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Supply chain downsizing under bankruptcy: A robust optimization approach

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ABSTRACT

Research on supply chain network design has mainly pursued efficiency oriented objectives for boosting service level and profit. However, the priority of an enterprise facing bankruptcy pressure shifts to fulfill debt obligation with limited financial resources and survive downsizing. In this paper, we define a supply chain downsizing problem (SCDP) under bankruptcy as streamlining a supply chain network in order to balance a business survival and its long term profitability. We formulate a mixed integer programming (MIP) model with specific downsizing features, which maximizes the utilization of investment resources through a combined operation of demand selection and production assets reallocation. The corresponding robust counterparts of the MIP model are further developed based on robust optimization techniques for dealing with uncertainties of demands and exchange rates. We analyze and validate the proposed downsizing MIP model with a series of systematically generated test cases while its robust counterparts are studied extensively using a large generated case. The findings demonstrate the value of our approach in discovering detailed downsizing plans in magnitude and direction and provide valuable insight into how financial debt payback could be arranged, and in a unique way show managers how the reconfigured downsized network would mitigate and lead to a sustainable and higher economic value supply chain.

1. Introduction

Financial meltdowns over the past decade together with business globalization of the 1990s have challenged all transnational supply chains in their attempts to deliver continued earnings growth. The slower economic growth of this century and tremendous market volatility is inhibiting revenue increase, whilst pressures from rising materials (supply), manufacturing, and distribution costs exacerbate the inevitable deterioration in profit margins (voluntary or involuntary), all bringing companies to the verge of bankruptcy. Companies under bankruptcy pressure very often resort to downsize in order to survive and resolve outstanding financial obligations. A recent example of this is the downsizing case of General Motors (GM) following Chrysler case which faced financial difficulties and, downsized its corporation in 2010, shed capacity to reduce cost and consolidated the manufacturing and supply base to maintain earning leverage to stay afloat. We are not aware whether these companies' decisions were based on any optimization model. However, we are convinced that mathematical modeling approach should be used in such situations to increase consistency, and help to recognize the trade-off of overall supply network and eliminate over-reacted decisions. Therefore, we derive here a mathematical model that addresses a case of downsizing a supply chain. In what follows, we first sketch out a very brief definition of downsizing and explore the literature to indicate the missing areas requiring major improvement to handle downsizing optimization.

In order to gain an understanding of the context of downsizing in supply chain, we first define the underlying concept of downsizing. Contemporary literature on downsizing provides numerous definitions. While Appelbaum et al. (1999) admit this and mention that each definition comes with its inadequacies, they consider the term as systematic reduction of workforce. The term is also interchangeably used in place of restructuring, rightsizing, unbundling, rebalancing, etc. These are adding to the confusion. As a result, we offer the following definition. Downsizing, as a retrenchment strategy implemented by managers for reducing the size of an organization and its work process, is characterized first by Freeman and Cameron (1993) as an intentional endeavor for improving efficiency or effectiveness of an organization, which usually results in reductions in personnel

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and work processes redesign. The emphasis here is not only on the workforce but also on the processes, an operational view for a strategic decision.

Given the above definition, downsizing from industrial organization perspective and as a managerial economic decision has been explored extensively under entry/exit strategy and has been a topic of interest for many researchers in organizational economics. The streamlining of firms has been perceived to be essential in gaining a competitive edge in the marketplace. The entry/exit strategy also appears in the literature as Restructuring or Unbundling (Divestment or Divestiture). While restructuring stands for making operations leaner and more efficient, the divestment refers to sale of parts of a company similar to the problem that we are considering, and divestiture signifies an alteration of the firm's productive portfolio, Moschieri and Mair (2005). Examples of such type of downsizing are Siegfried and Evans (1994) who examine the empirical evidence about why firms enter into and exit from industries. Other examples include Hamilton and Chow (1993) who studied 208 divestments made by large New Zealand companies during 1985–1990, and reported that the necessity of meeting corporate liquidity requirements was among the most important objectives motivating divestment. Their findings strongly support our research initiative in a sense that when cash is scarce, selling off units and rearrangement of part of business are prerequisites to afloat the corporate and avoid bankruptcy. Among theoretical papers we can refer to some pioneers like Fluck and Lynch (1999), they develop a theory of mergers and divestitures. An empirical study by Capron et al. (2001) analyzing 253 cases of horizontal acquisitions examines the causes of asset divestiture. While many theoretical perspectives believe that asset divesture is evidence of acquisition failure, the authors argue that acquisitions provide means of reconfiguring the structure of resources within firms and that asset divestiture is a logical consequence of this reconfiguration process. The finding is yet another evidence of the need for downsizing applications.

