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Common Holdings and Strategic Manager Compensation. The Case of an Asymmetric Triopoly

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Abstract

We study an asymmetric triopoly in a heterogeneous product market where quantity decisions are delegated to managers. The two biggest firms are commonly owned by shareholders such as index funds while the smallest firm is owned by independent shareholders. Under such a common holding owner structure, the owners have an incentive to coordinate when designing their manager compensation schemes. This coordination leads to a reallocation of production and induces a redistribution of profits. The trade volume in the market is reduced so that shareholder coordination is detrimental to consumer surplus as well as welfare.

Keywords: Common holdings, index funds, shareholder coordination, manager compensation

JEL Classification: G32, L22, M52

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1 Introduction

The owners of big firms usually have to hire managers in order to run the business. Managers, however, have their own interests and choose decisions depending on the incentives given by the compensation contracts. This unavoidably implies that the compensation schemes offered by the owners strategically influence the operational decisions of their managers and hence the profits of the firms. In the theory of Industrial Organization, these strategic effects are derived by applying models of two-stage games where owners simultaneously offer performance-related compensation contracts in the first stage and managers simultaneously decide on prices or quantities in the second stage.

Vickers (1985), Sklivas (1987) and Fershtman and Judd (1987, 2006) have been the first to analyze the consequences of strategic manager compensation in homogeneous markets. They assumed that the compensation contracts consist of fixed salaries and performance-dependent payments related to firm profits on the one hand and revenues (or equivalently sales) on the other hand. The managers maximize the performance-dependent payments by choosing optimal quantities. The main result of these models is that, due to the strategic effects, the incentives of the managers are biased: they decide to produce more than the firm owners would if no managers were involved.

This basic framework has been extended in several dimensions. First, other possible compensation contracts have been considered where revenues are replaced by market shares (see, e.g., Jansen et al. 2007, Kopel and Lambertini 2013, and Ritz 2008) or by relative profits (see, e.g., Salas Fumas 1992, Aggarwal and Samwick 1999, Chirco et al. 2011, and Miller and Pazgal 2001 and 2002). For the duopoly case, a comparison of the different compensation contracts has been provided by Jansen et al. (2009, 2012). Second, mixed markets have been studied where some firms are governed by managers while others are run by the owners themselves (see, e.g., Basu 1995 and Tseng 2001). Third, Spagnolo (2000) has considered a supergame with infinitely repeated competition to analyze dynamic compensation schemes based on the shareholder values of the firms.

This paper aims to concentrate on the role of common large shareholders such as mutual or index funds which coordinate the design of their manager compensation schemes.[1] Fund companies such as Blackrock, Vanguard, or

[1] We refer to 'common holdings' if some shareholders, e.g. index funds, are invested

CalPERS certainly hold shares of multiple firms competing in a relevant product market. A forteriori, index funds duplicate the entire stock market as represented by major stock indices like the S&P500, Nikkei, or DAX. Because of their common business model, even funds of different fund companies are invested in the same sample of firms. The obvious consequence of such a common holding is that the shareholders involved coordinate the design of the compensation contracts for the managers of the firms in which they are invested. Index funds experience a fast growing popularity. According to Bogle (2016, 9), they have accounted for 160% of net cash flows into equity mutual funds. Due to the increasing importance of mutual funds, most notably index funds, our topic is high on the research agenda.

Regardless of the role of institutional investors, and without referring to managerial incentives, the relevance of coordinated behavior in case of common and cross holdings has been intensively discussed in another strand of the literature. Reynolds and Snapp (1986) and Breshnahan and Salop (1986) have identified the incentives to mitigate competition in case of cross holdings. Some models deal with the effects of common ownership in infinitely repeated games. Common ownerships interact with general incentives to collude. According to Gilo et al. (2006), the stability of collusion subtly depends on the different amounts of cross holdings within an industry. An increase in cross holdings, however, always increases the stability of collusion. Additionally, they investigate the role of a controller who internalizes the interest of minority shareholders (not participating in the cross holdings). Given this controller, the stability of collusion may diminish in case of an increased cross holding. The latter point has been strengthened by DeHaas and Paha (2016) who have shown that this result continues to hold under a wider range of conditions. One of the most comprehensive approaches has been provided by Azar (2017). In his model, agents include consumers, workers, and shareholders, where the formers are also shareholders. Firms are run by managers whose objective is to maximize approval votes for new strategic plans. Due to this unusual assumption, it is hard to compare the results to the traditional models on that topic. Antón et al. (2018) have set up a model of product market competition with owners and managers. In contrast to our model, however, they assume that the performance-dependent payments in

in the same sample of firms. In contrast, 'cross holdings' means that firm i holds some shares of firm j and vice versa. In case of common holdings, in addition to the institutional investors, there are usually 'minority shareholders' without any control on the respective firms' decisions.

