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Alliance or no alliance—Bargaining power in competing reverse supply chains

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ABSTRACT

This work investigates how bargaining power affects negotiations between manufacturers and reverse logistics providers in reverse supply chains under government intervention using a novel three-stage reverse supply chain model for two scenarios, a reverse logistics provider alliance and no reverse logistics provider alliance. Utilizing the asymmetric Nash bargaining game, this work seeks equilibrium negotiation solutions. Analytical results indicate that the reverse logistics provider alliance increases the bargaining power of reverse logistics providers when negotiating with a manufacturer for a profitable recycled-component supply contract; however, manufacturer profits are often reduced. Particularly in the case of an recycled-component vender-dominated market, a reverse logistics alliance with extreme bargaining power may cause a counter-profit effect that results in the decreases of profits for all players involved, including buyers (*i.e.*, manufacturers) and allied recycled-component venders (*i.e.*, reverse logistics providers). Additional managerial insights are provided for discussion.

1. Introduction

As the concept of extended producer responsibility (EPR) has emerged along with government intervention, interactions between manufacturers and reverse logistics (RL) providers are unavoidable in cooperative reverse supply chains. Practical cases in various manufacturing industries, such as the high-tech manufacturing, automobile, iron and steel, textile, and garment industries, further demonstrate the increasing importance of cooperating with RL providers in reverse supply chains, particularly under government intervention. For example, China consumes over 200 million tons of steel annually, including 20 million tons of steel made from steel scrap, 26 million tons of iron recycled by society, and 13 million tons from productive and non-productive recycling of steel scrap. Most Chinese iron and steel manufacturers rely on RL providers to recycle iron and steel scrap at low operational costs and with high efficiency, such that the steel manufacturers can focus on their core businesses. Another example is the electronics manufacturing industry. For instance, ASUS, a well-known global branded computer manufacturer, has recently has adopted green practices (*e.g.*, green procurement, green design, and green manufacturing) to carry out its so-called "Green ASUS" strategy. In terms of green procurement, ASUS uses Acrylonitrile–Butadiene-Styrene plastic for the housing of its notebook computers. Nevertheless, the Regulations on the Administration of the Recovery and Disposal of Waste Electrical and Electronic Products are now enforced in China (Ministry of Environmental Protection, China, 2011), as are the Restriction on Hazardous Substances (RoHS) and Waste Electrical and Electronic Equipment (WEEE) directives in European Union nations. To comply with these new green regulations, ASUS must increase its purchase of recycled Acrylonitrile–Butadiene-Styrene plastic, which is produced by RL providers through reprocessing shredded transfusion tubes, plastic products, and plastic housings of discarded electronics products. Not surprisingly, as a global manufacturer of green notebook computers, ASUS must negotiate with RL providers to procure recycled Acrylonitrile–Butadiene-Styrene plastic.

Typically, via negotiation between a manufacturer and an RL provider, a contract is established for recycled material price and amount. The RL providers include recyclers that provide recycled components by recycling end-of-life products for the production of green products by manufacturers. Such a producer-RL provider negotiation process toward a contractual agreement is indispensible, particularly for those highly profitable recycled-materials, *e.g.*, gold, aluminum, copper, palladium, and other precious metals, that can be reused through recovery and recycling processes from electronic wastes (Chen, Sheu, & Lirn, 2012; Kang & Schoenung, 2005). Thus, RL providers play an important role in cooperative reverse supply chains by providing end-customers with opportunities to return defective products for repair (Tuğba, Semih, & Elif, 2008) and by collecting and recycling end-of-life products for

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manufacturers (Guide, Jayaraman, Srivastava, & Benton, 2000), while conforming with green laws/regulations implemented by governments.

Nevertheless, the cooperative reverse supply chain negotiations cannot ignore the issue of bargaining power (DiMatteo, Prentice, Morant, & Barnhizer, 2007). Bargaining power has been defined as the ability of one party to influence the terms and conditions in a contract or subsequent contracts in its favor due to its possession of unique and valuable resources (Argyres & Liebeskind, 1999). Inderst (2002) claimed that contractual distortions are caused typically by asymmetric bargaining power during negotiation. Crook and Combs (2007) further suggested that bargaining power differs among supply chain members. One notable example is the power-dependence relationship between Wal-Mart and its suppliers, where only large suppliers have an ability to exert countervailing power when facing Wal-Mart's "big squeeze" (Bloom & Perry, 2001).

Furthermore, a shift in bargaining power caused by either government intervention or an RL alliance may increase the complexity of such bilateral negotiations. Based on resource dependence theory (Pfeffer & Salancik, 1978; Ulrich & Barney, 1984), we propose that government intervention can increase the dependence of a manufacturer on an RL provider's resources to comply with green regulations (*e.g.*, take-back laws). According to Pfeffer and Salancik (1978), organizations are rarely self-sufficient with respect to their critical resources and, thus, are dependent upon the resources of others for survival in competitive environments. Conversely, we argue that government intervention increases the likelihood of an RL provider exerting countervailing power through an RL alliance to seek a balanced power relationship when negotiating with manufacturers. For example, government intervention via green legislation and financial incentives has altered the relative power of manufacturers and RL providers during negotiations. This argument is based on evidence from several practical cases in Europe, indicating that recyclers influence producer market share and costs for WEEE compliance (Clean Production Action. 2003; Stevels & Huisman, 2005). Particularly, strategic alliances of RL providers that have relatively less power than manufacturers seek opportunities to gain additional benefits while bargaining with manufacturers. This scenario has been observed increasingly in anecdotal evidence and real-world cases. Moreover, an RL alliance is very likely to facilitate a reduction in RL operational costs by consolidating small volumes of scattered RL tasks with similar attributes into full load tasks to attain economies of scale (Liu & Zhang, 2008).

