were provided instructions for the experiment, including those about the choice task and the prize package that they could potentially win (explained in more detail later). A sample of these instructions is provided in §A.1 of the appendix.

We used a 2×2 between-subjects design, where each participant was randomly assigned to one of four conditions. In all four conditions, new products sold by Apple were present. There were no remanufactured products present in the Control condition, only OEM-remanufactured products were present in the Onlyoem condition, only third-party-remanufactured products were present in the Only3p condition, and both were present in the Both condition. Since Apple uses the term "refurbished" instead of remanufactured, we used "refurbished'' in our experimental instructions. In each condition (except Control), participants were provided with the following description of refurbishing: "Refurbished products are returned items that are fully tested and inspected by highly trained technicians and restored to original factory specifications." Participants in the Onlyoem condition were also informed that only Apple refurbished and sold iPod Nanos. Those in the Only3p condition were informed that only a third party, Blue Bay Electronics, refurbished and sold iPod Nanos. Finally, those in the Both condition were informed that both the OEM and the third party refurbished and sold iPod Nanos. Blue Bay Electronics was chosen since it is an actual third-party remanufacturer selling refurbished iPod Nanos. In each condition, every participant took part in two sequential tasks, which are described below.

Choice Task. To measure their willingness to pay, we asked each participant to complete a choice task (see Green and Srinivasan 1990, Miller et al. 2011). For this task, we created 12 choice sets, which included 3 different new and/or remanufactured products and a "none of the above" option. Apart from the product type (new, OEM remanufactured, or third-party remanufactured), the products varied along two attributes: price (three levels: \$79, \$119, and \$159), and memory size (two levels: 8 GB and 16 GB). These attributes were selected based on qualitative interviews with a set of undergraduate students at a large Southern university that did not participate in this experiment. The attribute levels were chosen based on the typical values found in the market. The choice sets were created based on a randomized design generated by Sawtooth software SSI Web Version 8.1.4 (see Miller et al. 2011).

The participants were presented with the 12 choice sets sequentially and asked to choose one option in each one. They were asked to focus on the attributes provided and to assume that all product profiles

[2] Mechanical Turk has been successfully used in experimental research in several different fields (see Alter et al. 2010, Eriksson and Simpson 2010, Chiou and Tucker 2012, Erat and Bhaskaran 2012, Ülkü et al. 2012). It matches the U.S. population more closely than college student subject pools or other Internet panels, and there is recent evidence that results obtained from it do not significantly differ from those found in laboratory settings (Paolacci et al. 2010).

[3] This token payment is competitive with other studies on Mechanical Turk and is commensurate with \$8 per hour based on the average completion time of seven minutes.

Table 1 Statements Used to Obtain Measures in the Follow-up Task of Experiment 1

Measure	Statements	Response scale
SimO $\alpha = 0.80$	• The similarity between a new iPod Nano and an iPod Nano refurbished by Apple Inc. is _____.	(1 = low, 7 = high)
	• iPod Nanos refurbished by Apple Inc. are _____ to new iPod Nanos.[a]	(1 = similar, 7 = not similar)
Sim3P $\alpha = 0.89$	• The similarity between a new iPod Nano and an iPod Nano refurbished by Blue Bay Electronics Inc. is _____.	(1 = low, 7 = high)
	• iPod Nanos refurbished by Blue Bay Electronics Inc. are _____ to new iPod Nanos.[a]	(1 = similar, 7 = not similar)
QbO $\alpha = 0.85$	• The presence of iPod Nanos refurbished and sold by Apple Inc. suggests that new iPod Nanos are _____ quality products.	(1 = low, 7 = high)
	• Apple Inc. refurbishing and selling iPod Nanos implies that the quality of new iPod Nanos is _____.[a]	(1 = high, 7 = low)
Qb3P $\alpha = 0.87$	• The presence of iPod Nanos refurbished and sold by independent third parties like Blue Bay Electronics Inc. suggests that new iPod Nanos are _____ quality products.	(1 = low, 7 = high)
	• Independent parties like Blue Bay Electronics Inc. refurbishing and selling iPod Nanos implies that the quality of new iPod Nanos is _____.[a]	(1 = high, 7 = low)

[a]These scores were recoded by inverting them such that a higher score implies higher perceived similarity or belief of quality signal. The value of α denotes the Cronbach alpha for that measure in experiment 1.

were comparable on any of the other attributes they might normally take into consideration. The order of choice sets was randomized. To stimulate the participants to perform this task truthfully and carefully, we used the incentive-alignment mechanism proposed by Ding et al. (2005). The participants were informed that a randomly selected participant would receive a $200 prize package (in addition to a $1 payment that every participant received) consisting of an iPod Nano and a monetary sum and that both would be based on their responses in the choice task. They were also informed that the prize package would be constructed as follows. A choice set judged by the participant would be randomly selected. The participant would receive the iPod Nano chosen in that choice set, and the amount of cash would be $200 minus the price of the iPod Nano chosen. If the no-purchase option was chosen, the participant would receive $200 in cash. The participant who received the prize package was randomly selected from all interested participants and contacted by email to receive the prize package. An example of the information provided to the participants regarding this can be found in §A.1 of the appendix.

