ARTICLE IN PRESS

Transportation Research Part E xxx (2013) xxx–xxx

Contents lists available at SciVerse ScienceDirect

Transportation Research Part E

journal homepage: www.elsevier.com/locate/tre

Local sourcing and fashion quick response system: The impacts of carbon footprint tax ☆

Tsan-Ming Choi *

Business Division, Institute of Textiles and Clothing, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong

ARTICLE INFO

Article history:
Received 31 August 2012
Received in revised form 18 December 2012
Accepted 12 January 2013
Available online xxxx

Keywords:
Local sourcing
Quick response system
Carbon footprint tax
Sustainability

ABSTRACT

Quick response (QR) system is a well-established industrial practice in fashion apparel. It aims at enhancing inventory management by reducing lead time. In addition to employing a faster delivery mode, QR can be achieved by local sourcing (instead of offshore sourcing). This paper analytically studies how a properly designed carbon footprint taxation scheme can be imposed on a QR system to enhance environmental sustainability via employing a local manufacturer by offsetting the probable higher total logistics and production costs. By examining both the single-ordering and the dual-ordering QR systems, we illustrate how the carbon footprint taxation scheme affects the optimal choice of sourcing decision. Our analytical findings reveal that a properly designed carbon footprint taxation scheme by governing body not only can successfully entice the fashion retailer to source from a local manufacturer, but it can also lead to a lower level of risk for the fashion retailer. A mean-risk improving scenario hence results and it provides a significant incentive to convince the fashion retailer to support the idea of joining QR when the carbon footprint tax is in place.

1. Introduction

Environmental sustainability is receiving more and more public awareness all around the globe (Nagurney and Yu, 2012). There are many reports and scientific studies which indicate that the world is facing very serious environmental problems (see Lee, 2011). This issue is especially prominent in industries such as fashion apparel because the fashion supply chain is known to create all kinds of pollutants (de Brito et al., 2008; Caniato et al., 2012; Lo et al., 2012; Perry, 2012). Measures to stop environmentally unsustainable production, distribution and consumption are hence necessary (see Song and Leng, 2012 for the discussions on carbon trading quota, tax and other related sustainability measures). Among these measures, a recent proposal is to impose carbon footprint tax[1] (Larsen et al., 2012) as a kind of environmental protection tax on business operations. One idea of this kind of carbon footprint tax is to penalize companies on environmental-unfriendly "long-distance" production and distribution via increasing the tax on them (Gemechu et al., 2012). For example, if a fashion retailer chooses to source its merchandise from manufacturers located far away from the retail market (i.e., offshore sourcing), the corresponding long shipping distance will incur a substantial carbon footprint tax. Thus, the presence of this kind of carbon footprint tax helps entice the fashion retailers to source from nearby manufacturers and this will directly lead to reduced pollutants and help enhance environmental sustainability.

☆ The author sincerely thanks the guest editor for his kind invitation to contribute to this special issue. He also thanks the three anonymous reviewers for their kind and constructive comments which led to major improvement of this paper. This research is partially supported by The Hong Kong Polytechnic University under the research project with an account number of G-YJ23.

* Tel.: +852 27666450.
E-mail address: Jason.choi@polyu.edu.hk

[1] It is also known as the carbon emission tax.

1366-5545/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.tre.2013.03.006

On the other hand, in the fashion industry, in order to cope with the ever changing demand driven by the volatile fashion trend in the market, quick response (QR) has been a well-established practice for over two decades (Choi and Chow, 2008). The idea of quick response is to cut lead time and respond fast to market changes. With a reduced lead time, quick response helps to match market demand and supply better and this will directly reduce the amount of product leftover as well as the need of markdown and salvage of the unsold products. In addition to the implementation of versatile information systems (Choi and Sethi, 2010), many QR programs also employ local/nearby manufacturers as suppliers because this strategy can ensure a timely inventory supply in response to market demand changes. From this perspective, a QR program with sourcing from local manufacturers is also a program which is environmentally friendly in the sense that the required carbon footprint in shipping is much reduced compared to the sourcing scheme from far-away offshore manufacturers.

