Table 1 Properties of transfer pricing methods

Property \ Pricing method	Standard cost-based transfer pricing	Cost-plus transfer pricing	Market-based transfer pricing
Transfer price	t^{SC}	$t^{+} = C(I) + m$	$t^{M} = p_1 - \delta$
Equilibrium structure of the expected transfer price	Expected marginal cost, i.e. $t^{SC} = E[C(I^{SC})]$	Expected cost-plus, i.e. $t^{+} \geq E[C(I^{+})]$	Expected cost-plus, i.e. $t^{M} \geq E[C(I^{M})]$
Expected quantity on final market (given investments)	Expected first-best quantity, i. e. $E[q_2^{SC}(I)] = E[q_2^{FB}(I)]$	Underproduction, i. e. $E[q_2^{+}(I)] \leq E[q_2^{FB}(I)]$	Underproduction, i. e. $E[q_2^{M}(I)] \leq E[q_2^{FB}(I)]$
Expected quantity on intermediate market (given investments)	Expected first-best quantity, i.e. $E[q_1^{SC}(I)] = E[q_1^{FB}(I)]$	Expected first-best quantity, i.e. $E[q_1^{+}(I)] = E[q_1^{FB}(I)]$	Underproduction, i.e. $E[q_1^{M}(I)] \leq E[q_1^{FB}(I)]$
Investment level	First-best investment, i.e. $I^{SC} = I^{FB}$	Underinvestment, i.e. $I^{+} \leq I^{FB}$	Underinvestment, i.e. $I^{M} \leq I^{FB}$
Flexibility value	$\frac{Var[c]}{4}$	$\frac{Var[c]}{4} + \frac{Var[s]}{4}$	$\frac{7\ Var[c]}{16}$

Corollary 4.1 *In the absence of a specific investment problem,*

(i) cost-plus transfer pricing dominates market-based transfer pricing for a sufficiently informative signal s. i.e. $\alpha \geq \dfrac{3Var[c] - B^{FB}}{4Var[c]}$ *(and vice versa).*

(ii) cost-plus transfer pricing unambiguously dominates standard cost-based transfer pricing.

5.2 Performance Comparison in the Presence of a Specific Investment Problem

Returning to the general case, recall that with a specific investment problem inherent cost-plus pricing exhibits inefficient trade incentives so that $B^{+} \leq B^{FB}$. The difference between B^{+} and B^{FB} increases in the productivity of the investment x. As a consequence, cost-plus transfer pricing does not unambiguously dominate standard cost-based transfer pricing. In fact, cost-plus transfer pricing dominates standard-cost transfer pricing only if cost uncertainty is sufficiently high. Intuitively, the cut-off value $Var[c]_{S+}$ is decreasing in α, since higher precision of the signal s increases the information advantage of cost-plus transfer pricing.

Proposition 4.1 *In the presence of a specific investment problem, cost-plus transfer pricing dominates the standard cost-based transfer pricing for sufficiently high cost uncertainty, i.e.* $Var[c] \geq \dfrac{4x^2 B^{FB}}{(4 - 2x^2 - x^4)\,\alpha}$.

The basic value of cost-plus transfer pricing can decline even below the basic value of market-based transfer pricing. Comparison of B^{+} and B^{M} yields that $B^{+} < B^{M}$ if $x > (7 - \sqrt{13})^{1/2}/3$. In this situation, cost-plus transfer pricing dominates the market-based transfer pricing only for sufficiently high cost uncertainty, i.e. when cost information becomes important, and when the signal s is sufficiently informative. On the other hand, as long as $B^{+} > B^{M}$, cost-plus transfer pricing unambiguously dominates market-based transfer pricing for a sufficiently informative signal s. In fact, the flexibility value generated by cost-plus transfer pricing is larger than the flexibility value generated by market-based transfer pricing once $\alpha > 3/4$. This yields the following finding.

Proposition 4.2 *In the presence of a specific investment problem, cost-plus transfer pricing dominates market-based transfer pricing*

(i) if $\alpha < 3/4$ *and* $Var[c] < \dfrac{16\left(1 - x^2\right)\left(4 - 14x^2 + 9x^4\right) B^{FB}}{\left(4 - 3x^2\right)^2 \left(4 - 2x^2 - x^4\right)(3 - 4\alpha)}$.

(ii) if $\alpha > 3/4$ *and* $Var[c] > \dfrac{16\left(1 - x^2\right)\left(4 - 14x^2 + 9x^4\right) B^{FB}}{\left(4 - 3x^2\right)^2 \left(4 - 2x^2 - x^4\right)(3 - 4\alpha)}$.