Follow-up Task. After finishing the choice task, the participants were asked to respond to a number of statements. The goal of the follow-up task was to measure the participants' perceived similarity between the remanufactured and new products, and their beliefs regarding the quality signal from remanufacturing.

The statements to obtain measures for the OEM-remanufactured and the third-party-remanufactured products were presented sequentially, where the order within a set was randomized. Each measure was obtained by having participants respond to two statements. Table 1 summarizes these statements, used to obtain the following measures: the perceived similarity between OEM-remanufactured and new products (SimO), the belief regarding the quality signal from OEM remanufacturing (QbO), the perceived similarity between third-party-remanufactured products and new products (Sim3P), and the belief regarding the quality signal from third-party remanufacturing (Qb3P). We created composite scores by averaging the scores on the two statements for each measure. As can been seen from Table 1, Cronbach's alphas were 0.8 or higher for all of these measures.

WTP Estimation Procedure. To estimate the participants' WTP, we first calculated the individual-level partworths for each of the attribute levels using the data from the choice task. To do so, we used a hierarchical Bayes procedure that is commonly used for choice-based conjoint designs in the literature (see Allenby et al. 1998, Ding 2007, Miller et al. 2011). This procedure assumes that the individuals' partworths are given by a multivariate normal distribution, and a participant's probability of choosing a particular alternative is given by a multinomial logit model (see Ding 2007, Sawtooth Software 2009, and Miller et al. 2011 for further details about this procedure). We did not observe any trends after the first 100,000 iterations and used the following 100,000 iterations for parameter estimation. Table 2 reports the population means for these partworths. The root likelihoods suggest a good fit for the model (Sawtooth Software 2009).[4]

We next used these individual-level partworths to estimate a participant i's maximum WTP using the

[4] The root likelihoods are all more than 2.5 times greater than 0.25, which is the root likelihood of a chance model for a choice set with four alternatives, suggesting a good fit for the model (Sawtooth Software 2009).

Table 2 Means and Standard Errors of Partworth Estimates (Effect Coded) for Experiment 1

Attribute	Level	Control	Onlyoem	Only3p	Both
No purchase		−4.29 (0.23)	−3.23 (0.23)	−3.61 (0.19)	−2.39 (0.23)
Price	$79	3.43 (0.14)	3.50 (0.14)	3.27 (0.14)	3.10 (0.13)
	$119	0.36 (0.05)	0.23 (0.04)	0.28 (0.04)	0.38 (0.03)
	$159	−3.79 (0.12)	−3.72 (0.12)	−3.54 (0.14)	−3.47 (0.13)
Memory	8 GB	−2.24 (0.08)	−2.07 (0.08)	−1.88 (0.07)	−1.47 (0.06)
	16 GB	2.24 (0.08)	2.07 (0.08)	1.88 (0.07)	1.47 (0.06)
Type	New	—	1.10 (0.06)	1.33 (0.07)	1.69 (0.09)
	OEM Reman	—	−1.10 (0.06)	—	0.22 (0.03)
	3P Reman	—	—	−1.33 (0.07)	−1.91 (0.09)
Root likelihood		0.760	0.736	0.734	0.701

Note. See §A.2 in the appendix for a discussion of how to interpret these partworth estimates. Reman, remanufactured.

equation $u_{it|p} + v_i(p) \geq u_i^* + \epsilon$ (see Kohli and Mahajan 1991, Miller et al. 2011), where $u_{it|p}$ is the sum of all partworths for a given profile except price, $v_i(p)$ is the partworth for a given price level p, and u_i^* is the partworth of the no-purchase option. Note that we have three price levels, namely, \$79, \$119, and \$159. Therefore, we have three discrete values of $v_i(p)$, namely, $v_i(79)$, $v_i(119)$, and $v_i(159)$. By using linear interpolation and the three values of $v_i(p)$, a continuous, piecewise linear function $V_i(p)$ is constructed, which is given by

$$V_i(p) = \begin{cases} \dfrac{v_i(119)(p-79) + v_i(79)(119-p)}{119-79} \\ \qquad \text{if } p < 119, \\ \dfrac{v_i(159)(p-119) + v_i(119)(159-p)}{159-119} \\ \qquad \text{otherwise.} \end{cases} \quad (1)$$

The maximum WTP of participant i can then be calculated by determining the lowest value of p such that $V_i(p) = u_i^* - u_{it|p}$.

We did not find any differences in our results with respect to the testing of hypotheses and underlying mechanisms for different memory sizes.[5] Therefore, we averaged each participant's estimated maximum WTP across the two memory sizes and used this as our main unit of analysis for testing our hypotheses. The WTP estimates for the remanufactured products were calculated in a similar manner.

