Int. J. Production Economics 139 (2012) 69–79

Contents lists available at SciVerse ScienceDirect

Int. J. Production Economics

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

Cost-based transfer pricing under R&D risk aversion in an integrated supply chain

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ARTICLE INFO

Article history:
Received 22 August 2009
Accepted 31 October 2011
Available online 6 November 2011

Keywords:
Transfer pricing
R&D risk aversion
Allocation of fixed production costs

ABSTRACT

This paper examines the economic role of transfer pricing for a vertically integrated supply chain when a risk-averse production-division manager faces uncertainty on the outcomes from R&D investment. In particular, we compare two representative cost-based transfer pricing methods: full-cost and variable-cost pricing. We construct an economic model based on the assumption that R&D investment reduces the expected fixed costs of a production factor as well as the variable production costs. We show that a firm's profit under full-cost transfer pricing is greater than that under variable-cost transfer pricing under certainty. Contrary to this benchmark result, variable-cost pricing becomes more profitable than full-cost pricing when the risk-averse manager bears relatively high risk.

1. Introduction

A number of production economics studies have revealed that the choice of intrafirm transfer pricing method can affect the overall profits of a divisionalized firm and its value through coordination of benefits among multiple internal divisions. A global survey by Ernst & Young (1999) documents that 73 percent of managers find transfer pricing to be an important factor for maximizing operating performance. Eccles (1985) argues that transfer pricing without regard to "fixed costs, overhead, and profit for the selling division" leads to an unfair "measure of contribution to the company." Assuring some profit to the manufacturing division is particularly important if its manager is to enhance the efficiency of the production process by making discretionary investments. Because division managers are typically evaluated and compensated based on the reported income of their divisions, the method used for setting transfer prices directly influences the decisions delegated to them. For example, corporate headquarters of a divisionalized firm should take into consideration various risks that divisions bear to produce and deal in products. Risk-averse behavior of a division manager may distort internal transfer prices and quantities from levels that are optimal for the whole of the supply chains integrated by the firm.

A survey research paper by Tang (1992) on the transfer pricing methods employed by Fortune 500 firms reports that the "overall profit to the company" is the most important variable that influences the international transfer pricing method. Table 1 illustrates the survey results of Tang (2002) regarding what proportion of the surveyed Fortune 500 or 1000 firms employ each transfer pricing method, showing that the cost-based pricing method is the most prevalent in practice.[1] Of these, 62.8 percent use actual or standard full production costs, 30.8 percent use actual or standard full production costs plus a markup, and only 5.1 percent use variable production costs, indicating that the full-cost transfer pricing method is used more frequently than variable-cost transfer pricing.

Given the transfer pricing practices documented in the previous studies, this paper examines the economic role of transfer pricing for a vertically integrated supply chain when a risk-averse production-division manager faces uncertainty regarding the outcomes from R&D investment. Specifically, we investigate the advantages and disadvantages of two representative cost-based transfer pricing methods: full-cost pricing and variable-cost pricing, under uncertainty. We construct an economic model based on the assumption that R&D investment by a production division in a supply chain integrated by a firm reduces the expected overall fixed costs for a production factor as well as the variable production costs.[2] However, the effectiveness of the R&D investment in reducing fixed costs is assumed to be uncertain. With these settings, we first show that the overall profits of a

[1] Mills (1988) asserts that cost-based methods are the principal basis for determining prices. Based on a survey of the largest 3500 British companies, he reports that cost-based prices are usually modified by noncost considerations, with competitors' prices being the most important.

[2] R&D activities in manufacturing industries are usually classified into two categories: (1) new product development (i.e., research on what to make), and (2) manufacturing technology development (i.e., research on how to make). Note that this paper targets only the latter category of R&D because we focus on the allocation of costs that are reduced through R&D investment.

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doi:10.1016/j.ijpe.2011.10.030

Table 1
Transfer pricing methods used by major firms.
Source: Tang (2002, p. 35).