Although the number of RL studies has grown steadily, reflecting the increasing significance of RL in the context of government intervention, these studies primarily provide a strong basis for developing general frameworks and mathematical models for analyzing RL operational performance and practices for the case of no RL alliance. Krumwiedea and Sheu (2002) established an RL decision-making model to guide the process of examining the feasibility of implementing RL for third-party providers such as transportation companies. Kim, Song, Kim, and Jeong (2006) developed a mathematical model that maximizes total cost savings by determining the equilibrium quantity of parts to be processed at each remanufacturing facility and the number of parts that should be purchased from subcontractors. Additionally, Sheu (2007) built a linear multi-objective analytical model to systematically minimize total RL operating costs and risks, and developed a prototype green supply chain negotiation model (Sheu, 2011). Du and Evans (2008) established a bi-objective optimization model that minimizes overall costs and total tardiness in RL cycle time. Kara, Rugrungruang, and Kaebernick (2007) developed a simulation model to assess the performance of RL networks in collecting end-of-life appliances in the Sydney Metropolitan Area. Min and Ko (2008) utilized a mixed-integer programming model and a genetic algorithm to solve an RL problem involving location and allocation of repair facilities for third-party logistics providers. Mitra and Webster (2008) analyzed a two-period model of a manufacturer that produces and sells a new product and a remanufacturer that competes with the manufacturer during the second period; the effects of governmental subsidies used to promote remanufacturing activities were examined. Hu, Sheu, and Huang (2002) constructed a discrete-time linear analytical model that minimizes total RL operating costs, subject to constraints that consider such internal and external factors as business operating strategies and government regulations. Aksen, Aras, and Karaarslan (2009) developed and solved two bi-level programming (BP) models describing a subsidization agreement between a government and a company engaged in end-of-life product collection and recovery. Under the same collection rate and profitability ratio, a government must provide a higher subsidy with the supportive model than with the legislative model. Chen and Sheu (2009) established a differential game model comprising the Vidale–Wolfe equation, which favors product recycling. Despite these advances for cooperative reverse supply chains, the research scope of these studies was limited to the scenario of RL operations without considering RL alliances. Conversely, this work, including the proposed model and analyses, applies to both the cases of no RL alliance and an RL alliance.

The emergence of research in diverse public goods games used to address issues of resource sustainability in the area of evolutionary games is also noteworthy (Anderson, Goeree, & Holt, 1998; Andreoni, 1988; Hauert, De Monte, Hofbauer, & Sigmund, 2002; Helbing, Szolnoki, Perc, & Szabo, 2010; Semmann, Krambeck, & Milinski, 2003). Stemming from repeated mix-motive games, public goods games aim at the social dilemma in which individual actions enhancing personal prosperity harm the others within groups (Macy & Flache, 2002). Therein, group members are classified into different categories, *e.g.*, cooperators and defectors, interacting with each other, thus contributing to different outcomes designated with respective payoffs. Specifically, public goods games consider reward and punishment effects on the dynamics and dilemmas of collective actions of game players when moving equilibrium conditions (Helbing et al., 2010; Perc, 2012; Perc & Szolnoki, 2012; Szolnoki & Perc, 2010). Similarly, this work treats government intervention as a form of political power characterized by regulatory and financial instruments, which are embedded in the proposed three-stage game-theoretic model. Drawing from the theory of environmental economics (Dobbs, 1991; Polack & Heertje, 2000; Walls & Palmer, 2001), the ideas of external benefit and external cost are conceptualized in a social welfare objective function embedded in the first-stage game dominated by the government. Furthermore, this work considers the influences of green taxation and subsidization, mimicking the effects of punishment and reward effects in public goods games, on the decisions of producers and RL providers in negotiations and market competition, thus formulating the follow-up bargaining and market competition problems in the second- and third-stage using asymmetric Nash bargaining game. Relative to public goods games, the distinctive feature of the proposed model is noticeable in its capability of characterizing the relative bargaining power of game players (*i.e.*, competing manufacturers relative to either RL providers or RL-alliance) and its influence in the decision outcomes of game players when moving toward equilibrium conditions (*e.g.*, cooperative agreements).

Furthermore, scholars have made notable advances in addressing supply chain cooperation issues (*e.g.*, Cachon & Lariviere, 2005; Koulamas, 2006; Pasternack, 1985); however, literature is generally limited to vertical coordination of chain members, and does not discuss the phenomenon of bargaining power alteration in