3.1.2. Results. Table 3 summarizes estimated average values and standard errors of the WTP as well as measures of perceived similarity and beliefs regarding the quality signal from remanufacturing in each condition. Table 3 demonstrates that our experimental data exhibit regularities consistent with assumptions utilized in the existing literature: the WTPs for new products are higher than those for remanufactured products (all p-values < 0.01) in all conditions (see Guide and Li 2010, Subramanian and Subramanyam 2012). The WTPs for OEM-remanufactured products are higher than those for third-party-remanufactured products (all p-values < 0.01) (see Ferrer and Swaminathan 2006).

To test our hypotheses, we conducted a 2 (OEM-remanufactured product: absent, present) × 2 (third-party-remanufactured product: absent, present) analysis of variance (ANOVA) with the WTP for the new product as the dependent variable. This analysis suggests that the main effect of the OEM-remanufactured product is significant ($F(1, 773) = 3.4$, $p < 0.1$). The mean WTP for the new product is \$197.75 in the absence of the OEM-remanufactured product and \$184.37 in their presence. This implies that the presence of OEM-remanufactured products has a negative effect on the WTP for the new product. Therefore, we find support for Hypothesis 1. We next compare the

Table 3 Summary Statistics for Maximum WTP Estimates and Measures of Perceived Similarity and Beliefs of Quality Signal from Remanufacturing in Experiment 1

Condition	Control	Onlyoem	Only3p	Both
No. of participants	198	192	191	196
New WTP	\$190.73 (7.37)	\$175.57 (4.04)	\$204.77 (8.33)	\$193.17 (8.35)
OEM-Reman WTP	—	\$143.45 (6.44)	–	\$163.44 (8.0)
3P-Reman WTP	—	—	\$96.36 (4.24)	\$102.28 (10.30)
SimO	—	5.12 (0.10)	—	5.13 (0.12)
Sim3P	—	—	4.23 (0.12)	3.96 (0.11)
QbO	—	4.27 (0.11)	—	4.23 (0.10)
Qb3P	—	—	5.11 (0.12)	5.10 (0.11)

Notes. The WTP estimates are averaged across the two memory sizes. The other measures were obtained on a 7-point scale and a higher score denotes higher perceived similarity or belief of quality signal. Standard errors are reported in parentheses. Reman, remanufactured.

[5] Note that the WTPs for 16 GB products are consistently higher than those for 8 GB products, which can be observed from the partworth estimates in Table 2.

WTP for the new product between the ONLY3P and ONLYOEM conditions. We find that it is significantly higher ($t(381) = 3.16$, $p < 0.01$) under the ONLY3P condition, which provides support for Hypothesis 2A. The main effect of the third-party-remanufactured products is also significant ($F(1, 773) = 4.75$, $p < 0.05$). The mean WTP for the new product is \$183.15 in the absence of the third-party-remanufactured products and \$198.97 in its presence. This implies that the presence of third-party-remanufactured products has a positive effect on the WTP for the new product, which is consistent with Hypothesis 2B. The interaction effect between the two factors is insignificant ($F(1, 773) = 0.06$, $p > 0.2$). This suggests that the effect of OEM-remanufactured and third-party-remanufactured products is unchanged in their joint presence.

To examine the underlying mechanism proposed to explain the decrease in the WTP for the new product when OEM-remanufactured products are available, we conducted ordinary least squares regressions with WTP for the new product as the dependent variable and measures of perceived similarity and beliefs regarding quality signal from remanufacturing as independent variables (see Table 4 for details). We first focus on the condition where only OEM-remanufactured products are available. First, note that the perceived similarity between new and OEM-remanufactured products is high (5.12 on a 7-point scale). Second, we find that a higher perceived similarity between the new and OEM-remanufactured products has a negative effect on the WTP for the new product ($\beta = -11.94$, $p < 0.01$). This is consistent with our proposed theoretical framework that an OEM-remanufactured product acts as a contextual reference point; i.e., because of the high perceived similarity between new and OEM-remanufactured products, an assimilation effect takes place, decreasing the perceived value of the new product. We also find that the coefficient for the measure of quality signal from OEM remanufacturing is significant ($\beta = 8.38$, $p < 0.01$). This, combined with the decrease in WTP, provides support for our proposed theoretical mechanism that the presence of OEM-remanufactured products signals quality concerns for the new products.

Table 4 **Regression Results for WTP for the New Product in Conditions ONLYOEM and ONLY3P in Experiment 1**

	ONLYOEM	ONLY3P
Independent variable	Coefficient	Coefficient
SIMO	−11.94*** (2.72)	—
SIM3P	–	−13.45*** (4.82)
QBO	8.38*** (2.40)	—
QB3P	—	15.48*** (5.91)
R^2	0.14	0.06

Note. Standard errors are reported in parentheses.
***$p \leq 0.01$.

