MAGISTERARBEIT

Titel der Magisterarbeit

"Strategic use of transfer prices and relative performance evaluation –

A game theoretic approach to incentive mechanisms under duopolistic competition"

Verfasser

Dott. Hannes Blaas

Angestrebter akademischer Grad

Magister der Sozial- und Wirtschaftswissenschaften
(Mag. rer. soc. oec.)

Wien, 2012

Studienkennzahl lt. Studienblatt:	A 066 914
Studienrichtung lt. Studienblatt:	Internationale Betriebswirtschaft
Betreuer:	Univ.-Prof. Dr. Thomas Pfeiffer

Inhaltsverzeichnis

List of tables

List of figures

Glossary

α	= Factor illustrating a manager's participation rate in rival firm profits compared to his participation rate in own firm profits
B_i	= Payoff for the manager of firm i using relative performance evaluation
CEO	= Chief executive officer
d	= Total demand if price the price for both products was zero
e	= Marginal change in demand if own firm's sales price is changed by one unit
ε	= Common shock term
f	= Marginal change in demand if the sales price of the competitor is changed by one unit
F_i	= Constant fixed pay for manager of firm i
G_i	= Profit of firm i
H_i	= Payoff for the manager of firm i using strategic transfer pricing
γ_i	= Portion of payoff based on profit for manager of firm i using an incentive scheme based on profit and revenues
θ_i	= Participation rate for the manager of firm i in the sales (quantity) of firm i
i	= Firm index, $i = \{1,2\}$
j	= Firm index, $j = \{1,2\}$
k	= Variable cost for one unit of product
M_i	= Payoff for the manager of firm i using market-share based incentives scheme
O_i	= Objective function of the manager of firm i, $O_i \in \{G_i, H_i, B_i\}$
p_i	= Sales price of product of firm i
p_i^*	= Optimal sales price of firm i in equilibrium
P_i	= Constant participation rate for the manager of firm i in his objective function O_i

q_i	= Quantity produced by firm i
Q	= Total quantity produced by all firms in the market
R_i	= Reaction function of the manager of firm i
RPE	= Relative performance evaluation
s_i	= Participation rate for the manager of firm i in the profit of firm i
σ^2	= Variance
SEC	= Securities exchange commission
STP	= Strategic transfer prices
t_i	= Strategic transfer price for one unit of product for firm i
U_i	= Revenues of firm i (quantity multiplied by price)
v_i	= Participation rate for the manager of firm i in the profit of firm j
w_i	= Participation rate for the manager of firm i in the market share of firm i
x_i	= Demand faced by firm i

1. Introduction

In the modern corporation ownership is mostly separated from direct control over the business. Professional managers deal with day-to-day operations while shareholders only rarely get directly involved with major decisions. The well known agency problem arises as the owners[1] cannot closely monitor the agents assigned by them to act on their behalf.[2] The managers may act in a way that is not in the best interest of the owners. The resulting moral hazard problem consists of inducing the agents to supply the proper amount of effort and to take decisions consistent with the interests of the principal.[3] This conflict of goals under certain information asymmetries is often addressed using appropriate incentive systems, the most prominent being profit participation.[4] By compensating the manager partly in proportion to the earned profit his[5] objective function is aligned to the one of the principal.

This was however already pointed out by Vickers (1985) that "the separation of ownership from control in the large corporation may in some cases be no bad thing for the owners. Indeed the separation may be in some cases essential for the credibility of some threats, promises and commitments."[6] This is due to the strategic effects of certain decisions. Neus and Nippel (1996) define a strategic action as having a long-term influence on success by affecting the competitive environment. It is therefore a behaviour directed to influence the reaction of the competitors. The standard approach to principal-agent problems deals with one

---

[1] Following Fershtman/Judd (1987) and Miller/Pazgal (2002) I will use the following definitions throughout this paper. The owner or principal of a firm is an individual or group whose sole purpose is to maximize the profit of the firm. Manager refers to an agent that the owner hires to make real time operating decisions. The firm is the organization which is owned by the principal and employs the agent.

[2] The agency problem does obviously not only arise in the relationship between shareholders and managers but also through the delegation from top executives to lower management. Generally, the literature focuses however on an owner-manager-structure in order to be able to safely assume a profit-maximizing objective function on behalf of the principal. I anticipate that the classic agency problematic is only marginally touched in this paper as the focus lies on strategic firm interaction. To learn more about classic agency-theory I refer to the respective literature, e.g. Holmstrom (1982).

[3] C.f. Holmstrom (1982), p. 324.

[4] C.f. Dierkes/Hanrath (2002), Pfeiffer (2000) and Rogerson (1997).

[5] For reasons of readability throughout the paper the principal or owner will be referred to as being female while the agent or manager will be referred to as male. The choice is entirely discretionary and can freely be inverted by the reader.

[6] Vickers (1985), p. 143.

firm in isolation trying the best possible allocation of risk between a risk neutral principal and a risk averse agent. By doing so, strategic effects are ignored as monopolistic price-demand-functions are assumed. Most companies do however not operate in a monopoly but face more or less rational acting competition.[7] Therefore, unless operating in perfect competition, strategic effects of decisions should not be ignored. This paper and the models discussed within it, mainly deal with the strategic effects of decisions within a principal-agent framework. Therefore any moral hazard problems are mostly ignored to be able to focus exclusively on strategic effects.

As mentioned before the separation of ownership and management can have beneficial effects for the shareholders. It was Schelling (1960) who pointed out that using a delegate as commitment device can be of advantage to the principal. Traditional economic theory of competition assumes that the single aim of firms is profit maximization.[8] The use of an agent opens the possibility for the principal to set a strategic compensation scheme.[9] Through such an incentive contract the principal can commit to an objective function different from pure profit maximization. It is commonly observed in practice that bonus schemes for managers are not exclusively profit-based but firms also use sales, relative performance against a peer group or other key performance indicators to base remuneration on. It may be that the nature of such incentive schemes is largely exogenous to the firm, being determined by country-specific norms and rules.[10] If it is, however, endogenous it becomes a strategic decision for the owners. When studying an isolated firm a deviation from profit maximization as objective function can only have a negative consequence on profits because of the distortion effect. On the contrary however, when the reactions of competitors are included in the model one needs to consider also the strategic effect of the incentive distortion. This latter effect can indeed be positive and may well outweigh the negative distortion effect resulting in an overall increase of profits for the firm.[11]

The literature on strategic incentive distortion focuses mainly on two different approaches. The first approach is embossed by the works of Vickers (1985),

---

[7] C.f. Göx (1999), p. 23.
[8] C.f. Jansen et al. (2007), p. 531.
[9] C.f. Katz (1991), p. 307.
[10] C.f. Jansen et al. (2009), p. 142.
[11] C.f. Neus/Nippel (1996), p. 426.

Sklivas (1987) and Fershtman and Judd (1987) and deals with the use of strategic transfer prices (STP). The agent's pay in these models is based not only on profit but also on sales, which is virtually the same as changing the cost parameter for the manager. The common result is that using such a scheme is always a dominant strategy for each player in the duopoly model they study. The second approach deals with the use of relative performance evaluation (RPE) in a duopolistic setting. This line of study is based mainly on the paper of Aggarwal and Samwick (1999). In their model, the agents of both firms are paid not only on the basis of their own firm's profit but the profit of the competitor is also considered in their remuneration. They too find that the use of this distortion mechanism is always a dominant strategy for both players.

Both approaches appear to be beneficial for the principals in an oligopoly setting. A central role in the literature is however taken by the paper of Dierkes (2004). He is the first to bring the two lines of study in the strategic distortion literature together and to compare the two approaches in one single model. He acknowledges the beneficial effects of both compensation schemes but asks the question which one is better. This is an important question because even though all these models are specific the underlying idea is of general interest and the results are relevant for practical purposes.[12] In fact, Dierkes finds that in his model relative performance evaluation dominates strategic transfer prices. For each player it is always beneficial to choose RPE over STP in any possible situation. If this result was directly applicable in practice this would have huge implications for the design of incentive contracts. The motivation of this paper is, however, to make sure his results are not taken at face value. Even though Dierkes makes an important theoretical step it is necessary to critically analyze his model in order to avoid premature conclusions: a closer look is needed.

Dierkes clearly states most of the underlying assumptions of his model. Not surprisingly, he fails however to mention how a change in some of the key assumptions might affect the results. The goal of this paper is to critically examine Dierkes' model and its result and to provide the reader with a concise discussion of the related literature. By discussing models of other authors it is shown that a change in some assumptions (some of those to more realistically reflect the real

---

[12] C.f. Fershtman/Judd (1987), p. 928.

world) can decisively affect the model results and parameter implications. The model environment is crucial for the resulting outcome. The reader will be provided with an overview of what to consider before completely relying on any model results or taking steps for practical implication. Additionally, if further interest in the subject arises the reader will know what additional literature to consult and the assumptions or implications to question. Finally, reviewing all the discussed literature it will be deduced that a lot of research questions are still to be addressed; theoretical and practical alike.

Following this section the model used by Dierkes is explained in detail. It has a central role in joining the two lines of study in this research area and is therefore awarded a fundamental position in this work. Afterwards the most relevant literature is individually reviewed in section 3 divided into lines of research and ordered chronologically. This is not the convention as normally the literature leading up to the present research topic is introduced first. This convention is intentionally disregarded in this paper for two reasons. First, Dierkes' publication presents a cornerstone of this paper but is somewhat dated. Obviously, research has not stopped after the release of his article. A thorough review of related literature therefore includes not only papers published chronologically before Dierkes' article but also subsequently. Second, having already given a detailed presentation of the model used by Dierkes allows to more clear lay out the differences in assumptions and results of model specifications by other authors. This allows the reader to get an immediate critical glance at the work of Dierkes when related literature is discussed. Section 4 then follows with an exhaustive critical discussion of Dierkes' model based on all the findings of the previously discussed literature. The section includes omitted aspects as well as implications, empirical findings and an outlook on future research possibilities. Section 5 concludes and summarizes the findings. The appendices following section 5 include most proofs and some additional calculations.

2. A model of strategic transfer pricing and relative performance evaluation

The strategic implications of evaluating managers' performance considering both the own firm and the competitors reaction was recognized by Vickers (1985). He notes that "if control of my own decisions is in the hands of an agent whose preferences are different from my own, I may nevertheless prefer the results to those that would come about if I took my own decisions."[13] He continues that this implies that maximum profits on the market are not necessarily earned by firms whose managers' objective is to maximize profits.[14] "A manager's objective depends on the structure of the incentives that his owner designs to motivate him."[15] The owner can indeed benefit from committing herself to an objective function of her manager that is different from her own. Nonetheless, this is only possible in a market not characterized by a monopoly or by perfect competition.[16] The reason for this is that the outcome in the oligopolistic market depends, in contrast to the monopoly or perfect competition situation, on the objectives of *all* the players and therefore one has to consider strategic interaction. Distorting a manager's incentives can be valuable for the owner if the competitor's reaction has beneficial effects for the own firm.[17] There is, however, a trade-off in distorting the manager's incentives. While the "distorting" effect of deviating from the final goal is always negative, there is also a strategic effect of influencing the competitor's behaviour. Not only can this latter effect be positive but it can also outweigh the previous effect.[18]

Such self-commitment to goals different from pure profit maximization can be achieved through delegation and incentive schemes. In this sense, "the separation of ownership from control in the large corporation may in some cases be no bad thing for the owners. Indeed the separation may in some cases be essential for the credibility of some threats, promises and commitments."[19] Without delegation,

---

[13] Vickers (1985), p. 138.
[14] C.f. Vickers (1985), p. 138.
[15] Fershtman/Judd (1987), p. 927.
[16] C.f. Neus/Nippel (1996), pp. 423 ff.
[17] C.f. Fershtman/Judd (1987), p. 928.
[18] C.f. Neus/Nippel (1996), p. 426.
[19] Vickers (1985), pp. 143 f.

deviation from profit maximization would otherwise not be realistic for a firm were owners were to decide centrally on output and prices.[20]

It was first shown by Fershtman and Judd (1987) and Sklivas (1987) that rewarding a manager not only based on profit but also on sales (revenues or quantities) would alter the competitive outcome. Afterwards, some authors[21] studied how the use of strategic transfer prices could improve a firm's competitive position. It can, however, be shown that both mechanisms are basically equivalent.[22] In this paper I will focus on strategic transfer pricing, keeping in mind that this is equivalent to a participation in profits *and* sales.

Later, Aggarwal and Samwick (1999) showed that relative performance evaluation was a second mechanism of self-commitment through which it was possible to achieve results superior to pure profit orientation. Since then, the literature has discussed several aspects of these mechanisms in different environments and under different assumptions.[23] Dierkes (2004) was, however, the first to compare those two mechanisms *vis-a-vis* each other in a single model to find out which one yields better results. This is the reason why his article plays a central role in this paper and this section is devoted to explain his model and conclusions in detail.

2.1. Dierkes' model

Dierkes promotes a specific model to study the strategic delegation subject. Nevertheless, the idea behind it is of general interest as the conclusion can have various implications for the theory of the firm. Dierkes in his model assumes a

---

[20] C.f. Göx (1999), pp. 25 f.

[21] C.f. especially Neus/Nippel (1996), pp. 432 ff., Alles/Datar (1998) and Göx (1999).

[22] The logic is the same in both cases: through the manipulation of the manager's incentive scheme the owner can credibly convince the competitor of the own increase in production and sales through the distortion of marginal cost. C.f. Neus/Nippel (1996), p. 439. The mathematical proof is provided in appendix 3. Organizationally there is however a difference. While a profit-and-sales contract can be stipulated within the same organizational unit the use of transfer prices necessitates at least two divisions in order to charge a transfer price to one division for the product provided by the other one. As the implementation method is irrelevant for our purposes in this paper and the effects are exactly the same this organizational difference will be ignored throughout this work.

[23] A more detailed overview will be given in section 3.

non-cooperative duopoly[24] with two rational competitors as is standard in the literature on strategic delegation. It is a static model (as both players choose simultaneously the prices for one single period) with heterogeneous players selling only one type of products. This is to say, the products are differentiated, meaning that they are substitutable but not identical.[25] Further, it assumes symmetric cost and demand functions[26] and complete information. Additionally, marginal costs are assumed to be constant and there are no capacity restrictions allowing for any quantity to be produced.[27] Finally, the model assumes competition based on prices. This is a crucial assumption as it is well known in the literature that results and implications under Bertrand competition are normally very different to the results in Cournot models where competition is based on output quantities. This will be discussed extensively in section 3.

The model specifies a game with two profit maximizing players facing the same linear price-consumption curve:[28]

$$x_i(p_i, p_j) = d - e \cdot p_i + f \cdot p_j \tag{1}$$

with

d Total demand if the price for both products was zero

e Marginal change in demand if own sales price is changed by one unit

f Marginal change in demand if the sales price of the competitor is changed by one unit

p_i Sales price of product of firm i

---

[24] The cooperative result is therefore excluded. For a discussion of the cooperative result when using STP I refer to Göx (1999).

[25] C.f. Göx (1999), p. 27.

[26] Because of the Slutsky-Symmetry the demand function is always symmetric when it is derived from the utility maximizing consumption plan of a representative household. C.f. Dixit (1986), p. 108 and Göx (1999), p. 28.

[27] These are standard assumptions in duopoly theory. See any standard economics textbook, e.g. Varian (1994).

[28] I will follow the notation of Dierkes throughout this paper, even when discussing models of other authors in order to have a better overview.

Indexes

$$\text{Firm index, } i = \{1,2\}$$

$$\text{Firm index, } j = \{1,2\}$$

It is assumed that $i \neq j$, $d > 0$ and $e > f > 0$ and that prices are non-negative. These are straightforward assumptions as it seems obvious that prices and total demand are positive. Furthermore, a positive e together with the negative sign in front of it makes sure demand for the firm's product decreases if its price increases. This is the normal case and basically excludes Giffen goods.[29] The fact that f is also assumed to be positive implies that demand for the firm's good increases if the price for the competitor's good increases. This implicitly means that the two goods of the respective firms are assumed to be substitutes and not complements. Also, it is intuitive that the own price has more influence on a firm's demand for its product than has the price of the competitor. This follows from the assumption of product differentiation. It recognizes the possibility of quality differences and brand identity. Only these non-price factors allow a firm to differentiate their product from the competitor's product and raise prices above the perfect competition level. The customer is only willing to pay a higher price if the product fits his preferences more closely than the alternative choice.[30] Even for the theoretical case of prices equal to zero no firm would be able to capture the entire demand.[31] If that was not to be assumed, price competition would always result in the Bertrand-Paradox and hence in marginal cost pricing.[32] These are standard assumptions in the oligopoly theory.

Since the only believable goal for the owners is profit, the resulting objective function for the principal of firm i for $i, j \in \{1,2\}$ and $i \neq j$ is the following:

---

[29] Giffen goods are inferior goods for which the income effect dominates the substitution effect. Their demand curve therefore slopes upward and an increase in price raises the quantity demanded. If such goods exist at all they are very rare and the model does not lose any of its applicability by excluding them. C.f. Mankiw (2004), pp. 468f.
[30] C.f. Alles/Datar (1998), p. 454.
[31] C.f. Göx (1999), p. 29.
[32] C.f. Fershtman/Judd (1987), p. 938 and Tirole (2000), pp. 209 ff.

$$G_i = (p_i - k) \cdot x(p_i, p_j)$$

$$= (p_i - k) \cdot (d - e \cdot p_i + f \cdot p_j) \to \max_{p_i} \qquad (2)$$

with

G_i Profit of firm i

k variable unit cost for the product

The owner wants to maximize her profits and the only decision variable available to do so according to her objective function is the price of her own firm's product (since we assume Bertrand competition). However, the owner in this model delegates this pricing decision to a manager. The manager then chooses the price according to his personal objective function which in turn depends on the incentive scheme applied by the owner. The latter commits himself to the pricing decision of an agent but in turn gains the freedom to select and design an incentive scheme that is different from profit maximization. Again, while no other commitment than profit maximization would be believable for the owner of a firm this is not true for the incentive mechanism of a manager. Agents are expected to maximize their personal payoff. This does not have to be profit but is a result of the structure of their negotiated contract which defines the structure of the manager's incentives. In setting up this contract the owner has several degrees of freedom. Basically, by committing herself to her agent's pricing decision the principal exchanges one decision variable for another. By doing so she can use the additional variable to influence the competitive conditions in her own interest and expect to achieve a positive effect on profit from this self-commitment.[33] This is possible because the manager can be induced to act less competitively. Note that the beneficial effect is only due to the effect of committing to a different objective function since the principal and the agent are implicitly assumed to have the same capabilities.[34] Essentially, incentives will be altered in that direction which will cause the opposing agents to change their behaviour in beneficial directions.[35] Consequently a result may be achieved that is closer to the result in the case of

---

[33] C.f. Göx (1999), p. 59.
[34] C.f. Katz (1991), p. 310.
[35] C.f. Fershtman/Judd (1987), p. 938.

collusive behaviour which is obviously the highest possible[36] given the specific price-consumption function. I will return to this effect below.

In delegating the pricing decisions to their respective managers both firm's principals have the choice between three different approaches. The first approach is to use profit participation. In this scenario the managers objective is the same as the principal's which means that perfect goal alignment is achieved. Hence, the decision the manager makes will be equal to the decision the owner would make if he was to decide centrally. When both owners choose this approach we get the standard Bertrand result and therefore this situation is used as reference solution by Dierkes. This case will be discussed in section 2.1.

The second approach is to choose strategic transfer pricing as delegation mechanism. The resulting objective function for the agent of firm i for $i, j \in \{1,2\}$ and $i \neq j$ is:

$$H_i = (p_i - t_i) \cdot (d - e \cdot p_i + f \cdot p_j) \to \max_{p_i} \qquad (3)$$

with

H_i Payoff for the manager of firm i under strategic transfer pricing

t_i Strategic transfer price for one unit of product

There is no restriction on the strategic transfer price. Consequently, it is allowed to be higher or lower than the true unit cost of the firm.

Finally, the last approach is to choose relative performance evaluation. Under this mechanism the manager is paid not only on the basis of his own firm's profit but also considering the profit of the competing firm. The objective function for the agent of firm i for $i, j \in \{1,2\}$ and $i \neq j$ therefore becomes:

---

[36] While the cartel-solution yields the highest possible profit for both firms, it is not a stable equilibrium as each firm owner has a strong incentive to deviate from this solution. It is therefore a classic "prisoners' dilemma" situation. Additionally, such agreements are illegal in most of the cases. C.f. Göx (1999), pp. 39 ff.

$$B_i = s_i \cdot \left((p_i - k) \cdot (d - e \cdot p_i + f \cdot p_j) \right) + v_i \cdot \left((p_j - k) \cdot (d - e \cdot p_j + f \cdot p_i) \right) \to \max_{p_i} \quad (4)$$

with

B_i Payoff for the manager of firm i under relative performance evaluation

s_i Participation rate for the manager of firm i in the profit of firm i

v_i Participation rate for the manager of firm i in the profit of firm j

Note that there are no restrictions on v, allowing it to be positive or negative of any magnitude. On the other hand, s is assumed to be positive even though Dierkes does not explicitly explain the reason. This assumption is natural as it would very much surprise if a manager received a negative bonus for a positive result of his own firm. In fact, if it was negative the manager would be paid to work "against" the interests of his principal. Even if any model would result in a value of $s < 0$ being optimal, there is more than just a doubt that any owner or shareholder assembly would opt for such a scheme.

Regarding the value of v, the possibility of a positive effect of the competitors profit on the manager's salary has been criticised in the literature[37] for possibly being illegal violating anti-trust laws because of its clear collusive effect. However, Aggarwal/Samwick (1999) note that this is not the case, stating that "there are no legal constraints on firms limiting the amount of relative performance evaluation they employ in order to curb aggressive price setting by managers."[38] This is also shown by Gilo (1996). Another aspect of critique is that a firm has no exact information about its competitor's profits and sales.[39] This seems to be unrealistic though as such numbers are regularly published by most companies. Also, benchmarking programs and market research can help determine an approximation of costs, profits or sales even for most divisions within any company.[40] Consequently, RPE incentive scheme appears to be a realistic approach, even with the possibility of positive participation rate in the competitor's profit.

---

[37] Among others by Fershtman/Judd (1987), p. 931.
[38] Aggarwal/Samwick (1999), p. 2008.
[39] C.f. among others Fershtman/Judd (1987), p. 931.
[40] C.f. Alles/Datar (1998), p. 453.

Note that it is implicitly assumed that each approach involves equal implementation costs as they are being ignored in the model.

Note also that none of the possible objective functions proposed for the managers includes any risk premium. It is standard in principal-agent theory to assume the principal to be risk neutral. This approach is followed by Dierkes as well. The same is not normally true for the agent. However, while this model is based on a principal-agent structure, the problem it addresses is quite different. The standard literature in this area deals with the agency dilemma treating the difficulties that arise under conditions of incomplete and asymmetric information. In Dierkes' model complete information is assumed and the problem addressed is to use internal contracts for the distortion of incentives and internal relationships for interfirm strategic reasons.[41] For reasons of simplicity managers are therefore assumed to be risk neutral as well. While this might not be completely realistic, it is safe to say that the main conclusions of the model would not alter if incomplete and asymmetric information were assumed between the principal and the agent.[42]

Note also that the agent will not be rewarded $O_i \in \{G_i, H_i, B_i\}$ for $i \in \{1,2\}$ but a linear contract of the form $F_i + P_i O_i$, where F_i is his (constant) fixed pay while $P_i > 0$ is the (constant) participation rate in his objective function O_i which together define the variable part of the payoff. By the property of the assumed risk neutrality of the manager he acts to only maximize O_i while the values of the constants F_i and P_i are irrelevant.[43] This results in the objective functions specified previously.

Linear contracts are often used in theory because they are widely spread in practice. The reason for this might be that they are simple to understand and easy to administer. At the same time linear contracts have the beneficial property of causing uniform incentives compared to non-linear contracts which may create unintended or unhelpful incentives over the course of a period.

