Chapter 1

Introduction

1.1 Motivation

Supply chains consist of all processes which are needed in order to supply customers with the required products. These are, for instance, sourcing, production, transport or warehousing processes. Traditionally supply chain management decisions are based on the economic performance of the parties involved which can be expressed by (non-)financial measures, like profit or total landed costs and customer service (see, for instance, Chopra and Meindl, 2010, van Mieghem, 2008). Based on the economic performance measures, different supply chain strategies, like outsourcing and offshoring, which is the relocation of production activities to low-cost countries, or centralization of production or warehousing facilities have turned out to be advantageous in certain industries. These strategies lead to a reduction of procurement or production costs in the case of outsourcing and offshoring. By centralizing production facilities economies of scale can be exploited; in the case of centralization of warehousing facilities inventory costs can be reduced due to risk pooling effects (see, e.g., Anupindi et al., 2006, Chopra and Meindl, 2010). But as a negative side-effect supply chains become longer and/or more complex (Tang, 2006). Due to the increased length of supply chains, in general, more transport activities are necessary leading to an increase of the respective costs. Furthermore, even though some of the transport can be shifted to more environmentally friendly modes, such as sea transport, in general, the strategies go hand in hand with higher carbon emissions from transport.

In recent years, besides economic performance measures other criteria, like flexibility, quality or the environment, have become important as well (Ferreira and Prokopets, 2009). Environmental issues, especially carbon emissions related to the activities of companies, rank high on the political agenda because they are considered to be a major cause of the greenhouse gas effect (IPCC, 2007). Based on this, regulations concerning carbon emissions of companies’ activities have already been introduced. One example is the EU emission trading scheme (ETS) which restricts the carbon emissions of energy-intensive industries within the European Union (European Community, 2005). Beside these industries, which account for approximately half of the carbon emissions, transport is the second largest polluter (Eurostat, 2009). Therefore, stricter regulations with respect to carbon emissions of transport are expected to be introduced. For instance, based on an EU directive agreed in 2008 (European
Community, 2008) aviation will be included in the EU ETS by 2012. Alternatively, a transport carbon emission tax or charge may be introduced to make companies pay some part of the external costs of transport.

Beside the pressure of new regulations Walker et al. (2008) point out other drivers for “green” supply chain management, such as customer awareness with respect to the environmental impact of products, the personal commitment of managers or internal cost reduction initiatives. Due to these internal and external drivers companies start to consider the environment in their decision-making. It can be concluded that mainly stricter regulations and increasing customer awareness encourage companies to reconsider their strategies by incorporating the environmental dimension in supply chain management decisions. Companies have to search for strategies that are at the same time cost-efficient, provide the required customer service and have a low negative impact on the environment. Furthermore, companies will have to deal with more stringent regulations concerning carbon emissions.

1.2 Purpose of the work

In addition to economic performance measures, like total landed costs or profit and customer service, a further dimension, i.e. the environment, should be included in supply chain management decisions. Based on economic performance measures strategies, like offshoring, outsourcing of production and centralization inventory locations, are pursued in various industries. Often a single offshore sourcing strategy is pursued in order to lower product unit costs whereby the increase of transport costs is often negligible compared to the reductions of procurement costs. Transport activities, however, have a negative impact on the environment, mainly due to the carbon emissions produced by the use of fossil fuels, and should therefore be reduced from the viewpoint of environmental sustainability. Furthermore, it is to be expected that stricter regulations will be imposed on the transport sector, like the introduction of a carbon emission tax or the implementation of a carbon emission trading scheme for the transport sector.

Some work has already been done with regards to considering environmental criteria in supply chain management decisions. But, to the best of our knowledge, not much work has been done with respect to including the environmental impact of transport into the sourcing and ordering decision. To fill a part of this research gap, we compare a single offshore sourcing strategy with a dual sourcing strategy relying on an offshore and an onshore supplier. For the modelling, we rely on the newsvendor framework. The offshore supplier is cheap but is far away from the market. It has a long lead time and is therefore slow and inflexible. The onshore supplier is close to the market and...
1.3 Structure of the work

In Section 2 we present, first, the basics of “traditional” supply chain management and give a brief overview of supply chain planning levels and the related decisions. Furthermore, we briefly deal with the drivers of supply chains and their impact on the economic performance of supply chains. Second, the focus is on defining the general term sustainability and its relation to supply chains. The focus of our work is on economic and environmental sustainability, excluding the social dimension, and therefore, we present conceptual works related to “green supply chain management”. In addition to that, an overview of approaches of how to measure the carbon emissions resulting from supply chain activities is given. In this respect, the focus is on carbon emissions of transport and the respective calculation models and tools. This chapter ends with an overview of environmental regulations which have an impact on supply chains.

In Section 3 we provide an overview of works dealing with the integration of environmental aspects into supply chain decisions whereby we group the works...
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generating the decision support which they provide. For our purpose, these are network design decisions, inventory (ordering) decisions, production mix and production planning decisions and transport mode choice and transport planning decisions. Basically, the environment can be integrated in decision-making by adding (a) constraint(s), by monetarisation of the environmental impact and including it in the cost or profit function or by using multi-objective programming approaches. We conclude this chapter with a summary of the existing work and point out the relations to our field of research.

Section 4 is the core of this work. First, we provide a short review of inventory management and the classical newsvendor model which is the cornerstone of our work. Second, we present an overview of sourcing strategies and deal in detail with dual sourcing in the newsvendor context. We, then, extend the economic evaluation of dual sourcing by also accounting for its environmental performance, i.e. carbon emissions from transport. For that purpose, we develop a transport-focused dual sourcing framework and we compare a single offshore sourcing strategy with a dual sourcing strategy relying on an offshore and an onshore supplier. This chapter comprises the basic single-period dual sourcing model based on the newsvendor framework and its extensions to account for environmental regulations with respect to transport carbon emissions. We provide analytical results as well as numerical analyses from which we derive implications for management and policy-making.

In Section 5 we discuss the general conclusions of our work and point out limitations as well as further research opportunities.