Next, we analyze the proposed mechanism behind the increase in WTP when only third-party-remanufactured products are available in a similar fashion (see Table 4 for details). We find that the similarity of new and third-party-remanufactured products is relatively low (4.23 on a 7-point scale), and significantly lower than the perceived similarity between new and OEM-remanufactured products ($t(381) = 5.59$, $p < 0.01$). We also find that a lower perceived similarity between new and third-party-remanufactured products leads to a higher WTP for the new product ($\beta = -13.45$, $p < 0.01$). This result is consistent with our theoretical framework that the lower similarity of the new and third-party-remanufactured products gives rise to a contrast effect. We also find that the coefficient for the measure of quality signal from third-party remanufacturing is significant ($\beta = 15.48$, $p < 0.01$). This result, combined with the increase in the WTP for the new product, provides support for our proposed theoretical mechanism that the presence of third-party-remanufactured products acts as a positive quality signal for the new products. Finally, we note that the results regarding the underlying mechanisms (which we omit for brevity) also hold in the joint presence of both types of remanufactured products.

We also conducted a between-conditions test for mediation by perceived similarity using the bootstrapping procedure proposed by Preacher and Hayes (2004). Comparing conditions ONLYOEM and ONLY3P, we find that the indirect effect of the presence of OEM-remanufactured versus third-party-remanufactured products on the WTP for the new products through the perceived similarity is significant (mean bootstrap estimate = 10.26, SE = 3.46; the 95% bootstrap confidence interval is 4.62–18.80, which does not include 0).

3.2. Additional Experiments and Robustness

This section discusses the three additional experiments we carried out to explore the sensitivity of our experimental results to the choice of brand of MP3 players and the product category used in experiment 1 and to test whether our main results are specific to remanufacturing or if they hold for any product-line extension.

3.2.1. Experiment 2: Sansa MP3 Players. Experiment 2 utilized Sansa Fuze MP3 players as the product stimuli instead of Apple iPod Nanos to investigate potential brand effects by choosing a weaker brand than Apple. There were no other changes in our experimental design, incentive-alignment mechanisms, or WTP estimation procedure from experiment 1. This experiment was also conducted by using the Mechanical Turk online panel. We obtained responses from 788 participants, with an average age of 30.08 years, 39.1% of whom were female. Table 5 summarizes the WTP estimates and measures of similarity and beliefs of quality signal for this experiment. The partworth estimates are relegated to Table A.2 in the appendix for brevity.

We conducted a similar analysis to the one described in experiment 1 to test our main hypotheses and the underlying mechanism (see Table 5). We find that the main effect of the OEM-remanufactured product is insignificant ($F(1, 784) = 0.73$, $p > 0.2$). Therefore, we do not find support for Hypothesis 1. Comparing the WTP for the new product between the Only3P and OnlyOEM conditions, we find that it is significantly higher ($t(392) = 2.20$, $p < 0.02$) under the Only3P condition. This provides support for Hypothesis 2A. The main effect of third-party-remanufactured products is significant ($F(1, 784) = 6.98$, $p < 0.01$). The mean WTP for the new product is \$155.87 in the absence of a third-party-remanufactured product and \$167.15 in its presence. This implies that the presence of third-party-remanufactured products has a positive effect on the WTP for the new product, which is consistent with Hypothesis 2B. The interaction effect between the two factors is insignificant ($F(1, 784) = 0.002$, $p > 0.20$).

In the OnlyOEM condition, we find that a higher perceived similarity between new and OEM-remanufactured products has a negative effect on the WTP for the new product ($\beta = -5.69$, $p < 0.01$), which is again consistent with our proposed theoretical framework based on contextual reference points. However, the coefficient for the measure of quality signal from OEM remanufacturing is insignificant ($\beta = 3.02$, $p > 0.10$). This, along with the insignificant effect of OEM-remanufactured products, suggests that, although the assimilation effect takes place, it is not strong enough to significantly change the perceived value of the new product.

The similarity between the new and third-party-remanufactured products is significantly lower than that between new and OEM-remanufactured products ($t(392) = 3.04$, $p < 0.01$). When only third-party-remanufactured products are available, we find that a lower perceived similarity between the new and third-party-remanufactured products leads to a higher WTP for the new product ($\beta = -16.37$, $p < 0.01$). This provides support for our proposed theoretical mechanism that third-party-remanufactured products are perceived to be relatively dissimilar, giving rise to a contrast effect. The coefficient for the measure of quality signal from third-party remanufacturing is also significant ($\beta = 12.53$, $p < 0.01$), which provides support for our proposed theoretical framework that the presence of third-party-remanufactured products acts as a positive quality signal for the new products, influencing the WTP for the new products,

Table 5 Summary Statistics for Maximum WTP Estimates and Measures of Perceived Similarity and Beliefs of Quality Signal from Remanufacturing in Experiments 2 and 3

