Int. J. Production Economics 158 (2014) 267–277

Contents lists available at ScienceDirect

Int. J. Production Economics

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

Redesign of global supply chains with integration of transfer pricing: Mathematical modeling and managerial insights

R. Hammami [a,*], Y. Frein [b]

[a] ESC Rennes School of Business, Rennes, France
[b] Laboratoire G-SCOP, Grenoble INP, UJF, CNRS, Grenoble, France

ARTICLE INFO

Article history:
Received 16 May 2013
Accepted 5 August 2014
Available online 21 August 2014

Keywords:
Supply chain redesign
Transfer pricing
Profit split
Capacity relocation
International factors

ABSTRACT

Unlike the supply chain (SC) design problem which deals with the configuration of a new SC, the redesign problem assumes that a SC already exists and focuses on its reconfiguration in order to take profit of the changing logistics, financial, and fiscal advantages offered by each country. First, this requires considering specific decisions and cost factors such as those associated with facility closing and capacity relocation. These aspects are often ignored by SC design models. Second, to better capitalize on the tax advantages in each country, the redesign of SC requires the consideration of taxation rates and, mainly, transfer pricing. Indeed, companies can use transfer pricing to shift profits to lower-tax countries which may impact on the SC redesign decisions (e.g., on the relocation of operations and manufacturing facilities).

This paper contributes to the literature by (1) developing a large scale optimization model that is specific to the problem of SC redesign while addressing decisions, costs, and complexity factors that are often ignored by the model-based SC design literature, (2) integrating transfer pricing in the model by using two methods, one of them is the profit split method that is dictated by the OECD transfer pricing guidelines (1995, 2010), which could be considered as a novelty in large scale SC optimization models, and (3) using the model to derive a series of insights that may be helpful for companies and governments, most of these insights are difficult to obtain without the support of models like the one developed here.

1. Introduction

Motivated by the opportunities and advantages of globalization, basically in terms of low production costs and tax advantages offered by some countries, companies are increasingly interested in the redesign of their supply chains by considering new potential locations for their production sites and new potential suppliers in different countries. Melo et al. (2009) argue that network redesign processes have become more frequent and have gained increasing importance. Many authors (e.g., Chandra and Grabis 2007, Hammami et al., 2008; Melo et al., 2009) have identified situations that may force companies to change the configuration of their supply chains through the relocation of some facilities to areas with more favorable economic conditions. Basically, supply chain redesign processes are triggered by offshoring, expansion opportunities to new markets, mergers, acquisitions, and strategic alliance.

Supply chain redesign problem: Unlike the Supply Chain (SC) design, the redesign problem assumes that the SC already exists and focuses on the reconfiguration decisions such as the relocation of production activities from existing to new facilities and the closing/opening facility decisions. In a typical SC redesign project, the firm breaks its existing SC up and relocates each activity where it gives the highest value. For instance, we may have a situation where the manufacturing of final product is kept close to customer while the semi-finished products are transferred towards different new sites in different countries. This common situation (e.g., in automotive industry) may lead to a complex SC where different echelons are involved in the manufacturing of a given final product. For instance, the final product is manufactured in site A, the semi-finished products of first level are manufactured in one or different sites B, the semi-finished products of second level in one or different sites C, etc. Clearly, the number of reconfiguration possibilities is very large. To each reconfiguration alternative corresponds to a new SC structure with its associated number of echelons (stages in the SC). The optimal configuration cannot be known in advance but is determined by the model. Consequently, the optimal number of echelons in the SC should not be imposed (should not be defined in advance) but will be given by the model solution. This example shows that, on one hand, the intermediate products play a key role in SC redesign projects and, on the other hand, the number of echelons of the new SC (after reconfiguration) should not be imposed in advance since, otherwise, one can miss the optimal reconfiguration.

* Corresponding author.

http://dx.doi.org/10.1016/j.ijpe.2014.08.005
0925-5273/

The redesign of SC should also take into consideration the initial conditions; mainly the initial structure of the SC network and the amounts of existing capacities. Furthermore, some specific cost factors, such as the costs of closing facilities and relocating capacities, should be taken into account as they are expected to impact on SC redesign decisions. One of the main motivations of SC redesign projects is to take profit of the financial and tax advantages offered by some countries. In this case, in order to make the best decision, global companies' analysis should encompass operational, financial, and tax considerations (Shunko et al., 2013). In particular, it is of major interest to combine transfer pricing and operations decisions in SC redesign models.

Transfer pricing and its correlation with supply chain decisions: Transfer pricing refers to the strategy of determining the transfer price (TP), defined as the price that a buying subsidiary of a firm has to pay to a selling subsidiary of the same firm to obtain a given product (Perron et al., 2010). With globalization, it is increasingly common that intermediate and final products are exchanged between the different subsidiaries of a global firm. If the involved subsidiaries are in different countries then transfer pricing is viewed as a powerful tool for shifting income to subsidiaries in lower-tax countries and consequently increasing after-tax profit of the SC (Shunko and Gavirneni, 2007). Examples on how global companies can use transfer pricing to shift incomes from high-tax to low-tax countries and to maximize the global after tax profit are given, for instance, in Shunko et al. (2013), Shunko and Gavirneni (2007) and Lakhal et al. (2005).