the compensation schemes are restricted to the uncertain firm profits only. Thus, there is no strategic distortion of manager incentives at work. Nevertheless, an increasing degree of common holdings induces less steep managerial incentive schemes, thus leading to less intensive competition in the product market.

Given the increasing importance of equity funds, it is hardly surprising that a growing empirical literature on the topic has emerged. A first line of research addresses the competition effects of substantial common holdings. Referring to common ownership by a small set of institutional investors, Azar et al. (2018) have tackled the question empirically by investigating the U.S. airline market. They find evidence for the hypothesis that commonly held firms induce additional price premia in addition to what should be expected, given the traditional Herfindahl index of market concentration. The results seem to be robust although they are being disputed to some extent (see, e.g., O'Brian and Waehrer 2017 and Azar et al. 2017). He and Huang (2017) present empirical evidence that cross-holdings foster explicit forms of product market coordination such as joint ventures, strategic alliances and intra-industry acquisitions. Using data from the U.S. banking market, Azar et al. (2016) have developed a generalized Herfindahl concentration measure by accounting for common holdings as well as cross holdings and are able to show that both types of holdings induce softer competition.

A second line of empirical research is concerned with the corporate governance implications of institutional investors. McCahery et al. (2016) have presented a survey on the role of institutional investors in corporate governance. One of their main findings is that the decisive triggers for interventions from institutional investors are governance and strategy. This is the issue we deeply want to emphasize with our study. Cvijanovic et al. (2016) have found that mutual funds regularly support management proposals except for compensation proposals. Even though these papers highlight the level of compensation rather than its structure, the idea that mutual funds intervene in management compensation and strategic aspects strongly supports the relevance of our research question.

Finally, our topic has direct consequences for antitrust authorities and competition law. Recently, the German Monopolies Commission has expressed concerns about competition-reducing effects of increasing cross holdings induced by institutional investors (see Monopolkommission 2016, note S24). In the U.S., several legal scholars have debated necessary amendments to antitrust law. Posner et al. (2017) suggest a limitation of institutional inves-

tors' ownership to either not more than 1% of the total size of an industry or only one single firm per industry. Funds committing to strict passivity should be excepted from this rule. Elhauge (2016) pleads instead for a stricter case-by-case analysis on the basis of the current law. Baker (2016) questions the operability of the latter proposal. Lambert and Sykuta (2018, 2) come to the conclusion: "The prevailing view among the antitrust elite thus seems to be (1) that common holdings by institutional investors significantly diminish competition in oligopolistic industries, and (2) that additional antitrust intervention is appropriate to prevent competitive harm. ... We believe that even if competition were softened by institutional investors' common ownership of small minority interests in competing firms, the unintended negative consequences of an antitrust fix would outweigh any benefits from such intervention."

To investigate the effects of common holdings and shareholder coordination on managerial incentives and hence product market competition in a satisfying but still tractable way, we extend the basic management compensation model in several directions. First, to allow for a more complex market structure, we consider the case of a triopoly instead of the much simpler case of a duopoly. This enables us to study an ownership structure where two firms are commonly owned by coordinating shareholders while the shareholders of the third firm are not involved in that coordination. Second, to take into account the empirical evidence that major stock indices consist of the biggest firms, we introduce asymmetric unit costs of the firms as the source of asymmetric firm sizes. Such an extension to asymmetric firm structures is interesting in its own right. Furthermore, it enables us to analyze a scenario where the index funds coordinate the behavior of the two bigger index firms while the smaller, outside firm is not part of the index. Third, in case of a homogeneous market, coordinating shareholders would take a less efficient firm out of the market. To exclude this possibility, we consider a heterogeneous market. To sum up, we deal with a heterogeneous triopoly market, where the output decisions are delegated to managers who are compensated by optimized contracts and who have to run firms of different sizes.