	Experiment 2				Experiment 3			
Condition	Control	OnlyOEM	Only3P	Both	Control	OnlyOEM	Only3P	Both
No. of participants	198	197	197	196	199	197	202	194
New WTP	\$157.60 (3.50)	\$154.14 (3.26)	\$169.05 (5.95)	\$165.24 (3.85)	\$165.36 (3.35)	\$160.83 (2.30)	\$175.67 (3.23)	\$173.75 (2.67)
OEM-Reman WTP	—	\$131.70 (4.71)	—	\$145.60 (3.71)	—	\$144.51 (2.37)	—	\$149.25 (4.22)
3P-Reman WTP	—	—	\$125.16 (3.85)	\$122.53 (4.69)	—	—	\$137.47 (3.67)	\$117.00 (8.52)
SimO	—	5.40 (0.11)	—	5.44 (0.10)	—	5.46 (0.10)	—	5.33 (0.10)
Sim3P	—	—	4.94 (0.11)	4.75 (0.10)	—	—	4.84 (0.10)	4.39 (0.11)
QbO	—	4.69 (0.09)	—	4.49 (0.10)	—	4.72 (0.10)	—	4.56 (0.11)
Qb3P	—	—	5.09 (0.11)	5.05 (0.10)	—	—	5.06 (0.09)	5.06 (0.09)

Notes. The WTP estimates are averaged across the two memory sizes. The other measures were obtained on a 7-point scale and a higher score denotes higher perceived similarity or belief regarding quality signal. Standard errors are reported in parentheses. Reman, remanufactured.

as in experiment 1. Finally, mediation analyses (Preacher and Hayes 2004) confirmed that the indirect effect of the presence of OEM-remanufactured versus third-party-remanufactured products on the WTP for the new products through the perceived similarity is significant (mean bootstrap estimate = 4.99, SE = 2.41; the 95% bootstrap confidence interval is 1.52–11.25, which does not include 0).

3.2.2. Experiment 3: Printers as Product Stimulus. Experiment 3 utilizes consumer printers instead of MP3 players. Since printers are less innovative and more utilitarian than MP3 players, this experiment allows us to investigate whether our results hold for other types of consumer products. In particular, we used HP LaserJet P1006 printers because there were remanufactured versions available in the market. We modified the price levels to be \$99, \$129, and \$159 based on levels observed in the market. In addition, we used print-quality level (with two levels: 600 dpi and 1,200 dpi) instead of memory size as an attribute. There were no other changes in the experimental design and procedures from experiment 1. This experiment was also conducted by using the Mechanical Turk online panel. We obtained responses from 792 participants, with an average age of 29.51 years, 39.3% of whom were female. Table 5 summarizes the WTP estimates and measures of similarity and beliefs of quality signal for this experiment. The partworth estimates are relegated to Table A.2 in the appendix for brevity.

We conducted a similar analysis to the one described in experiment 1 to test our main hypotheses and their underlying mechanism (see Table 5). We find that the main effect of the OEM-remanufactured product is insignificant ($F(1, 788) = 1.21$, $p > 0.20$). Therefore, we do not find support for Hypothesis 1. Comparing the WTP for the new product between the Only3p and Onlyoem conditions, we find that it is significantly higher ($t(397) = 3.73$, $p < 0.01$) under the Only3p condition. This provides support for Hypothesis 2A. The main effect of third-party-remanufactured products is significant ($F(1, 788) = 15.75$, $p < 0.01$). The mean WTP for the new product is \$163.11 in the absence of a third-party-remanufactured product and \$174.73 in its presence. This implies that the presence of third-party-remanufactured products has a positive effect on the WTP for the new product, which is consistent with Hypothesis 2B. The interaction effect between the two factors is insignificant ($F(1, 784) = 0.20$, $p > 0.20$).

In the Onlyoem condition, we find that a higher perceived similarity between new and OEM-remanufactured products has an insignificant negative effect on the WTP for the new product ($\beta = -2.43$, $p > 0.10$). The coefficient for the measure of quality signal from OEM remanufacturing is significant ($\beta = 2.91$, $p < 0.1$). These results suggest that participants consider the presence of remanufactured products as a signal of new product quality. However, this effect is not strong enough to significantly change the perceived value of the new product, given that the main effect of OEM-remanufactured products on the WTP for the new product is insignificant.

The similarity between new and third-party-remanufactured products is significantly lower than that between new and OEM-remanufactured products ($t(397) = 4.34$, $p < 0.01$). When only third-party-remanufactured products are available, we find that a lower perceived similarity between new and third-party-remanufactured products leads to a higher WTP for the new product ($\beta = -5.14$, $p < 0.05$). This provides support for our proposed theory that the third-party-remanufactured products are perceived to be relatively dissimilar, resulting in a contrast effect and increasing the perceived value of the new product. The coefficient for the measure of quality signal from third-party remanufacturing is also significant ($\beta = 8.11$, $p < 0.01$). As before, this is consistent with our proposed theoretical framework that the presence of third-party-remanufactured products acts as a positive quality signal for the new products. Finally, mediation analyses (Preacher and Hayes 2004) confirmed that the indirect effect of the presence of OEM-remanufactured versus third-party-remanufactured products on the WTP for the new products through the perceived similarity is significant (mean bootstrap estimate = 2.21, SE = 1.09; the 95% bootstrap confidence interval is 0.61–5.23, which does not include 0).

