Networks against time. Supply chain analytics for perishable products

Networks Against Time. Supply Chain Analytics for Perishable Products by Anna Nagurney, Min Yu, Amir H. Masoumi, and Ladimer S. Nagurney, Springer, 2013, 142 pp., EUR 51.99, ISBN 978-1-4614-6276-7

This book aims to provide a unified analytic framework to support the management of supply chains dealing with time-sensitive and perishable products. Time-sensitivity coming from both the characteristics of the product and consumer purchasing decisions is considered.

The authors move steps from the fact that the production, distribution, and consumption of highly time-dependent products, as well as the associated decision-making, need to be appropriately organised in order to gain competitive advantage in global markets. The very rich literature about the different supply chain topics is still fragmented when it comes to time-sensitive products. Hence the need to develop a general framework that systematically represents and quantifies supply chains, together with assisting in management choices.

By relying on network theory, optimisation theory, and game theory, the present work carefully analyses a number of representative time-sensitive products and proposes for each of them a supply chain network model that can be also adapted to other similar contexts. A variational inequality formulation of each problem is defined and most of the solution computational approaches rely on the Euler method.

The book is organised in three parts. Part I is devoted to providing the reader with the necessary background and laying down the methodological approach of the work. Part II is concerned with supply chain network optimisation and discusses two models about blood and medical nuclear supply chains respectively. Part III focuses on supply chain network models characterised by multiple competing firms in the food, pharmaceutical, and fast fashion sectors. Possible demand structures are considered and for each of them market equilibrium conditions are determined.

The theoretical foundations, the methodological framework, and the organisation of the book are presented in chapter 1. Chapter 2 develops a generalised network optimisation model for a blood banking system that takes into account disposal costs, shortage and surplus costs, and the risks associated to both the supply and the demand sides. Some numerical blood supply chain examples are given in order to clarify the network structure. After introducing the computational approach to solve the problem, the authors offer a detailed case study in order to prove the applicability and the effectiveness of the model. Chapter 3 discusses a supply chain network model in the medical nuclear field, with particular reference to the radioisotope molybdenum. The total operational cost, the total waste cost, and the risks associated with the supply chain activities are optimised. The problem is modelled as a multi-criteria system optimisation problem on a generalised network which is then solved by means of the projection method. The case study is related to a molybdenum 99 supply chain in North America and analyses different operational scenarios. Chapter 4 turns to multiple decision-maker competitive equilibrium models and puts forward a fresh food supply chain network model under oligopolistic competition. Such model includes food decay, discarding costs, product differentiation as a consequence of freshness and food safety concerns, together with alternative technologies supporting supply chain operations. A case study focused on the American cantaloupe market is provided: multiple scenarios before, during, and after the outbreak of a foodborne disease are analysed. Demand, price, and profit are calculated according to a Cournot-Nash equilibrium. Chapter 5 develops a generalised network oligopoly model for a

pharmaceutical supply chain. This framework captures the Cournot competition among firms during manufacturing, storage, and distribution activities, with the aim of maximising profits and minimising waste discarding costs. As in the food supply chain network model, product perishability and brand differentiation are taken into account. The solution algorithm is applied to the case of the cholesterol - regulating drug competition in the US. Three scenarios corresponding to various market conditions are studied in order to determine the associated equilibrium demand, price, and profit. The authors also explain how the provided network representation could be modified to capture outsourcing of production and other supply chain activities as well as mergers and acquisitions. Finally, chapter 6 introduces an oligopoly pure network model for fast fashion supply chains in the case of differentiated products. In such a model the time is captured by means of time consumption functions. Each firm maximises its profit while minimising its environmental emissions as a consequence of supply chain activities. The case study is structured around three scenarios each comprising a number of numerical examples under different market conditions. The effects of changes in demand functions, total costs, emission levels, and the importance to each firm of environmental issues are investigated and managerial insights derived.

The structure of the book is very straightforward since all the chapters from 2 to 6 start by introducing the focus supply chain then unfold with the formulation of the model, the computational approach for its solution, and the case study. The repetitive structure helps the reader easily understand and connect the various parts of the book. Furthermore, each of these chapters ends with additional notes and links to other works about the supply chain at issue, as well as a rich and updated list of references, so that the content of the chapter can be related to and compared with the current state of the art. The level of mathematical formulation is adequate and all the presented formulas are explained in detail. Also, complete input and output data about case studies are presented.

In my opinion this book is a valid contribution to the discipline of supply chain management in the time-sensitive product field because it provides a systematic and analytic framework of analysis which actually lacks in the existing literature.

Both researchers and practitioners might benefit from reading the book. As a matter of fact, it can guide researchers in advancing knowledge about the topic by developing network problems and deriving associated solutions in various supply chain and competitive environments. In this way, they can define approaches that specifically capture the perishable and time-sensitive properties of products and services and the impacts they have on supply chain dynamics. Practitioners, not only in the analysed industries but also in other sectors, can find the present work a useful reference in understanding the structure and the behaviour of their supply chains and formulating appropriate management strategies to either establish or retain a competitive advantage in complex global marketplaces. To this end, they can be inspired by the numerous numerical examples and case studies provided by the book.

Although the book gives clear descriptions of models and their solution algorithms, I think it is pretty much beneficial to the reader to a have a good knowledge about network, optimisations, and game theories.

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