Furthermore, this linear form of compensation allows to scale the amount the agent gets actually paid. Consider the objective function G_i for example. The

---

[41] C.f. Fershtman/Judd (1987), p. 934.
[42] Aggarwal/Samwick (1999) show this for the case of relative performance evaluation.
[43] C.f. Fershtman/Judd (1987), p. 930.

agent maximizes according to his principal's profit function. If however he would also get paid the resulting outcome the principal would not receive any benefits. By choosing a P_i smaller than one or a negative F_i the principal can make sure the agent still acts to maximize O_i while avoiding that he appropriates all the benefits.

Another convenience follows from this assumption. Recall that the owner's objective function was specified to maximize profits defined by profit margin multiplied by demand. However, normally one would deduct not only (production-)costs but also the managers pay to calculate the final profit for the owner. Nevertheless, since the manager maximizes O_i and is risk neutral, the owner can set F_i in such a way that $F_i + P_iO_i$ equals the opportunity cost of her agent. This implies that the cost of hiring a manager is fixed and unaffected by risk, making it equivalent for the principal to maximize profits ignoring the managers (total) payoff.[44]

These properties are very convenient and make the model much more "user-friendly". Assuming this form though is at the same time one of the weaknesses of the model. In the principal-agent theory the existence of (linear) incentive contracts is motivated by an asymmetric information structure and the following moral hazard problem.[45] The alternative for the case of complete information as is assumed here would then be a forcing contract with no need for linear incentive components. However, the assumption of linear contracts is standard in the strategic delegation literature as it is consistent with the principal-agent framework. Also, this restriction makes most models analytically traceable as many of the used techniques would not be applicable if this assumption would be dropped.[46] Nevertheless, Aggarwal and Samwick (1999) show for their model that including risk aversion on the part of the manager as well as disutility and an effort choice in the determination of the optimal contract does not affect their major conclusions.

---

[44] C.f. Fershtman/Judd (1987), p. 932.

[45] C.f. Fershtman/Judd (1987), pp. 930 and 939 f. and Aggarwal/Samwick (1999), p. 2007.

[46] C.f. Jansen et al. (2007), p. 533

As both players have three different alternatives we get nine possible situations. However, as Dierkes assumes symmetric cost and demand functions those nine possibilities reduce to six subgames. They are presented in table 1.

		Firm 2		
		Profit Participation	Strategic Transfer Pricing	Relative Performance Evaluation
Firm 1	Profit Participation	Subgame I	Subgame II	Subgame III
	Strategic Transfer Pricing	Subgame II	Subgame IV	Subgame VI
	Relative Performance Evaluation	Subgame III	Subgame VI	Subgame V

Table 1: Full game
Source: Dierkes (2004), p. 49.

The game consists of two stages. In the first stage the owners of both firms simultaneously choose the incentive mechanism.[47] Note at this point, that renegotiation of the contracts is implicitly excluded by assumption. Subsequently, in stage two the managers choose the price of sale for their product given their incentive scheme and considering their expectations about the opponent's price choice. In this sense, within each firm the owner acts as a Stackelberg leader[48] with respect to her manager.[49] The two stages are essential. Neus and Nippel (1996) note that strategic behaviour is only possible if decisions are not taken simultaneously or if a plurality of decisions is taken one after the other (the latter being the case in Dierkes' model). The second condition is that after each stage the decisions that have been taken are observed by all players (and Dierkes

---

[47] The choice in fact does not have to be simultaneous. It is however necessary that when choosing a mechanism the owners and managers of the firm do not already know the choice made by the competitor. Nevertheless, as we assume complete information both competitors know the objective function and the possible choices of the opponent and can therefore perfectly anticipate the decision of the other player. C.f. Göx (1999), p. 30.

[48] For the concept of Stackelberg leadership see any standard game theory textbook, e.g. Holler/Illing (2006).

[49] C.f. Alles/Datar (1998), p. 457.

follows this assumption as well). The overall timing of the game is shown in figure 1.
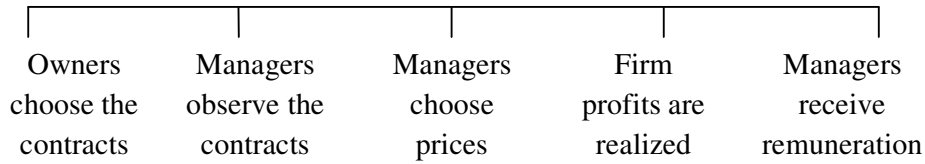

Figure 1: Timing of the game

To solve multi-stage games one uses backwards induction.[50] First, the Nash equilibrium at the last stage is identified. Then, using these results as we assume complete information, the same procedure is applied to the previous stage until stage one is reached. It is necessary to perform this procedure for each subgame. Only afterwards, the solution to the full game can be determined. The solution to each subgame will be presented throughout the next subsections.

If the decisions could not be observed the competitor could not be influenced by it. Consequently, there would only be the negative "distorting" effect without any positive strategic effect. Is such a case it would be best to simply do without the incentive distorting variable.[51] The envelop theorem best demonstrates why this is the case. Taking the example of strategic transfer prices the effect of a change in the transfer price on firm profit can be decomposed the following way for $i, j \in \{1,2\}$ and $i \neq j$:[52]

$$\frac{dH_i}{dt_i} = \frac{\partial H_i}{\partial t_i} + \frac{\partial H_i}{\partial p_i} \cdot \frac{\partial p_i^*}{\partial t_i} + \frac{\partial H_i}{\partial p_j} \cdot \frac{\partial p_j^*}{\partial t_i} \qquad (5)$$

where p_i^* and p_j^* are the optimal prices in equilibrium.

The first summand corresponds to the distortion effect associated with the transfer price different from marginal cost and is hence always negative. The second part can be ignored as it is zero because due to the first-order condition of the manager

---

[50] Backward induction is a main mathematical optimization method of dynamic programming. See any standard game theory textbook, e.g. Holler/Illing (2006).

[51] It can however not be excluded that the use of an additional decision variable might be useful for reasons other than strategic incentive distortion. C.f. Neus/Nippel (1996), p. 438.

[52] C.f. Neus/Nippel (1996), p. 435.

the transfer price is always set in a position where $\frac{\partial H_i}{\partial p_i} = 0$. Finally, the last summand represents the strategic effect. Its sign depends on the model specifications. Given our demand function $\frac{\partial H_i}{\partial p_j} > 0$ because an increase in the competitors price increases the profit for the own firm. Hence, the expression $\frac{\partial p_j^*}{\partial t_i}$ will determine the sign of this last part and it will be positive if the increase in the own transfer price induces the competitor to increase the price of its product in equilibrium. So only if this strategic effect is positive and outweighs the negative distortion effect can it be beneficial for the firm to self-commit to a transfer price different from actual marginal cost.

2.2. Solution to subgame I

This is the situation were both agents are paid a share of their own firms' profit. Consequently, their objective function is equal to the objective function of their respective principal. Hence, this is the only one of the six subgames where the solution is determined in one single stage. In order to find the Nash equilibrium for this stage we first need to differentiate both managers' objective functions with respect to the sales price. The first-order conditions for $i, j \in \{1,2\}$ and $i \neq j$ therefore are:

$$\frac{\partial G_i}{\partial p_i} = d - e \cdot (2 \cdot p_i - k) + f \cdot p_j \overset{!}{=} 0 \tag{6}$$

If these equations are reformulated to be written as $p_i(p_j)$, the price of the own product as a function of the competitor product's price, the resulting equations are known as the agents' reaction curves and will be denominated by $R_i(p_j)$ for for $i, j \in \{1,2\}$ and $i \neq j$. They are identified in this manner as they describe the best reaction of one agent to his competitor's price decision.[53] It becomes obvious at this point that each agent will have to base his decision on his expectations about

---

[53] As the game in this case is simultaneous nobody is really reacting to a known decision of the opponent. Therefore, the notation reaction function is less intuitive for a simultaneous game and more appropriate in a Stackelberg setting. C.f. Göx (1999), p. 33.

the other manager's choice. We will see that this will be the case in all subgames so that the manager will not be able to make a decision independently from his competitor's decision. Despite this fact, since there is complete information each manager can perfectly anticipate the decision the opponent will take.[54] The Nash equilibrium is the point where both managers' expectations materialize and none can improve his position by altering his pricing decision.[55]

Solving the system of two equations given by the first-order conditions in (6) for the corresponding prices in the Nash equilibrium can be calculated, being:

$$p_1^I = p_2^I = \frac{d + e \cdot k}{2 \cdot e - f} \tag{7}$$

As mentioned before, this is the known standard Bertrand-competitive result.[56] To be better able to compare the results, Dierkes uses simple algebra to present the same result in a slightly different form:

$$p_1^I = p_2^I = k + \frac{d - (e - f) \cdot k}{2 \cdot e - f} > k \tag{8}$$

It was already mentioned earlier that the model makes the reasonable assumption of $e > f$. Additionally, it is assumed that $d - (e - f) \cdot k > 0$. The latter assumption makes sure that the price is larger than the unit cost. This is also a very realistic assumption since otherwise the profit margin would be negative which is not economically sensible. The resulting profits for the owners of both firms are given by:

$$G_1^I = G_2^I = \frac{e \cdot (d - (e - f) \cdot k)^2}{(2e - f)^2} \tag{9}$$

2.3. Solution to subgame II

In subgame II the owner of firm 1 still uses profit participation as incentive system for its manager, the principal of firm 2 on the other hand uses strategic

---

[54] C.f. Göx (1999), p. 32.

[55] A Nash-equilibrium is the point where the strategy of each player maximizes the respective expected utility, given that all other players also play their equilibrium strategies. See any standard game theory textbook, e.g. Holler/Illing (2006).

[56] C.f. Varian (1994), pp. 292 ff.

transfer pricing. Now we have to solve a subgame with two stages. First, we differentiate the agents' objective functions again with respect to their relevant prices. While obviously the first-order condition for the manager of firm 1 remains unchanged, the one for the manager of firm 2 changes to:

$$\frac{\partial H_2}{\partial p_2} = d - e \cdot (2 \cdot p_2 - t_2) + f \cdot p_1 \overset{!}{=} 0 \tag{10}$$

Solving the system of equations for the prices gives the second stage Nash equilibrium at:

$$p_1^{II} = \frac{2 \cdot e \cdot (d + e \cdot k) + f \cdot (d + e \cdot t_2)}{4 \cdot e^2 - f^2} \tag{11}$$

$$p_2^{II} = \frac{2 \cdot e \cdot (d + e \cdot t_2) + f \cdot (d + e \cdot k)}{4 \cdot e^2 - f^2} \tag{12}$$

While the manager of firm 1 still decides exactly as his owner would do if deciding centrally, the owner of firm 2 has still one variable of influence. Since we assume complete information the principal of firm 2 can use his expectations about the agents' reaction curves to optimally choose a strategic transfer price. Mathematically this is done by inserting (11) and (12) into her objective function and maximizing with respect to the strategic transfer price. The calculus is shown in appendix 1. For reasons of comparison the result is, as in subgame I, presented in a slightly different but equivalent way by Dierkes:

$$t_2^{II} = k + \frac{f^2 \cdot (2 \cdot e + f) \cdot (d - (e - f) \cdot k)}{8 \cdot e^4 - 4 \cdot e^2 \cdot f^2} > k \tag{13}$$

It should be noted that the transfer price is higher than the actual unit cost. The manager is therefore forced to act as if the costs were higher than they actually are. Using this result and inserting it into the result of stage 2 gives the equilibrium sales prices for this subgame (results are simplified and rearranged for reasons of comparison):

$$p_1^{II} = k + \frac{(4 \cdot e^2 + 2 \cdot e \cdot f - f^2) \cdot (d - (e - f) \cdot k)}{8 \cdot e^3 - 4 \cdot e \cdot f^2} > k \tag{14}$$

18

$$p_2^{II} = k + \frac{(2 \cdot e + f) \cdot (d - (e - f) \cdot k)}{4 \cdot e^2 - 2 \cdot f^2} > k \tag{15}$$

Hereby it holds that $p_2^{II} > p_1^{II}$.[57] So the firm applying strategic transfer prices will charge a higher price than its competitor. Finally, inserting these results into the owners' objective function gives us their profit:

$$G_1^{II} = \frac{(4 \cdot e^2 + 2 \cdot e \cdot f - f^2)^2 \cdot (d - (e - f) \cdot k)^2}{16 \cdot e \cdot (2 \cdot e^2 - f^2)^2} \tag{16}$$

$$G_2^{II} = \frac{(2 \cdot e + f)^2 \cdot (d - (e - f) \cdot k)^2}{16 \cdot e^3 - 8 \cdot e \cdot f^2} \tag{17}$$

Contrary to the prices, the profit of firm 2 using strategic transfer prices is higher than for the competitor using profit participation as $G_1^{II} > G_2^{II}$. The higher transfer price induces the manager of firm 2 to charge a higher price. This reduces competitive intensity and results in higher profits for both firms.[58]

2.4. Solution to subgame III

Subgame III describes the situation where the principal of firm 1 still chooses profit participation but firm 2 applies the relative performance evaluation incentive scheme. The steps are the same as in subgame II but while for the manager of firm 1 the first-order condition remains the same, the first-order condition for the agent of firm 2 changes to:

$$\frac{\partial B_2}{\partial p_2} = (e \cdot (k - p_2) + d + f \cdot p_1 - e \cdot p_2) \cdot s_2 - f(k - p_1) \cdot v_2 \overset{!}{=} 0 \tag{18}$$

As before, solve the system of equations to get the Nash equilibrium at the second stage:

$$p_1^{III} = \frac{2 \cdot e \cdot (d + e \cdot k) \cdot s_2 + f \cdot (d \cdot s_2 + e \cdot k \cdot s_2 - f \cdot k \cdot v_2)}{4 \cdot e^2 \cdot s_2 - f^2 \cdot (s_2 + v_2)} \tag{19}$$

$$p_2^{III} = \frac{2 \cdot e \cdot (d + e \cdot k) \cdot s_2 + f \cdot (d \cdot s_2 + e \cdot k \cdot s_2 + d \cdot v_2 - e \cdot k \cdot v_2)}{4 \cdot e^2 \cdot s_2 - f^2 \cdot (s_2 + v_2)} \tag{20}$$

Again, the manager of firm 1 makes the same decisions as his principal would make. The principal therefore has no remaining decision variable. The owner of firm 2 on the other hand still has influence on the design of the incentive scheme, equally to subgame II. The difference lies in the decision variable. In Subgame II it was the strategic transfer price. Now it is the relation between the participation rate in the own firm's profit and the participation rate in the competitor firm's profit. Consequently, only the principal of firm 2 is considered at stage one.

Remember that the participation rate in the own firm's profit is assumed to be positive while only v is allowed to assume any value. Additionally, Aggarwal and Samwick (1999) show what effectively determines the incentives are not the values of the participation rates but their ratio $\frac{s}{v}$. Hence, one can be small if the other is small as well. In fact, Fumas (1992) and Miller and Pazgal (2002) who also discuss the use of relative performance evaluation completely omit a parameter for the participation in the profits of the own firm. This is equal to setting s equal to one. Nevertheless, as only the ratio is crucial, this does not change the conclusions. Note that also the sign of the ratio is entirely determined by the denominator as the numerator is assumed to be positive. The logical consequence is that the objective function of the owner is maximized with respect to v and the result written as a relation between the two participation rates.

Note however an additional peculiarity: stating that the incentives are entirely determined by the ratio $\frac{s}{v}$ does not hold true if a fully specified agency model with effort cost and risk aversion were to be assumed. The resulting risk premium would cause the absolute level of the parameter s to become a relevant factor in making the decision as it would directly influence the effort level. Nevertheless, remember that the objective function is only part of the total compensation of the manager. The linear contract consists determining total compensation is actually $F_i + P_iO_i$ consisting of a fixed part and the variable part. It has been discussed that assuming risk neutrality the agents objective function restricts to simply maximize O_i. It would therefore be possible to avoid the absolute level of s to become

relevant by sticking to the ratio $\frac{s}{v}$ in the objective function O_i and modeling the effect on risk premium and effort through a change of the parameter P_i. Nonetheless the problem would not vanish as the new specification would cause the whole expression of $F_i + P_iO_i$ to become the agent's objective function and instead of the absolute value of s becoming decisive the absolute value of P_i would become part of the decision problem. So in conclusion, when a fully specified agency model is assumed the ratio $\frac{s}{v}$ does not any more completely determine incentives but the absolute level of the parameter s (or P_i depending of the model specification) becomes decisive as well. This additional complication can be avoided only if risk neutrality by the agent is assumed. The reader should keep this in mind in what follows.

The prices calculated in (19) and (20) are consequently inserted into the owner's objective function which subsequently is maximized for v_2 to get:

$$v_2^{III} = \frac{f \cdot (2 \cdot e + f)}{4 \cdot e^2 + 2 \cdot e \cdot f - f^2} \cdot s_2^{III} = \alpha^{III} \cdot s_2^{III} \tag{21}$$

where s_2^{III} is by assumption positive and α^{III} lies between zero and 0.6. The participation rate for the competitor's profit is therefore also positive, meaning that the manager's payoff increases if his competitor's profit increases. Hereby it ensures that the intensity of competition is reduced. As would be expected, the participation rate is however lower for the rival firm. This mechanism will be discussed in more detail in subgame V in section 2.6.

As in subgame II only the results are presented here while the intermediate steps can be found in appendix 1. Using (21) and inserting it into (19) and (20) gives the equilibrium sales prices for this subgame. The resulting prices are identical to (14) and (15) calculated in subgame II:

$$p_1^{III} = p_1^{II} = k + \frac{\left(4 \cdot e^2 + 2 \cdot e \cdot f - f^2\right) \cdot \left(d - (e - f) \cdot k\right)}{8 \cdot e^3 - 4 \cdot e \cdot f^2} > k$$

$$p_2^{III} = p_2^{II} = k + \frac{(2 \cdot e + f) \cdot \left(d - (e - f) \cdot k\right)}{4 \cdot e^2 - 2 \cdot f^2} > k$$

Obviously, as a consequence also the resulting profits for the firms are equal to (16) and (17) calculated in subgame II:

$$G_1^{III} = G_1^{II} = \frac{\left(4 \cdot e^2 + 2 \cdot e \cdot f - f^2\right)^2 \cdot \left(d - (e - f) \cdot k\right)^2}{16 \cdot e \cdot \left(2 \cdot e^2 - f^2\right)^2}$$

$$G_2^{III} = G_2^{II} = \frac{\left(2 \cdot e + f\right)^2 \cdot \left(d - (e - f) \cdot k\right)^2}{16 \cdot e^3 - 8 \cdot e \cdot f^2}$$

The reason why both results are identical is that in both situations firm 2 basically has to act as a Stackelberg leader. While prices in stage two are set simultaneously by the managers of the two firms, in stage one only the principal of firm 2 has a decision to make. Since firm 1 still applies profit maximizing, the decision can be delayed and made by the manager in stage two. No other decision variable is available at stage one. The owner of firm 2 on the other hand must decide on the transfer price or the relation of the participation rates in stage one. Firm 1 only follows reacting optimally to the decision made by the principal of firm 2.[59] Therefore, we get the same Stackelberg equilibrium in both subgames. As is well known in the literature, a Stackelberg equilibrium in a heterogeneous duopoly based on Bertrand-competition is characterized by a second-mover-advantage.[60] This is confirmed here as the profit of firm 1 is higher than the profit of firm 2:[61]

$$G_1^{II} = G_1^{III} > G_2^{II} = G_2^{III} \tag{22}$$

The opposite is true for their respective prices:[62]

$$p_2^{II} = p_2^{III} > p_1^{II} = p_1^{III} \tag{23}$$

Göx (1999) discusses that what is decisive in this unilateral situation is not the sequence of the decisions but the observability of them as will be discussed in more detail later. At the same time he notices a conceptual problem: since both firms would want to be the follower, in the absence of certain market or sector conditions it is unlikely that any firm would voluntarily choose to be the leader.

---

[59] In this scenario, therefore, the notion reaction curve is more intuitive.
[60] C.f. among others Göx (1999), pp. 37 f. and pp. 48 ff.
[61] The proof can be found in appendix 2.
[62] This proof can also be found in appendix 2.

For a closer examination of this these aspects I will return to his paper in more detail in the next section.

Subgames II and III have shown that both distortion mechanisms, strategic transfer pricing and relative performance evaluation, lead to the same result if the competing firm keeps relying on pure profit maximization. It is however worth noting, that both approaches operate in a distinct way which can be examined when looking at the corresponding reaction functions. It was mentioned earlier that the reaction function of each manager is derived when setting the first-order condition of his objective function to zero and reformulating the own products price as a function of the competing manager's price. I will derive the reaction function for the manager of one firm (firm 2^{63}) for all three objective functions. Then I will graphically show how the two incentive distortion mechanisms work differently compared to the standard Bertrand outcome.

First, the reaction function of the standard Bertrand equilibrium with profit participation can be derived reformulating equation (6). The reaction curve for the agent of firm 2 thus is:

$$R_2^B(p_1) = \frac{d + f \cdot p_1 + e \cdot k}{2 \cdot e} \tag{24}$$

This reaction curve represents the reference case. Using STP the reaction function derived from (10) for the manager from of firm 2 becomes:

$$R_2^{STP}(p_1) = \frac{d + f \cdot p_1 + e \cdot t_2}{2 \cdot e} \tag{25}$$

It is basically the same as before only instead of marginal cost we have the corresponding transfer price. Using RPE instead the reaction function of the firm's manager derived from (18) becomes:

$$R_2^{RPE}(p_1) = \frac{s_2 \cdot (d + f \cdot p_1 + e \cdot k) + f \cdot v_2 \cdot (p_1 - k)}{2 \cdot e \cdot s_2} \tag{26}$$

---

[63] The choice is only made for illustrative reasons. The results apply symmetrically also to firm 1.

Figure 2 shows how the two incentive mechanisms have different effects on the original reaction curves. It is apparent from equation (25) that a change in the transfer price which replaced marginal cost compared to equation (24) of firm 2 causes the reaction function to shift parallel. In subgame II we found in equation (13) that the optimal transfer price is higher than the actual marginal cost. This corresponds to an upwards shift of the reaction curve from $R_2^B(p_1)$ to $R_2^{STP}(p_1)$ in figure 2.[64] Using RPE the parameters s_2 and v_2 are introduced compared to equation (24). It has been previously mentioned that maximization takes place according to v_2. The result is a relation of this parameter to the size of s_2. Therefore, the change in the reaction curve is also discussed with reference to a change in the participation rate in the competitor's profit. An increase in v_2 has the effect of increasing[65] the slope of the reaction curve.[66] Note that $R_2^{RPE}(p_1)$ intercepts with the original reaction curve $R_2^B(p_1)$ where price equals marginal cost. The dashed lines in figure 2 describe how the two reaction curves appear mathematically. In economic terms however, the agent would not offer his firm's product below marginal cost. Therefore, the actual reaction curve has a minimum at this point and is flat until the values of the dependant variable in formulas (24), (25) and (26) exceed this minimum. The increase in v_2, therefore, corresponds to a rotation of the original reaction curve around the point where price equals marginal cost. This can clearly be seen by looking at figure 2.

Comparing the two mechanisms, we find that the use of strategic transfer prices causes a parallel shift of the manager's reaction function while the use of relative performance evaluation results in the change of the slope of the reaction curve. As we have seen in subgames II and III, they both shift the equilibrium outwards compared to the standard Bertrand result and have thus beneficial effects for the firms. The next subsections will show which distortion scheme provides more positive when the owners of both firms use strategic incentive distortion.

---

[64] This is a well-known result. See any standard economics textbook, e.g. Varian (1994).

[65] For firm 1 using RPE the effect would be the other way around and the slope would become flatter. Nevertheless, the effect is symmetrical and beneficial in both cases as it moves the equilibrium outwards to a new equilibrium with higher prices.

