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# **Advertising and Competition for Market Share Between a New Good Producer and a Remanufacturer<sup>1</sup>**

by

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# Advertising and Competition for Market Share Between a New Good Producer and a Remanufacturer

## Abstract

We study the strategic interaction between a new good producer and a remanufacturer who use advertising campaigns to compete for a *dominant* share of the market for a certain good. Each firm chooses one of three possible strategies for running its advertising campaign. The two rival firms care only about capturing a dominant share of the relevant market. Hence, if a firm expects to capture dominant market share with probability  $p \in [0,1]$  then its payoff in the game we study is also  $p$ . Our analysis leads to four results. First, we provide the normal form representation of the game between the new good producer and the remanufacturer. Second, we specify the game in matrix form. Third, we indicate what happens at each stage of the elimination of strictly dominated strategies. Finally, we show that the iterated elimination of strictly dominated strategies yields a clear and unique prediction about the outcome of the advertising game.

**Keywords:** Advertising, Duopoly, New Good Producer, Remanufacturer, Dominated Strategy

**JEL Codes:** M37, L21, D21

## 1. Introduction

The term remanufacturing refers to the rebuilding, the repairing, and the restoration of a product or equipment to meet or exceed a new good producer's<sup>4</sup> performance specifications. Remanufactured products are often sold and serviced by third-parties and the remanufactured products themselves typically carry a warranty that is different from the one provided by the new good producer.

There are essentially two reasons that account for the importance of remanufacturing in the United States today. First, in an attempt to regulate injurious environmental outcomes, in 1995, the Environmental Protection Agency (EPA) implemented the "Comprehensive Procurement Guideline." This guideline sought to cut waste and encourage resource conservation by making sure that materials collected in recycling programs would be used again to manufacture new products.<sup>5</sup> Second, there are the actual cost savings experienced by firms. In this regard, Mitra and Webster (2008) note that in 1996, Ford was able to avoid the disposal of more than 67,700 pounds of toner cartridges and thus saved \$180,000 in disposal costs. Given the growing importance of remanufacturing from environmental and practical standpoints, a growing literature has now begun to examine the properties of this industrial process. We now briefly survey this literature.

First consider the perspective of firms. Lebreton and Tuma (2006) analyze remanufacturing in the context of the disposal of 600,000 tons of used tires in Germany and they point to particular factors that are likely to raise remanufacturing rates in this country. Ferrer and Swaminathan (2006)

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A new good producer is also frequently referred to as an original equipment manufacturer (OEM). Therefore, in the remainder of this paper, we shall use these two terms interchangeably.

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Go to <https://www3.epa.gov/epawaste/conserve/tools/cpg/index.htm> for additional details. Accessed on April 12, 2016.

study the competition between an OEM and an independent operator (IO). They show that when the threat of competition increases, the OEM is more likely to fully utilize all available cores and offer the remanufactured product itself and at a lower price.

New and remanufactured goods are often sold in the same market and therefore it makes sense to consider them together in the design of a product line. Aydin *et al.* (2015) adopt this point of view and set forth a new methodology that permits them to compute the maximum profit and the market share associated with a product line. Shi *et al.* (2015) study the stability of the Nash equilibrium in the game between an OEM and a remanufacturer. They show that a higher willingness-to-pay (WTP) on the part of consumers can either fortify or weaken the stability of the relevant Nash equilibrium. Finally, Batabyal and Beladi (2016a) have analyzed the strategic interaction between an OEM and a remanufacturer when the aim of both firms is to use expenditures on product development to capture a dominant share of the market in which they are operating.

Now consider remanufacturing from the perspective of consumers. The relevance of this perspective stems from the fact that like firms, consumers can also affect the market shares obtained by an OEM and a remanufacturer through their purchases of one or the other kind of good. Batabyal and Beladi (2016b) is the only paper to conduct a game-theoretic analysis of the strategic interaction between two types of consumers who seek to raise the market share of either new or remanufactured toner cartridges. These researchers point out that one way to extend the analysis in their paper would be to analyze a game in which the firms that produce the new and the remanufactured goods are able to influence consumer preferences by *advertising* the relative strengths of their goods.