The rest of the paper is organized as follows: Section 2 presents the basic assumptions and the structure of the model. As a benchmark case, Section 3 studies the model with common holdings but without coordination of shareholders. Section 4 extends the analysis to the case of coordination by index fund shareholders and compares the results to the basic scenario. Section 5 summarizes the main results and concludes the paper.

2 Assumptions and the Structure of the Model

In order to study more complex ownership structures, we consider a product market with three firms $i = 1, 2, 3$, each producing a substitute good. Since almost all real markets are characterized by an intermediate degree of product differentiation, we assume that the market is heterogeneous and the preferences of consumers with mass 1 can be captured by the quasi-linear quadratic utility function

$$U = q_0 + \alpha(q_1 + q_2 + q_3) - (q_1^2 + q_2^2 + q_3^2 + q_1q_2 + q_1q_3 + q_2q_3), \alpha > 0 \ , \tag{1}$$

where $q_i, i = 1, 2, 3$, are the quantities of the differentiated products supplied by the three firms and $q_0 > 0$ is the quantity of the numéraire good.[2] Substituting q_0 from the budget constraint $I = q_0 + p_1q_1 + p_2q_2 + p_3q_3$ and maximizing the utility function with respect to the quantities gives the inverse demand system

$$p_i = \alpha - Q - q_i \ , \quad i = 1, 2, 3 \ , \tag{2}$$

where $Q \equiv q_1 + q_2 + q_3$ is the quantity produced by the firms altogether.

To allow for different firm sizes, which will prove to be important in the case of common shareholders, we assume constant but different unit costs c_i of the firms. In order to keep the model tractable, we follow Barros (1998) in assuming equal differences in the unit costs such that

$$c_i = \begin{cases} c - \delta & \text{for } \ i = 1 \\ c & \text{for } \ i = 2 \\ c + \delta & \text{for } \ i = 3 \ , \end{cases}$$

where $\delta \geq 0$ indicates the degree of asymmetry. To guarantee that all firms realize nonnegative profits in the triopoly market, we have to assume that the unit cost differences are not too large and restrict them to the interval

[2] This is a special case of the quasi-linear quadratic utility function $U = q_0 + \alpha(q_1 + q_2 + q_3) - (1/2)[\beta(q_1^2 + q_2^2 + q_3^2) + 2\gamma(q_1q_2 + q_1q_3 + q_2q_3)]$, $0 \leq \gamma \leq \beta$, where $\beta = 2$ and $\gamma = 1$ indicate intermediate heterogeneity. The limit case of a homogeneous market would be characterized by $\gamma = \beta$, the opposite limit case of three separated monopoly markets would be captured by $\gamma = 0$.

$0 \leq \delta/\mu \leq 13/28 \approx 0.4643$ where $\mu \equiv \alpha - c$ is an appropriate measure of market size. This leads to the firms' gross profits

$$\pi_i = \begin{cases} (\mu + \delta - Q - q_1)q_1 & \text{for } \ i = 1 \\ (\mu - Q - q_2)q_2 & \text{for } \ i = 2 \\ (\mu - \delta - Q - q_3)q_3 & \text{for } \ i = 3 \ , \end{cases} \tag{3}$$

depending on the basic market conditions α, c, and δ. Managers are awarded according to the contracts offered by the owners. We follow Fershtman and Judd (1987, 2006) and assume simple contracts implying the linear payments

$$s_i = f_i + b_i\psi_i \ , \qquad i = 1, 2, 3 \ .$$

f_i denotes the fixed salary for the manager of firm i, $b_i > 0$ serves as a weight parameter which, in combination with f_i, guarantees that the total payments s_i to each manager are equal to a given market-specific payment $\bar{s}$. $\psi_i = (1 - \hat{\kappa}_i)\pi_i + \hat{\kappa}_i p_i q_i, \ i = 1, 2, 3$, is the performance-dependent payment as a weighted sum of the performance measures profit π_i and revenue $p_i q_i$. This specification leads to the managers' objective functions $\psi_i = \pi_i + \hat{\kappa}_i c_i q_i$, where $\hat{\kappa}_i$ is the strategic contract parameter set by the owner of firm i. For convenience we define the transformed strategic parameters $\kappa_i \equiv \hat{\kappa}_i c_i$ to obtain the performance-dependent manager payments

$$\psi_i = \begin{cases} (\mu + \delta + \kappa_1 - Q - q_1)q_1 & \text{for } \ i = 1 \\ (\mu + \kappa_2 - Q - q_2)q_2 & \text{for } \ i = 2 \\ (\mu - \delta + \kappa_3 - Q - q_3)q_3 & \text{for } \ i = 3 \ . \end{cases} \tag{4}$$