3.2.3. Experiment 4: Attribution of Main Effect to Remanufacturing. Experiment 4 builds on experiment 1 by including a number of additional conditions. These additional conditions were included to test whether our main results are unique to remanufactured products or if they also apply to a non-remanufactured low-end, product-line extension. Each of these three new conditions included new iPod Nanos and a slightly inferior new product. In particular, in condition C1, the alternative product was a new product sold by the same OEM, namely, a fifth-generation Apple iPod Nano. To make sure that the new and alternative products were clearly identified, we referred to the new product as a new seventh-generation iPod Nano and to the alternative product as a new fifth-generation iPod Nano. In conditions C2 and C3, the second product was a new product sold by a low-end competitor, namely, Sony MP3 players in condition C2 and Philips MP3 players in condition C3.

There were no other changes in the experimental design from experiment 1. This experiment was also conducted by using Amazon's Mechanical Turk

Table 6 Summary Statistics for Maximum WTP Estimates in Experiment 4

Condition	Control	Onlyoem	C1	Only3p	C2	C3
No. of participants	119	114	117	114	109	119
New WTP	\$188.50 (5.75)	\$173.80 (8.51)	\$209.91 (15.23)	\$214.46 (19.12)	\$164.86 (6.31)	\$169.22 (9.18)
Alternative product WTP	—	\$142.03 (8.40)	\$171.02 (10.75)	\$119.36 (9.00)	\$144.64 (4.89)	\$138.38 (7.34)

Note. Standard errors are reported in parentheses.

online panel. We obtained responses from 692 participants, with an average age of 30.33 years, 35.7% of whom were female. Table 6 provides the summary statistics for the WTP estimates obtained in this experiment.

We first investigate whether the effect of OEM-remanufactured products is unique to remanufacturing or is similar to that of non-remanufactured low-end extensions offered by the same firm. To do so, we compare the WTP for the new product between conditions Onlyoem and C1. We find that the OEM-remanufactured product leads to significantly lower WTP for the new product compared to the non-remanufactured low-end product (\$173.80 versus \$209.91, $t(229) = 2.06$, $p < 0.05$). This implies that the effect of OEM-remanufactured products is significantly different than that of low-end extensions. Next, we test whether the effect of third-party-remanufactured products is unique to remanufacturing or is similar to that of inferior products offered by a competitor. We compare the WTP for the new product between conditions C2 and C3, and condition Only3p. We find that the third-party-remanufactured product leads to significantly higher WTP for the new product compared to the non-remanufactured low-end competitor product (\$214.46 versus \$164.86, $t(221) = 2.42$, $p < 0.01$ for comparison with C2; \$214.46 versus \$169.22, $t(231) = 2.16$, $p < 0.05$ for comparison with C3). This implies that the effect of third-party-remanufactured products is significantly different than that of inferior products sold by a competitor.

In sum, the results from this experiment suggest that the main effects identified in this paper are specific to remanufactured products and may not apply to a generic low-end product-line extension.

4. Conclusions and Managerial Implications

In this paper, we use behavioral experiments to investigate the effect of remanufactured products and the identity of the remanufacturer on the perceived value of an OEM's new products.

We find that an OEM's concerns regarding the potential negative impact of selling remanufactured products may go beyond the fear of cannibalizing the demand for new products. The results from our experimental study with Apple MP3 players suggest that OEM-remanufactured products may further reduce OEM profits by eroding the perceived value of new products. It is nevertheless important to note that the same effect is absent in our experiments with Sansa MP3 players and HP printers, implying that this effect may differ across brands and product categories. There can be several post hoc explanations for this difference: first, an Apple MP3 player is a high-end product and may be perceived to be of high quality, whereas a Sansa MP3 player or HP printer may be perceived to be a relatively low-end product. That is, the negative effect of OEM-remanufactured products may be stronger for high-quality brands. Second, it may be possible that participants have stronger initial perceptions regarding hedonic or emotional brands such as Apple as compared to more utilitarian brands such as Sansa or HP. Such initial perceptions may lead to a stronger negative effect of OEM-remanufactured products. As such, an analysis of whether and how the role of similarity varies for low- and high-end products appears to be an important research question in this context.

Our results also suggest that the presence of third-party-remanufactured products has a positive effect on the perceived value of the new product. More importantly, this effect holds irrespective of the product category and brand in our experiments. We further note that these effects seem specific to remanufactured products, and do not apply to a generic low-end product-line extension or an inferior product sold by a competitor. These results have important implications for the operations management literature analyzing an OEM's competitive remanufacturing strategy (e.g., Debo et al. 2005, Ferguson and Toktay 2006, Atasu et al. 2008b). This literature focuses on the following OEM options: an OEM may (i) preemptively remanufacture, i.e., deter the entry of third-party remanufacturers by recovering and remanufacturing products; (ii) preemptively dispose, i.e., deter the entry of third-party remanufacturers by recovering and disposing (e.g., recycling) remanufacturable products; or (iii) competitively remanufacture, i.e., do nothing to deter third-party competition and pursue

remanufacturing. However, this stream mainly analyzes trade-offs associated with the cannibalization of new products and the level of cost savings from remanufacturing in determining the OEM's competitive remanufacturing strategy. Our results suggest that the OEM's choice should also depend on the effect of remanufactured products on the perceived value of new products. This observation allows us to provide the following managerial insights, which readily speak to practice.