Researchers such as Giuntini and Gaudette (2003) and Hong *et al.* (2015) have recognized the importance of advertising in making consumers aware of the properties of new and

remanufactured goods. Even so, Batabyal and Beladi (2016c) is the only paper to formally study the effect that *negative advertising* has on the relative market shares of a new good producer and a remanufacturer. We *generalize* the analysis in Batabyal and Beladi (2016c) by studying not just negative advertising but the advertising campaigns of an OEM and a remanufacturer where negative advertising is one of three possible strategies the two rival firms use to compete for a *dominant* share of the market for a certain good such as a toner cartridge.

Section 2.1 describes the static game of complete information model—see Tadelis (2013, pp. 43-126) for details—of the interaction between an OEM and a remanufacturer who use advertising campaigns to compete for a dominant share of the market for a certain good (toner cartridge). Each firm chooses one of three possible strategies for running its advertising campaign. If a firm expects to capture dominant market share with probability  $p \in [0,1]$  then its payoff in the game is also  $p$ . Section 2.2 provides the normal form representation of the game. Section 2.3 specifies the game in matrix form. Section 2.4 indicates what happens at each stage of the elimination of strictly dominated strategies. Section 2.5 shows that the iterated elimination of strictly dominated strategies yields a clear and unique prediction about the outcome of our advertising game. Finally, section 3 concludes and then discusses two ways in which this paper’s research might be extended.

## **2. Analysis**

### ***2.1. The theoretical framework***

Consider a particular market in which a new good producer (firm 1) and a remanufacturer (firm 2) produce toner cartridges for sale to consumers. Note that our subsequent analysis does *not* depend in any way on the numbering of the two rival firms or on the specific good we have chosen

to concentrate on. Each one of the two firms under consideration has one of *three* choices in running its advertising campaign. First, it can choose to focus exclusively on the positive aspects of its own product. This is the positive advertising campaign which we denote by  $A^P$ . Second, a firm can choose to focus on the positive aspects of its own product and attack one's rival's product. This is the balanced advertising campaign and it is denoted by  $A^B$ . Finally, a firm can focus solely on attacking one's rival's product. This is the negative advertising campaign and we denote this by  $A^N$ .

We suppose that all the OEM and the remanufacturer care about is the *probability* of capturing a dominant—greater than 50 percent—share of the market for toner cartridges. As such, if a firm expects to capture dominant market share with probability  $p \in [0,1]$  then its payoff is simply  $p$ . The probability that either firm will capture a dominant share of the market for toner cartridges depends not only on its own advertising campaign strategy but also on its rival's strategy.

The probabilities of capturing a dominant share of the market for toner cartridges are as follows. If both firms use the same advertising campaign strategy then each captures dominant market share with probability 0.5. If firm  $i$  uses the positive strategy  $A^P$  but firm  $j \neq i$  uses the balanced strategy  $A^B$  then firm  $i$  does not capture dominant market share with certainty. If firm  $i$  uses the positive strategy  $A^P$  but firm  $j \neq i$  uses the negative strategy  $A^N$  then firm  $i$  captures dominant market share with probability 0.3. Finally, if firm  $i$  uses the negative strategy  $A^N$  but firm  $j \neq i$  uses the balanced strategy  $A^B$  then firm  $i$  captures dominant market share with probability 0.6.

With this background in place, our next task is to provide the normal form representation of the static game between the two rival firms with the features delineated in this and the preceding two

paragraphs.<sup>6</sup>

## 2.2. The game in normal form

We need to stipulate the number of players, their strategy spaces, and their payoff functions. Clearly, there are two firms or players  $i \in \{1, 2\}$ . Each firm  $i$  has three strategies given by  $S_i = \{A^P, A^B, A^N\}$ . Finally, the payoff to firm  $i$  is given by the function  $\pi_i(S_i, S_j)$ ,  $i \neq j$ . Using the capture probabilities specified in the last paragraph of section 2.1, the various payoffs to the two rival firms can be written explicitly. We get

$$\pi_i(A^P, A^P) = \pi_i(A^B, A^B) = \pi_i(A^N, A^N) = 0.5, \quad (1)$$

$$\pi_1(A^B, A^P) = \pi_2(A^P, A^B) = 1, \quad (2)$$

$$\pi_1(A^P, A^B) = \pi_2(A^B, A^P) = 0, \quad (3)$$

$$\pi_1(A^P, A^N) = \pi_2(A^N, A^P) = 0.3, \quad (4)$$

$$\pi_1(A^N, A^P) = \pi_2(A^P, A^N) = 0.7, \quad (5)$$

$$\pi_1(A^N, A^B) = \pi_2(A^B, A^N) = 0.6, \quad (6)$$

and

$$\pi_1(A^B, A^N) = \pi_2(A^N, A^B) = 0.4. \quad (7)$$

Let us now specify the advertising game between the new good producer and the remanufacturer in