In general, when in downsizing supply chain network strategic decisions from operational points of view are examined, the organization economic theory or the game theory approach like the one proposed by Renna and Argoneto (2011) is not an effective tool. The literature that closely relates to our research suggests that Roodman and Schwarz (1975) were among the first authors who addressed a format of downsizing problem. They solve a problem of withdrawing inventory and/or service facilities for a good or service whose overall demand is declining overtime due to economic obsolescence. The proposed approach considers closing some or all of these support facilities over time and reassign demand to remaining facilities such that all continuing demand is met with minimized total discounted costs. Eppen et al. (1989) point out the excess capacity problem of GM and suggest a closure of two to four plants based on a scenario approach designed especially for its capacity planning. The proposed approach charges penalty cost for unsatisfied demands. Melachrinoudis et al. (2005) consider the consolidation and the phase-out of a part of existing warehouses of a distribution network that are under the consideration based on a multiple criteria model. Melo et al. (2005) present a mathematical model for a deterministic network design problem which relocates capacities within an existing network to satisfy all demand, while capacity reduction and facility closure are addressed as possible extensions. The vast part of literature reports mainly on supply chain network design, see Cohen and Lee (1989) and Hodder and Dincer (1986) as pioneer papers. For a detailed review, interested reader might read Goetschalckx et al. (2002), Mieghem (2003), Meixell and Gargeya (2005) and Kouvelis et al. (2006).

In general, up to date literature studies classical supply chain design and consolidation problems, which pursue the operation efficiency while operation content and target are predetermined. Research questions usually face specified demands to serve, and try to minimize the total operations cost for satisfying the specified demands, while the time value of investments and loan payment are not in the core of consideration. Furthermore, none evaluates the benefits of having a flexible and robust supply network that would disregard certain demands for being able to maintain cost-effective delivery of profitable customers in times of large and unscheduled demand fluctuations.

Continued drive for ever increasing supply chain network efficiency, combined with the current recession, represents danger for supply chains facing huge debt. The focus on only increasing efficiency based revenue of entities does not necessarily result in a superior supply chain network; a strategic redesign aggregating disinvestment perspective is required. As such options that can be explored will include reducing the risk from future demand changes, demand substitutions, and price (exchange rate) fluctuations.

As the economy is not rebounding as anticipated, priority is shifted to survival. Therefore, reactionary approach to rightsizing the supply chain network structure will not hold up a prolonged economic downturn. Downsizing a company facing bankruptcy pressure draws special attention to the demand selection and the cash reserve in the context of supply chain management. We see this downsizing problem as a special case of supply chain redesign and capacity reallocation problem. However, the redesign and the reallocation process emphasize on shedding or relocating (consolidating) capacity to maintain future earnings by reusing the existing assets of a supply chain network while extra investment is nonexistent or very limited.

In this paper, we refer to finding the best downsizing strategy of a supply chain network with respect to both fulfilling debt obligation and maximizing the utilization of the investment as a SCDP under bankruptcy. Compared with classical supply chain redesign problems, the SCDP under bankruptcy has the following unique features:

Network status: The SCDP optimizes the closure problem of existing production centers and cutting production capacities. This is opposite to the traditional facilities network design problem which optimizes to open new production centers and to add production capacities. For instance, Lin et al. (2009) present a study which simultaneously seeks an optimal capacity allocation plan and a capacity expansion policy for a computer screen production network.

Demand satisfaction: As the objective is to maximize the possible return on investment, certain demands may not be profitable to satisfy and should be disregarded from demand portfolio. Based on our knowledge of existing literature of capacity allocation, it has been very common to constraint a larger capacity than the total demand. The SCDP under consideration only allocates sufficient production capacity to the profitable demands generating earnings even when it climb down.

Multi-period planning: A multi-period transformation plan is preferred in order to capture the tradeoffs between the benefits and the extra costs from downsizing optimization operations. Note that moving production facilities and closing factories is not only costly but also time consuming. Therefore, associated delays in relocating production facilities can be considered and demand scenarios can be incorporated.

Financial status: The cash reserve of an organization is of crucial importance for fulfilling debt payments and keeping