- An OEM should first investigate the effect of OEM- and third-party-remanufactured products on the perceived value of new products before embarking on costly and potentially detrimental preemption of third-party remanufacturers.
- If the presence of OEM-remanufactured products has a strong negative effect on the perceived value of an OEM's new products, the OEM may benefit from remanufacturing and enabling third parties to be present in the market. This would allow the OEM to enjoy the positive effect of third-party-remanufactured products on the perceived value of new products, yet limit the competitive presence of third-party-remanufactured products by cannibalizing third-party sales through OEM-remanufactured products. However, this option may need to be exercised with caution because it effectively implies increased cannibalization of the OEM's new product sales (by both OEM- and third-party-remanufactured products). As such, OEM remanufacturing to compete with third parties may require substantially low remanufacturing costs to compensate for the potentially higher new product cannibalization through relatively large margins from sales of remanufactured products. In addition, OEMs may benefit from remanufacturing their own products but selling them under a different brand name to limit their negative effect on the new products.
- If the effect of OEM-remanufactured products on the perceived value of new products is weak, it may be profitable for an OEM to deter competition from third-party remanufacturers. The best mechanism to do this would depend on the OEM's remanufacturing cost (see Ferguson and Toktay 2006): if the OEM's remanufacturing cost is sufficiently low, it would benefit from preemptive remanufacturing (similar to the argument above); otherwise, the OEM may prefer preemptive disposal (e.g., recycling) of remanufacturable cores to limit the third party's access to remanufacturable products.

Our results also offer support for some OEM strategies that are observed in practice. OEMs can benefit from limiting the negative effect of their own remanufactured products via different mechanisms that can reduce the likelihood that the target customers of the new products observe the presence of the remanufactured products. For example, Apple sells remanufactured products only on the Internet, and HP sells remanufactured computers only through separate secondary channels in Europe (Guide et al. 2005), which may be effective in reducing the negative effect of OEM-remanufactured products on the perceived value of new products. In addition, an OEM may further benefit from the presence of third-party remanufacturers by highlighting the differences between its new products and existing third-party-remanufactured products to strengthen the quality perception of its new products. For example, HP uses marketing techniques to reinforce the idea that new cartridges are far superior to third-party-remanufactured cartridges, which have low quality and reliability (Hewlett-Packard 2014).

We conclude by discussing other directions for future research. We carried out experiments for two types of consumer products (MP3 players and printers) and three brands. More research is required to examine the effects we identify across different brands and product categories. We also focused on the setting where the OEM is the only firm selling new products. In practice, there may be competition from new products sold by other firms as well. A promising direction for future research would be to explore the effect of remanufactured products on the perceived value of the new product in the presence of competition from other OEMs.

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Appendix

A.1. Sample Instructions

A set of sample instructions are provided below. Note that (ONLYOEM), (ONLY3P), and (BOTH) indicate that the details provided apply only to the corresponding condition.

INSTRUCTIONS. You are about to rate different MP3 players (more details will follow). We ask you to rate them assuming you plan to actually purchase an MP3 player. As a token of our appreciation, we will randomly select one participant who will win a $200 prize package. The prize package will consist of an MP3 player and some cash. The exact composition of the prize package will depend on your choices. The computer will randomly select one of the choice situations you face. If you are a winner in the lottery, you will receive the MP3 player that you picked in

Table A.1 Calculating Hypothetical Choice Shares for Specific Profiles in a Set

	Score	Exp(Score)	Choice share
Profile A	2.6	13.46	13.46/16.76 = 80.3%
Profile B	1.19	3.29	3.29/16.76 = 19.6%
No purchase	−4.29	0.01	0.01/16.76 = 0.1%
Total		16.76	100%

the randomly selected choice situation. In addition, you will receive cash. The cash amount is equal to the difference between $200 and the price of the MP3 player you picked.

Example. The computer randomly selects a choice situation. In this randomly selected choice situation, you picked MP3 player X at a price of $125. As a winner of the raffle, you would receive the chosen MP3 player X in addition to $75 ($200 MINUS the price of your chosen MP3 player).

Please note: none of the MP3 players offered to you during this study is priced at more than $200. Hence, there can be NO LOSSES. If you win the subsequent raffle, you are guaranteed to receive an MP3 player AND cash.

