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Consumer environmental awareness and competition in two-stage supply chains

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ABSTRACT

This paper focuses on the impact of competition and consumers' environmental awareness on key supply chain players. We consider both the production competition between partially substitutable products made by different manufacturers, and the competition between retail stores. We use two-stage Stackelberg game models to investigate the dynamics between the supply chain players given three supply chain network structures. We find that as consumers' environmental awareness increases, retailers and manufacturers with superior eco-friendly operations will benefit; while the profitability of the inferior eco-friendly firm will tend to increase if the production competition level is low, and will tend to decrease if the production competition level is high. In addition, higher levels of retail competition may make manufacturers with inferior eco-friendly operations more likely to benefit from the increase of consumers' environmental awareness. Moreover, as production competition intensifies, the profits of the retailers will always increase, while the profits of the manufacturers with inferior eco-friendly operations will always decrease. The profitability of the manufacturers with superior eco-friendly operations will also tend to decrease, unless consumers' environmental awareness is high and the superior manufacturer has a significant cost advantage related to product environmental improvement.

1. Introduction

A notable link has been examined between environmental and economic performance (Hart, 1997; Porter and Linde, 1995, 1997; Corbett and DeCroix, 2001; Nagurney and Nagurney, 2010). For example, Klassen and McLaughlin (1996) found positive stock market effects after announcements of environmental awards and negative effects after environmental crises. In tandem, companies are integrating their supply chain processes to lower costs and better serve customers. These two trends are interrelated as companies must involve suppliers and purchasers to meet and even exceed environmental expectations, ensure security of supply, reduce risk and liability, as well as innovation opportunities (Rao and Holt, 2005; Walton et al., 2006).

Corporate responsibility in the environmental domain has a significant positive effect on the process of green products penetrating into the manufacturing/production sector and then into the competitive market (Mohr and Webb, 2005; Cruz, 2008; Hsueh and Chang, 2008; Ni et al., 2010). As a result, voluntary approaches to address climate change are increasingly considered as relevant as policy instruments to promote environmentally sound production practices (Anton et al., 2004; Delmas and Keller, 2005; Glachant, 2007; Dawson and Segerson, 2008). The ability to generate short-term economic gains must be present to promote acquiescence (Khanna, 2001), and the demand effects from product differentiation when consumers exhibit eco-friendly preferences (Ibanez and Grolleau, 2008; Conrad, 2005; Amacher et al., 2004).

Green products are costlier to produce than those created conventionally, making these goods more expensive (Conrad, 2005). The key issue is whether consumers would be willing to pay a premium large enough to cover the additional costs; otherwise, governments would have to subsidize those producers adopting production process improvements (Moon et al., 2002). A survey conducted for StarKist tuna predicted that, even in a product category where price competition is fierce and brand loyalty is weak, consumers would be willing to pay a premium of $0.21 per can for dolphin safe tuna (Reinhardt, 1998). Additionally, the prices of hybrid-cars are more than 1.5 times those of their gasoline powered counterparts, whilst Toyota (2007) reports that these cars have contributed to reduce carbon dioxide by approximately 3.5 million tons as of April 2007 (Yakita, 2009).

The higher the consumers' environmental awareness, the more the consumers are willing to pay higher prices for eco-friendly products (Chitra, 2007). Such awareness and willingness may vary

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significantly across industries, could change over time, and differ among consumer groups distinguished by demographics, knowledge, values, attitudes and behavior (Laroche et al., 2001; Carlson, 2005). Moon et al. (2002) collected consumer survey data in former West and East Berlin after the unification of Germany to address the issue of willingness to pay for foods produced with techniques consistent with environmental stewardship. The results identified unique consumer groups by geographic region and age with respect to preferences for environmental attributes of agricultural products, with old consumers being less willing to pay the premium. In conclusion, Moon et al. (2002) stated that a stronger willingness to pay for green products would result in an immediate effect that the higher premium will induce more producers to convert to environmentally-friendly techniques.

The consumer must realize some benefit to be willing to burden the additional costs which include those not limited to health and reduced environmental degradation. Through the US State Energy Efficient Appliance Rebate Program, according to the US Department of Energy, consumers have the ability to save upfront and over the life of the appliance with, for example, cost savings up to $135 a year by replacing a clothes washer made before 2000 (USDOE, 2009). As the direct health or cost benefit becomes less clear, it comes down to the consumers' willingness to pay more to avoid supporting certain production practices. Such agricultural practices comprise of the antibiotic use in animals, which could promote resistant bacterial strains, or the use of growth hormones, which could prematurely wear down the animal (Cropper, 2004).