[66] C.f. Aggarwal/Samwick (1999), pp. 2003 ff. and Polo/Tedeschi (1992), pp. 289 ff.
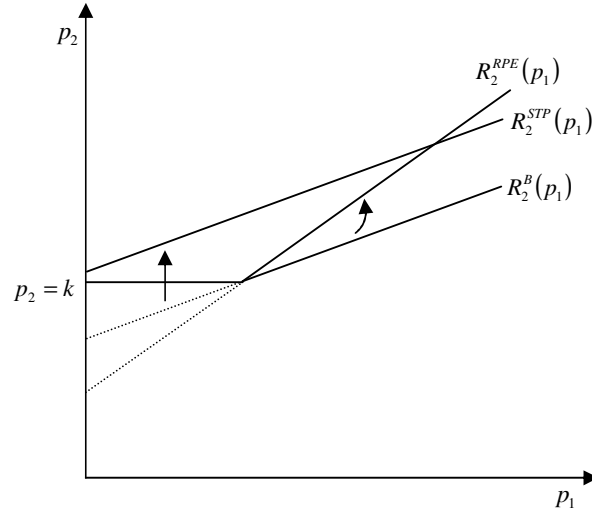
Figure 2: Effects of distortion mechanism on reaction functions

2.5. Solution to subgame IV

Subgame IV considers the case where both principals choose strategic transfer pricing to be the incentive scheme for their agents. Analogous to (10) in subgame II for firm 2 the first-order conditions for $i, j \in \{1,2\}$ and $i \neq j$ therefore are:

$$\frac{\partial H_i}{\partial p_i} = d - e \cdot (2 \cdot p_i - t_i) + f \cdot p_j \overset{!}{=} 0$$

Given this homogeneous choice and the assumption of symmetry it is clear that the resulting prices from solving this system of equations are also uniform for $i, j \in \{1,2\}$ and $i \neq j$:

$$p_i^{IV} = \frac{2 \cdot e \cdot (d + e \cdot t_i) + f(d + e \cdot t_j)}{4 \cdot e^2 - f^2} \tag{27}$$

Inserting these into the objective function of the owners and maximizing for the respective strategic transfer prices gives the optimal transfer price (obviously also symmetric) of subgame IV:[67]

$$t_i^{IV} = k + \frac{f^2 \cdot (d - (e - f) \cdot k)}{e \cdot (4 \cdot e^2 - 2 \cdot e \cdot f - f^2)} > k \qquad i \in \{1,2\} \tag{28}$$

---

[67] Again, the result is presented in the same format as does Dierkes and the intermediate steps are presented in appendix 1.

Both owners charge their manager a transfer price that is higher than the actual unit cost (similar to subgame II). The transfer prices therefore make the manager act as if their costs were higher than they actually are. This induces the agents to increase their sales prices which for reasons of comparison are presented here in the shape used by Dierkes:[68]

$$p_i^{IV} = k + \frac{2 \cdot e \cdot (d - (e - f) \cdot k)}{4 \cdot e^2 - 2 \cdot e \cdot f - f^2} > k \qquad\qquad i \in \{1,2\} \tag{29}$$

Applying these prices to the objective function of the owners gives their profits for this subgame:

$$G_i^{IV} = \frac{2 \cdot e \cdot (2 \cdot e^2 - f^2) \cdot (d - (e - f) \cdot k)^2}{(4 \cdot e^2 - 2 \cdot e \cdot f - f^2)^2} > k \quad i \in \{1,2\} \tag{30}$$

The use of transfer prices results in a reduction of competitive intensity by making the managers act as if their costs are higher than they actually are.[69] This can only be of interest if it influences the behavior of the competitor.[70] The agents are implicitly forced to act with a partial collusive strategy.[71] As a result, the implied profit is closer to the cartel case and higher than in the cases of unilateral (subgame II) or bilateral (subgame I) profit participation. Since already the unilateral deviation from profit maximization raises profits for both firms, this commitment has a cooperative effect.[72] If both principals delegate the decision using optimal strategic transfer pricing profits can be raised even more (but not as far as the joint-profit-maximizing level[73]). This means that strategic transfer pricing in a Bertrand duopoly is a dominant strategy when the alternative is profit participation. The same conclusion is drawn by Fershtman and Judd (1987) and Sklivas (1987) who were the first to consider this option in a model.[74] They note however "that the nature of the desired distortion critically depends on the nature

---

[68] The proof that given the assumptions these prices are higher than those in subgame I is provided in appendix 2.

[69] C.f. Alles/Datar (1998), p. 458.

[70] C.f. Neus/Nippel (1996), pp. 432 f.

[71] C.f. Göx (1999), p. 55.

[72] C.f. Sklivas (1987), p. 457.

[73] C.f. Sklivas (1987), p. 457.

[74] Appendix 3 shows that their model based on profits and revenues is effectively the same as using strategic transfer prices.

of oligopolistic competition."[75] They find that this positive effect of self-commitment is only achieved when competition is based on prices. If, on the other hand, the model is based on Cournot competition, then the effect is quite the opposite. In fact, profits are lower for both firms compared to the profit maximizing case, while at the same time STP still remains a dominant strategy. It is therefore a classic case of prisoners' dilemma.[76]

Additionally, Alles and Datar (1998) note that improving one's competitive position by using transfer prices above marginal cost is only possible in an oligopoly. This is not surprising as considerations of strategic interaction lie at the very heart of all these models. Hence, in a monopoly or in perfect competition where this crucial element is missing no strategic advantage can be achieved through self-commitment. Consequently, "both a monopolist and a perfectly competitive firm will choose transfer prices equal to marginal cost."[77] They prove this statement also mathematically.

I will return to these interesting aspects in more detail in the next section.

2.6. Solution to subgame V

Subgame V deals with the case where both principals' choose to apply relative performance evaluation. The agents' objective functions are thus analogue to (18) in subgame III and for the reasons discussed in subgame IV the first-order conditions are again symmetric. For $i, j \in \{1,2\}$ and $i \neq j$ they are:

$$\frac{\partial B_i}{\partial p_i} = \left(e \cdot (k - p_i) + d + f \cdot p_j - e \cdot p_i \right) \cdot s_i - f \left(k - p_j \right) \cdot v_i \overset{!}{=} 0$$

Solving the system of equations for the prices yields:

---

[75] Fershtman/Judd (1987), p. 928. See also Sklivas (1987), p. 457.
[76] A prisoner dilemma situation is a game in which the choice of a specific strategy would be beneficial to the parties but that outcome is not a Nash-equilibrium because some other strategy is dominant even though the resulting equilibrium-outcome is worse for both players. See any standard game theory textbook, e.g. Holler/Illing (2006).
[77] Alles/Datar (1998), p. 459.

$$p_i^V = \frac{2 \cdot e \cdot s_j \cdot (d \cdot s_i + e \cdot k \cdot s_i - f \cdot k \cdot v_i) + (f \cdot s_i + f \cdot v_i) \cdot (d \cdot s_j + e \cdot k \cdot s_j - f \cdot k \cdot v_j)}{4 \cdot e^2 \cdot s_i \cdot s_j - (f \cdot s_i + f \cdot v_i) \cdot (f \cdot s_j + f \cdot v_j)}$$

(31)

for $i, j \in \{1,2\}$ and $i \neq j$.

Inserting these into the owners' objective functions we can maximize and solve for the optimal ratio of participation in the rival firm's profit with respect to the own firm's profit. As always, the result is presented here while the intermediate steps can be found in appendix 1:

$$v_i^V = \frac{f}{2 \cdot e - f} \cdot s_i^V = \alpha^V \cdot s^V \qquad\qquad i \in \{1,2\}$$

(32)

As in subgame III s^V is positive by assumption. As α^V results positive as well the same holds true for v^V. The latter one, in contrast to subgame III, now lies between zero and one. This implies that in the incentive for the competitor's profit could be as high as to equal the incentive given for the own firm's profit. Once more, this works to reduce competitive intensity. These results hold obviously true for both firms in this subgame.

Given these incentives the managers' will set the following prices (as always presented in the format chosen by Dierkes):

$$p_i^V = k + \frac{(2 \cdot e - f) \cdot (d - (e - f) \cdot k)}{4 \cdot e \cdot (e - f)} > k \qquad\qquad i \in \{1,2\}$$

(33)

This in turn will make sure both firms get a profit of:

$$G_i^V = \frac{(4 \cdot e^2 - f^2) \cdot (d - (e - f) \cdot k)^2}{16 \cdot e^2 \cdot (e - f)} \qquad\qquad i \in \{1,2\}$$

(34)

Similar to the use of strategic transfer prices also relative performance evaluation results in a reduction of competitive intensity because each manager also profits from the success of the competitor. Consequently, the profit in this case is higher than in the cases of unilateral (subgame III) or bilateral (subgame I) profit participation[78], as it was with strategic transfer prices. Hence, relative performance evaluation is a dominant strategy over profit participation in a

---

[78] The proof can be found in appendix 2.

duopoly based on Bertrand competition. This conclusion was first pointed out by Aggarwal and Samwick (1999). The most striking aspect of their result was however the positive participation rate in the competitor's profit because it is the opposite of what the principal-agent theory suggests. In principal-agent models, the participation rate for the competitor's profit is always negative so as to filter common shocks, thereby reducing the risk for the agent and consequently the necessary risk premium to be paid by the principal.[79] The result reached here shows that while classic benchmarking as proposed by the principal-agent literature has a risk-reducing purpose and value, at the same time it has an important cost by inducing the manager to compete more aggressively.[80] The latter effect can be more important in an oligopoly setting where strategic interaction is crucial. This might explain why benchmarking in the classic sense is so rarely used in practice. I will return to this in more detail in the next section.

2.7. Solution to subgame VI

We have seen from subgames IV and V that both RPE and STP have basically the same effects and benefits over pure profit participation in a Bertrand duopoly. It has been mentioned that this was already known in the literature due to the works of Fershtman and Judd (1987), Sklivas (1987) and Aggarwal and Samwick (1999). However, it was not known which of the two incentive mechanisms was better until Dierkes (2004). His main improvement was to compare both strategic transfer pricing *and* relative performance evaluation as incentive systems in the *same* model. This is most obvious when looking first at subgame VI and then at the full game.

Subgame VI describes the situation where one firm's owner chooses strategic transfer pricing while the other one chooses relative performance evaluation. So in this subgame there is a direct confront of these two approaches. Assuming firm 1 applies STP and firm 2 uses RPE, the managers' objective functions are then analogous to (3) and (4) respectively. Differentiating with respect to their own sales price yields the first-order conditions of the second stage Nash equilibrium. These are obviously the same ones already calculated in equation (10) and (18)

---

[79] C.f. Holmstrom (1982), p. 339 and Gibbons/Murphy (1990), p. 30.

[80] C.f. Aggarwal/Samwick (1999), p. 2008. For other disadvantages of this benchmarking approach see Gibbons/Murphy (1990), pp. 33 ff.

from subgames II and III and are represented here again only for illustrative reasons:

$$\frac{\partial H_1}{\partial p_1} = d - e \cdot (2 \cdot p_1 - t_1) + f \cdot p_2 \overset{!}{=} 0$$

$$\frac{\partial B_2}{\partial p_2} = (e \cdot (k - p_2) + d + f \cdot p_1 - e \cdot p_2) \cdot s_2 - f(k - p_1) \cdot v_2 \overset{!}{=} 0$$

As usual, the system is solved for the resulting prices:

$$p_1^{VI} = \frac{2 \cdot e \cdot s_2 \cdot (d + e \cdot t_1) + f \cdot (d \cdot s_2 + e \cdot k \cdot s_2 - f \cdot k \cdot v_2)}{4 \cdot e^2 \cdot s_2 + f^2 \cdot (s_2 + v_2)} \tag{35}$$

$$p_2^{VI} = \frac{2 \cdot d \cdot e \cdot s_2 + d \cdot f \cdot s_2 + 2 \cdot e^2 \cdot k \cdot s_2 + e \cdot f \cdot s_2 \cdot t_1 + d \cdot f \cdot k \cdot v_2 + e \cdot f \cdot t_1 \cdot v_2}{4 \cdot e^2 \cdot s_2 - f^2 \cdot (s_2 + v_2)} \tag{36}$$

These prices are inserted into the objective functions of the owners in stage 1. The owner of firm 1 decides on the optimal transfer price while the owner of firm 2 decides on the optimal ratio of participation rates in own and rival firm profits. Differentiating for the respective decision variables and solving for the stage 1 Nash equilibrium yields:[81]

$$t_1^{VI} = k + \frac{f^2 \cdot (e + f) \cdot (d - (e - f) \cdot k)}{4 \cdot e^4 - 3 \cdot e^2 \cdot f^2} > k \tag{37}$$

$$v_2^{VI} = \frac{f \cdot (4 \cdot e^2 + 2 \cdot e \cdot f - f^2)}{8 \cdot e^3 + 4 \cdot e^2 \cdot f - 2 \cdot e \cdot f^2 + f^3} \cdot s_2^{VI} = \alpha^{VI} \cdot s_2^{VI} \tag{38}$$

where s_2^{VI} is positive by assumption and α^{III} lies between zero and $\frac{5}{11}$. Similar to previous results the charged transfer price for the manager of firm 1 is higher than the actual unit cost and the manager of firm 2 is positively incentivized by his own and the competitor firm's profit. In stage two of the game they will then set the following prices (presented in the usual form):

$$p_1^{VI} = k + \frac{(8 \cdot e^3 + 4 \cdot e^2 \cdot f - 2 \cdot e \cdot f^2 + f^3) \cdot (d - (e - f) \cdot k)}{4 \cdot e^2 \cdot (4 \cdot e^2 - 3 \cdot f^2)} > k \tag{39}$$

---

[81] Results are presented in the format used by Dierkes. To see the intermediate steps check appendix 1.

$$p_2^{VI} = k + \frac{\left(4 \cdot e^2 + 2 \cdot e \cdot f - f^2\right) \cdot \left(d - (e - f) \cdot k\right)}{8 \cdot e^3 - 6 \cdot e \cdot f^2} > k \qquad (40)$$

Using these prices the profits of the two firms become:

$$G_1^{VI} = \frac{(2 \cdot e + f) \cdot \left(8 \cdot e^3 + 4 \cdot e^2 \cdot f - 2 \cdot e \cdot f^2 + f^3\right) \cdot \left(d - (e - f) \cdot k\right)^2}{16 \cdot e^3 \cdot \left(4 \cdot e^2 - 3 \cdot f^2\right)} \qquad (41)$$

$$G_2^{VI} = \frac{\left(4 \cdot e^2 + 2 \cdot e \cdot f - f^2\right) \cdot \left(8 \cdot e^4 + 4 \cdot e^3 \cdot f - 6 \cdot e^2 \cdot f^2 - 2 \cdot e \cdot f^3 + f^4\right) \cdot \left(d - (e - f) \cdot k\right)^2}{8 \cdot e^3 \cdot \left(4 \cdot e^2 - 3 \cdot f^2\right)^2}$$
$$(42)$$

Appendix 2 shows that the price for the product of the firm using relative performance evaluation is smaller than the sales price for the product of the firm using strategic transfer pricing:

$$p_2^{VI} < p_1^{VI} \qquad (43)$$

The opposite is true, however, for the respective profits:[82]

$$G_2^{VI} > G_1^{VI} \qquad (44)$$

Thus, subgame VI has shown that when playing strategic transfer pricing in one firm against relative performance evaluation in the other firm the latter one achieves the better result.

All six subgames have now been solved and it is therefore possible to analyze the results and draw conclusions for the overall game.

2.8. Solution to the full game

Let us first summarize the conclusions we have already drawn in the subgames. It has been shown that under the given assumptions strategic transfer pricing is a dominant strategy over profit participation. This had already been proven by the works of Fershtman and Judd (1987), Sklivas (1987). Additionally, it has been concluded that also relative performance evaluation dominates profit participation as strategic incentive mechanism. Any firm is therefore better off if they move away from profit participation and apply one of the other two approaches.

---

[82] The proof can be found in appendix 2.

Playing STP and RPE directly against each other has resulted in higher profit for the firm using relative performance evaluation. It remains to be shown that when both firms' principals choose this latter mechanism the resulting profit will be higher than when they both choose strategic transfer pricing. This is in fact the case[83] as can be seen from table 2 which shows the relations between the decision variables and profits of the subgames. For a numerical example of the results the interested reader is referred to the article of Dierkes as he includes such an illustration.

Decision variables of the principals	$0 < \alpha^{VI} < \alpha^{III} < \alpha^{V} < 1;$ $k < t_2^{II} < t_i^{IV} < t_1^{VI}$
Decision variables of the agents	$p_i^{V} > p_1^{VI} > p_2^{VI} > p_i^{IV} > p_2^{II} = p_2^{III} > p_1^{II} = p_1^{III} > p_i^{I}$
Firm profits	$G_i^{V} > G_2^{VI} > G_i^{IV} > G_1^{II} = G_1^{III} > G_2^{II} = G_2^{III} > G_i^{I};$ $G_2^{VI} > G_1^{VI} > G_1^{II}$

Table 2: Relations between the firm profits and the decision variables of the principals and the agents
Source: Dierkes (2004), p. 54.

Using the information given the resulting choice can be intuitively explained the following way: for any firm it is best to abandon profit participation as incentive scheme since both alternative strategies dominate over it. In choosing one of the two alternatives they consider the expected choice of the competitor. If the competitor chooses STP, than the better choice would be to choose RPE. If, on the other hand, the competitor chooses RPE it is still the better choice to pick the same mechanism. Therefore, relative performance evaluation is a dominant strategy. Only when both firms' owners choose this incentive system their expectations will be met and none of them has a motivation to abandon this strategy for a better alternative. Hence, this situation described by subgame VI is a Nash equilibrium in dominant strategies. At the same time it has the convenient property of providing both firms with the highest profit achievable in any of the subgames. A "prisoners' dilemma"-situation is consequently avoided in this game

---

[83] The proof can be found in appendix 2.

making sure both parties end up in the best possible position.[84] Given that the purpose of Dierkes in his paper was to find out whether STP or RPE is the better incentive distortion mechanism, he finds a clear answer. In his model relative performance evaluation is always the better choice for each firm and provides both with the highest possible profits.

---

[84] This is obviously only the best possible situation from a firm perspective as from a social benefit perspective this is not the case. Since the result is closer to the monopoly outcome the two firms benefit while the overall society suffers in economic terms.

3. Comparison with related models

In section 2, one specific model from Dierkes (2004) was described and explained in detail. In many instances I made references to remarks and conclusions of authors and papers that were the fundament of Dierkes' model. Dierkes adopted many of the ideas but could of course not incorporate everything that was discussed previously in the literature. In building his model he made a selection of what to include in his model and what assumptions to make. Many of these choices are implicit and do not result directly from the paper, some can even be the basis for critique.

Additionally, there has been other interesting literature which was not considered by Dierkes. Also, research has progressed since his paper was published in 2004. While his model has a central role in this paper because it was the first to confront strategic transfer pricing and relative performance evaluation in the same model, the purpose of this section is to give an overview of the residual most relevant literature in this area. Therefore, this section will briefly discuss the conclusions of the most fundamental as well as interesting recent literature in the field. To avoid confusion, the papers will be dealt one by one, beginning with the literature about strategic transfer prices and followed by the one on relative performance evaluation. To be consistent, within these two blocks the order will be chronological.

Throughout the section I will also point out the connection of each paper to the work of Dierkes. While some indications will also be given, a complete discussion of the model of Dierkes in the light of these additional findings will be provided in section 4.

3.1. Related literature on strategic transfer pricing

In this subsection the most important literature concerning strategic delegation through the use of transfer prices (or mathematically equivalent mechanisms) will be discussed. The focus will be on ground-setting papers as well as literature referred to by Dierkes. However, these are complemented by additional literature of major significance, published before and after Dierkes' paper.

3.1.1. Vickers (1985)

In 1985 Vickers was the first to recognize that evaluating a managers performance considering not only the own firm but also the reaction of the competitor can have important strategic implications. Delegating a decision to an agent with different preferences may as a result lead to results that are preferable to the principal over the result she would have achieved if taking the decision by herself.

To prove this Vickers uses an objective function for the agents of the form:[85]

$$H_i = G_i + \theta_i \cdot x_i \underset{x_i}{\rightarrow} \max \qquad\qquad i \in \{1,2,...,n\} \qquad\qquad (45)$$

with G_i being the profit, x_i being sales and θ_i being the manager's participation rate in sales of firm i.[86] Since Vickers bases his model on an oligopoly with Cournot competition, each firm's profit depends on the output of all the competitors in the market. All major other assumptions are equal to those made by Dierkes. The owners want to maximize only G_i but strikingly this is achieved by providing also positive incentives for sales to the manager. Indeed, θ_i is positive for every number of firms in the market larger than one.

This was a tremendous conclusion given that since the introduction of professional managers the separation of control and ownership was considered a "necessary bad". Contrary to this widespread belief, Vickers realizes that "the separation of ownership from control in the large corporation may in some cases be no bad thing for the owners."[87] In fact, this is the case for every market situation that lies between the two extremes of monopoly and perfect competition. While for the monopoly case any distortion of incentives is clearly unnecessary, Vickers shows in his model that with increasing number of firms θ_i decreases approaching zero in the limit.

Vickers shows that when profit-maximizing principals delegate the production decision to the agents, the optimal contract is different from pure profit maximization. At the same time, he finds that when all firms in the market switch

---

[85] Recall that even when discussing models of other authors I have used the notation of Dierkes whenever possible (for variables not present in the model of Dierkes I have used the notation of the respective authors whenever possible) in order to simplify the overview.

[86] Appendix 3 shows how this objective function is basically equal to the objective function based on strategic transfer prices used in section 2.

[87] Vickers (1985), p. 143.

to this new optimal type of contract, the output per firm is higher, price is lower and, most importantly, profits are lower. So where is the benefit of switching to the new incentive scheme? In fact, if none would switch, every firm would be better off. However, each firm's owner individually has an incentive to switch because it can improve its situation at the expense of the others. Simultaneously, not switching would imply the risk of ending in a worse condition if competitors change. Using the new incentive scheme is therefore a dominant strategy in this game but with the inconvenient property of ending up in a prisoners' dilemma situation with everyone being worse off than in the original state.

Vickers finishes off his paper discussing implications of his findings for the theory of the firm. Specifically, he identifies four relevant aspects. First, he notes that from pursuing profit maximization does not necessarily follow the maximum profit. Therefore, the rules of natural selection might cause pure profit maximizers to become extinct among managers (not among owners). Second, Vickers already points out that based on his findings relative performance evaluation might also have a strategic advantage. Third, it is discussed that horizontal mergers in an oligopoly are often disadvantageous to the merging parties. The reverse operation, splitting the company, can therefore be beneficial, even if it is for the purpose of organizing the firm in different divisions. As these divisions have different objective functions than the parent the strategic effect on the output of rival firms may be positive. Finally, Vickers notes that if vertical integration harmonises interests, strategic delegation may provide a good reason for non-integration as a divergence of interests can lead to beneficial outcomes.

3.1.2. Sklivas (1987)

Sklivas picks up Vickers ideas and designs a similar model (considering only two players) with the objective function of the manager of firm i being:

$$H_i = \gamma_i \cdot G_i + (1 - \gamma_i) \cdot U_i \rightarrow \max_{\gamma_i} \qquad\qquad i \in \{1,2\} \qquad\qquad (46)$$

where G_i is the firm's profit and U_i is the firm's revenue. The latter term is obviously the product of price and quantity.[88] The major improvement of this model over the one by Vickers is that Sklivas explicitly considers two different environments, once competition based on quantity and the other time competition based on price. Afterwards the results are compared. Besides modelling separately these two competitive environments all major assumptions are equal to those made by Dierkes.