Finally, market-based transfer pricing only can dominate standard cost-based transfer pricing for sufficiently high cost uncertainty. Since market-based transfer

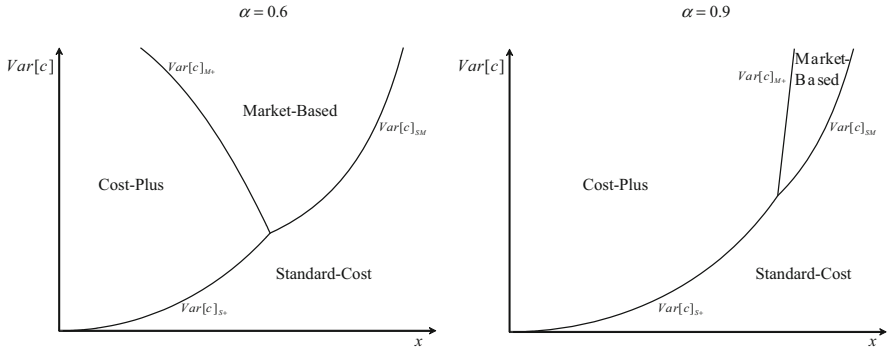

Fig. 2 Performance comparison. Own representation

pricing induces a coordination problem due to Division 1's opportunistic behaviour, this transfer pricing method can only legitimate its existence if the market based transfer price provides sufficiently important cost information.

Proposition 4.3 *In the presence of a specific investment problem, market-based transfer pricing dominates standard cost-based transfer pricing for sufficiently high cost uncertainty, i.e.* $Var[c] \geq 16B^{FB}/3\left(4 - 3x^2\right)$.

Figure 2 illustrates the outcome of the performance comparison in terms of the productivity of investments x and the cost uncertainty $Var[c]$.

Figure 2 highlights that standard cost-based transfer pricing becomes more useful (i) if cost uncertainty is rather low and for increasing productivity of investments x. This is quite intuitive, since standard cost-based transfer pricing provides no cost information for the final market but prevents the creation of coordination problems in expectations that increase under the other two transfer pricing methods with increasing productivity of investments x. The underinvestment problem of cost-plus transfer pricing increases because Division 1 is not equipped with sufficient investment incentives. Headquarters has to trade-off the creation of investment incentives with concurrently creating a double marginalization problem. Under market-based transfer pricing, the opportunistic behaviour problem increases because a more profitable final market increases Division 1's incentives to shift rents via an appropriate transfer price.

Finally, Fig. 2 illustrates that the benefit of market-based transfer pricing generally diminishes if Division 2's signal becomes more informative.

6 Conclusion

In the presence of an intermediate market for their products, firms frequently use as a transfer price the market price that the upstream division charges to its external costumers (e.g. Emmanuel et al. 1996). From a coordination perspective,

our analysis shows that market-based transfer pricing can be optimal although it provides the upstream division with incentives to distort the market price for the intermediate product.

In a seminal case study on implementation issues of various transfer pricing methods, Eccles (1983, p. 2) notes that using a "market price isn't the best approach in imperfectly competitive markets." In this context, cost-based transfer prices are frequently proposed as an alternative to market-based transfer pricing. Empirical studies indeed show that cost-based transfer prices are widely used in practice, e.g. Borkowski (1990), Oyelere and Turner (2000), Tang (2002). According to these studies 36–52% of the firms use cost-based transfer prices.

Conducting a performance comparison, our analysis provides the straightforward proposal of using cost-based transfer pricing in quite distinctive situations. While actual cost-plus transfer pricing is the correct cost-based transfer pricing method in the absence of a specific investment problem and perfect information transmission within the firm, standard cost-based transfer pricing is the correct cost-based transfer pricing method when the upstream division's costs are deterministic and a specific investment problem arises. In particular, standard cost-based transfer pricing can only be optimal if a specific investment problem arises. In this case, we find briefly stated that (i) market-based transfer pricing is optimal for sufficiently high cost uncertainty and if the precision of information transmission is not extremely high, (ii) standard cost-based transfer pricing is optimal if the productivity of investments is high and cost uncertainty is rather low, and (iii) actual cost-plus transfer pricing is optimal if cost uncertainty is sufficiently high and the precision of information transmission is rather high.

Our analysis provides insights into the determination of adjustments that are frequently applied in practice for transfer prices (e.g. Drury 2009; Sahay 2013) generating interesting empirical predictions. As Merchant and van der Stede (2012) state: *"…many firms use quasi market-based transfer prices by allowing deviations from observed market prices"* (Merchant and van der Stede 2012, p. 271). Indeed, empirical studies identify that 38.2–48.4% of the firms use adjusted market-based transfer prices rather than directly prevailing market prices, see for example Borkowski (1990), Tang (2002), Abu-Serdaneh (2004). These adjustments are usually explained to reflect internal cost savings, potential internal synergies, imperfect comparables, and price distortions arising from imperfectly competitive markets, e.g. Zimmerman (2004), Baldenius and Reichelstein (2006), Drury (2009), Merchant and van der Stede (2012), Sahay (2013).