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We use specific numerical values for the various “capture probabilities” primarily to show how the process of iterated elimination of strictly dominated strategies—which builds on the assumption of the common knowledge of rationality—works in the context of the advertising game that we are studying here. Without the use of such explicit numerical values, it would be impossible to solve the underlying game of interest. Having said this, it should be clear to the reader that an analysis of the sort that we are conducting here can be conducted for any numerical values of the capture probabilities.



matrix form.

### 2.3. The game in matrix form

Using equations (1) through (7), we get

Firm 1 (OEM)	Firm 2 (Remanufacturer)		
		$A^P$ (Positive)	$A^B$ (Balanced)
$A^P$ (Positive)	0.5, 0.5	0, 1	0.3, 0.7
$A^B$ (Balanced)	1, 0	0.5, 0.5	0.4, 0.6
$A^N$ (Negative)	0.7, 0.3	0.6, 0.4	0.5, 0.5

**Figure 1**

Now, as a prelude to solving the advertising game depicted in figure 1, let us first ascertain what happens at each stage of the elimination of strictly dominated strategies.

### 2.4. Elimination of strictly dominated strategies

Inspecting the above game in matrix form, we see that for both the firms seeking to capture a dominant share of the market for toner cartridges, the balanced advertising strategy  $A^B$  strictly dominates the positive advertising strategy  $A^P$ . Therefore, we can eliminate the strategy  $A^P$  from any further consideration. This leaves us with the following 2x2 game

Firm 1 (OEM)	Firm 2 (Remanufacturer)	
	$A^B$ (Balanced)	$A^N$ (Negative)
$A^B$ (Balanced)	0.5, 0.5	0.4, 0.6
$A^N$ (Negative)	0.6, 0.4	0.5, 0.5

**Figure 2**

Our next task is to solve the 2x2 game depicted in matrix form in figure 2.

### 2.5. The solution

Inspecting the above game, it is clear that the negative advertising strategy  $A^N$  strictly dominates the balanced strategy  $A^B$  for both the firms. Therefore, the iterated elimination of strictly dominated strategies leads to a clear prediction about the outcome of this advertising game. In particular, the solution to the game is that the OEM and the remanufacturer will engage in negative advertising campaigns in their quest to capture a dominant share of the market for toner cartridges. Equation (1) tells us that for either firm, the likelihood of capturing a dominant share of the market for toner cartridges with a negative advertising campaign is one-half. This completes our analysis of advertising and the competition for dominant market share between an OEM and a remanufacturer.

### 3. Conclusions

In this paper we studied the strategic interaction between a new good producer and a remanufacturer who used advertising campaigns to compete for a dominant share of the market for toner cartridges. Each firm chose one of three possible strategies for running its advertising campaign. The two rival firms cared only about acquiring a dominant share of the relevant market. Hence, if a firm expected to capture dominant market share with probability  $p \in [0,1]$  then its payoff in the game we studied was also  $p$ . Our analysis led to four results. First, we provided the normal form representation of the game between the new good producer and the remanufacturer. Second, we specified the same game in matrix form. Third, we indicated what happened at each stage of the elimination of strictly dominated strategies. Finally, we showed that the iterated elimination of strictly dominated strategies yielded a clear and unique prediction about the outcome of the advertising game.

The analysis in this paper can be extended in a number of different directions. In what follows, we suggest two possible extensions. First, it would be useful to analyze the strategic competition between a new good producer and a remanufacturer in a repeated game in which the two firms interact with each other on multiple occasions over time. Second, it would also be informative to study the efficacy of advertising as a market share enhancing device when an OEM and a remanufacturer have access to other such devices including, but not limited to, price reductions from membership in loyalty programs and volume purchase discounts. Studies that analyze these aspects of the underlying problem will provide further insights into the functioning of markets with remanufacturing and the ways in which such markets can efficiently enhance the conservation of scarce resources.

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