Regarding quantity competition the findings of Sklivas are conceptually equal to the conclusions of Vickers. Under Cournot competition output is higher and profits are lower. Contrary to this result, the effects under price competition are reversed. Under Bertrand competition prices are higher, quantities lower and profits higher. Sklivas concludes that "because firm 1's unilateral deviation from profit maximization raises both firms' profits, commitment has a cooperative effect on the price-competing duopoly: both firms earn higher profits."[89] Nevertheless, the profits are still lower than the joint-profit-maximizing level.

This difference in outcome depending on the competitive environment is the most striking aspect of Sklivas' paper. In fact, "if duopolists compete in quantity, both firms earn lower profits. Conversely, if duopolists compete in price, both firms earn higher profits."[90]

Dierkes bases his model solely on Bertrand competition. Within this framework his conclusions are coherent with the findings of Sklivas. While his paper builds on the works of both Sklivas and Vickers, Dierkes completely fails to mention the different outcomes that might result by framing the model under the assumption of Cournot competition. Since the purpose of his paper is to confront strategic transfer pricing and relative performance evaluation to see which is better this is a point of heavy critique.

---

[88] Appendix 3 shows how this objective function is basically equal to the objective function based on strategic transfer prices used in section 2 and hence equal to the objective function used by Vickers.

[89] Sklivas (1987), p. 457.

[90] Sklivas (1987), p. 457.

3.1.3. Fershtman and Judd (1987)

The paper of Fershtman and Judd was published shortly after the one by Sklivas, so it can be assumed that they worked simultaneously and independently on the subject. Both use the exact same structure of the model based on profits and revenues, which is basically the same as using strategic transfer pricing.[91] Analogous to Sklivas, Fershtman and Judd also play the game based on both, Cournot and Bertrand competition and compare the results. Additionally, they include uncertainty about crucial market parameters describing demand and costs. The major conclusions of the paper are not altered, which is probably why Dierkes renounces the use of a random variable. Nevertheless, the inclusion of this aspect provides some additional insight into the sensitivity of some variables. All the other major assumptions are fundamentally similar to those made by Sklivas and Dierkes except that they allow for different costs among the two competitors.

The findings of Fershtman and Judd are basically identical to the ones of Sklivas in the way that the "desired distortion critically depends on the nature of oligopolistic competition."[92] Under the assumption of quantity competition the owner wants to motivate her manager toward high production in order to get the competing manager, being aware of these incentives, to reduce his output. Besides that they find that assuming random demand the participation rate in profit may even be negative. Also, assuming random costs incentive distortion will be higher if shocks are common while deviation from profit maximization will be reduced if shocks are not common or the variance in costs is too high. On the contrary, in price competition the owner wants the managers to set high prices encouraging also the competitors to raise prices while keeping sales low. Basically, they find the participation rate in sales to be negative[93], which translates mathematically into a transfer price above costs.

So far, the conclusions are the same as the ones put forward by Sklivas: "the owner of a firm will alter his managers' incentives in that direction which will cause opposing agents to change their behavior in beneficial directions."[94]

---

[91] See proof in appendix 3.
[92] Fershtman/Judd, p. 928.
[93] Obviously, a negative participation rate in sales will be very rare if not inexistent in actual contracts in practice.
[94] Fershtman/Judd (1987), p. 939.

Fershtman and Judd also observe that incentive distortion is vanishing as the number of firms is approaching infinity (thereby translating into perfect competition). In this sense they are also coherent with Vickers in finding that the strategic use of incentives makes only sense in an oligopoly. Furthermore, they make one crucial observation. They realize that the possibility of strategically influencing the decisions of the competitor is only possible if the manager's incentives are common knowledge. Therefore, each owner will want to publish her manager's remuneration scheme. This provides another reason for why incentive schemes of managers are made public. It might not be solely for corporate transparency reasons but the true (or additional) motivation might well come from strategic considerations.

Fershtman and Judd also involuntarily provide critique for the concept of relative performance evaluation. This happens when they try to justify why they limit themselves only to the own firm's profit and sales as parameters in the incentive contract. First, they argue that a firm has much better information about its own profits and sales than about its competitors'. Second, they put forward the argument of possible illegality of positive incentives to increase a competitor's profit. However, as was already mentioned in section 2, Gilo (1996) and Aggarwal and Samwick (1999) show that this argument does not hold in practice. Dierkes ignores this discussion completely. Implicitly we can hereby assume that he has no doubts about the availability of competitor information or the legitimacy of relative performance contracts.

Finally the paper points out its major weakness, as seen by Fershtman and Judd. There appears to be a conceptual problem as the model is based on linear contracts but at the same time through the absence of a detailed asymmetric information structure is lacking the basic motive for such contracts. This problem is analogously transferrable to Dierkes' paper and could be an argument of rigorous critique of the two articles. Dierkes notes the lack of information asymmetry in his paper but does not discuss possible problems or effects of this omittance. He refers to the work of Schiller (2000) who identifies several problems if information asymmetry is combined with uncertainty. Nevertheless, as has already been mentioned in section 2, Aggarwal and Samwick (1999) have showed that including information asymmetry does not change the main

conclusion of their paper. The same can be safely assumed for the models of Fershtman and Judd and Dierkes, making the omittance of information asymmetry less problematic.

3.1.4. Neus and Nippel (1996)

The paper of Neus and Nippel makes some very general points. Vickers and Fershtman and Judd derive mathematically that strategic behaviour makes only sense in a market not characterized by perfect competition. Neus and Nippel develop this discovery further. They state that manipulating the decision variables away from profit maximization is bound to have a negative effect on profits when used in isolation. If no strategic interaction is taking place the "distortion" effect is always negative. In an oligopoly, however, the effects on other players cannot be ignored and hence there is also a "strategic" effect. This latter one can be positive and might in some situations more than outweigh the negative effect of distortion.

In the model Neus and Nippel the interest rate for the calculation of the capital costs for investments is the decisive variable. This is conceptually the same as simply adapting overall costs through the use of transfer prices. The profit depends on the decisions of both the own manager and the competitor's agent and competition is solely based on quantity. Most of the major assumptions in the model reflect those made by Dierkes. The crucial difference is that Neus and Nippel allow for different costs among the two players. Also, they play the game in several variants changing the timing of the decision, the availability of the decision variable or the observability by the competitor.

First, they assume both parties make their decisions simultaneously without the use of transfer prices. Not surprisingly, they find that the firm with lower costs earns a higher profit. Second, they play a Stackelberg game where one firm's agent has to choose first; still without the use of transfer prices. By the time the second firm's manager has to make a decision he therefore already knows the choice made by his competitor. Nevertheless, the agent of firm 1 can anticipate the reaction of the manager of firm 2 and use this knowledge for his own firm's benefit. Consequently, firm 1 obtains a higher profit than firm 2. A first-mover-advantage can be observed in the oligopoly under Cournot competition. Of course, Neus and Nippel add, this Stackelberg outcome can only be realized if the

decision made by the agent of firm 1 can be observed by the manager of firm 2 and is credible. If that was not the case, the second firm would not be influenced by the decision. Dierkes assumes that the decisions taken at stage one of his game are observed by the players but he fails to emphasize the importance of this aspect. Besides this, Neus and Nippel are puzzled by another property of the outcome. Both players will want to be a Stackelberg leader in the game, yet it is unclear how the choice of who is allowed to take the first decision is determined. If both take their decision under the assumption of being the leader, both end up making no profit (and there is no equilibrium as the expectations of the parties are not met).

Second, the authors include transfer prices in their model. As mentioned before, since any distortion by itself is bound to have a negative effect the use of transfer prices can only be interesting for strategic reasons. So its sole purpose is to influence the competitor. Consequently, the outcome will depend on the decisions of both players. If only one firm can use transfer prices the owner will use them in such a way to make the manager act as if his costs were lower, thereby increasing output. Since the choice of the transfer price is made before the decision on quantities the result is equal to the Stackelberg outcome. Recall from section 2 that Dierkes also found the Stackelberg outcome when only one player used STP. The difference is however that Neus and Nippel get the Cournot-Stackelberg equilibrium while Dierkes' result is of Bertrand-Stackelberg type as the basic assumption on the type of competition differs.

When Neus and Nippel allow for both players to use transfer prices they find that the used transfer price is lower compared to the unilateral case. Additionally, the firm who was allowed the use of transfer prices before has now reduced its profit while the competitor improves profit in comparison to the unilateral case. Nevertheless, both profits are lower than when none makes use of strategic transfer prices. Hence, the result is again a prisoners' dilemma as it was in the model of Vickers. This means that competitive intensity is increased. While this conclusion implies that the competing parties are worse off it also signifies that social welfare as a whole benefits. This is an interesting fact but even more so Neus and Nippel describe the use of strategic transfer prices in a market with Cournot competition from a new perspective. They state that the use of this

instrument is not a means to benefit compared to the original situation but rather a defence mechanism against exploitation from the competitor. The authors compare it to an arms race which costs a lot of money but needs to be done in order to protect against the opponent. Remember however that this holds only for competition based on quantities. As was mentioned, the results from Sklivas, Fershtman and Judd and Dierkes in Bertrand competition yield completely different results.

Finally, Neus and Nippel study the situation where the transfer price cannot be observed by the players. When that is the case, both firms' principals and agents will have to make their decisions based solely on expectations. There is no strategic effect in this scenario as the competitor cannot be influenced by the transfer price because of its missing observability. Therefore, the owners will renounce the use of any distorting variable as the effect can only be negative.[95] The result is both firms relying purely on profit participation as in the initial case of reference. The major new finding of Neus and Nippel is therefore that a necessary condition for strategic behaviour is not only the existence of not simultaneous or multiple decisions but also the observability of the decisions taken. Additionally, it is always an advantage to make the value of one's own decision variable public. However, they present no empirics if transfer prices are actually made public in oligopolies. Actually, this would need to hold for any strategically distorting variable (e.g. the whole details of any incentive contract). They do not discuss how such a publication can be achieved and if it is even possible in legal terms. Dierkes avoids this problematic by simply assuming complete information at any stage. While this is common practice in strategic delegation literature, Dierkes fails to discuss possible problems of this assumption.

3.1.5. Alles and Datar (1998)

The paper of Alles and Datar studies strategic transfer prices in a Bertrand environment. It uses a variant of the Hotelling model where each of the two firms produces multiple products. Costs are the only relevant variable in the model and

---

[95] Neus and Nippel note however that the use of transfer prices could well be useful for other than strategic reasons.

therefore can obviously differ among the competitors. While Alles and Datar are aware that in practice costs are not the only input into the pricing process (e.g. demand conditions, requirements of specific customers, etc.) they note that it is undoubtedly one of the most important ones. Similar to most other papers (including Dierkes), the model assumes no incentive issues (absence of risk aversion), no uncertainty about costs or demand, and that all the parameters are common knowledge. The authors also give a reason why commonly known costs might be a reasonable assumption, stating that the competitor's costs can be determined through benchmarking programs. The validity of this assumption can at least be doubted, especially for multi-product firms as information on internal processes and value chain are heavily safeguarded in most companies. Additionally, equally to Dierkes, the authors assume differentiated products which might fit the preferences of some customers more than others through distinctions in quality or brand identity. As was mentioned in section 2, this is the only way to allow a firm to raise prices above the perfect competitive level. All other major assumptions reflect those made by Dierkes, which are standard in the strategic delegation literature.

Similar to previously discussed literature, in order to maximize profits in this Bertrand environment, firms will raise prices as much as the market will bear. However, due to the Hotelling approach of the model, this price increase is limited. There is a countervailing incentive to gain market share by undercutting the other firm's price. Transfer prices are then used to offset this countervailing incentive. Alles and Datar find the effect to be that the optimal transfer prices of the firms are closer together than their actual marginal costs. The same is true for the sales prices. Consequently there is less incentive for a price war and the consumers become more indifferent as the price differences are small. Accordingly, the average price level can be raised without disrupting the market shares. The transfer prices make managers act as if their costs were higher than they actually are. For these transfer prices, to become more similar than actual marginal costs while still maximizing profits, it is necessary for the owners to cross-subsidize their products. This implies that the transfer price for the low-cost product is increased, while the one for the high-cost product is decreased. This finding is very interesting as such product-cross-subsidizing is commonly observed in practice.

It was already mentioned in this paper that strategic delegation can only make sense if it influences the decision of the competitors, hence in a not perfectly competitive market. Alles and Datar prove mathematically that in their model both, a monopolist as well as a perfectly competitive firm will choose the transfer prices to equal marginal costs, hereby renouncing the additional distorting variable. This confirms what has already been shown by Vickers and Fershtman and Judd.

The most interesting finding of this paper is however another aspect. Not surprisingly, the authors find that fixed costs play no direct role in the determination of the transfer prices or sales prices. This is often the case for a constant in a model. Nevertheless, and this is most interesting, fixed costs are relevant in establishing market power. Basically, "it is not fixed costs that differentiate firms and make fixed cost recovery feasible, but rather their successful application to create market power."[96] This means that only if fixed costs translate into more market power (on the basis of lower variable cost, higher brand identity, etc.) is it possible to also recover these fixed costs in terms of higher sales and prices. The mark-up of transfer prices over marginal cost hereby becomes directly a function of the firm's market power. It follows that, "unless the firm is already in a hopeless competitive position in a market, it pays for it to invest in the creation of market power to gain the leeway to raise prices without fear of customer defections."[97] While this result certainly depends on the specific Hotelling model assumption made by the authors, it is still a valid aspect that should be considered when discussing strategic delegation.

3.1.6. Göx (1999)

Göx studies strategic delegation through transfer prices in his dissertation. The third chapter of his work is the most relevant one for the purposes of this paper as the assumptions made in that section reflect those made by Dierkes. He models the use of strategic transfer prices in various ways. He analyzes the Stackelberg environment first and afterwards the cartel solution. Thirdly, the unilateral use of transfer prices is examined and finally symmetric use of transfer prices is

---

[96] Alles / Datar (1998), p. 457.
[97] Alles / Datar (1998), p. 457.

investigated. Each time, both the Cournot and the Bertrand case are considered. Additionally, he explicitly states the implicit assumption made by Dierkes that each possible incentive scheme has the same implementation cost to make it easier to compare them. Building on the notation of Bulow, Geanakoplos and Klemperer (1985) he finds that in Cournot competition quantities are strategic substitutes while in Bertrand competition the prices are strategic complements.[98] "A firm's decisions are called strategic substitutes when its marginal profits are decreasing in the rival's actions. A firm's decisions are called strategic complements when its marginal profits are increasing in the rival's actions."[99]

Göx finds the already known result in the Stackelberg situation. The leader will have a higher quantity than in the reference case while the follower's quantity will be lower. Both will have higher prices. The difference, as we already know, lies in the type of competition. In the Cournot-case the profit of the leader is higher than in the reference case, while the follower suffers a profit reduction. In the Bertrand case, on the other hand, both firms increase their profits, with the follower gaining more benefits. As was already mentioned by Neus and Nippel for the Cournot case is now apparent also for the Bertrand case: there is a conceptual problem as no party can be assumed to voluntarily choose the unfavourable position in the game. Göx suggests that the decision of who will be leader and who will be follower has to be determined by the characteristics and history of the market or sector.

The cartel-solution with collusive behaviour would yield the highest profit. This is straight-forward. Also, it yields the situation of a prisoners' dilemma where each party has an incentive to deviate from this solution. The solution would then be a forcing contract. However, this is not possible, as it would be illegal due to violation of anti-trust laws. This is again true for both, the Cournot and the Bertrand case.

In the unilateral case Göx first recalls what had been found by Neus and Nippel, namely that the observability of the transfer price by the competitor is crucial for its effectiveness in influencing the opponent's decisions. Similar to Alles and

---

[98] This is true as long as the goods in consideration are assumed to be substitutes. If they were assumed to be complements the situation would be the other way around. See also Miller/Pazgal (2002), p. 52.

[99] Kedia (2005), pp. 876 f.

Datar who explained the plausibility of known costs by benchmarking programs, Göx also suggests that known transfer prices is a realistic assumption. He states that since transfer prices are commonly changed only on a yearly basis it is likely that in an oligopolistic market their value becomes common knowledge. Göx does not state the process through which this appears to happen which leaves a lot of doubt with this explanation. His second possible explanation, while not completely satisfactory, is more reasonable. In many corporate groups certain divisions are separate legal entities. Information on transfer prices can consequently be derived from the financial statements. While it might be possible to get a certain idea about the used transfer price, a close derivation of single transfer prices for specific products (especially in multi-product firms or divisions) can still be doubted. Keeping this critique in mind we see the result when using unilateral transfer prices in the model of Göx to be equal to the Stackelberg result. Neus and Nippel had proven this already for the case of Cournot competition. Göx expands this result also to the Bertrand case. Recall from section 2 that this is the same result Dierkes gets in his model in subgame II where strategic transfer prices are used unilaterally. Also, same as in those discussed cases, the firm using STP automatically becomes the Stackelberg leader as the decision on the transfer price precedes the final product pricing decision. Note however that in the Cournot case the leader position is an advantage (and the follower suffers a loss in profits) while in the Bertrand-case (even though it is advantageous for both) the follower benefits more.

Turning to the case of symmetric use of transfer prices Göx finds the same results we already know from the previous discussed authors. When competition is based on prices the resulting transfer price lies above actual cost and the competitive intensity is reduced as managers are driven to choose an implicitly collusive strategy. Consequently, both firms achieve higher profits. On the other hand, when competition is based on quantity the transfer price will be below the actual cost and the profit of both firms will be lower than in the reference case of profit participation. However, the resulting prisoners' dilemma prevents the principals from renouncing the use of transfer prices as they need to protect against exploitation by the competitor. In any case, transfer prices provide an additional decision variable to influence the market conditions in a favourable way and their use is always a dominant strategy.

While most of these results were already known, Göx's major addition to the literature lies in the comparative statics. He finds that, in determining the difference in optimal transfer prices and consequently sales prices, a crucial factor is the similarity of the products. This is comprehensible as the consumers will react stronger (ceteris paribus) to a change in sales price (induced by a change in the transfer price) the easier it can be substituted by another product.

Especially under Bertrand competition the effect of transfer prices is higher when products are very similar. When they are very different, each firm is already acting almost as a monopolist. Since the benefit of transfer prices is to reduce the competitive intensity, the effect will be stronger when competitive intensity is high. And the latter is the case when the substitutability of products is high. Conversely, while the effect of transfer prices becomes larger with increasing substitutability, the absolute deviation of the transfer prices from actual costs becomes smaller. The reason is basically the same and also intuitive, namely the high competitive intensity that does not allow for high mark-ups.

Most interesting, Göx finds out that the increasing substitutability of products has a stronger increasing effect on competitive intensity when competition is based on prices compared to the case when it is based on quantity. Through transfer prices this difference can be reduced. Also, Göx has shown that comparative statics provide interesting insights into a model. Dierkes fails to pursue this possibility in his model limiting his conclusions to the most obvious ones.

3.1.7. Mujumdar and Pal (2007)

In a recent paper Mujumdar and Pal change one key assumption of the typical models in the STP literature to get a deeper understanding of the effects of the use of strategic transfer prices. Their model based on quantity competition maintains most of the standard assumptions also made by Dierkes but changes from a static to a dynamic environment. More specifically, the model still has two stages but the second stage is subdivided into two periods. In the first stage, the owners still choose simultaneously their incentive contract and in the second stage the agents decide on their output quantities. However, this second stage in their model has two production periods and after the first period the output produced becomes common knowledge. The argument for assuming this is that "a firm can usually

find out, at some point, before committing to its final output, how much output has thus far been produced by its rival(s). This gives a firm the opportunity to react to such information by adjusting its production in the subsequent periods."[100] Firms are therefore given the opportunity to revise their initial output targets after the first production period. Additionally, the authors relax the assumption of constant marginal costs by allowing them to change from one production period to the next (they are still equal for both firms and remain constant within a production period). "This is a frequently-made assumption in models with a 'dynamic' production environment."[101] It seems to be fairly realistic, as in practice marginal costs may vary over time, e.g. because of changing input prices.

Since the approach of this model goes beyond the typical framework of this paper I will not discuss too many details of the paper but only mention some final conclusions that provide interesting hindsight for our purpose. Their major result is that when costs remain unchanged or fall moderately there exists an equilibrium with one firm acting as pure profit maximizer and the other being a pure sales maximizer.[102] While we know from Basu (1995) that such a situation can also emerge as a result of cost asymmetry among the two firms, there is a huge difference in the results. In Basu's model the firm using strategic transfer prices unavoidably becomes the Stackelberg leader while the firm using profit participation becomes the Stackelberg follower. In the model of Mujumdar and Pal on the other hand it is the profit-maximizer to emerge as Stackelberg leader while the rival firm with the manager maximizing sales becomes the Stackelberg follower. As in both cases the leader always has the higher profits, the favourable choice of incentive contract in the eyes of the owners is quite different. That is to say that the outcome changes quite drastically when switching from a static to a dynamic model. Besides this, Mujumbar and Pal offer an explanation for diverging incentive contracts among firms within the same industry.

To avoid wrong conclusions an important peculiarity has to be noted. In all the previously discussed cases where both Cournot and Bertrand competition were

---

[100] Mujumdar/Pal (2007), p. 339.
[101] Mujumdar/Pal (2007), p. 342.
[102] Recall that maximizing sales is the same as using strategic transfer prices. See appendix 3.

studied one could have gained the impression that the Bertrand case would be better for the participating firms. This intuition arose because even though the use of transfer prices is always a dominant strategy only in the price competition case both firms increase their profits compared to the standard Bertrand outcome. In the Cournot case on the other hand the result is a prisoners' dilemma where both firms reduce their profits compared to the reference case. Despite this fact, Singh and Vives (1984) show that in a symmetric duopoly with linear demand functions and substitutable products the profit of the firms is always higher when competition is based on quantity compared to competition based on prices. Thus, in the standard models price competition is fiercer than quantity competition resulting in higher firm profits in the Cournot case. Since the use of STP decreases competitive intensity in the Bertrand case while in the Cournot case it is increased this implies that the difference between the firms' profits in the two cases is reduced. It is, however, not extinct. This fact should be kept in mind when comparing the two different types of competitive markets.

3.2.   Related literature on relative performance evaluation

This subsection will cover the most important literature concerning relative performance evaluation as a mechanism of strategic delegation. The literature on RPE is not nearly as vast as the one on STP. Nevertheless, fundamental papers published before and after Dierkes' work will be discusses.

3.2.1. Fumas (1992)

It has already been mentioned that the main theoretical foundation of relative performance evaluation as strategic delegation instrument is provided by Aggarwal and Samwick (1999). Nevertheless, it was Fumas who first noted that the use of RPE in the classic benchmarking approach may cause undesired effects in an oligopolistic industry. By benchmarking I mean here that the agent is paid not depending on his own firm's performance but of his firm's performance relative to the market. Basically, principal-agent theory suggests that a bonus is paid if the agent achieves above industry returns. The argument behind this proposal is that by using this relative performance measure fluctuations beyond the manager's control (common shocks) are flattened out. Hereby incentive

contracts become more efficient because risk sharing is improved as uncertainty is diminished. Information is used more efficiently and the moral hazard problem is alleviated.[103] Mathematically speaking this approach corresponds to the use of a positive participation rate for the performance of the own firm and a negative participation rate for the competitors' profit. This reduces the executive's exposure to risk but provides an incentive to take actions that lower industry returns. Fumas finds that the use of benchmarking in the described form "may cause a conflict between the objectives of risk sharing and the implications for strategic competition derived from such performance measures, especially if firms compete in prices."[104]

The assumptions made by Fumas differ from those made by Dierkes in some key aspects. First, Fumas assumes risk averse managers as is the standard principal-agent approach (the principals are risk neutral as always). Also, the objective functions of both, principals and agents, are slightly different. The owners are still pure profit maximizers but Fumas uses net profits, namely the firm's profit net of the manager's salary. In Dierkes' model this distinction is irrelevant because of the assumed risk neutrality of the agent.[105] The difference is crucial, however, in Fumas' setting because the agents are assumed to be risk averse. Regarding the utility of the agents in Fumas' model not only are they risk averse in contrast to Dierkes but also their incentive scheme is slightly different. For $i, j \in \{1,2\}$ and $i \neq j$ it is:

$$B_i = G_i + v_i \cdot G_j \rightarrow \max_{v_i} \qquad (47)$$

Compared to Dierkes, Fumas uses a participation rate only for the competitor's profit implicitly setting the participation rate in the own firm's profit to one. As described in section 2 and shown by Aggarwal and Samwick (1999) this does not change any of the conclusions as in the end it is the ratio of the two participation rates that effectively determines the incentives.