In order to curtail the opportunities of depriving a country of its incomes, most countries (e.g. US) have adopted transfer pricing methods based on the arm's length principle defined in the Organization for Economic Cooperation and Development (OECD) Transfer Pricing Guidelines for Multinational Enterprises and Tax Administrations (Huh and Park, 2013). Indeed, the transfer price should be the best estimate of the price if the two divisions involved are independent entities rather than parts of the same firm. The OECD transfer pricing guidelines were first issued in 1979 and have become internationally respected. They have been updated in 1995 and 2010. They provide five transfer pricing methods: the comparable uncontrolled price method, the resale price method, the cost plus method, the transactional net margin method, and the profit split method. These five transfer pricing methods represent the international consensus on the manner of applying the arm's length principle (OECD guidelines, 2010). These methods are generally accepted by national tax authorities (Li, 2002). The US transfer pricing regulations authorize also the use of any other unspecified method if its use can be justified (see Huh and Park, 2013, for a deeper discussion of US regulation). The determination of the TP is less complicated when the intermediate product has its own market outside the firm. In such a case, the arm's length price is the market price (this is referred to by the comparable uncontrolled price method). However, this method is less likely to be suitable for the SC redesign problem which involves many intermediate products. As highlighted by Huh and Park (2013), an intermediate product is often specific to the firm and not sold outside it. In this case, profit based transfer pricing methods are generally suitable (Li, 2002). Anyway, a company could choose to determine the TP by any method as long as it can justify its use to the authorities.

Traditionally, the SC design has been done independently of transfer pricing (Shunko et al., 2013). However, many authors argue that transfer pricing and SC decisions are highly correlated (e.g., Huh and Park, 2013; Shunko et al., 2013; Perron et al., 2010; Sutton, 2008; Meixell and Gargeya, 2005). Tax-aligned design and management of SC are poised to be a new frontier of excellence for global companies which have recently recognized that significant savings can be achieved if transfer pricing and SC activities are coordinated (Shunko et al., 2013). A global transfer pricing survey conducted by Ernst and Young found that 80% of US based multinationals involve tax directors at the "concept or initiation phase" of business planning (Ernst and Young, 2007).

Transfer pricing has been considered by two categories of works in the SC model-based literature. In the first category, transfer pricing can be viewed as the main decision of the model. The focus is generally made on the impacts of transfer pricing on some SC decisions or on the comparison of different TP policies (e.g., Huh and Park, 2013; Shunko et al., 2013; Villegas and Ouenniche, 2008; Shunko and Gavirneni, 2007; Lakhal, 2006; Lakhal et al., 2005). Most of these papers consider transfer pricing methods dictated by OECD guidelines. However, they generally consider a simple SC structure (e.g., one buyer and one supplier) and deal with the transfer price of only one product. The second category regroups papers that optimize large scale SC models where transfer pricing is coupled with many SC decisions (e.g., Perron et al., 2010; Hammami et al., 2009; Canel and Khumawala, 1997; Cohen et al., 1989; Nieckels, 1976). Our work falls into this second stream of research. Given the complexity of such models, most of published works determine transfer prices by imposing acceptable lower and upper bounds on the transfer price of each product.

Purpose of the paper: In this paper, we develop a profit-maximization optimization model that is specific to the redesign of global supply chains while integrating transfer pricing. The model captures the characteristics of the SC redesign problem presented above such as the consideration of activity relocation, facility closing, initially existing production capacities, intermediate products, and arbitrary number of SC echelons. In addition, we integrate transfer pricing in the model since, on one hand, the correlation between transfer pricing and SC modeling has been well established in the recent operations management literature and, on the other hand, SC redesign projects are often motivated by tax advantages offered by some countries which raises the role of transfer pricing as explained earlier.

We consider two transfer pricing methods. Firstly, we proceed by imposing acceptable lower and upper bounds on the TP of each product as usual in the model-based SC literature (e.g., Vidal and Goetschalckx, 2001; Hammami et al., 2009; Perron et al., 2010). This assumes that comparable products can be found in the external market and that lower and upper bounds can be determined. However, in many cases, it is very difficult to find comparable products for semi-finished products that are usually transferred between the different sites of a global firm. Hence, we secondly use the Profit Split (PS) method that is dictated by OECD guidelines (OECD, 2010, 1995) and that can be adopted when no quality comparable data are available. According to the PS method, the combined profits resulting from all the parties of the SC are split between the entities involved in earning those profits based on the contribution of each entity. The TP are then fixed according to the profit that should be allocated to each entity.

We show in this paper that while a large number of works are dedicated to the SC design, the SC redesign problem is still underdeveloped. Also, to the best of our knowledge, there is a lack of large scale SC optimization models that integrate transfer pricing by using one of the methods dictated by the OECD guidelines such as the PS method. In addition to the development of the model, we conduct different experiments on a realistic case study and derive a series of insights that may be valuable for policy makers in both companies and governments. For instance, we study the impacts of taxation rates, transfer pricing, and currency exchange rates on the relocation of production activities from origin to new sites. We also assess the effect of considering capacity relocation and facility closing cost on model decisions.