Market-based transfer pricing entails a markup over expected marginal costs in order to decrease the division's price on the intermediate market. The markup increases when the productivity of investments increases, since Division 1 has an increasing incentive to extract rents from Division 2. Cost-plus transfer pricing exhibits a markup over actual cost that also increases when the productivity of investments increases.

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Clemens Löffler is currently a post-doctoral researcher at the Institute for Corporate Governance at the WU Vienna University of Economics and Business. He holds a doctoral degree in economics from the Vienna University of Technology, and received his habilitation in 2015 from the University of Vienna for his thesis "Essays on: Decentralized Decision Making, Coordination, and Incentives". His research focusses on various aspects related to management accounting, such as performance measurement, institutional design, coordination of decentralized firms, and competitive strategy. Currently, he is analysing problems, including: the optimal design of incentive schemes (e.g. incentive contracts or transfer pricing schemes) when firms face asymmetric information and/or market competition; the design, switching and investment decisions in supply chains; and organizational design issues in multinational enterprises. His main research method is analytical modelling, applying game theory, agency-theory, real option models, information economics, or differential games. His work has been published in international journals, such as *European Journal of Operational Research*, *Journal of Economic Behavior and Organization*, *Journal of Economics and Management Strategy*, among others.

Managerial Compensation, Investment Decisions, and Truthfully Reporting

Günter Bamberg and Michael Krapp

Abstract This paper provides a formal analysis of investment decisions with special emphasis to mechanisms which induce managers to reveal their knowledge truthfully. In a one-period context 'knowledge' usually means the profit ratio. In a multi-period setting 'knowledge' is referred to the (multivariate) cash flow stream or the (univariate) net present value. Both situations are analysed in the paper. We start with the basic case 'one firm, one manager' and continue with the case 'divisional firm, division managers'. With respect to the first case, we criticise two approaches (Rogerson, JPolE 105(4):770–795, 1997; Reichelstein, RAS 2(2):157–180, 1997) and develop a solution based on extended incentive contracts. To tackle the second case, we analyse pros and cons of Groves schemes.

Keywords Extended incentive contracts • Groves mechanism • Goal congruence • Impatient manager • Investment decisions • Managerial compensation • Preinreich/Lücke-theorem

Contents

G. Bamberg
Chair of Statistics in the Faculty of Business and Economics, University of Augsburg, Universitätsstr. 16, 86159 Augsburg, Germany
e-mail: guenter.bamberg@wiwi.uni-augsburg.de

M. Krapp (✉)
Chair of Quantitative Methods in Economics, University of Augsburg, Universitätsstraße 16, 86159 Augsburg, Germany
e-mail: michael.krapp@wiwi.uni-augsburg.de

D. Mueller, R. Trost (eds.), *Game Theory in Management Accounting*,
Contributions to Management Science, DOI 10.1007/978-3-319-61603-2_5

1 Introduction

Investment planning is often characterized by asymmetric information. Managers are frequently better informed about the technology and market opportunities than the corporate headquarters. Therefore, incentive mechanisms are needed to limit the scope of opportunistic managers. When selecting and implementing investment projects, managers shall act according to the corporate objectives. In particular, they shall report the profitability of investment opportunities truthfully ahead of investment decision making.

Incentive mechanisms discussed in the literature are—with only few exceptions—based on one-period models. On the other hand, typical investment projects span a multi-period planning horizon T (for example, 10 years). What is more, a real dynamic model should also consider e.g. changes in the economic environment, the development of other (later starting) projects, whether interactions between projects exist etc. As soon as stochastics and different risk attitudes are taken into account, the risk of misspecification increases and practicality decreases.

This paper strives to study a compromise between the overly restrictive one-period models and the complex multi-period models. This compromise is based on

- the examination of investment projects by the (deterministic or stochastic) net present value (NPV) and
- the remuneration of managers by payments in the periods $t = 1$ to $t = T$ proportional to residual income (RI_t).

The last point is of particular interest from a practical point of view. Many incentive mechanisms determine managers' compensation depending on the realized NPV or the deviation between the actual NPV and $\widehat{NPV}$, i.e. the NPV reported to central management at date $t = 0$. Both, the NPV as well as its deviation from $\widehat{NPV}$, cannot be evaluated without major dissent until date $t = T$ (for example, in 10 years). A remuneration only at the planning horizon $t = T$ without interim payments at dates $t = 1, 2, \ldots, T$ is problematic in practise. It seems reasonable (cf. Sect. 2.2) to make these interim payments proportional to residual income RI_t. However, the ongoing determination of project-specific RI_t involves high requirements to be met by the accounting system.

Section 2 sums up the foundations of NPV from the perspectives of money market and utility theory as well as the interrelations of net present value and residual income. In Sect. 3, the case 'one firm, one manager' is treated. Special attention is paid to the problem of the impatient manager, i.e. when the duration