---

[103] C.f. among others Holmstrom (1982).
[104] Fumas (1992), p. 473.
[105] In section 2 I explained how through risk-neutrality (and assuming complete information) it is possible to set the manager's wage to his reservation wage. Consequently, total wage becomes a constant for the principal and hence is not relevant in decision making.

It needs to be noted, that the profit function G in Fumas' model is also different from Dierkes, as it is based on multiple products and includes the respective manager's effort as well as a common shock term ε with zero mean and variance σ^2. In this sense it is a fully specified principal-agent model in the classic sense.

The findings of Fumas using relative performance evaluation are similar to some findings of the strategic transfer pricing literature. Assuming Cournot competition he finds that if only one firm uses RPE as incentive scheme the outcome is the standard Stackelberg result with that firm being the leader.

For the symmetric case of both firms using RPE in a Cournot environment Fumas finds that through this mechanism the owners can increase their net profits; benchmarking allows them to reduce the expected salary of the risk averse managers as their amount of risk is reduced. So, according to Fumas, the basic suggestion of the classic principal-agent theory for the firm considered in isolation without any strategic effects also holds true in the duopoly case with quantity competition. Furthermore, compared to the standard Cournot outcome total output is now higher (with the more risk averse manager producing more than the less risk averse) and gross profit[106] is lower. Fumas' final conclusion for the Cournot case is, therefore, that using relative performance evaluation is a dominant strategy. In fact, Gibbons and Murphy (1990) find strong empirical support for the use of this benchmarking approach in compensation contracts in practice.[107]

The situation changes for the Bertrand case. The optimal contracts in this situation induce the managers to increase prices and profits by putting a positive weight on the competitor's profit. Fumas is however quite undetermined on his final conclusion because of the risk aversion of the managers. The positive participation rate in the rival firm's profit is in conflict with the optimal risk

---

[106] As Fumas uses net profits as the objective function of the owner gross profit is defined as profit before the subtraction of the agent's wage.

[107] Nevertheless, they also note that the examined cash compensation may only be a small part of total compensation of the CEO's analyzed in their study. For the top executives they only investigated stock options while stock holdings may in fact well be far more important. Additionally, they note that using relative performance evaluation may also have several disadvantages, including the cost of observing or measuring average output and an undesired incentive to distort average output. The latter can be achieved by the agent via sabotage (reducing competitor's returns), collusion (via agreements to collectively provide less effort), influence on the choice of the reference group (by choosing weaker competitors) or by causing certain production externalities (e.g. not to develop innovations that would increase productivity of all members of the reference group).

allocation ideas put forward by the principal-agent theory (which in fact suggests a negative rate). The positive value is good for strategic reasons but increases the risk allocated to the manager (as both firms' profits move in correlated fashion) and hence also increases his expected salary (due to the higher risk premium needed in order to match the reservation wage). This latter effect in turn reduces the expected net profit by the firm. The opposite is obviously true for a negative participation rate. Fumas concludes by stating that the final choice therefore has to weight these two conflicting effects and that the participation rate will decrease as risk aversion increases.

3.2.2. Aggarwal and Samwick (1999)

As was already mentioned in several occasions the basic paper regarding relative performance evaluation in the strategic delegation literature is provided by Aggarwal and Samwick. Their approach starts from the premise of the classic principal-agent theory to use benchmarking in incentive contracts. Aggarwal and Samwick note however that this benchmarking approach is limited by the need to soften the competition in the market. In fact, paying the manager on above industry return basis induces strong competitive behaviour driving industry rents down. Aggarwal and Samwick's model is less general (excluding risk aversion and effort choice by the managers) than that of Fumas so as to allow them to better test their results. They find empirical support that the strategic reason might be the cause as to the benchmarking approach suggested by the principal-agent theory is not more often followed in practice. In fact, they make the empirical prediction that the more competitive the industry is, the less will benchmarking of the above described form will be used.

The model of Aggarwal and Samwick is basically identical to subgame V in the paper of Dierkes. The only difference is that the objective functions of the principals include a common shock term ε with zero mean and variance σ^2. The profit functions for the firms $i, j \in \{1,2\}$ for $i \neq j$ hence become:

$$G_i = (p_i - k) \cdot (d - e \cdot p_i + f \cdot p_j) + \varepsilon \rightarrow \max_{p_i} \qquad (48)$$

At the same time, the objective function of the managers becomes:

$$B_i = s_i \cdot \left((p_i - k) \cdot (d - e \cdot p_i + f \cdot p_j) + \varepsilon \right) + v_i \cdot \left((p_j - k) \cdot (d - e \cdot p_j + f \cdot p_i) + \varepsilon \right) \to \max_{p_i}$$

(49)

Given the assumed risk neutrality of both owners and managers the common shock term does, however, not have any influence on the results. All other major assumptions are the same as made by Dierkes. However, while Dierkes only models the Bertrand case, Aggarwal and Samwick include both cases, Bertrand and Cournot, in their paper. Also, they add an empirical survey to support their results. They find that using the classic benchmarking approach in a market environment where competition is based on prices encourages more aggressive price setting. While common shocks are filtered out this happens at the expense of tougher competition. To avoid this, the optimal contracts in equilibrium have positive participation rates for both, the own and the competitor firms' profits. Aggarwal and Samwick note that such contracts may seem to violate anti-trust laws but refer to Gilo (1996) who shows that in fact they do not. These optimal contracts help to soften the competition and increase the returns for both firms (this result is identical to the conclusion made by Dierkes).

The authors' empirical prediction consequently is that in more competitive industries managers are more incentivized to maximize the value of all firms in the industry and not just their own. In fact, the optimal contracts in the model depend on the values of e and f from the demand function (1). The ratio $\frac{e}{f}$ measures the degree of substitutability between the products of the two firms. When the influence of the own firm's price (e) is much higher than the influence of the competitor's price (f) the situation is closer to two separate monopolies. Correspondingly, the optimal value of s increases with e and decreases as f increases. Therefore, in the case of a high ratio $\frac{e}{f}$, which corresponds to low substitutability, the value of s is also high. This effect is intuitive as in an almost monopoly situation more weight is given to the profits of the own firm. Obviously, the opposite is also true. If the ratio decreases products become more substitutable and the industry is more competitive. Consequently, more weight is given to v rather than s and the sales price gets closer to marginal cost. Hence,

"the need to soften competition is highest in those industries that are most competitive."[108]

The result changes when competition is based on quantities. Aggarwal and Samwick find that classic benchmarking with a positive participation rate for own firm performance and negative participation for the performance of the competitor is indeed the optimal result. Nevertheless, the reason for this outcome is not the reduction of risk by filtering out common shocks, as suggested by the principal-agent theory, but is motivated by strategic interaction. It is a "strategic choice rather than a response to moral hazard."[109] The agents are given incentives to behave aggressively in order to deter competitors. In fact, the model results in higher quantities and lower expected profits. The situation is therefore closer to perfect competition than the standard Cournot outcome. The corresponding empirical prediction of the authors is that in more competitive industries of Cournot type, managers are given stronger incentives to minimize the value of the competing firms in their industry than to maximize the value of their own firm. Note, that the use of relative performance evaluation in the Cournot situation results in a prisoners' dilemma as was the case with strategic transfer pricing. Both firms get lower profits by using RPE but in the case of unilateral use by the competitor they are even worse off. Hence, using RPE is a dominant strategy even though doing without it would make both firms better off.

Note also that, same as Göx, Aggarwal and Samwick find that when using relative performance evaluation in strategic delegation in the Bertrand situation prices are strategic complements while in the Cournot situation quantities are strategic substitutes.

In section 2 it was shown that the results of subgame V in the model of Dierkes resemble the result of the Bertrand case in the paper of Aggarwal and Samwick. Since the latter focused only on relative performance evaluation they could, however, be more complete in their approach. The authors not only included the case of Cournot competition but also added a more detailed discussion on the ratio

$\dfrac{e}{f}$ and its effect on s and v. Actually, they find that it is the ratio $\dfrac{s}{v}$ that

---

[108] Aggarwal/Samwick (1999), p. 2030.
[109] Aggarwal/Samwick (1999), p. 2012.

54

determines the incentives in the model and state that s can be small if v is also small. Conclusively they find that "in general, if the return to effort or the cost of effort is negligible, then there is no reason to provide high-powered incentives to risk averse managers."[110] Unfortunately, Dierkes is missing any deeper discussion or a sensitivity analysis of the effects of changing values of his parameters.

Besides these features, Aggarwal and Samwick enrich their paper by showing that using a fully integrated principal-agent model including an effort choice, a disutility of effort, a common shock and risk aversion would not change the major conclusions of their initial model. Also, they show that through the use of a signalling game (with information asymmetry) in the Bertrand case the need for observable contracts can be eliminated.

Finally, an empirical study is included in their paper. The predictions are tested against the ratio $\dfrac{e}{f}$ measuring the competitive intensity of the market. Generally they find that "as products become more substitutable (markets become more competitive), an executive's pay will depend less on own firm performance and more on the performance of the rival firms."[111] This result is statistically significant and was intuitively expected as described before. Three other major conclusions emerge from the study. First, the authors find that participation rates s and v are positive. Second, the ratio of the two participation rates $\dfrac{s}{v}$ is lower in more competitive industries. This means that when competition is intense, more (relative) weight is given to the competitor firm's profit to reduce the intensity of competition. These two findings support the Bertrand model. Third, in short-term compensation data they find some evidence for classic benchmarking with a negative v but limited by strategic competition. And the more competitive the industry is, the less negative the rival firm's participation rate becomes. Also, the magnitudes of s and v are consistent with the values expected by the model. All together, the empirical study supports the differentiated Bertrand model and could explain the practical lack of classic benchmarking.

---

[110] Aggarwal/Samwick (1999), p. 2032.
[111] Aggarwal/Samwick (1999), p. 2017.

3.2.3. Miller and Pazgal (2002)

Even though the work of Miller and Pazgal was published a few years after the paper of Aggarwal and Samwick, they approach the same topic without reference to this previously written paper. Nevertheless, and even though their approach is quite similar, they offer some interesting additional insight.

Different to Fumas, and Aggarwal and Samwick the setup of Miller and Pazgal does not model relative performance evaluation via an incentive contract. They assume that "managers have a variety of different attitudes toward relative performance."[112] They assume a continuous set of managers of different "types", from very aggressive ones to very cooperative ones. Aggressive managers place more weight on outperforming competitors while cooperative managers want good results for their own and their rival firms ("a healthy industry is essential to a healthy firm"[113]). The objective function for the agents in their model is the same as in (47) used by Fumas.[114]

The difference is however that Fumas models profits in terms of multiple products including an effort choice and a common shock term while Miller and Pazgal follow the approach of Vickers, Sklivas and Fershtman and Judd. In this sense, all the major assumptions in this model are equal to those made by Dierkes. Again, the major difference is that the relative performance approach is modelled in the type of the manager and not in their incentive contract. Using this approach has two major advantages according to the authors. First, it avoids the net payoff problem. However, it was already mentioned in this paper that the payoff of the manager can be set to his respective reservation wage if risk neutrality by the managers and complete information is assumed, as done by Miller and Pazgal. Consequently, the net payoff approach is obsolete. Second, including RPE in the type of the manager avoids any anti-trust issues with cooperative managers being paid a positive participation rate in their competitors' profits. Again, it was shown by Gilo (1996) that such passive investment positions do not violate anti-trust laws. Therefore, this argument is also irrelevant. As a conclusion it can be said,

---

[112] Miller/Pazgal (2002), p. 52.

[113] Miller/Pazgal (2002), p. 54.

[114] Actually, Miller and Pazgal use $B_i = G_i - v_i \cdot G_j$ but as only the sign of the parameter changes I have adapted the formula to avoid confusion in the interpretation of the values compared to the models of Fumas, Aggarwal and Samwick and Dierkes.

that modelling RPE via incentive contract or via the types of managers does not appear to make any relevant difference.

Note also that Miller and Pazgal use only one participation rate parameter, namely only for the competitor's profit. This is the same approach as was used by Fumas. Again, this implicitly means that s in the model of Aggarwal and Samwick is set to one. Aggarwal and Samwick used participation rates for both, the own firm's profit and the competitor's profit. While this latter approach is more complete, the authors showed that in the end what effectively determinates the incentives is the ratio of the two participation rates. Hence, it is not a problem using only one participation rate as the conclusions basically remain the same.

Regarding the demand function in the model of Miller and Pazgal they differentiate using both, a model with substitute goods and one with complementary goods. Most previously discussed authors, including Dierkes, assumed simply substitute goods. Miller and Pazgal, however, note the well known fact from oligopoly theory that this distinction is not material. Price competition with complementary goods and quantity competition with complementary goods both result in dealing with strategic substitutes. Hence, the cases are symmetric. Discussing one implies that the same conclusion can be applied to the other case. The same is true for the case of strategic complements, being either substitute goods in price competition or complementary goods in quantity competition. Hence, the discussion reduces to the case of strategic substitutes vs. strategic complements.[115] It should be noted that Dierkes simply focuses on one special case but fails to mention possible implications or differences of changing assumptions.

The last significant difference in the assumptions of Miller and Pazgal compared to Dierkes is that they also consider cost differences among the two firms. They find that under Cournot competition, and independent of considering strategic substitutes or strategic complements, the principal of the firm with lower production costs will hire the more aggressive manager (negative v). Hence, as was found by previous models, Cournot competition supports the classic

---

[115] Consequently, everything that has been discussed in this paper so far for the Bertrand and the Cournot case is valid for the respective opposite case if products are assumed to be complements instead of substitutes.

benchmarking approach. Total profits (sum of both firms' profits) are smaller, total quantity is larger and total welfare is higher than in the standard Cournot case; the model is closer to perfect competition. Also, it has the socially desirable effect of the firm with lower costs having the higher market share. While the firms are worse off using RPE it is still a dominant strategy as unilateral deviation would result in even lower profits. These results reflect previous research and confirm the prisoners' dilemma situation in the quantity competition case. However, if the cost for the more efficient firm is low enough it can achieve a profit even higher than in the standard Cournot case (the less efficient firm is always worse off). Therefore it is intuitive that the model predicts the low cost firm to hire the more aggressive manager in order to exploit this relative cost advantage.

Interestingly, Miller and Pazgal show for the Cournot case that using relative performance evaluation as incentive scheme (even though they model it as part of the type of manager) has some other features we already know from the literature on strategic transfer pricing. First, they prove that as the number of firms increases the model approaches perfect competition. In this case the owners hire only pure profit maximizers without any incentive distortion. Second, when the selection of the manager is sequential the owner allowed to choose first hires the more aggressive manager and the result is the classic Stackelberg outcome. The leader produces more and will make larger profits than in the simultaneous case while the opposite is true for the follower. Total industry production is also higher while total profits are lower.

While for the Cournot case the conclusions made where basically the same for complements and for substitutes this changes in the Bertrand situation. In this latter case the result is that the produced quantity is always lower while the price is always higher. However, profits are larger when goods are substitutes (which explains the term strategic complements in the price competition case – this is the case assumed by Dierkes) while they are lower assuming goods are complements (hence, strategic substitutes). In other words, when strategic substitutes are assumed, then a value of $v < 0$ increases competitiveness and reduces total profits. On the other hand, assuming strategic complements a value of $v > 0$

makes the firms' managers more cooperative which in turn increases total profits. These are the same conclusions found by Fumas and Aggarwal and Samwick.

Finally, Miller and Pazgal note another very interesting fact about the use of relative performance evaluation. We know from Singh and Vives (1984) that in the standard models price competition is fiercer than quantity competition resulting in higher firm profits in the Cournot case. Since the use of RPE (assuming goods are substitutes) decreases competitive intensity in the Bertrand case while in the Cournot case it increases, it is implied that the difference between the firms' profits is reduced compared to the standard models. Remember that the same effect was noted using strategic transfer prices.

3.2.4. Albuquerque (2009)

In a recent paper Albuquerque provides some additional insight into the use of relative performance evaluation in incentive contracts. In her model she assumes cost heterogeneous firms in Cournot competition where contracts are not observable. This setup is slightly different to the ones used by Fumas, Aggarwal and Samwick, and Miller and Pazgal; moreover, it is certainly very different from the model of Dierkes. However, it shows a very interesting effect in the quantity competition case under certain conditions. Previous authors had uniformly shown that incentive distortion schemes intensify competition in the Cournot case. Albuquerque on the other hand shows that there is a countervailing effect if the production cost difference of the firms is sufficiently large. If that is the case and product substitutability (again measured by the ratio $\frac{e}{f}$) increases than the low cost firms gives incentives to soften competition in his model. The explanation is that as the ratio, and hence the effect of the competitor's price, increases competition becomes more intense. Consequently, the owner of the more efficient firm wants to give incentives in order to reduce competition. The participation rate in the competitor's profit (v) is therefore less negative in the optimal contract. Nevertheless, it is still negative, so the effect is not strong enough to induce truly cooperative behaviour where any incentive to hurt the returns in the industry is removed. The most interesting fact, however, is that the high cost firm never engages in any effort to reduce competition. Consequently, Albuquerque's model

provides an explanation why incentive contracts can vary across firms with different cost structure (with cost being a major source of performance disparity among firms). The same is true for firms of different sizes, if one assumes larger firms to be more efficient. Anyway, in the light of these recent findings one could criticize Dierkes' assumption of symmetric costs of being too simplistic.

3.3. Combinations of incentive mechanisms

In this subsection I will discuss two other interesting papers related to the subject which are not directly attributable to either strategic transfer pricing or relative performance evaluation. The first one because it does not focus on any of those two bonus schemes but discusses a third, additional or alternative, possible incentive distortion mechanism. The second paper on the other hand deals with both, STP and RPE, and even includes a third bonus scheme. In this sense these very recent papers expand the strategic incentive distortion literature.

3.3.1. Jansen, van Lier and van Witteloostuijn (2007)

Jansen et al. use another bonus scheme besides strategic transfer pricing and relative performance evaluation, namely market share. They note that market share may also be a crucial motive for firm owners and can be part of an incentive contract. Recall from Alles and Datar (1998) that in their variant of the Hotelling model, transfer prices were used to prevent the manager to undercutting the competitors prices in order to gain market share. Jansen et al. on the other hand include market share directly as a component of the incentive contract of the manager. Consequently the objective function of the manager in their model is the following:

$$M_i = G_i + w_i \frac{q_i}{Q} \underset{w_i}{\rightarrow} \max \qquad\qquad i \in \{1,2\} \qquad\qquad (50)$$

with

w_i Incentive parameter for the market share

q_i Quantity produced by firm i

Q Total quantity produced by all firms in the market

The authors assume w_i to be non-negative in their model. While it seems plausible to only give a positive bonus for an increase in market share it remains unclear why the model should be restricted such to exclude the case where the manager would be "punished" for an increase in market share.

Following the previous literature they discuss this new incentive distortion scheme in a duopoly and for the case of multiple competing firms. They stick to the standard assumptions of the literature which are essentially the same as the ones used by Dierkes. Regarding the type of competition, however, they focus on the Cournot case while only briefly touching on the Bertrand environment. In addition, they compare their results to the ones obtained by Vickers, Fershtman and Judd, and Sklivas.

The results of the model show that if both firms use incentive mechanisms based on profits and market share (symmetric case) then including the non-profit incentive causes the manager of that firm to behave more aggressively. He produces more in order to force the competing manager to reduce his output. As both managers act this way, total output in the market increases compared to the standard Cournot outcome. Consequently, total profits in the market (and obviously also the profits of the single firms as the case is symmetric) are lower than in the reference solution. This is the same effect already known from the literature on strategic transfer prices. However, profits remain slightly higher using market share instead of transfer prices. Nevertheless, social welfare (defined by the sum of consumer and producer surplus) is somewhat lower. This is possible because the slight increase in market imperfection has a redistribution effect and

causes a notable shift of surplus from the demand to the supply side. All this is true for the case of two as well as for multiple firms.

To deal with the asymmetric case where firm principals might choose different incentive schemes Jansen et al. adapt the approach by Basu (1995) of including an additional stage where the owners can choose whether or not to hire a manager.[116] Not surprisingly, as was the case with STP and RPE, if one owner decides not to hire a manager this leads to the Stackelberg output. Their conclusion is that overall it is a dominant strategy to hire a manager with both, profit and market share incentives. This choice is in any case better than choosing either pure profit maximization or an incentive scheme based on profits and sales. Nevertheless, doing so results in lower profits compared to the standard Cournot case. It is therefore confirmed what has been shown using STP or RPE in a situation of quantity competition, namely that the result is a prisoners' dilemma situation.

As mentioned before, the authors only briefly touch upon the Bertrand version of their model. They find that similar to the Cournot case the profits of the firms are higher when both firm owners use incentives based on profits and market share compared to the (symmetric) choice of strategic transfer prices. Nonetheless, they do not discuss effects on (total or firm) output, social welfare or any asymmetric case (and hence whether or not including the market share objective in incentives might still be a dominant strategy). These aspects would have been interesting, especially in comparison with the results of Dierkes.

3.3.2. Jansen, van Lier and van Witteloostuijn (2009)

Expanding on their own paper of 2007, Jansen et al. choose an approach very similar to Dierkes in there more recent paper. In fact, they pick four different bonus systems and play all possible combinations of them in a duopoly delegation game. Three of the selected possible incentive contracts are the same as the ones used by Dierkes, that is to say pure profit evaluation, sales evaluation (which was already mentioned is the same as the use of strategic transfer prices) and relative performance evaluation (even though Jansen et al. follow Fumas and Miller and

---

[116] By doing this the choice of delegating the decision process from owner to manager becomes endogenous. The important underlying assumption is that each incentive approach requires the same fixed cost.

Pazgal by using only one parameter, namely the weight for the competitor's profit[117]). Additionally, they also incorporate the approach of including the market share criteria as an incentive, which was introduced by Jansen et al. in their paper of 2007.

The model in this paper is very similar to the approach of Dierkes. However, there is one crucial difference: while Dierkes assumed Bertrand competition, Jansen et al. deal with the Cournot case in their model. Therefore, this paper closes an important gap left by Dierkes. All other major assumptions are the same and standard in the literature. It should be noted however that Jansen et al. do not only discuss the duopoly case but consider also a market of three firms.[118]

Regarding the duopoly situation, instead of discussing all 16 subgames in their paper, they refer to previous work for those already covered in the literature (most of them are among the papers covered in this section). The case of symmetric choice of strategic transfer prices is covered by the works of Vickers (1985), Sklivas (1987) and Fershtman and Judd (1987). For the case of STP against pure profit maximization they refer to Basu (1995). Miller and Pazgal are their reference for the case of symmetric relative performance evaluation. Finally, Jansen et al. (2007) is indicated as the source for the cases of symmetric use of the market share approach and the asymmetric case of this last approach against strategic transfer prices. The standard Cournot result remains the reference solution. So the only subgames that remain to be explicitly covered in their paper are the ones playing relative performance evaluation against strategic transfer prices and against the market share approach. Quite surprisingly, the result for both is the same and equal to the standard Stackelberg outcome. In fact the firm using RPE produces twice as much and generates twice the profit of the competitor. The latter is basically "forced" to use pure profit maximization as its best response results in setting t_i or w_i respectively equal to zero. The firm using relative performance evaluation thus becomes a Stackelberg leader, a position characterizes by a first-mover advantage in a Cournot oligopoly.[119]

---

[117] Recall from section 2 and Aggarwal and Samwick (1999) that this difference does not change any of the conclusions.