Manager delegation is modeled as a strategic two-stage game, where owners simultaneously write observable compensation contracts with the strategic variables κ_i in the first stage and managers simultaneously choose production quantities q_i in the second stage.[3] While owners aim to maximize the firm profits (3), the managers aim to maximize the performance-dependent payments (4).

[3] Quantity competition can be regarded as a reduced form of competition by capacity choice with subsequent price competition, as in Kreps and Scheinkman (1983) for the case of homogeneous markets and in Maggi (1996) for the generalized case of heterogeneous markets.

3 Common Holdings without Owner Coordination

As a benchmark, we start our analysis by considering the case of manager delegation without owner coordination. In the second stage of the game, the managers decide on quantities q_i, given the (transformed) contract parameters κ_i. The maximization of (4) with respect to the quantities leads to a system of three linear first-order conditions which can be solved in terms of the quantities

$$q_i = \begin{cases} (3\mu + 6\delta + 5\kappa_1 - \kappa_2 - \kappa_3)/18 & \text{for } i = 1 \\ (3\mu - \kappa_1 + 5\kappa_2 - \kappa_3)/18 & \text{for } i = 2 \\ (3\mu - 6\delta - \kappa_1 - \kappa_2 + 5\kappa_3)/18 & \text{for } i = 3\,. \end{cases} \tag{5}$$

These quantities imply the gross profit functions of the firms

$$\pi_i = \begin{cases} (6\mu + 12\delta - 8\kappa_1 - 2\kappa_2 - 2\kappa_3)(3\mu + 6\delta + 5\kappa_1 - \kappa_2 - \kappa_3)/324 & \text{for } i = 1 \\ (6\mu - 2\kappa_1 - 8\kappa_2 - 2\kappa_3)(3\mu - \kappa_1 + 5\kappa_2 - \kappa_3)/324 & \text{for } i = 2 \\ (6\mu - 12\delta - 2\kappa_1 - 2\kappa_2 - 8\kappa_3)(3\mu - 6\delta - \kappa_1 - \kappa_2 + 5\kappa_3)/324 & \text{for } i = 3\,. \end{cases} \tag{6}$$

In the first stage of the game, since managers' total payment $s_i = \bar{s}$ is fixed, the firm owners maximize the profit functions (6) with respect to the contract parameters κ_i. In the subgame perfect Nash equilibrium, the first-order conditions consist of the system of linear reaction functions

$$\begin{aligned} \kappa_1 &= (3\mu + 6\delta - \kappa_2 - \kappa_3)/40\,, \\ \kappa_2 &= (3\mu - \kappa_1 - \kappa_3)/40\,, \\ \kappa_3 &= (3\mu - 6\delta - \kappa_1 - \kappa_2)/40\,, \end{aligned} \tag{7}$$

which can be solved in terms of the strategic owner decisions

$$\kappa_i^* = \begin{cases} (13\mu + 28\delta)/182 & \text{for } i = 1 \\ 13\mu/182 & \text{for } i = 2 \\ (13\mu - 28\delta)/182 & \text{for } i = 3\,. \end{cases} \tag{8}$$

Obviously, these contract parameters indicate biased compensation schemes.[4] Given these compensation contracts, managers choose the production

[4] According to the basic taxonomy of business strategies (see, e.g., Tirole 1988, Chapter 8), this represents an example of an aggressive top-dog strategy of the owners.

quantities

$$q_i^* = \begin{cases} (65\mu + 140\delta)/364 & \text{for } \; i = 1 \\ 65\mu/364 & \text{for } \; i = 2 \\ (65\mu - 140\delta)/364 & \text{for } \; i = 3 \, , \end{cases} \tag{9}$$

which lead to the gross firm profits

$$\pi_i^* = \begin{cases} (104\mu + 224\delta)(65\mu + 140\delta)/364^2 & \text{for } \; i = 1 \\ 6760\mu^2/364^2 & \text{for } \; i = 2 \\ (104\mu - 224\delta)(65\mu - 140\delta)/364^2 & \text{for } \; i = 3 \, . \end{cases} \tag{10}$$

Comparative statics show that the quantities and profits are increasing in the market size $\mu = \alpha - c$. The degree of cost asymmetry δ has a positive impact on the quantities and profits of the most efficient firm 1 and a negative impact on the quantities and profits of the least efficient firm 3, whereas there is no influence on the performance of firm 2.

