

# The Budget Constrained Multi-product Newsboy Problem with Reactive Production: A Problem from Entrepreneurial Network Construction\*

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**Abstract:** This paper develops an extended newsboy model and presents a formulation for this model. This new model has solved the budget contained multi-product newsboy problem with the reactive production. This model can be used to describe the status of entrepreneurial network construction. We use the Lagrange multiplier procedure to deal with our problem, but it is too complicated to get the exact solution. So we introduce the homotopy method to deal with it. We give the flow chart to describe how to get the solution via the homotopy method. We also illustrate our model in both the classical procedure and the homotopy method. Comparing the two methods, we can see that the homotopy method is more exact and efficient.

**Key words:** newsboy problem, entrepreneurial network, construction, multi-product, budget constrained, reactive production, homotopy method

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## 1 Introduction

The classical newsboy problem is a single period stochastic inventory model. Harris<sup>[1]</sup> presented a formula for the optimal economic order quantity (EOQ) in simple inventory models. Afterwards, much more attention was paid to the character of the single period product, and this problem was called single-period problem (SPP) or newsboy problem (NP). Hadley and Whitin<sup>[2]</sup> developed the constrained newsboy problem in 1963. Khouja<sup>[3]</sup> classified the extensions into 11 categories in 1999. The newsboy problem with reactive production is

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not in the 11 extensions. Chung and Flynn<sup>[4]</sup> first developed this extension to the newsboy problem in 2001, and they divided the production into two stages, an anticipatory stage and a reactive stage. But there are two aspects of localization in [4], only one product is concerned and there are no budget constraints to the production. Some constrained newsboy problems have been studied (see [4–6]).

In today's supply chain management, the most frequent instance we have to face is the newsboy problem which contains multiple products and has to constrain the budget. If the products are seasonal products with a long-selling season and a highly volatile stochastic demand, we have to divide the production into two parts, an anticipatory stage and a reactive stage. So we extend the newsboy problem to deal with this situation. In this paper we consider the newsboy model which contains multiple products. The production occurs in two stages, an anticipatory stage and a reactive stage. The budgets in both stages have to be constrained. It can be explained as follows. There are several products that are all the seasonal ones. And each of them has a highly volatile stochastic demand. The demand of each product is very high at the peak period and is negligible at the off-peak period. Chung and Flynn<sup>[4]</sup> said that if this situation was solved by the classical newsboy problem model, it leads to a low service level or a highly volatile demand. Both of the two results are not what we want to see. So Chung and Flynn<sup>[4]</sup> modified the classical model, and introduced two production periods, which are the anticipatory stage and the reactive stage.

In the real world, the budgets in both of the two production periods should be constrained. Our main work is to find whether the optimal order quantities for each product in the two stages exist or not. To solve our problem, we can follow the classical procedure which is used to solve the constrained multi-product newsboy problem. However, it is too complex for us to get the exact solution of the model. So we introduce a new method, the homotopy method, to deal with our problem. We illustrate our model in both the classical procedure and the homotopy method. Compared with the two methods, we can find that the homotopy method is more exact and efficient. In entrepreneurial network construction, we face that the energy is constrained. So we must optimize the network, as the budget is constrained in [7].

This paper is organized as follows. In Section 2, we give a brief review of the newsboy Problem. We uniformize the formula into the same parameter, and give the solution procedure. In Section 3, the model formulation of our problem is given. We use the classical procedure and the combined homotopy interior point method to deal with our problem respectively. And then compared with the two procedures, we find the better one. In Section 4, We give a numerical example to illustrate our solution procedure.

## 2 A Brief Review of the Newsboy Problem

In this section, we review the classical newsboy problem and its two extensions. First, we give some notations and assumptions.