[118] The relative performance evaluation approach in this situation changes from giving a participation only in the competitor's profit to the use of total profits of the two rival firms.

[119] C.f. Varian (1994), pp. 297 ff.

Putting all the pieces together and solving the full game it emerges that using relative performance evaluation is a dominant strategy. Even when the authors include the additional stage suggested by Basu (1995) where owners can choose whether to hire a manager or not, this result does not change. The conclusion is that emphasizing pure profits too much (as done in many companies in practice) can lead to a strategically weak position.

This conclusion for the duopoly does not change much even when the market environment switches to including three competing firms. Relative performance evaluation still remains the dominant strategy. Additionally, "if no owner uses a bonus based on pure profits, the highest producer surplus – or highest industry-level profitability – corresponds with the case where all firms reward their managers on the basis of relative profits evaluation."[120]

The result for the Cournot case is consequently similar to the one obtained by Dierkes in the Bertrand case (even though the latter does not include the market share approach). Independently of whether competition is based on prices or quantities, RPE is always the dominant strategy. The implications for any practical implementation are, however, very different for the two cases regarding the design of the key parameter. In the Cournot case benchmarking, in the classical sense, with a negative participation rate in the competitor's profit is suggested. The recommendation for the Bertrand case on the other hand is the use of a positive v. Another major difference is that while in a Bertrand environment both firms achieve the highest profits using relative performance evaluation, the Cournot case results in a prisoners' dilemma. If in the latter situation both owners chose pure profit maximization (or decided not to hire a manager) they would yield higher profits than using RPE. However, they are "pushed" to use this incentive scheme in order to protect against opportunism from the competing firm.

---

[120] Jansen et al. (2009), p. 153.

4. Critical discussion of Dierkes' model

Section 3 has shown that there is considerable literature dealing with the issue of strategic delegation. However, almost all of them deal exclusively with one specific mechanism in comparison to the reference case. Some at least consider both Cournot and Bertrand environments. By far the most discussed approach is the use of strategic transfer prices.[121] The second most considered scheme is the use of relative performance evaluation. Even though this latter mechanism is covered relatively less in the literature compared to STP, the approach seems natural, as the use of RPE in the classic benchmarking approach is already suggested for risk-sharing purposes by the principal-agent theory. In every piece of work on strategic delegation discussed in this paper the conclusion was that the use of the respectively covered mechanism was beneficial to the firm under certain circumstances. In fact, most of them even identified their approach to be a dominant strategy in any case given their respective assumptions. So the common tenor is that it is beneficial for the firm to engage in strategic delegation through the use of either STP or RPE. Until Dierkes however, the question of which of these two central mechanisms was better had never been answered. Dierkes' paper therefore was the first to bring these two previously separately progressing lines of literature together and allow for a direct confrontation. Hence, it can be considered a ground-setting approach which is why it has the central role in this paper.

When discussing the related literature in section 3, I have shown that in pursuing the solution to this well-selected problem Dierkes had to make some restrictive choices. To be able to deal with his relatively more complicated model setup the author made many assumptions. While most of them are standard in the literature on oligopolies and strategic delegation, others appear to be overly simplistic. This may well be necessary in order to deal with such a complex problem. Nevertheless, the reader may be misled as Dierkes fails to adequately discuss the possible consequences of relaxing certain of his assumptions. Additionally, certain implicit assumptions or possible problems are not even mentioned and

---

[121] Or mathematically equivalent approaches.

completely ignored. This might cause the reader to remain unaware of certain implications or practical problems.

This section is devoted to fill this gap and to discuss the paper of Dierkes in the light of the additional understanding gained by the study of the most relevant related literature. In the four subsections of this section I will first re-evaluate the assumptions made in Dierkes' model and discuss good features as well as the problematic aspects of certain choices. In subsection 4.2 I will turn to omitted aspects, problems and discussions of which one becomes only aware by studying the related literature. Several implications and practical relevance will be discussed in subsection 4.3, complemented by some empirical findings and indications for implementation in real world situations. Finally, subsection 4.4 gives an outlook on future research possibilities that could help expand Dierkes' model and widen its general validity. In this sense this section works as a useful supplement for the reader of Dierkes' paper to get a better understanding and critical view of his findings.

4.1. Assumptions in Dierkes' model

The main purpose of the paper by Dierkes is to confront strategic transfer prices and relative performance evaluation to see which mechanism is the better approach in strategic delegation. In order to do so he makes the implicit assumption that the implementation cost for both incentive schemes (and in fact also for the reference case of pure profit participation) is the same and equal to zero. While this assumption is obviously fairly unrealistic it is nevertheless a necessary assumption in order to be able to make a comparison based solely on the strategic effects. This is also why it is among the standard assumptions in the strategic delegation literature.

Another quite unrealistic assumption in the model of Dierkes is the duopoly environment. A market of only two competitors is very rare in practice. However, the duopoly case is the standard approach when studying oligopolies, a situation far more common in the real world. The properties are normally the same in a duopoly model as in an oligopoly with more than two firms but the effects are far more pronounced when only two competitors are present. As we have seen in section 3 in the works of Vickers (1985), Fershtman and Judd (1987), Alles and

66

Datar (1998), Miller and Pazgal (2002), Jansen et al. (2007) and Jansen et al. (2009) the implications remain the same if the number of firms is increased, although the effect tends to fade out the closer one moves towards a perfect competitive market. The assumption is therefore perfectly legitimate. Nevertheless, the reader of Dierkes' paper should be aware that the magnitudes may change if the number of competitors in the market is increased.

A further assumption which hold true only very rarely in practice is the supposition that both firms produce only one single type of product. Nevertheless, this is also a frequently made assumption as allowing multiple products severely increases the complexity of an oligopoly model. Furthermore, Fumas (1992) has shown for RPE that the basic implications do not change. Alles and Datar (1998) have done the same for the use of STP. The latter ones, nevertheless, have shown that while the main conclusions remain unchanged there are some other interesting effects, for example cross-subsidization of products. Hence, the reader can accept the assumption since the major corollaries do not change but needs to be aware that a more realistic multiple product setting increases complexity by several dimensions. These would need to be considered in case one considers practical implementation of one of the discussed incentive schemes within a firm producing more than one product.

Dierkes mentions that the products produced by the two firms are differentiated. This is necessary to avoid the Bertrand-Paradox.[122] He does however not explicitly mention that the goods are assumed to be substitutes. This becomes obvious though when looking at the parameter assumptions of the demand function (1) and is standard in strategic delegation literature. This proposition becomes very important in combination with another crucial assumption, namely that competition is based on prices. These two factors together (substitutes vs. complements and Bertrand vs. Cournot) determine whether one is dealing with strategic complements or strategic substitutes. Miller and Pazgal (2002) noted that price competition with complementary goods and quantity competition with substitute goods both result in dealing with strategic substitutes and thus the two cases yield identical results. The same is true for the case of strategic complements, being either complementary goods in quantity competition or

---

[122] Recall this from section 2.

substitute goods in price competition. It is this very last case we find in the model of Dierkes, which does not cover the case of strategic substitutes. Fortunately, this void has been filled since than by the work of Jansen et al. (2009). Opportunely, the main conclusion in both papers is the same, namely that using relative performance evaluation is always a dominant strategy. Nevertheless, the way this strategy is optimally implemented is completely different for the two cases.[123] As Dierkes fails to mention that his suggestions might change drastically if one of these key assumptions is changed (so that the situation changes from involving strategic complements to dealing with strategic substitutes) the reader of his paper might not be aware of this restriction.

Regarding the demand function in Dierkes' model it does not only include the implicit assumption of the goods being substitutes but has some other interesting properties worth noting. First and most obvious, it is linear. This specification is also standard in oligopoly theory as it allows to yield straightforward comparative statics. Moreover, the results remain unchanged for nonlinear demand functions with certain properties.[124] Second, the demand function is symmetric for the products of both firms. Because of the Slutsky-Symmetry this is always the case when it is derived from the utility maximizing consumption plan of a representative household.[125] Hence, linear and symmetric demand functions are standard assumptions.

Even though the demand function (1) is intuitive and standard for a Bertrand duopoly, it is not without issue. In addition to the more or less realistic implicit assumptions discussed in the previous two paragraphs, it has other properties which are questionable from an economic point of view. Kopel and Lambertini (2012) show that for an increasing f (which corresponds to a decreasing product differentiation) both price and profits decrease monotonically. In economics, one would expect the opposite to hold. Additionally, assuming full substitutability ($f = 1$) instead of the economically reasonable zero profits and marginal cost pricing, they find prices which remain above marginal cost and profits to be positive. Finally, they get the unreasonable result with this demand function of "the duopoly price with homogeneous goods to be higher than full monopoly

---

[123] See subsection 4.3 for a more detailed discussion of this aspect.
[124] C.f. Aggarwal/Samwick (1999), p. 2003.
[125] C.f. Dixit (1986), p. 108 and Göx (1999), p. 28.

price."[126] This finding might seriously influence the economic validity of Dierkes' results.

Another standard assumption in this area of research is marginal costs being constant[127] even though it might seem quite unrealistic. The fact however that costs are also assumed to be symmetric needs a little more consideration. Obviously, this appears to be only very rarely the case in practice. This is one reason why some of the papers discussed in section 3 assumed cost heterogeneity.[128] It is no surprise that this difference plays a crucial role in determining the outcome. A firm's cost structure is a major factor of its competitiveness. So if through incentive contracts competitive intensity can be reduced or increased the effect is certainly facilitated or aggravated by differences in production costs. On the other hand, it consequently enhances significantly the complexity of such a model. Hence, it is not a coincidence that the assumption of cost heterogeneity was not included in the paper of Dierkes nor by Jansen et al. (2009) but merely by others studying only one incentive distortion scheme. Dierkes used a symmetric cost function not because the assumption seemed realistic but solely to avoid making his model too complex. The reader of the paper should, nevertheless, be aware that dropping this assumption might have a radical influence on the outcome. As the works of Basu (1995) and Albuquerque (2009) have shown it might even lead to a situation in which the dominant strategy (and therefore the used incentive distortion approach) differs for the owners of the two firms. In fact, this might be one reason why even within the same industry in practice we still do not observe uniformity among incentive contracts. The reader of Dierkes' article should keep this important aspect in mind.

This is not the only unrealistic assumption that if changed might seriously alter the main conclusions. Dierkes' paper is based on a static model with a game excluding repetition and in which the players choose simultaneously. If the choice about an incentive scheme for the owners happens to be sequential instead of simultaneous because of the structure of the sector or for any other reason the

---

[126] Kopel/Lambertini (2012), p. 3.
[127] See any standard economics textbook, e.g. Varian (1994).
[128] C.f. Fershtman/Judd (1987), Basu (1995), Neus/Nippel (1996), Alles/Datar (1998), Miller/Pazgal (2002), Mujumdar/Pal (2007) and Albuquerque (2009).

outcome changes drastically. These cases have been covered by Göx (1999) for the use of STP and by Miller and Pazgal (2002) for RPE. Both find that the use the respective incentive scheme remains a dominant strategy but that the optimal contract parameters have changed and are not symmetric anymore. For the case where the owners have a choice of different incentive distortion approaches, as in Dierkes', it could even be imagined that the best reaction of the follower might involve a different choice than the one made by the leader. Furthermore, Albuquerque (2007) shows that a dynamic (and more realistic) model with changing parameters and/or possible observations of certain choices might also be a cause for drastically changed results. In this sense, the simultaneous choice and the static model are key assumptions that if dropped might make the model more realistic but could decisively alter the conclusions as was the case for symmetric costs. The reader of Dierkes' paper should be aware of this fact.

Another important issue is the assumption of complete information. Neus and Nippel (1996) and Göx (1999) have shown that the effectiveness of incentive distortion schemes stands and falls with the observability of the contract parameters by the competitors. Katz (1991) had already shown that unobservable contracts cannot serve as precomittments if "it is common knowledge that there exists a contract that 'solves' the standard agency problems and that the principal and agent have the same preferences over income and effort."[129] He shows however also that if these conditions are not met than the use of an agent can affect the outcome even when contracts are not observable. Fershtman and Kalai (1997) also study situations were commitment via delegation is beneficial even when the contracts are unobservable. They find that this critically depends on the type of delegation (incentive delegation is found to be more efficient than instructive delegation), whether unobservability is certain or only very likely, the game being one shot or repeated (repeated games are found to be more efficient) and the equilibrium concept used in the analysis (they use a trembling hand model). Similar, Aggarwal and Samwick (1999) show with a signalling game that strategic delegation can be effective even if information asymmetry is assumed. Schiller (2000) shows for a model of strategic transfer prices that already the slightest uncertainty about the competitors transfer price cause the value of self-commitment to vanish. However, he also shows that it can be beneficial again if

---

[129] Katz (1991), p. 309.

there is at the same time uncertainty about the marginal cost of the competing firm. Possible effects of dropping the observability assumption are therefore not completely determined. Nevertheless, Neus and Nippel (1996) find that making contract details public is a dominant strategy for the firm and Schiller (2000) adds that keeping marginal cost information secret is also beneficial. Nonetheless, this is rarely observed in practice. Göx (1999) is convinced that since many divisions in large companies are actually organized as separate legal entities it is possible to derive the used transfer prices from the financial statements. Schiller strongly doubts this[130] as do I, especially when considering companies producing multiple products and engaging in cross-subsidizing. Dierkes' point of view is that the observation of the participation rates will be less problematic than for transfer prices but does not give any arguments why this might hold. Fact remains that in practice incentive contract details are rarely made public and the reader of Dierkes' article should know that in such a situation incentive distortion through strategic delegation may be useless or at least have reduced effectiveness.

Complete information refers, however, not only to the observability of the incentive contract parameters but also to the cost and demand functions which both managers face. It is natural to assume that a manager has an idea about the costs and demand he and his competitor are facing. However, having perfect knowledge of it is a very rigid assumption. This is why the standard principal-agent theory normally includes some kind of random shock term in order to reflect the risk the manager is facing. Assuming complete information Dierkes does not include such a term in his model. The reason for doing so lies within another assumption, namely that the agent is risk neutral and his performance does not involve any effort. These are assumptions made quite commonly in the strategic delegation literature in order to be able to focus on the strategic effects of incentive distortion without having to worry too much about any moral hazard problems. The inclusion of a random variable becomes obsolete in this case as in the absence of risk aversion the linear wage contract of the agent can always be constructed in such a way to equal exactly his reservation wage.[131] Additionally, Fershtman and Judd (1987) show that including a random variable does not change the main conclusions in their STP model. Regarding relative performance

---

[130] Schiller (2000), pp. 2 f.
[131] See section 2.

evaluation it is Fumas (1992) who first notes that using a fully specified agency model including risk-aversion, an effort choice and a common shock term in a strategic delegation model may cause a conflict with the implications of the standard principal-agent theory, especially in the Bertrand case. In fact, while the principal-agent theory suggests negative participation rates for the competitor's profit, the strategic delegation literature proposes a positive value for this variable. Aggarwal and Samwick (1999) on the other hand show that adapting their RPE model to a fully specified agency model does not change its implications. Nevertheless, the magnitudes of the variable values of their optimal contracts are altered. Therefore, it cannot be said with certainty what the final effect of including the moral hazard problem in Dierkes' model would be and how the outcome might be altered. The reader should however notice that doing so might change the main implications, or if not, at least the magnitudes of the optimal parameters will be different.

The absence of an asymmetric information structure and the moral hazard problem appears to make another of Dierkes' assumption obsolete. In fact, the existence of these prepositions is the foundation in the principal-agent theory for justifying the use of (linear) incentive contracts. Even though there is no moral hazard problem in Dierkes' model, the use of incentive contracts is justified by its incentive distorting properties. The restriction of these contracts to be linear is probably made on one hand to be consistent with the principal-agent framework and on the other hand to make the model analytically traceable. This seems however not to be problematic as the assumption is standard in the strategic delegation literature and linear incentive contracts are by far the most dominant form of such contracts in practice.

Finally, it is implicitly assumed that for the contracts made between principals and agents there is no possibility of renegotiation. This point is important because Katz (1991) shows that renegotiable contracts are in many ways similar to unobservable contracts and that as a conclusion the commitment value of the contract can vanish.[132] The question if and how often contract renegotiation is the case in practice will probably vary among firms, industries and time and is beyond

---

[132] In his model this is the case for renegotiation under complete information while under incomplete information the contract can still have commitment value.

the purpose of this paper. This is however an additional aspect which should be kept in mind by the reader of Dierkes' article.

4.2. Aspects not discussed by Dierkes

In this subsection aspects and problems that Dierkes fails to discuss are going to be picked up. Hereby it makes no difference whether Dierkes implicitly assumed the reader to be aware of these characteristics or whether forgot or was unconscious about these omissions.

Actually, some have already been mentioned in the previous subsection when discussing explicit or implicit assumptions. I have discussed some problems with certain assumptions and possible effects if these assumptions were to be dropped. This is important to know, especially when the assumptions might appear unrealistic as the outcomes in the real world could consequently be very different. Omitting a detailed discussion of these aspects might lead the incautious reader to give the model a greater validity than it actually has. Accordingly, it has been mentioned that the effects of strategic delegation lessen as the number of firms in the market increases. Also, the optimal contracts change drastically when switching from strategic complements to strategic substitutes or when using a fully specified agency model. Finally, Dierkes fails to justify the use of linear incentive contracts in his model and does not sufficiently point out the importance of the observability of the contracts. As these aspects have already been dealt with I will refer to the previous subsection for the detailed discussion.

Beyond these problems there are however additional aspects of which one only becomes aware by reading the related literature as Dierkes does not mention them. Speaking of the observability of the contracts, the author not only fails to sufficiently emphasize its importance but also does not engage in a discussion of how these details might or might not become common knowledge in practice. As mentioned in the previous subsection, Göx (1999) implausibly suggests that transfer prices can be derived from the financial statements of firms. Dierkes is convinced that it would be easier to observe the participation rates of competing firms rather than their transfer prices but without giving any reasons for this belief. One mechanism of making contract details observable to the public might be that the firms announce them themselves. Fershtman and Judd (1987) as well

as Neus and Nippel (1996) and Schiller (2000) suggest that this is in fact a dominant strategy for the firm. Furthermore, such a publication would be beneficial in terms of corporate transparency. We can indeed observe in practice that some companies reveal their top managers compensation package, especially in listed companies. Nevertheless, such announcements are normally restricted to the board level and are not nearly as wide-spread as the discussed findings would suggest. Considering that most of the benefits of strategic incentive distortion go to the principals (according to the models) that there seems not to be any apparent reason why the managers should provide the consent to make their contract details public. If the approval by the agent is a legal prerequisite, this might explain why companies do not actually publish them. There might, however, well be other than strategic reasons frustrating such publication efforts.

One important aspect that is not emphasized sufficiently by Dierkes in his paper is the question why he restricts himself to comparing STP and RPE. He does mention in his conclusion that there might be other incentive distorting mechanisms but fails to discuss why he limits himself to these two. It seems obvious that this is done because of several reasons. First, transfer prices (for strategic reasons or not) and relative performance evaluation are two very commonly used concepts in practice. Second, these are also the two mainly discussed incentive schemes in the strategic delegation literature. Finally, many other mechanisms are mathematically equivalent to one of these two. Considering this, the limitation to discussing STP versus RPE seems straightforward. However, as we have seen from Jansen et al. (2009), there might well be additional contract schemes having different effects and these may even dominate one or both of the others. So while the choice of the two mechanism made by Dierkes is completely sensible, the reader should be aware that the results may provide an optimum within his model framework but that there might also be other schemes that could offer even better results. I am however not aware that so far the literature does offer any better incentive delegation mechanism from a strategic incentive distortion perspective.

Dierkes' work is very helpful in determining the optimal contract within his framework. Additionally, his findings are stable for any sensible specification of the model parameters. Even though linear demand functions, as used in Dierkes'

model, allow to yield straightforward comparative statics he refrains from discussing any such properties. Other authors have however shown that looking at comparative statics can provide interesting additional insight into the effects of certain parameter values. Specifically, Aggarwal and Samwick (1999) and Göx (1999) have shown that especially the degree of substitutability measured by the ratio $\frac{e}{f}$ is important in determining the optimal contracts. The effects on the participation rates or the difference of transfer price minus real unit costs are not explored by Dierkes. For many reasons that have been discussed, Dierkes' work is very valuable. Nevertheless, a consideration of comparative statics would have provided his paper with more profound completeness. For the interested reader the papers of Aggarwal and Samwick (1999) and Göx (1999) are indicated as appropriate complements to get deeper insights into this aspect, even though each paper only focuses on one of the two mechanisms.

The conclusion of Dierkes' paper is that given his framework it is optimal to stipulate an incentive contract based on relative performance evaluation with two positive participation rates s (by assumption) and v for the own and the rival firm performance. The observant reader might be surprised about the positive value of the latter. This might be on one hand due to the surprising contrast to the suggestions of classic principal-agent theory. On the other hand the reader might doubt the legality of paying a manager for the success of a competitor. This seems to violate anti-trust laws as it clearly encourages collusive behaviour. I have already discussed in this paper that Gilo (1996) and Aggarwal and Samwick (1999) have shown that this is actually not the case. Passive investments are generally allowed and anti-trust laws pose no restrictions on RPE-contracts. Nevertheless, omitting this discussion, as is the case in Diekes' work, might cause the reader to be worried about the practicability of the suggested implications. Mentioning this could help ease any concerns a reader may have in this regard.

There is another omission connected to illegality in Dierkes' paper. Contrary to the previous anti-trust violation which an uninformed reader might have been led to assume, the following is indeed illegal. Recall, that the reference case in Dierkes' model is represented by the standard Bertrand duopoly outcome. This is, however, only one possible reference solution. Another possibility would be the

cartel solution in which both firms engage in the most collusive behaviour.[133] The first option is the reference case for most fierce competition with no cooperation. The latter is quite the opposite as basically a monopoly is formed and the benefits are shared among the two players. Naturally, this second option yields the highest possible profit for the firms but is clearly a violation of anti-trust laws. Hence, it hereby represents the upper limit of the possible outcome in terms of benefits for the firms and is thus a natural reference solution. Nevertheless, its missing practical relevance (due to the illegality) has probably lead Dierkes to refrain from the use of this benchmark. This is a valid choice as it helps to avoid additional confusion for the reader in the absence of a clear supplementary utility. Nonetheless, it would have been useful for the reader in terms of completeness to mention this upper limit and reveal the reasons for its exclusion.

There is another aspect which could have been included in Dierkes' paper to increase completeness. The article is clearly written from the perspective of the firm which makes perfect sense since its results are of normative nature and the decision makers are the principals of the firms (at least considering the main question of which incentive scheme is superior). In determining the conclusion that relative performance evaluation is the dominant mechanism within his framework Dierkes therefore uses firm profits as decision criteria. Contrary to Neus and Nippel (1996), Miller and Pazgal (2002) and especially Jansen et al. (2007) he does however not discuss any social welfare implications or redistribution effects. Again, in light of the main problem setting of his paper this decision appears natural. Nevertheless, there are at least two arguments suggesting that enriching the paper with a discussion of social welfare effects of incentive distorting mechanisms might have been beneficial. First, oligopoly theory is a concept originally derived within an economics and not a business framework. It would therefore appear to be appropriate to discuss also the economic effects of the model on social welfare. Second, not all the readers of Dierkes' article are necessarily shareholders, firm owners or managers. Politicians and/or economists might well be interested in the effects beyond firm profits. In fact, adding the social welfare effects could include valuable information for policy makers. For example, the optimal contract in Dierkes' model maximizes firm profits through the use of relative performance evaluation with a positive participation rate in

---

[133] C.f. Göx (1999), pp. 31 ff.

rival firm profits. This leads to a collusive-like behaviour among the competitors increasing their profits and presumably reducing total social welfare. Hence, by making the use of such a positive rival firm participation rate illegal with an addition to anti-trust laws competition among firms could be favoured and social welfare could be increased. The reader therefore should be aware that the article has a clear business perspective and does not fully cover all economic effects.