The welfare in the market is defined as the sum of the producer surplus

$$\Pi^* = \pi_1^* + \pi_2^* + \pi_3^* = (20,280\mu^2 + 62,720\delta^2)/364^2$$

and the consumer surplus $CS = U - q_0 - p_1 q_1 - p_2 q_2 - p_3 q_3$. Given the utility function (1) and the inverse demand functions (2), we obtain the consumer surplus

$$\begin{aligned} CS^* =& q_1^2 + q_2^2 + q_3^2 + q_1 q_2 + q_1 q_3 + q_2 q_3 \\ =& (25,350\mu^2 + 19,600\delta^2)/364^2 \, , \end{aligned}$$

so that the welfare adds up to

$$W^* = \Pi^* + CS^* = (45,630\mu^2 + 82,320\delta^2)/364^2 \, .$$

Both measures are increasing in the market size μ and the degree of cost asymmetry δ.

4 Common Holdings and Owner Coordination

In order to capture the influence of a coordinated owner behavior, we assume that the bigger firms 1 and 2 are owned by index fund shareholders. This implies that these owners have an incentive to cooperate in specifying their managers' contracts while the managers compete in quantities as before.

4.1 Manager Compensation with Owner Coordination

The index fund shareholders of the firms 1 and 2 maximize their common profit $\pi_1+\pi_2$ in (6) with respect to the contract variables κ_1 and κ_2 while the owners of firm 3 maximize the profit π_3 in (6) as before. The corresponding first-order conditions consist of the system of reaction functions[5]

$$\begin{aligned}\kappa_1 =&(-3\mu+6\delta-2\kappa_2+\kappa_3)/38\ ,\\ \kappa_2 =&(-3\mu-12\delta-2\kappa_1+\kappa_3)/38\ ,\\ \kappa_3 =&(3\mu-6\delta-\kappa_1-\kappa_2)/40\ ,\end{aligned}$$

which are solved in terms of the subgame perfect contract variables

$$\kappa_i^{**}=\begin{cases}(-26\mu+61\delta)/356 & \text{for}\ \ i=1\\ (-26\mu-117\delta)/356 & \text{for}\ \ i=2\\ (28\mu-52\delta)/356 & \text{for}\ \ i=3\ ,\end{cases} \tag{11}$$

implying the managers' quantity decisions

$$q_i^{**}=\begin{cases}(52\mu+145\delta)/356 & \text{for}\ \ i=1\\ (52\mu-33\delta)/356 & \text{for}\ \ i=2\\ (70\mu-130\delta)/356 & \text{for}\ \ i=3\end{cases} \tag{12}$$

and the firm profits

$$\pi_i^{**}=\begin{cases}(130\mu+229\delta)(52\mu+145\delta)/356^2 & \text{for}\ \ i=1\\ (130\mu+51\delta)(52\mu-33\delta)/356^2 & \text{for}\ \ i=2\\ (112\mu-208\delta)(70\mu-130\delta)/356^2 & \text{for}\ \ i=3\ .\end{cases} \tag{13}$$

The consumer surplus is

$$CS^{**}=(20,292\mu^2-6,408\mu\delta+23,059\delta^2)/356^2\ ,$$

the welfare amounts to

$$W^{**}=(41,652\mu^2-6,408\mu\delta+81,621\delta^2)/356^2\ .$$

In addition to the number of firms and the degree of heterogeneity, which are given in our model, there are two decisive explanatory factors determining

[5]Remarkably, while the contract parameters generally are strategic substitutes, they prove to be strategic complements in the relation between each inside firm and the outside firm.

firm behavior and performance: the first is the ownership structure leading to a (partial) coordination in the design of the compensation contracts, the second is the firms' unit cost asymmetry. To separate these two determinants, we will first discuss the results for identical unit costs, i.e. $\delta = 0$, in order to identify the strategic effects in isolation. Afterwards, we will analyze the overall results by additionally taking into account the technological asymmetry. The results are summarized in Table 1.

