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Modelling product returns in inventory control—exploring the validity of general assumptions

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Abstract

The literature on stochastic models for inventory control with product returns commonly makes the following simplifying assumptions: demand and returns are each a homogeneous (compound) Poisson Process, and the processes are independent of each other. In this paper, we explore the validity of these assumptions by analysing real data on return flows. In addition, we discuss practical implications of our findings and we provide insights on information management for inventory systems with return flows.

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1. Introduction

Already for a long time, companies take back products, which if in good condition go back to inventory. Furthermore, environmental consciousness, legal and economic forces have brought more attention to systems with reverse flows, and to its control. Fleischmann et al. (2002), van der Laan et al. (1999) and Inderfurth and van der Laan (2001) are recent examples of scientific literature on inventory control in case of returns. From a modelling perspective, one of the consequences of reverse flows is the loss of monotonicity of inventory levels between replenishments of new products. That is, the inventory level does not only decrease because of demand but it may also increase in case of returns. Since this makes the

analysis much more difficult than traditional inventory control, authors use simplifying assumptions regarding the return process. These assumptions typically are: (1) the demand flow is a homogeneous Poisson Process; (2) the return flow is a homogeneous Poisson Process; and (3) the return process is independent of the demand process (see Fleischmann, 1997; Dekker and van der Laan, 1996). However, there is nearly no (scientific) literature on empirical analysis of data with reverse flows. Thus, in this paper, we explore the empirical validity of these common assumptions. First of all, we present a methodology to check the assumptions empirically. We describe actual practice in companies with respect to information storage on returns and inventory control. Moreover, we apply the methodology to real data and we discuss practical implications of our findings, for instance with respect to information management on inventory systems with

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returns. We employ data from three companies here referred to as CERN, MOC and RF. CERN, the database of the European Organization for Nuclear Research (CERN Web Communications, 2000) and RF, a refinery, regards internal material returns. MOC, a mail-order company, handles customer product returns.

The remainder of the paper is organised as follows. The next section is dedicated to a survey of relevant issues concerning return handling in practice. Next, a review of the main assumptions in the literature when it comes to inventory models with return flows is presented. Then, in Section 4 the methodology is put forward and in Section 5 the data is described. The analysis can be found in Section 6. The last sections sum up the conclusions, practical implications and research needs.

2. Handling returns in practice

Regarding product returns one may distinguish products which are in a good state and those which are not. The former can be put again in inventory after a short period of inspection, sorting, possible testing and repackaging. The latter ones usually go out of the company's system to be sold in another market, remanufactured,

recycled or disposed. This paper studies product returns of the first group, e.g. products in good condition, whose handling is of relatively short duration and which are put again in the inventory of new goods (Fig. 1).

One can distinguish several situations where this type of returns occurs:

- due to commercial agreements (supplier/retailer, retailer/customer);
- in-company warehouses (internal returns);
- in maintenance settings (e.g., spare-parts returns from maintenance engineers);
- lease of equipment.

To illustrate the dimensions of product returns systems we add below more details to each of these situations. Take-back guarantees by suppliers to retailers are very common for products that become out-of-fashion quickly as newspapers or personal computers. Also, mail-order companies and electronic retailers (e-tailers) allow their customers to return products within certain amount of days. For instance, *amazon.com* fully refunds products returned within 30 days after the customer has received them. In case of a self-owned warehouse, "customers" have more freedom to return products, as these products belong to the same organisation as the store. Another

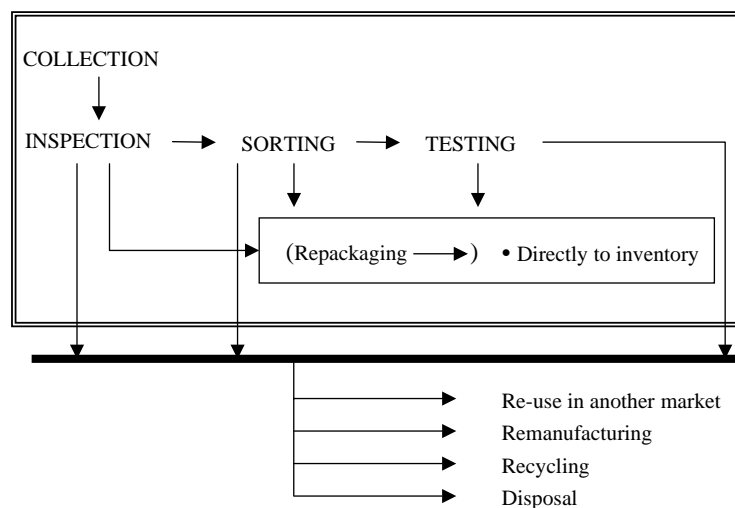


Fig. 1. Handling returns in practice.

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