Finally, the implications of the model discussed by Dierkes are all with regard to the design of the optimal contract given his specific environment. What he neglects to examine are more general implications for the theory of the firm, contrary to what Vickers (1985) did. The implications derived by Vickers are of general nature and apply generally to incentive distortion, independently of using strategic transfer prices or relative performance evaluation. In fact, they could be equally applied to the model of Dierkes. Maybe this is a reason why generally authors, not just Dierkes, have been neglecting to discuss these or further implications. Nevertheless, Dierkes could have explored additional propositions or at least reproduce Vickers arguments to give the reader a complete picture of the implications of strategic incentive distortion for the theory of the firm.

4.3. Implications and practical relevance

This subsection deals with implications for the practice combining the results of Dierkes and findings from the related literature. Additionally, some empirical evidence is discussed to emphasize the practical relevance.

When covering the article of Vickers in section 3, I have already pointed out the four major implications for the theory of the firm for his model of strategic transfer pricing. The mechanism through which relative performance evaluation works is slightly different from the effects of STP, as was shown in figure 2 in section 2, but the effect is merely the same. Hence, the implications he derived are more generally applicable to the genuine case of strategic incentive distortion, independent of the specific mechanism on hand or the market environment. Therefore, profit maximization might extinct among managers (not owners) as it does not yield the highest profits. Splitting a company (or even only reorganizing into several divisions) might be beneficial while too much vertical integration

might be harmful. I refer to section 3 for a more detailed discussion of these implications.

Besides these implications throughout the literature it has emerged that using relative performance evaluation is a dominant strategy of strategic delegation within most model environments. This holds true independent of the type of competition, Cournot or Bertrand, and of the type of products, strategic substitutes or complements. Nevertheless, the optimal contract of RPE might well look very different depending on the product-market environment. In fact, while in an environment of strategic complements the participation rate in the rival firm's profit is positive, the opposite sign is optimal for a situation with products being strategic substitutes. To be able to achieve the desired effects companies need to know in which type of environment they are competing. This might not be as easy in practice as it may seem in theory.

Furthermore, a positive participation rate in the rival firm's profit induces collusive behaviour among firms. While I have mentioned in several occasions that Gilo has shown this to conform to existing anti-trust laws, this situation might well change if such a positive contract parameter value develops to become common practice. I will show at the end of this subsection that such a positive value is not convincingly supported by empirical evidence. If however this might develop into a kind of industry standard it would probably not surprise if the legislative authorities would step in to prohibit such behaviour in order to insure a competitive market environment. Before stipulating a contract with positive value of the participation rate in the rival firm's profit, the owner should consider possible costs of renegotiation with the agent against the likelihood of such a scenario. Considering the other perspective, policy makers should give such prohibitive laws some serious thoughts in order to preventively ban behaviour that could damage social welfare.

While legislative authorities have the possibility to interfere and prevent collusive behaviour among two or more firms, they do not have this option within the organizational structure of one single corporation. If the ideas of strategic incentive distortion are extended to the organizational design of one firm the results could imply a partial solution to the well known problem represented by the cannibalization effect. Similar to the reduction of competitive intensity among

78

firms, incentive systems could be used to alleviate competition among employees or divisions of the same corporation. Ziss (1999) goes even further suggesting the purposely creation of horizontal divisions within the firm are in order to create intra-firm competition. Assuming a Bertrand environment and appropriate incentive systems it might well have the effect of higher prices and higher profits for both divisions and consequently for the whole organization.[134] However, these intra-firm effects have so far found only little consideration in the literature and possible effects on competitors outside the firm would need to be considered before deciding on changing the organizational design accordingly.

It needs to be recalled that many implications discussed here apply to the case of simultaneous choice of contracts and prices based on some specific assumptions. The best reaction in a sequential game might well be different from the use of relative performance evaluation, especially for the follower. The literature has offered a few explanations when the result might be the Stackelberg outcome. First, Göx (1999) suggests that the characteristics and history of a market or sector might cause such a result and determine which firm will be leader and which will be follower. Second, Mujumbar and Pal (2007) show that the same situation is likely when dealing with a dynamic instead of a static environment. Third, Albuquerque (2009) obtains the same result for firms with considerably different cost structure (which could be due to different size and economies of scale). Hence, firms need to be aware that if these (or other not yet determined) conditions hold which make a Stackelberg outcome likely, the use of relative performance evaluation might not be the dominant strategy.

Generally speaking, firm owners should never rush the incentive contract decision but very carefully value their product and market environment when deciding which incentive mechanism to use and how to shape the contract parameters. In doing so, they should however strongly consider the use of relative performance evaluation as a possibly very effective tool of strategic delegation in order to better pursue their goal of profit maximization. Note however that the models discussed in this work are generally not designed to provide an optimal solution for any specific practical problem. The magnitudes of parameter values are not to be taken at face value but should be interpreted as being a helpful indication of

---

[134] Additionally, he finds that given demand uncertainty divisionalization has the strategic benefit of making the firm more responsive to demand shocks.

possible consequences. The same is true for changes in assumptions or model specifications causing the parameters to change. Only the direction of change is interesting, less so the amount. This should be remembered when considering the actual implementation of a solution according to the results of the mentioned literature.

This subsection is concluded by pointing out a few empirical studies to get an impression of the practical relevance of the topic. Note however upfront that this subsection does not pretend to give an extensive overview of empirical findings in the area but just discusses a few selected articles in order to give a general impression of the importance of the topic and the problems associated with the empirical study of it.

First, the study of Gibbons and Murphy (1990) has already been mentioned in section 3. They find strong empirical support for the use of RPE in the classic benchmarking approach with negative participation rates in the rival firms' profits. This would support a competitive environment of Cournot type. Also, in their study it appears that the agent is more likely to be evaluated relative to aggregate market movements than relative to industry movements. They argue that this appears plausible considering that many firms engage in several industries. However, as they define their studied industries quite broadly this is at least questionable.

The empirical findings of Aggarwal and Samwick (1999) have also been discussed in more detail in section 3. Their results are quite different from those of Gibbons and Murphy. What is of most interest here is that they find statistically significant support for a positive participation rate in the profits of the peer group. Together with some other findings they derive empirical support for the differentiated Bertrand model. While Gibbons and Murphy focus on the risk-sharing argument of the agency theory, Aggarwal and Samwick point out the conflict between strategic competition and the principal-agent problem. In this sense they provide an explanation for the restricted use of classic benchmarking in practice.

Aggarwal and Samwick looked at empirical evidence to be able to conclude which of their model environments, Bertrand or Cournot, is supported by the evidence. Kedia (2006) uses a different approach. She first tries to distinguish whether an industry is characterized by strategic complements or strategic substitutes and then checks if the empirical evidence supports the theory. Contrary to the previous two studies she opts for a model of profits and sales which, as was explained on several occasions in this paper, is equivalent to the use of strategic transfer pricing. The nature of competition is determined by estimating the slope of the reaction function.[135] As the theory suggests, she finds that a transfer price smaller than marginal cost dominates in industries characterized by strategic substitutes. On the other hand, where competition is based on strategic complements she finds the transfer price to be above marginal cost.[136] Moreover, Kedia identifies characteristics possibly determining the nature of competition in the industry. She finds that "industries with competition in prices among differentiated goods are more likely to compete in strategic complements."[137] Competition in strategic substitutes on the other hand is more likely in "industries where firms compete in market share and where substantial investment is required in plant and equipment."[138]

The three studies discussed all somehow support the theoretical models but are far from consistent. Besides the obvious differences in timing and data of the studies this might have additional reasons. First, it is difficult to test for STP as data on internal transfer prices is normally not made public and therefore one has to rely on proxies. Second, when testing for RPE normally the implicit approach is used regressing executive pay on industry performance across a population of firms. This approach is hardly criticized by Gong, Li and Shin (2011). The method includes implicit assumptions about the peer group composition, the used performance metrics and the components covered by relative performance

---

[135] To be precise she only estimates the sign of the slope and not to absolute value. This is the reason why no statement about the intensity of competition is possible.

[136] The differences in pay for performance sensitivities are studied using data on stock option grants, CEO stock ownership and cash compensation instead of actual data on transfer prices. Although the mechanisms through which incentives are affected are actually quite different the basic effect on the objective function is the same.

[137] Kedia (2006), p. 883. In her study these are the industries „department stores" and „soap, detergent and toilet preparations".

[138] Kedia (2006), p. 883. Examples in her study include „beverages", „paper mills", „trucking, not local" and "farm machinery and equipment".

evaluation which do not represent reality. The fact that the SEC passed new executive compensation disclosure rules in 2006 is used by the authors to test this. According to the new rules firms have to provide more details on the compensation of their executives including relative performance targets. When explicitly analyzing the contracts Gong, Li and Shin find that about 25% of the firms use some sort of RPE. However, this is not identified when using the implicit approach because of the above mentioned problems associated with it. Additionally, the study identifies that firms exposed to higher common risk or more competition are more likely to use relative performance evaluation. Especially the influence of competition intensity has been discussed in great length in the present work and is an important factor of the usefulness of strategic delegation. Fewer growth opportunities, less wealthy CEO's, smaller sizes, independent boards and use of compensation consultants are other factors positively influencing the use of RPE.

When discussing most models in this paper it has been argued that observability of the self-committing action is crucial for the strategic effect to be effective. Additionally, making the details of the distortive contract public has been identified as always being a dominant strategy. An interesting study connected with the observability of such details is provided by Park, Nelson and Huson (2001). In 1993 Canada introduced new disclosure rules on executive compensation which obliges firms to make the individual compensation of their executives public and not just the aggregate as previously required. The study compares pay levels and composition before and after the introduction of the new law. In the disclosure period general pay levels increase significantly, probably as a result of increased competition for managerial talent. More interestingly for our purposes, however, is that the magnitude of the participation rate has also been found to have increased. Despite the fact that this has mostly been achieved through market-based incentive pay[139] and that the authors attribute this to shareholder and political pressure, what is interesting for our purposes is the general strong effect caused by the abrupt observability. It might, however, well be that part of the effects could be due to strategic considerations following the disclosure. More empirical research in this area is needed.

---

[139] The study considers the number of stock options granted and the corresponding dollar value. It does not study the use of relative performance evaluation or strategic transfer prices.

This selection of empirical studies shows that the topic is of high practical relevance. Empirics in this area are however difficult to conduct and models are not easy to be tested because much of the data needed is internal of the firms, especially when talking about transfer prices. This might also be the reason for the different conclusions drawn among the studies. The increasing diffusion of relative performance evaluation and the strong impact of executive compensation disclosure prove that firm owners are becoming increasingly aware of this topic and are adapting to its implications. More empirical research should shed further light on real world implementation of the discussed suggestions.

4.4. Further research possibilities

The article of Dierkes has a central role in this work and it has emerged from the literature overview that it fills an important gap in this research area. Nevertheless, there are several other aspects and options that could be subject to future research to get a more detailed insight into strategic delegation. A few of them are mentioned by Dierkes himself while others emerge when having a broader look at the literature.

First, Dierkes' main objective is to find out which of the two incentive schemes examined by him is better under the given assumptions. Nevertheless, he suggests that a combination of both approaches could also yield interesting results. The idea that a combination of two incentives can be better than each one on its own was already put forward by Ziss (1999). It is well possible that using strategic transfer prices and relative performance evaluation at the same time could further improve the outcome for the firms. This thought can be expanded to possibly include even more incentive distorting measures like the market share approach or others. With every additional criterion the degrees of freedom in manipulating the agents' incentives increase and so could possibly the resulting payoffs. Nevertheless, there are at least two problems to such an approach. First, the literature on incentive systems suggests that the variable pay component should be as simple as possible. Otherwise the system becomes too complicated for the managers to understand and act accordingly. It will therefore be difficult to communicate to the staff and might not be accepted. Additionally, the information cost required would increase and might diminish the profitability of the whole

system. The second problem is of more technical nature. If the number of decision variables is increased it is not possible with known mathematical methods to derive a Nash equilibrium on the first stage; neither analytically or numerically.[140] Therefore, there would be huge limitations in solving such a model.

Another further research possibility indicated by Dierkes and more easily implemented is the incorporation of additional incentive distortion mechanisms. Even if the study of combinations of such approaches seems prohibitive there might still be other "pure" strategies worth considering. Jansen et al. (2009) have pursued this approach by studying a market share approach next to STP and RPE in an environment with Cournot competition. The logical next step would be to also extend Dierkes' model of Bertrand competition by including this approach. Further, there might be other possible approaches that could be worth some theoretical consideration. There is in fact lots of room for creativity.

Dierkes also points out that implementing a fully specified agency model with effort cost and risk aversion by the agent could yield interesting new results. We have seen this being actually the case in a few other papers in the literature like Fumas (1992) and Aggarwal and Samwick (1999). While these works have shown that the basic implications do not considerably change, this extension could nevertheless provide additional information. For example it might be possible to derive in more detail not only the optimal ratio of participation rates when using relative performance evaluation but also some indication of their optimal absolute level compared to the fixed part of compensation.

Switching from a static to a dynamic model is another research extension proposed by Dierkes. Mujumdar and Pal (2007) show with their model that a dynamic model specification can lead to very different results compared to the static environment. Since in most real world application cases a dynamic model appears to be more reasonable it might prove very useful to extend Dierkes' approach to such a dynamic context. The results would consequently have higher practical relevance and the expected outcome would be more realistic.

Beyond these research possibilities listed by Dierkes there are others which can be deduced from the literature. One such option is to consider firms producing

---

[140] C.f. Dierkes (2004), p. 55.

multiple products. As with the switch from a static to a dynamic environment, switching to multiple product firms would make the model far more realistic. Fumas (1992) and Alles and Datar (1998) have pursued this approach in their respective model environments and gained interesting results as was discussed in section 3. Especially aspects connected to the possibility of cross-subsidizing products could be of great interest as it is commonly observed in practice.

Another interesting enrichment of Dierkes' model could consist of allowing cost differences among the firms. Quite a few papers discussed in section 3 include this difference in their respective models, namely Fershtman and Judd (1987), Neus and Nippel (1996), Miller and Pazgal (2002) and Albuquerque (2009). They all derive interesting conclusions as has been discussed in section 3. However, all of them consider only one distortion mechanism. Using this approach in a model similar to the one of Dierkes where two or more incentive schemes are compared will be much more complicated to implement. Nevertheless, if it can be achieved the results would be even more informative, again especially because the model would better resemble reality in most practical cases.

Besides the possibility of having different cost structures among the firms another cost assumption could also be relaxed to improve the model. Dierkes and all other authors comparing different incentive schemes assume the implementation costs of these mechanisms to be equal. This is necessary to be truly able to compare different systems. Nevertheless it would be interesting to see how much better relative performance evaluation performs in Dierkes' model compared to strategic transfer pricing. In other words, how much more could the implementation of RPE cost (in terms of administration, information costs, transaction costs and so forth) for it to overall yield the same result as STP? This could especially be useful for firms to judge the mechanisms in terms of costs and benefits before deciding on which incentive scheme to implement.

In many articles mentioned in section 3 not only the highest possible profits for the firms are discussed but also social welfare effects are considered. This aspect is ignored by Dierkes. Analyzing the consequences for social welfare in his model would give a more complete picture of the model outcome. Also, it could add relevance to the article for readers outside the caste of entrepreneurs like

politicians and law makers or anti-trust regulation authorities. Further research should close this gap.

When analyzing strategic delegation the standard approach is to use a game theoretic model. Dierkes followed this approach, too. Nevertheless, in section 3 the article of Alles and Datar (1998) was discussed, which contrary to most other literature used a variant of the Hotelling model. In their model the objective of gaining market share is a powerful counter veiling incentive against raising prices in Bertrand competition. It is also very intuitive for many oligopolies in practice. It therefore proves to be an interesting addition to the existing literature. Further research could pursue this approach and apply such a model for example to firms applying not only transfer prices but perhaps relative performance evaluation or any other incentive mechanism. Furthermore, there might well be other model specifications, different from a game theoretic approach or a variant of the Hotelling model, that could yield interesting results for this area of study. Researchers might explore different settings to derive useful conclusions.

Besides these interesting theoretical research expansions there is a lot of empirical work to be done, too. In the previous subsection it was shown through a few examples that empirical conclusions are still controversial. Research could study the nature of competition of certain industries and check whether firm owners and managers act in line with the predictions of the theory. Also, the magnitudes of the parameter values of the models could be tested. Moreover, an investigation to check whether relative performance evaluation dominates strategic transfer pricing not only in the model but also in the real world would be of great significance. Obviously the list could be carried on much further. Empirical research in this area is however quite difficult. The model implications are quite different depending on the nature of competition in the industry which is not easy to identify. The transfer prices used by firms are rarely published. The implicit approach often used in detecting relative performance evaluation is also problematic. Additionally, even though firm owners might realize RPE to be dominant over STP they might opt for the latter option in a Bertrand environment as it appears easier to communicate a transfer price above marginal cost compared to a positive participation rate in the competitor's profit. All this together makes clear-cut conclusions very difficult. Puzzling as it is, that while the theory

suggests that making contract details public is always a dominant strategy it is very rarely observed in practice unless some disclosure regulation makes it obligatory. Future research could investigate how such publication could be possible and why it is not done more commonly. We see that lots of work is still to be done.

5. Conclusion

The purpose of this work was to give an overview of the literature on strategic incentive distortion, particularly the ones focusing on the two dominant lines of study namely strategic transfer pricing and relative performance evaluation. Within this selection of articles especially a model used by Dierkes (2004) has been analyzed in detail. It was the first model to use both approaches within the same model, thus bringing the before separate research streams together. In fact he approaches the question which of the two distortion mechanisms achieves better results. This is why it has such a central role in this paper. The analysis is however followed by a critical discussion of the model using the findings, mainly theoretical but also empirical, of other authors.

Generally, incentive distortion mechanisms are found to have beneficial effects for the firm applying them. Comparing them, Dierkes found that RPE is a dominant strategy over STP in his model. Looking at the related literature I found that most results do in fact point in the same direction. The dominant majority of models posing this question conclude that relative performance evaluation is the best choice in every thinkable situation. Nevertheless, the underlying assumptions heavily influence the design of the optimal contract parameters. Results and implications should not be taken for granted but be looked at with caution. For this purpose I have indicated what aspects should receive special consideration by the reader and how changes in the assumptions could alter the conclusions. This is particularly true for the type of assumed competition, Bertrand or Cournot, the assumption of complete information and the presence of uncertainties.

Finally, I pointed out that a lot of research still has to be done in order to be able to make clearer propositions. Other incentive mechanisms or a combination of discussed ones might yield better results. Further, the models could be integrated in fully-specified agency models. Dynamic environments, multi-product firms and cost differences among firms are also only rarely considered. Above all though, a lot of empirical research to support or disprove the theories is needed. This shows that there are still a lot of interesting research questions in the field of strategic incentive distortion.

Appendix 1

Additional calculus to subgame II:

Inserting prices into the objective function of the principal of firm 2:

$$G_2^{II} = \frac{e \cdot (d \cdot (2 \cdot e + f) + e \cdot f \cdot k - t_2 \cdot (2 \cdot e^2 \cdot - f^2)) \cdot (d \cdot (2 \cdot e + f) + e \cdot f \cdot k + f^2 \cdot k - e^2 \cdot (4 \cdot k - 2 \cdot t_2))}{(4 \cdot e^2 - f^2)^2} \rightarrow \max_{t_2}$$

(1)

Maximizing for decision variable:

$$\frac{\partial G_2^{II}}{\partial t_2} = \frac{2 \cdot e^3 (d \cdot (2 \cdot e + f) + e \cdot f \cdot k - t_2 \cdot (2 \cdot e^2 \cdot - f^2)) - e \cdot (2 \cdot e^2 - f^2)(d \cdot (2 \cdot e + f) + e \cdot f \cdot k + f^2 \cdot k - e^2 \cdot (4 \cdot k - 2 \cdot t_2))}{(4 \cdot e^2 - f^2)^2} \overset{!}{=} 0$$

(2)

Additional calculus to subgame III:

Inserting prices into the objective function of the principal of firm 2:

$$G_2^{III} = \frac{(d - (e - f) \cdot k)^2 \cdot (2 \cdot e^2 \cdot s_2 + e \cdot f \cdot (s_2 - v_2) - f^2 \cdot v_2) \cdot (2 \cdot e \cdot s_2 + f \cdot (s_2 + v_2))}{(4 \cdot e^2 \cdot s_2 - f^2 \cdot (s_2 + v_2))^2} \rightarrow \max_{v_2}$$

(3)

Maximizing for decision variable:

$$\frac{\partial G_2^{III}}{\partial v_2} = \frac{2 \cdot f^2 \cdot (d - (e - f) \cdot k)^2 \cdot (f^2 \cdot v_2 - 2 \cdot e^2 \cdot s_2 - e \cdot f \cdot (s_2 - v_2)) \cdot (2 \cdot e \cdot s_2 + f \cdot (s_2 + v_2))}{(f^2 \cdot (s_2 + v_2) - 4 \cdot e^2 \cdot s_2)^3} +$$

$$\frac{f \cdot (d - (e - f) \cdot k)^2 \cdot (2 \cdot e^2 \cdot s_2 + e \cdot f \cdot (s_2 - v_2) - f^2 \cdot v_2) - f \cdot (e + f) \cdot (d - (e - f) \cdot k)^2 \cdot (2 \cdot e \cdot s_2 + f \cdot (s_2 + v_2))}{(f^2 \cdot (s_2 + v_2) - 4 \cdot e^2 \cdot s_2)^3} \overset{!}{=} 0$$

(4)

Additional calculus to subgame IV:

Inserting prices into principals' objective function:

$$G_i^{IV} = \frac{e \cdot \left(d \cdot (2 \cdot e + f) + t_i \cdot \left(f^2 - 2 \cdot e^2\right) + e \cdot f \cdot t_j\right) \cdot \left(d \cdot (2 \cdot e + f) + f^2 \cdot k - e^2 \cdot (4 \cdot k - 2 \cdot t_i) + e \cdot f \cdot t_j\right)}{\left(f^2 - 4 \cdot e^2\right)^2} \to \max_{t_i}$$

$i, j \in \{1,2\}$ and $i \neq j$

(5)

Maximizing for decision variable:

$$\frac{\partial G_i^{IV}}{\partial t_i} = \frac{2 \cdot e^3 \cdot \left(d \cdot (2 \cdot e + f) + t_i \cdot \left(f^2 - 2 \cdot e^2\right) + e \cdot f \cdot t_j\right)}{\left(f^2 - 4 \cdot e^2\right)^2} +$$

$$\frac{e \cdot \left(f^2 - 2 \cdot e^2\right) \cdot \left(d \cdot (2 \cdot e + f) + f^2 \cdot k - e^2 \cdot (4 \cdot k - 2 \cdot t_i) + e \cdot f \cdot t_j\right)}{\left(f^2 - 4 \cdot e^2\right)^2} \overset{!}{=} 0$$

$i, j \in \{1,2\}$ and $i \neq j$

(6)

Additional calculus to subgame V:

Inserting prices into principals' objective function:

$$G_i^V = \frac{(d - (e - f) \cdot k)^2 \cdot s_j \cdot (2 \cdot e \cdot s_i + f \cdot (s_i + v_i)) \cdot \left(2 \cdot e^2 \cdot s_i \cdot s_j + e \cdot f \cdot s_j(s_i - v_i) - f^2 \cdot v_i \cdot (s_j + v_j)\right)}{\left(f^2 \cdot (s_i + v_i) \cdot (s_j + v_j) - 4 \cdot e^2 \cdot s_i \cdot s_j\right)^2} \to \max_{t_i}$$

$i, j \in \{1,2\}$ and $i \neq j$

(7)