You are about to be presented with 12 choice sets, each consisting of three Apple iPod Nanos that you may consider to buy. The iPod Nanos you are going to look at are described based on three characteristics: 1. Price: $79, $119, or $159, 2. Memory size: 8 GB or 16 GB, 3. (Onlyoem) *Type of product*: *New by Apple Inc. or Refurbished by Apple Inc.*, (Only3p) *Type of product*: *New by Apple Inc. or Refurbished by Blue Bay Electronics Inc., an independent third party*, (Both) *Type of product*: *New by Apple Inc., Refurbished by Apple Inc., or Refurbished by Blue Bay Electronics Inc., an independent third party*.

Refurbished products are returned items that are fully tested and inspected by highly trained technicians and restored to original factory specifications.

(Onlyoem) *As part of company policy, Apple Inc. sells new and refurbished iPod Nanos. Only Apple Inc. refurbishes their own iPod Nanos and sells them. Independent third-party refurbishers like Blue Bay Electronics Inc.* do not *collect, refurbish, and sell refurbished iPod Nanos.*

(Only3p) *As part of company policy, Apple Inc. only sells new iPod Nanos. Apple Inc.* does not *refurbish nor sell refurbished iPod Nanos. Only independent third-party refurbishers like Blue Bay Electronics Inc. collect and refurbish iPod Nanos and sell them.*

(Both) *As part of company policy, Apple Inc. sells new and refurbished iPod Nanos. Apple Inc. refurbishes their own iPod Nanos and sells them. Independent third-party refurbishers like Blue Bay Electronics Inc. also collect and refurbish iPod Nanos and sell them.*

For each choice set, we ask you to select which iPod Nano you would purchase. We understand that there are many more characteristics you normally would take into consideration when buying an MP3 player. However, for this study, we would like you to focus on the ones presented above and assume that all MP3 players you check out are comparable with respect to any other characteristic you might normally take into consideration when buying an MP3 player.

A.2. Interpreting Partworth Estimates

We now provide a brief example of how the partworth estimates reported in Table 2 can be interpreted. In particular, given a set of profiles, we show how these estimates can be used to predict a hypothetical choice share for a specific profile from the set. We will calculate the hypothetical choice share of two specific profiles and the no-purchase

Table A.2 Means and Standard Errors of Partworth Estimates (Effect Coded) for Experiments 2 and 3

		Experiment 2				Experiment 3			
Attribute	Level	Control	Onlyoem	Only3p	Both	Control	Onlyoem	Only3p	Both
No purchase		−4.28 (0.28)	−3.80 (0.30)	−2.32 (0.20)	−2.25 (0.25)	−4.64 (0.25)	−3.33 (0.21)	−3.39 (0.27)	−3.42 (0.28)
Price	$79/$99	5.28 (0.14)	4.45 (0.12)	4.06 (0.12)	3.66 (0.10)	4.75 (0.18)	3.70 (0.10)	3.40 (0.10)	3.14 (0.09)
	$119/$129	0.28 (0.04)	0.35 (0.04)	0.38 (0.05)	0.09 (0.04)	0.55 (0.05)	0.49 (0.03)	0.23 (0.04)	0.23 (0.04)
	$159	−5.56 (0.11)	−4.80 (0.09)	−4.44 (0.13)	−3.75 (0.09)	−5.30 (0.14)	−4.19 (0.09)	−3.63 (0.09)	−3.37 (0.07)
Memory/Print quality	8 GB/600 dpi	−3.47 (0.10)	−2.64 (0.08)	−2.55 (0.10)	−2.32 (0.08)	−4.37 (0.15)	−2.89 (0.10)	−2.68 (0.09)	−2.28 (0.08)
	16 GB/1,200 dpi	3.47 (0.10)	2.64 (0.08)	2.55 (0.10)	2.32 (0.08)	4.37 (0.15)	2.89 (0.10)	2.68 (0.09)	2.28 (0.08)
Type	New	—	0.88 (0.06)	1.38 (0.08)	1.43 (0.07)	—	1.03 (0.06)	1.66 (0.10)	1.96 (0.09)
	OEM Reman	—	−0.88 (0.06)	—	0.04 (0.04)	—	−1.03 (0.06)	—	0.07 (0.04)
	3P Reman	—	—	−1.38 (0.08)	−1.47 (0.07)	—	—	−1.66 (0.1)	−2.03 (0.1)
Root likelihood		0.849	0.786	0.773	0.731	0.853	0.771	0.776	0.741

Note. *X*/*Y* denotes *X* for Experiment 2 and *Y* for Experiment 3. Reman, remanufactured.

option from the Control condition, namely, a new 16 GB iPod Nano sold at \$119 (Profile A) and a new 8 GB iPod Nano sold at \$79 (Profile B).

First, we can calculate a "score" for each specific profile by adding up their partworth estimates. The score for Profile A is $0.36 + 2.24 = 2.60$, the score for Profile B is $3.43 + (-2.24) = 1.19$, and the score for the no-purchase option is -4.29. We next exponentiate these scores and calculate the hypothetical choice share of a profile by dividing its exponentiated score by the total sum of the exponentiated scores. As can be seen from Table A.1, the hypothetical choice share of Profile A is 80.3% and that of Profile B is 19.6%.

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