Table 1: Equilibrium results of the compensation game

	without coordination (*)	with coordination (**)
κ_1/μ	0.0714 + 0.1538 (δ/μ)	-0.0730 + 0.1713 (δ/μ)
κ_2/μ	0.0714	-0.0730 - 0.3287 (δ/μ)
κ_3/μ	0.0714 - 0.1538 (δ/μ)	0.0787 - 0.1461 (δ/μ)
q_1/μ	0.1786 + 0.3846 (δ/μ)	0.1461 + 0.4073 (δ/μ)
q_2/μ	0.1786	0.1461 - 0.0927 (δ/μ)
q_3/μ	0.1786 - 0.3846 (δ/μ)	0.1966 - 0.3652 (δ/μ)
Q/μ	0.5357	0.4888 - 0.0506 (δ/μ)
CS/μ^2	0.1913 + 0.1479 $(\delta/\mu)^2$	0.1601 - 0.0506 (δ/μ) +0.1819 $(\delta/\mu)^2$
π_1/μ^2	0.0510 + 0.2198 (δ/μ) + 0.2367 $(\delta/\mu)^2$	0.0533 + 0.2427 (δ/μ) + 0.2620 $(\delta/\mu)^2$
π_2/μ^2	0.0510	0.0533 - 0.0129 (δ/μ) - 0.0133 $(\delta/\mu)^2$
π_3/μ^2	0.0510 - 0.2198 (δ/μ) + 0.2367 $(\delta/\mu)^2$	0.0619 - 0.2298 (δ/μ) + 0.2133 $(\delta/\mu)^2$
Π/μ^2	0.1531 + 0.4734 $(\delta/\mu)^2$	0.1685 + 0.4621 $(\delta/\mu)^2$
W/μ^2	0.3444 + 0.6213 $(\delta/\mu)^2$	0.3287 - 0.0506 (δ/μ) + 0.6440 $(\delta/\mu)^2$

4.2 Shareholder Coordination with Symmetric Firms

Let us start with the case of symmetric firms, i.e. $\delta = 0$. Whenever we refer to numerical values, we normalize the market size variable $\mu = \alpha - c$ to one without loss of generality. Indeed, as can be seen from Table 1, the results continue to qualitatively hold for all values $\mu > 0$.

The coordination between index fund shareholders leads to less intensive competition between the firms because the strategic effects of manager compensation are mitigated when they are internalized by the coordinated firms. The coordinating shareholders now choose an inoffensive puppy-dog strategy in designing the compensation contracts ($\kappa_1^{**} = \kappa_2^{**} = -0.0730 < \kappa_1^{*} = \kappa_2^{*} =$

0.0714), whereas the shareholders of the outside firm choose an even more aggressive top-dog strategy ($\kappa_3^{**} = 0.0787 > \kappa_3^* = 0.0714$).

The modified incentive structure induces managers to reallocate production. The quantities of the coordinated firms decrease from $q_1^* = q_2^* = 0.1786$ to $q_1^{**} = q_2^{**} = 0.1461$, while the quantity of firm 3 increases from $q_3^* = 0.1786$ to $q_3^{**} = 0.1966$. The overall quantity Q is decreasing ($\Delta Q = -0.0469$), implying that the coordination leads to softer competition and higher overall profits ($\Delta\Pi = 0.0154$). The profit gains, however, are asymmetrically distributed: the profits of the two coordinated firms only slightly increase from $\pi_1^* = \pi_2^* = 0.0510$ to $\pi_1^{**} = \pi_2^{**} = 0.0533$, while the profit of the outside firm 3 increases from $\pi_3^* = 0.0510$ to $\pi_3^{**} = 0.0619$. Remarkably, the profit gain of firm 3 even exceeds the joint profit gains of the coordinated firms. This is a reminiscence of an important result which is well-known from the merger literature: the merging firms slightly increase their profits while the non-merging firms experience an even higher increase of their profits (see Salant et al. 1983).

Evidently, the decline of the trade volume reduces the consumer surplus (from $CS^* = 0.1913$ to $CS^{**} = 0.1601$) as well as the welfare (from $W^* = 0.3444$ to $W^{**} = 0.3287$) in the market.