Motivated by the industrial practice of QR in fashion apparel and the proposal of carbon footprint taxation scheme, this paper analytically studies how a properly designed carbon footprint taxation scheme can be imposed into a QR system to enhance environmental sustainability by offsetting the probable higher total logistics and production costs in employing local supplier. By examining both the single-ordering and the dual-ordering QR systems, we illustrate how the carbon footprint taxation scheme affects the optimal choice of sourcing decision. Our analytical findings reveal that a well-designed carbon footprint taxation scheme by governing body not only can successfully entice the fashion retailer to source from the local supplier, but it can also help to lower the level of risk for the fashion retailer. A mean-risk improving scenario hence results and it provides a significant incentive to convince the fashion retailer to support the idea of participating in QR in the presence of carbon footprint tax.

The organization of the rest of this paper is given as follows. Section 2 presents a concise literature review. Section 3 shows the basic analytical QR model with Bayesian forecast updating and carbon footprint taxation scheme. Section 4 describes the findings and analytical results for the case with single ordering. Section 5 presents the dynamic inventory policy and insights for the case with dual ordering flexibility. Section 6 concludes the paper with a discussion on future research. To enhance exposition, all proofs are relegated to Appendix A.

2. Literature review

This paper relates to two areas in the literature, namely QR programs, and carbon footprint related green operations management. We provide a concise review of some recent papers as follows.

QR programs are a well-established industrial practice first implemented in the American apparel industry (Iyer and Bergen, 1997). The features of QR include: (i) reducing lead time (Choi et al., 2003), (ii) responding fast to the consumer demand (Pourakbar et al., 2009), (iii) achieving high inventory service level (Iyer and Bergen, 1997), (iv) utilizing market information to drive the supply chain operations (Donohue, 2000). In the operations management literature, Iyer and Bergen (1997) pioneered a study on QR supply chain with a formal analytical information updating model. They found that under QR in their model setting, the retailer is always benefited but the manufacturer suffers if the inventory service level is larger than 50% (the usual case). With reference to real world industrial practice, they proposed various practical policies, such as wholesale pricing commitment, service level commitment, and total volume commitment, which can help to achieve Pareto improvement in the QR supply chain. After that, Gurnani and Tang (1999) considered the optimal inventory policy with dual ordering flexibility. They considered the situation that the retailer can place orders at two distinct stages (i.e. time points). At the earlier stage (Stage 1), the ordering cost is known while the market demand is less accurate. At the later stage (Stage 2), after information updating, the market demand is more accurate but the ordering cost is unknown before reaching Stage 2. They formulated the problem by using the bivariate normal distribution with which market demand and the information factor are modelled. They developed the optimal inventory policy. They examined the cases with worthless and perfect information and generated a number of important insights. Similar to Gurnani and Tang (1999), Choi et al. (2003) examined an optimal two-stage two-ordering policy. By employing the information updating model similar to Iyer and Bergen (1997), they constructed a dynamic optimization model and derived the optimal inventory policy. They generated further insights by studying the service level and level of risk associated with the optimal inventory policy. Some other QR related analytical studies include: (i) A mean–variance analysis of QR program and the achievability of supply chain coordination (Choi and Chow, 2008), (ii) a study on whether the manufacturer can benefit from selling to the better forecasting retailer in a supply chain context (Taylor and Xiao, 2010), (iii) an exploration on unreliable retail inventory problem with a forecast update (Tiwari et al., 2011), and (iv) an analytical study of multi-item quick response system with budget constraint (Serel, 2012). For details of more related literature on QR,[2] readers can refer to Choi and Sethi (2010) and the references therein.

Green operations management is a very timely area. There are more and more published studies in the literature. For example, Sundarakani et al. (2010) investigated the carbon footprint in a supply chain context. They formulated an analytical model based on the methods such as long-range Lagrangian and the Eulerian transport. They approximated the three-dimensional infinite carbon footprint model by some finite difference methods to enhance the derivation of optimal solution. They argued that including carbon footprint into the supply chain model can be very influential. Bae et al. (2011) developed a two-stage game theoretic model to explore the management of green transportation fleets. Their model includes factors such as

[2] Other industrial practices related to QR include vendor managed inventory (VMI) and collaborative planning, forecasting and replenishment (CPFR). See Yao and Dresner (2008) for a related study.

Please cite this article in press as: Choi, T.-M. Local sourcing and fashion quick response system: The impacts of carbon footprint tax. Transport. Res. Part E (2013), http://dx.doi.org/10.1016/j.tre.2013.03.006