Perhaps the most convincing evidence supporting the growth of ecologically favorable consumer behavior is the increasing number of individuals who are willing to pay more for environmentally-friendly products (Laroche et al., 2001). The BBMG Conscious Consumer Report shows that 67% of Americans agree it is important to buy products with environmental benefits and 51% say they are willing to pay more for products with environmental benefits (Bemporad and Baranowski, 2007). In the US, despite slower consumer spending throughout the economy, the marketplace for natural products grew 25% between 2006 and 2008 (Mintel, 2009) and Consumer Reports states that nearly two-thirds of American consumers purchase at least some organic products (Cropper, 2004; Barksdale, 2009). In 2008, 75% of Europeans were reported as ready to buy costlier green products, compared to 31% in 2005 (European Commission, 2008, 2009). As a result, the Japanese government (Ministry of International Trade and Industry (MITI)) expects that nearly 40% of world economic production by the middle of the twenty-first century will come from energy and environment related products and technologies (Shrivastav, 1995).

In the last decade, new patterns of production competition have emerged in which the natural environment has become an important arena for changing the competitive landscape in many industries (Shrivastav, 1995). If the focus on environmental stewardship is attributed, in part, to consumer environmental awareness levels, as well as increased competition, it is important to understand how the environmental improvement decision of a firm is linked to its competitors' choice of environmental levels and the degree of competitive intensity between firms. Environmental technologies as a source of production process improvements, such as cleaner technologies and pollution control, can change the production cost function within firms and industries to both reduce risks and enhance revenues as a tool for competitive advantage (Tushman and Anderson, 1986). In recognition of this important role of environmental improvement technologies, countries such as Japan, Germany, Sweden, and Denmark are targeting them for rapid development (Shrivastav, 1995).

Conrad (2005) developed a spatial duopoly model to determine how consumer environmental concern affects prices, product characteristics, and market shares of the competing firms; but assumed costs of production are equal and did not consider competition intensity levels. Fanelli (2008) expanded on the work of Conrad (2005) and Davies (2005) to construct a two-stage duopoly game that allowed for the proportions of groups of consumers to not be fixed a priori, where the groups are defined by consumers who prefer buying the good by an ethical firm and the group of consumers who prefers buying the good by the lowest price firm. Game theoretical models have been widely utilized to study the competition among participants in the supply chain (see, for example, Xiao et al., 2007; Miyaoka and Hausman, 2008; Li and Zhang, 2008; Deo and Corbett, 2009). Choi (1991, 1996) used game theoretical models to study the impact of competitions on retailers and manufacturers in various channel structures. For a detailed review regarding the applications of game theory in supply chain management we refer the audience to the book by Cachon and Netessine (2004) as well as applications by Chung et al. (2011), Zhao et al. (2010), and Guiomar and Sigué (2011).

The majority of literatures have focused on either the supply or demand side of production while this is the first paper to study the impact of consumers' environmental awareness and competition intensity levels on the profitability of manufacturers and retailers from a supply chain network perspective. Moreover, to our knowledge, the general supply chain structures discussed in this paper have not been modeled, even in studies in the broader literature where other types of demand enhancement efforts were investigated.

In particular, in this paper, we consider both the production competition between partially substitutable products made by different manufacturers and the competition between retail stores; and use two-stage Stackelberg game models to investigate the interactions between the supply chain players given three supply chain network structures. The first structure does not have either product or retail competition; the second structure only has production competition; and the third structure has both production and retail competitions.

We study three types of decision makers in the various supply chain network structures: the retailer(s), the manufacturer with superior eco-friendly operations, and the manufacturer with inferior eco-friendly operations. We focus on the following main research question: *How do the consumers' environmental awareness and competition intensity influence the profits of the decision-makers in the three supply chain network structures?* In addition, we study the optimal eco-friendly improvement levels of the manufacturers.

We find that as consumers' environmental awareness increases, retailers and manufacturers with superior eco-friendly operations will benefit, while the profitability of manufacturers with inferior eco-friendly operations will tend to increase if the production competition level is low, and will tend to decrease if the production competition level is high. In addition, higher levels of retail competition may make manufacturers with inferior eco-friendly operations more apt to benefit from the increase of consumers' environmental awareness. Moreover, as the production competition intensifies, the profits of the retailers will always increase, while the profits of the manufacturers with inferior eco-friendly operations will always decrease. The profitability of manufacturers with superior eco-friendly operations will also tend to decrease unless consumers' environmental awareness is high, and the superior manufacturers have a significant cost advantage related to product environmental improvement. As the retail competition intensity increases, the profits of the retailers tend to fall while the profits of the superior manufacturers tend to increases. The profit of the inferior manufacturers will tend to increase if they do not have a significant cost disadvantage related to product environmental improvement; otherwise, their profits may decrease. A summary table of the relationships can be found in the section of managerial insights.