4.3 Shareholder Coordination with Asymmetric Firms

The coordination effects of index fund shareholders become more interesting when we additionally allow for cost differences between firms ($\delta > 0$). Since index fund shareholders are typically invested in the bigger index firms (here firms 1 and 2), we assume that the outside firm (firm 3) is the smallest one. The technological asymmetry offers a further option for a reallocation of production between the coordinated firms. Of course, production quantities and firm profits can be moved from the less efficient firm 2 to the most efficient firm 1. Table 1 summarizes the results in terms of the market size parameter $\mu > 0$ and the parameter $0 \leq \delta \leq (13/28)\mu \approx 0.4643\mu$ which measures the size of cost asymmetry.

A comparison of the strategic decisions on the contract designs shows that the inequalities

$$\kappa_1^{**} < \kappa_1^*, \quad \kappa_2^{**} < \kappa_2^*, \quad \kappa_3^{**} > \kappa_3^*$$

continue to hold true. However, the technological differences induce the index fund shareholders to design compensation contracts, providing the ma-

nager of the most efficient firm 1 with an incentive to act more aggressively and the manager of the less efficient firm 2 to act even more inoffensive. The consequence is that some production is moved from firm 2 to firm 1. A comparison of the managers' quantity decisions showes that the relations

$$q_1^{**} < q_1^*, \quad q_2^{**} < q_2^*, \quad q_3^{**} > q_3^*, \quad Q^{**} < Q^*$$

generally hold. For all feasible δ-values, the profit relations prove to be

$$\pi_1^{**} > \pi_1^*, \quad \pi_2^{**} \gtrless \pi_2^* \text{ for } (\delta/\mu) \lesseqgtr 0.1539, \quad \pi_3^{**} > \pi_3^* \, .$$

Of course, an implication of the reallocation of production is that the profitability of firm 1 further increases. The low profit of the least efficient outside firm 3 still increases as a consequence of shareholder coordination. The overall coordination effect on the profit of firm 2 can be positive or negative, depending on the size of cost differences. In case of small unit cost differences, $(\delta/\mu) \leq 0.1539$, its profit goes up due to the less aggressive behavior of both coordinated firms. However, in case of large unit cost differences, $(\delta/\mu) > 0.1539$, the coordination of the index fund shareholders drives its profit down.

This result reflects a basic conflict between institutional investors invested in firms 1 and 2 and minority shareholders being solely invested in firm 2. Of course, the minority shareholders of firm 2 are not interested in shifting quantities to firm 1. The relevance of this effect is further strengthened by the fact that institutional investors usually act in a well organized manner while small investors often prefer not to participate in general meetings.

Finally, it generally holds for all feasible δ-values that $CS^{**} < CS^*$ and $W^{**} < W^*$, i.e., shareholder cooperation reduces the consumer surplus as well as the welfare in the market. While firms benefit from a less aggressive compensation scheme, consumers suffer from a loss of surplus due to shareholder coordination. The reduction in welfare is less severe when there are cost differences. Accordingly, the increase of overall profits declines with increasing cost differences. Since the latter effect is stronger than the former one, the reduction in welfare increases in the cost differences.

5 Summary and Conclusion

In many markets, bigger firms are to a considerable extent commonly owned by institutional investors like index funds while smaller firms are owned by

independent shareholders. Given such a common-holding ownership structure, the index funds have an incentive to coordinate in designing their manager compensation schemes.

This paper studied the consequences of such a coordination by analyzing an asymmetric triopoly where the two biggest firms are owned by an index fund and the smallest firm by independent shareholders. We showed that this type of collusion leads to compensation contracts which make the managers less aggressive such that the firms involved in the coordination reduce their production while the outside firm increases its output. This reallocation of production induces a redistribution of the profits: the outside firm and the most efficient firm owned by the index funds gain from the coordination while the less efficient firm owned by the index funds might suffer from a loss of profits when the cost differences are large.

The total output in the market is reduced such that shareholder coordination is detrimental to consumer surplus as well as welfare. Therefore, the neglect of index funds in previous models of strategic manager compensation may lead to serious shortcomings of the theory. Our results confirm the concerns about coordination activities of index funds with common holdings. This coordination behavior induces crucial implications with respect to reduced competition and redistributed firm profits in the product markets.

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