Maximizing for decision variable:

$$\frac{\partial G_i^V}{\partial v_i} = \frac{f \cdot (d - (e + f) \cdot k)^2 \cdot s_j \cdot \left(2 \cdot e^2 \cdot s_i \cdot s_j + e \cdot f \cdot s_j \cdot (s_i - v_i) - f^2 \cdot v_i \cdot (s_j + v_j)\right)}{\left(f^2 \cdot (s_i + v_i) \cdot (s_j + v_j) - 4 \cdot e^2 \cdot s_i \cdot s_j\right)^2} -$$

$$\frac{(d - (e + f) \cdot k)^2 \cdot s_j \cdot (2 \cdot e \cdot s_i + f \cdot (s_i + v_i)) \cdot \left(e \cdot f \cdot s_j + f^2 \cdot (s_j + v_j)\right)}{\left(f^2 \cdot (s_i + v_i) \cdot (s_j + v_j) - 4 \cdot e^2 \cdot s_i \cdot s_j\right)^2} -$$

$$\frac{2 \cdot f^2 \cdot (d - (e + f) \cdot k)^2 \cdot s_j \cdot (2 \cdot e \cdot s_i + f \cdot (s_i + v_i)) \cdot (s_j + v_j) \cdot \left(2 \cdot e^2 \cdot s_i \cdot s_j + e \cdot f \cdot s_j \cdot (s_i - v_i) - f^2 \cdot v_i \cdot (s_j + v_j)\right)}{\left(f^2 \cdot (s_i + v_i) \cdot (s_j + v_j) - 4 \cdot e^2 \cdot s_i \cdot s_j\right)^3} \overset{!}{=} 0$$

$i, j \in \{1,2\}$ and $i \neq j$

(8)

Additional calculus to subgame VI:

Inserting prices into principals' objective function:

$$G_1^{VI} = \frac{e \cdot s_2 \cdot \left(d \cdot (2 \cdot e + f) + f \cdot (e \cdot k + f \cdot k) - e^2 \cdot (4 \cdot k + 2 \cdot t_1)\right)}{f^2 \cdot (s_2 + v_2) - 4 \cdot e^2 \cdot s_2} \cdot$$
$$\frac{\left(d \cdot (2 \cdot e + f) \cdot s_2 + e \cdot f \cdot k \cdot s_2 - 2 \cdot e^2 \cdot s_2 \cdot t_1 + f^2 \cdot (s_2 \cdot t_1 - k \cdot v_2 + t_1 \cdot v_2)\right)}{f^2 \cdot (s_2 + v_2) - 4 \cdot e^2 \cdot s_2} \to \max_{t_i}$$

(9)

$$G_2^{VI} = \frac{e \cdot f^2 \cdot k \cdot s_2 - 2 \cdot e^3 \cdot k \cdot s_2 - f^3 \cdot k \cdot v_2 + d \cdot (2 \cdot e^2 \cdot s_2 + e \cdot f \cdot (s_2 - v_2) - f^2 \cdot v_2) + e^2 \cdot f \cdot (s_2 \cdot t_1 + 2 \cdot k \cdot v_2 - t_1 \cdot v_2)}{f^2 \cdot (s_2 + v_2) - 4 \cdot e^2 \cdot s_2} \cdot$$
$$\frac{f^2 \cdot k \cdot (s_2 + v_2) - 2 \cdot e^2 \cdot k \cdot s_2 + e \cdot f \cdot (s_2 \cdot t_1 - 2 \cdot k \cdot v_2 + t_1 \cdot v_2) + d \cdot (2 \cdot e \cdot s_2 + f \cdot (s_2 + v_2))}{f^2 \cdot (s_2 + v_2) - 4 \cdot e^2 \cdot s_2} \to \max_{v_2}$$

(10)

Maximizing for decision variable:

$$\frac{\partial G_1^{VI}}{\partial t_1} = \frac{e \cdot s_2 \cdot (8 \cdot e^4 \cdot s_2 \cdot (k - t_1) + d \cdot f^2 \cdot (2 \cdot e + f) \cdot (s_2 + v_2) + e \cdot f^3 \cdot k \cdot (s_2 + v_2) + f^4 \cdot k \cdot (s_2 + v_2) - 2 \cdot e^2 \cdot f^2 \cdot (3 \cdot k - 2 \cdot t_1) \cdot (s_2 + v_2))}{\left(f^2 \cdot (s_2 + v_2) - 4 \cdot e^2 \cdot s_2\right)^2} \overset{!}{=} 0$$

(11)

$$\frac{\partial G_2^{VI}}{\partial v_2} = \frac{f^2 \cdot s_2 \cdot (d \cdot (2 \cdot e + f) + e \cdot f \cdot k + f^2 \cdot k - e^2 \cdot (4 \cdot k - 2 \cdot t_1))}{4 \cdot e^2 \cdot s_2 - f^2 \cdot (s_2 + v_2)} \cdot$$
$$\frac{\left(f^3 \cdot k - 2 \cdot e^2 \cdot f \cdot k\right) \cdot (s_2 + v_2) + e^3 \cdot v_2 \cdot (8 \cdot k - 4 \cdot t_1) + e \cdot f^2 \cdot (s_2 \cdot t_1 - 4 \cdot k \cdot v_2 + t_1 \cdot v_2) + d \cdot (2 \cdot e \cdot f \cdot (s_2 - v_2) - 4 \cdot e^2 \cdot v_2 + f^2 \cdot (s_2 + v_2))}{\left(4 \cdot e^2 \cdot s_2 - f^2 \cdot (s_2 + v_2)\right)^2} \overset{!}{=} 0$$

(12)

Appendix 2

Calculations to prove relations:

It holds $p_2^{II} = p_2^{III} > p_1^{II} = p_1^{III}$, because[141]

$$p_2^{II} - p_1^{II} = \frac{f^2 \cdot (d - (e - f) \cdot k)}{8 \cdot e^3 - 4 \cdot e \cdot f^2} > 0.$$ (1)

It holds $G_1^{II} = G_1^{III} > G_2^{II} = G_2^{III}$, because[142]

$$G_1^{II} - G_2^{II} = \frac{f^3 \cdot (4 \cdot e + 3 \cdot f) \cdot (d - (e - f) \cdot k)^2}{16 \cdot e \cdot (2 \cdot e^2 - f^2)^2} > 0.$$ (2)

It holds $p_2^{II} = p_2^{III} > p_1^{I} = p_2^{I}$, because

$$p_2^{II} - p_1^{I} = \frac{f^2 \cdot (d - (e - f) \cdot k)}{2 \cdot (2 \cdot e - f) \cdot (2 \cdot e^2 - f^2)} > 0.$$ (3)

Since it was above shown that $G_1^{II} = G_1^{III} > G_2^{II} = G_2^{III}$ it also holds that $G_1^{II} = G_1^{III} > G_2^{II} = G_2^{III} > G_1^{I} = G_2^{I}$, because

$$G_2^{II} - G_1^{I} = \frac{f^4 \cdot (d - (e - f) \cdot k)^2}{8 \cdot e \cdot (2 \cdot e - f)^2 \cdot (2 \cdot e^2 - f^2)} > 0.$$ (4)

It holds $p_1^{IV} = p_2^{IV} > p_1^{I} = p_2^{I}$, because

$$p_1^{IV} - p_1^{I} = \frac{f^2 \cdot (d - (e - f) \cdot k)}{f^3 - 8 \cdot e^2 \cdot f + 8 \cdot e^3} > 0.$$ (5)

---

[141] Taken from Dierkes (2004), p. 56.
[142] Taken from Dierkes (2004), p. 56.

Since it was above shown that $G_1^{II} = G_1^{III} > G_2^{II} = G_2^{III} > G_1^{I} = G_2^{II}$ it also holds that $G_1^{V} = G_2^{V} > G_1^{II} = G_1^{III} > G_2^{II} = G_2^{III} > G_1^{I} = G_2^{II}$, because

$$G_1^{V} - G_1^{III} = \frac{f^4 \cdot \left(3 \cdot e^2 + e \cdot f - f^2\right) \cdot \left(d - (e-f) \cdot k\right)^2}{16 \cdot e^2 \cdot (e-f) \cdot \left(2 \cdot e^2 - f^2\right)^2} > 0. \tag{6}$$

It holds $p_1^{VI} > p_2^{VI}$, because[143]

$$p_1^{VI} - p_2^{VI} = \frac{f^3 \cdot \left(d - (e-f) \cdot k\right)}{4 \cdot e^2 \cdot \left(4 \cdot e^2 - 3 \cdot f^2\right)} > 0. \tag{7}$$

It holds $G_2^{VI} > G_1^{VI}$, because[144]

$$G_2^{VI} - G_1^{VI} = \frac{f^4 \cdot \left(8 \cdot e^2 + 8 \cdot e \cdot f + f^2\right) \cdot \left(d - (e-f) \cdot k\right)}{16 \cdot e^3 \cdot \left(4 \cdot e^2 - 3 \cdot f^2\right)^2} > 0. \tag{8}$$

It holds that $G_1^{V} = G_2^{V} > G_1^{IV} = G_2^{IV}$, because

$$G_1^{V} - G_1^{IV} = \frac{f^4 \cdot \left(8 \cdot e^2 - 4 \cdot e \cdot f - f^2\right) \cdot \left(d - (e-f) \cdot k\right)^2}{16 \cdot e^2 \cdot (e-f) \cdot \left(f^2 + 2 \cdot e \cdot f - 4 \cdot e^2\right)^2} > 0. \tag{9}$$

---

[143] Taken from Dierkes (2004), p. 56.
[144] Taken from Dierkes (2004), p. 56.

Appendix 3

We provide the proof that the incentive scheme based on profit and sales or revenues is identical to the incentive scheme based on strategic transfer prices used in this paper.

First, the objective function based on profits and sales used by Vickers (1985) for $i, j \in \{1,2\}$ and $i \neq j$ is:[145]

$$H_i = G_i + \theta_i \cdot x(p_i, p_j) \Rightarrow$$
$$H_i = (p_i - k) \cdot x(p_i, p_j) + \theta_i \cdot x(p_i, p_j)$$

This can be reformulated using simple algebra:

$$H_i = (p_i - k + \theta_i) \cdot x(p_i, p_j)$$

As k is fixed while θ_i is an arbitrary decision variable we can define:

$$t_i \equiv k - \theta_i$$

It does, therefore, not make any difference if the explicit decision variable is θ_i or t_i. Using this last replacement results in the objective function:

$$H_i = (p_i - t_i) \cdot x(p_i, p_j)$$

This is exactly the objective function based strategic transfer prices used in this paper and hence the proof is completed.   □

Second, the objective function based on profit and revenues used by Fershtman/Judd (1987) and Sklivas (1987) for $i, j \in \{1,2\}$ and $i \neq j$ are basically equal and defined as:[146]

$$H_i = \gamma_i \cdot G_i + (1 - \gamma_i) \cdot U_i$$
$$H_i = \gamma_i \cdot (p_i - k) \cdot x(p_i, p_j) + (1 - \gamma_i) \cdot p_i \cdot x(p_i, p_j)$$

---

[145] To be exact the objective function is slightly different as Vickers based his model on Cournot competition. The adaptation here is done however without loss of generality.
[146] Again, a slight adaptation has been made without loss of generality.

Using simple algebra this can be reformulated:

$$H_i = \left(\gamma_i \cdot (p_i - k) + (1 - \gamma_i) \cdot p_i\right) \cdot x(p_i, p_j) \Rightarrow$$
$$H_i = (p_i - \gamma_i \cdot k) \cdot x(p_i, p_j)$$

As k is fixed while γ_i is an arbitrary decision variable we can define:

$$t_i \equiv \gamma_i \cdot k$$

It does, therefore, not make any difference if the explicit decision variable is γ_i or t_i. Using this last replacement results in the objective function:

$$H_i = (p_i - t_i) \cdot x(p_i, p_j)$$

This is exactly the objective function based strategic transfer prices used in this paper and hence the proof is completed. $\square$

It was shown that both incentives schemes, including either sales or revenues, can be rewritten to give the objective function based on strategic transfer prices. This implies that all three approaches are basically the same. Hence, it follows that it must also be possible to rewrite the combination of profits and revenues as a combination of profits and output volume. Since this has less relevance in this paper, I refer to Jansen et al. (2007) for this mathematical proof.

References

Aggarwal, Rajesh K. / Samwick, Andrew A. (1999): Executive Compensation, Strategic Competition, and Relative Performance Evaluation: Theory and Evidence, in: The Journal of Finance, Vol. 54, pp. 1999-2043.

Albuquerque, Ana (2010): Does firm heterogeneity lead to differences in relative executive compensation?, in: Finance Research Letters, Vol. 7, pp. 80-85.

Alles, Michael / Datar, Srikant (1998): Strategic Transfer Pricing, in: Management Science, Vol. 44, pp. 451-461.

Basu, Kaushik (1995): Stackelberg equilibrium in oligopoly: An explanation based on managerial incentives, in: Economics Letters, Vol. 49, pp. 459-464.

Bulow, Jeremy I. / Geanakoplos, John D. / Klemperer, Paul D. (1985): Multimarket Oligopoly: Strategic Substitutes and Complements, in: Journal of Political Economy, Vol. 93, pp. 488-511.

Dierkes, Stefan (2004): Strategische Kostenanpassung oder relative Leistungsbewertung – Was ist besser?, in: zfbf, Vol. 56, pp. 45-59.

Dierkes, Stefan / Hanrath, Stephanie (2002): Steuerung dezentraler Investitions-entscheidungen auf Basis eines modifizierten Residualgewinns, in: zfbf, Vol. 54, pp. 246-267.

Dixit, Avinash (1986): Comparative Statics for Oligopoly, in: International Economic Review, Vol. 27, pp. 107-122.

Fershtman, Chaim / Judd, Kenneth L. (1987): Equilibrium Incentives in Oligopoly, in: The American Economic Review, Vol. 77, pp. 927-940.

Fershtman, Chaim / Kalai, Ehud (1997): Unobserved Delegation, in: International Economic Review, Vol. 38, pp. 763- 774.

Fumas, Vincente S. (1992): Relative performance evaluation of management: The effects on industrial competition and risk sharing, in: International Journal of Industrial Organization, Vol. 10, pp. 473-489.

Gibbons, Robert / Murphy, Kevin J. (1990): Relative Performance Evaluation for Chief Executive Officers, in: Industrial and Labor Relations Review, Vol. 43, Special Issue, pp. 30-51.

Gilo, David (1996): The Anticompetitive Effect of Passive Investment, Discussion paper no. 189, Harvard Law School, John M. Olin Center for Law, Economics and Business.

Gong, Guojin / Li, Laura Yue / Shin, Jae Yong (2011): Relative Performance Evaluation and Related Peer Groups in Executive Compensation Contracts, in: The Accounting Review, Vol. 86, pp. 1007-1043.

Göx, Robert F. (1999): Strategische Transferpreispolitik im Dyopol, Wiesbaden.

Holler, Manfred J. / Illing, Gerhard (2006): Einführung in die Spieltheorie, 6th edition, Berlin.

Holmstrom, Bengt (1982): Moral hazard in teams, in: The Bell Journal of Economics, Vol. 13, pp. 324-340.

Jansen, Thijs / van Lier, Arie / van Witteloostuijn, Arjen (2007): A note on strategic delegation: The market share case, in: International Journal of Industrial Organization, Vol. 25, pp. 531-539.

Jansen, Thijs / van Lier, Arie / van Witteloostuijn, Arjen (2009): On the Impact of Managerial Bonus Systems on Firm Profit and Market Competition: The Cases of Pure Profit, Sales, Market Share and Relative Profits Compared, in: Managerial and Decision Economics, Vol. 30, pp. 141-153.

Katz, Michael L. (1991): Game-playing agents: unobservable contracts as precommitments, in: RAND Journal of Economics, Vol. 22, pp. 307-328.

Kedia, Simi (2005): Estimating product market competition: Methodology and application, in: Journal of Banking & Finance, Vol. 30, pp. 875-894.

Kopel, Michael / Lambertini, Luca (2012): On price competition with market share delegation contracts, Working paper DSE no. 806, Università di Bologna, Department of economics.

Mankiw, Gregory N. (2004): Principles of Economics, 3rd edition, International student edition, South-Western.

Miller, Nolan / Pazgal, Amit (2002): Relative Performance as a Strategic Commitment Mechanism, in: Managerial and Decision Economics, Vol. 23, pp. 51-68.

Mujumdar, Sudesh / Pal, Debashis (2007): Strategic managerial incentives in a two-period Cournot duopoly, in: Games and Economic Behaviour, Vol. 58, pp. 338-353.

Neus, Werner / Nippel, Peter (1996): Was ist strategisch an strategischem Verhalten? Überlegungen zur Präzisierung eines inflationär benutzten Begriffs am Beispiel von Investitionsentscheidungen, in: zfbf, Vol. 48, pp. 423-441.

Park, Yun W. / Nelson, Toni / Huson, Mark R. (2001): Executive Pay and the Disclosure Environment: Canadian Evidence, in: The Journal of Financial Research, Vol. 24, pp. 347-365.

Pfeiffer, Thomas (2000): Good and Bad News for the Implementation of Shareholder-Value Concepts in Decentralized Organizations: A Critical Study Comparing the DCF Method and the EVA Method, in: sbr, Vol. 52, pp. 68-91.

Polo, Michele / Tedeschi, Piero (1992): Managerial Contracts Collusion and Mergers, in: Ricerche Economiche, Vol. 46, pp. 281-302.

Rogerson, William P. (1997): Intertemporal Cost Allocation and Managerial Investment Incentives: A Theory Explaining the Use of Economic Value Added as a Performance Measure, in: Journal of Political Economy, Vol. 105, pp. 770-795.

Schelling, Thomas C. (1960): The Strategy of Conflict, Cambridge.

Schiller, Ulf (2000): Strategische Selbstbindung durch Verrechnungspreise?, in: zfbf, Special Issue 45, pp. 1-21.

Singh, Nirvikar / Vives, Xavier (1984): Price and quantity competition in a differentiated duopoly, in: RAND Journal of Economics, Vol. 15, pp. 546-554.

Sklivas, Steven D. (1987): The strategic choice of managerial incentives, in: RAND Journal of Economics, Vol. 18, pp. 452-458.

Tirole, Jean (2000): The Theory of Industrial Organization, 11th edition, Cambridge.

Varian, Hal R. (1994): Mikroökonomie, 3rd edition, München.

Vickers, John (1985): Delegation and the theory of the firm, in: Economic Journal, Vol. 95, pp. 138-147.

Ziss, Steffen (1999): Divisionalization and strategic managerial incentives in oligopoly under uncertainty, in: International Journal of Industrial Organization, Vol. 17, pp. 1163-1187.

Abstract: English

The separation of ownership and management in the large corporation presents the problem of goal alignment but also offers an opportunity. In an imperfectly competitive market this separation allows the owner of a firm to self-commit to a goal differently than profit maximization. Doing so becomes a strategic decision when it affects the behavior of competing firms. If the strategic effect of this decision outweighs the distorting effect then deviation from profit maximization is beneficial.

Strategic transfer prices (STP) and relative performance evaluation (RPE) have both been acknowledged to provide the positive effects above mentioned when used as an incentive system in a duopoly setting. The question which of the two is better has been addressed by Dierkes (2004) with the conclusion that RPE dominates STP. Therefore, this paper thoroughly discusses and explains his model. However, the reader is given more insight through the discussion of related literature. This allows one to yield a more critical view of Dierkes' work and to point out practical implications and omitted aspects. It appears that RPE is indeed a dominant strategy in most settings. Nonetheless, switching from a Bertrand to a Cournot environment, dropping the assumption of complete information or including additional uncertainties might significantly change the conclusions.

Abstract: Deutsch

Die Trennung von Eigentum und Kontrolle in großen Unternehmen führt zum Problem die Zielkonsistenz sicherstellen zu müssen. Gleichzeitig ergeben sich dadurch aber auch Chancen. In Märkten, welche von unvollkommener Konkurrenz gekennzeichnet sind, erlaubt diese Trennung dem Eigentümer sich selbst an ein von der Gewinnmaximierung abweichendes Verhalten zu binden. Wenn sich das Verhalten der Konkurrenten dadurch beeinflussen lässt, handelt es sich um eine strategische Entscheidung. Ein positives Ergebnis wird erreicht, wenn der strategische Effekt dieser Entscheidung den Verzerrungseffekt der Abweichung vom Gewinnmaximierungsziel überwiegt.

Es ist bekannt, dass die Verwendung sowohl von Strategischen Transferpreisen (STP) als auch von Relativer Performance Evaluation (RPE) als Anreizsysteme in Duopolmodellen zu solch positiven Effekten führt. Dierkes (2004) hat sich der Beantwortung der Frage angenommen, welcher dieser beiden Mechanismen zum besseren Ergebnis führt. Seine Schlussfolgerung ist, dass RPE über STP dominiert. Aufgrund der Wichtigkeit dieser Erkenntnis wird sein Modell in dieser Arbeit gründlich diskutiert und erklärt. Des Weiteren wird dem Leser durch die Diskussion themenspezifischer und weiterführender Literatur eine tiefere Einsicht in dieses Forschungsgebiet vermittelt. Dadurch wird dieser in die Lage versetzt, Dierkes' Arbeit kritisch zu betrachten und sowohl vernachlässigte Aspekte als auch praktische Implikationen zu erkennen. Dies führt zu dem Ergebnis, dass RPE für die meisten Annahmen tatsächlich die dominierende Strategie darstellt. Wird hingegen von der Annahme vollständiger Information Abstand genommen oder werden zusätzliche Unsicherheiten mit einbezogen, so können sich die Schlussfolgerungen signifikant verändern. Ebenso führt auch ein Wechsel von einem Bertrand zu einem Cournot Modell zu starken Veränderungen der Ergebnisse.

Curriculum Vitae

Nationality:	Italian
Date of Birth:	01.10.1986
Contact No.:	+49 151 58005196
Current Address:	Lautensackstraße 9, 80687 Munich, Germany
E-mail:	blaas_hannes@yahoo.de

Education

2009-2012	**University of Vienna, Austria** **Master** in International Business - Specialisation in Management Control *Thesis* title: Strategic use of transfer prices and relative performance evaluation – A game theoretic approach to incentive mechanisms under duopolistic competition
Fall 2010	**Copenhagen Business School, Denmark** Exchange semester
2005-2009	**Free University of Bolzano, Italy** **BSc** in Economics and Management *Thesis* title: Value based performance measurement and incentive systems ***Graduation with honours 110 c.l./110*** as the only one of my year
Spring 2008	**University of Tasmania, Australia** Exchange semester
2000-2005	**Commercial high school "Franz Kafka" Merano, Italy** Business and informatics Diploma with ***maximum score 100/100*** as the only one of my year

Relevant Work Experience

Since 01/2012	**Deloitte & Touche GmbH, Munich, Germany** *Professional – Transaction Advisory Services* – Deloitte offers audit, consulting, financial advisory, risk management, and tax services to selected clients around the world. Transaction Advisory Services include due diligence (buy-side and sell-side), restructuring and Sale and purchase agreement advisory.
04/2011-06/2011	**Bureau Plattner, Milano, Italy** *Junior Auditor* – As a partner of Moore Stephens International the advisory services of Bureau Plattner include national and international tax law, commercial and corporate law, accounting, mergers & acquisitions, investment and financial consulting as well as audit and due diligence services. My function as intern was to carry out audits according to both Italian and International Accounting Standards in a small team.

09/2008- 08/2009	**Handelsoberschule "Heinrich Kunter", Bolzano, Italy** High school teacher in mathematics

Languages

German	Mother Tongue
Italian	Fluent
English	Fluent (TOEFL – test result 113/120 taken in 2009)
Spanish	Basic

IT skills

- Excellent general computer skills
- Very good skills in MS Office (Word, Excel, PowerPoint and Access)
- Good skills in the programming languages Java, C# and VBA
- Familiar with SPSS