	For domestic transfers		For international transfers	
	Number of firms	Percent of total	Number of firms	Percent of total
Pricing methods				
Cost-based transfer prices				
Standard full production cost	25	16.9	8	6.4
Actual full production cost	24	16.2	9	7.3
Actual or standard full production cost plus a markup	24	16.2	35	28.2
Actual or standard variable cost of production	4	2.7	0	0.0
Other cost-based pricing method	1	0.7	1	0.8
Subtotal for cost-based methods	78	52.7	53	42.7
Market-based transfer prices				
Market price	27	18.2	23	18.6
Market price less selling expenses	10	6.7	17	13.7
Other market-based pricing methods	2	1.4	4	3.2
Subtotal for market-based methods	39	26.3	44	35.5
Negotiated prices	25	16.9	17	13.7
Other transfer pricing methods	6	4.1	10	8.1
Total—all methods	148	100.0	124	100.0

Note: This table suggests that full production cost methods are more frequently employed for transfer pricing than variable costing methods among the Fortune 500 or 1000 firms surveyed.

firm under full-cost transfer pricing is always greater than that under variable-cost transfer pricing when no subordinate divisions face uncertainty. The intuition behind the dominance of the full-cost method is that it induces the production-division manager to invest more in R&D because the manager wishes to reduce production costs when the transfer price includes the fixed cost per unit.

Contrary to the benchmark result without uncertainty, the most important finding from the current research is that variable-cost transfer pricing becomes more profitable from the corporate perspective than full-cost transfer pricing if the risk-averse production-division manager is confronted with greater uncertainty associated with the effectiveness of the investment. The intuition behind this result is summarized as follows. If the manager of the production division adopts risk-averse behavior, the full costing system induces him/her to overinvest compared with the total optimal level for the whole of the supply chain because he/she attempts to avoid variations in the realized fixed cost under uncertainty. Consequently, the production volume becomes greater than the first-best level and the central management has to lower the transfer price from the production division to the downstream division to facilitate the greater transfer quantity. Therefore, in such environments, variable-cost pricing imparts to the production division a more appropriate investment incentive than does full-cost pricing. No previous study has documented such an advantage of variable-cost transfer pricing for a firm integrating a supply chain under uncertainty, and this is the primary contribution of this paper.

Our findings give useful insights into supply chain design in multi-echelon corporations. For example, firms should recognize the advantage of the variable-cost transfer pricing method under uncertainty and be cautious about simply implementing full-cost transfer pricing. If the firms' headquarters pass the risk associated with R&D investment to the production-division manager through the full-cost transfer pricing, the internal transfer price is more likely to deviate from the total optimal level. In such environments, variable-cost transfer pricing becomes superior.

Since Hirshleifer (1956) advocated that the internal transfer price be set equal to the marginal cost to alleviate attendant double marginalization problems, subsequent operations research studies have proposed mathematical models that address this problem. Shubik (1962) introduced game theory into cost accounting in the allocation of joint costs at the corporate level. Baumol and Fabian (1964) were the first to employ linear programming to address the transfer pricing problem. Kriens et al. (1983) present industrial problems relating to both management accounting and operations research in divisionalized organizations, including transfer pricing as well as budgeting through input–output analysis and cost–volume–profit analysis. Johansen (1996) investigates the queuing system for the services industry and analyzes how randomness of demand influences optimal transfer pricing. Lantz (2009) focuses on the double marginalization problem arising from the divisionalization and demonstrates that negotiation on transfer price between divisions in a bilateral monopoly setting yields a solution to the problem based on economic experiments.

In the production economics literature, Karmarkar and Pitbladdo (1994) investigate the efficacy of certain cost allocation schemes for common production factors in a competitive environment. They show that, using the gross contribution as an allocation basis, optimal product-line decisions are achieved without distorting the selection of production levels. Vidal and Goetschalckx (2001) present a model for optimizing a global supply that maximizes the after-tax profits of a multinational corporation and that includes transfer prices and the allocation of transportation costs as explicit decision variables. They note that, the more restrictive the transfer price determination methods are, the lower is the interest in including decisions on the transfer prices in supply chain models. Villegas and Ouenniche (2008) extend the theory of the multinational firm to the case of multinational supply chains. They establish a model that integrates many factors, such as transport costs and duty drawbacks, which are critical for supply chains that operate under international trade regulations. Rosenthal (2008) studies the problem of setting transfer prices in a vertically integrated supply chain, in which the divisions share technology and transactions costs. He develops a cooperative game that provides transfer prices for the intermediate products in the supply chain, providing a solution that is fair and acceptable to all divisions. Hammami et al. (2008) argue that transfer prices should be considered as an important factor for the design of supply chains in the context of delocalization of organizations.

Moreover, previous management science studies investigate transfer-pricing forms and the ensuing distortions that can affect