Product Market Competition, Managerial Incentives and Firm Valuation

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Abstract

This paper contributes to the very small empirical literature on the effects of competition on managerial incentive schemes. Based on a theoretical model that incorporates both strategic interaction between firms and a principal agent relationship, we analyse the relationship between product market competition, incentive schemes and firm valuation. The model predicts a nonlinear relationship between the intensity of product market competition and the strength of managerial incentives. We test the implications of our model empirically based on a unique and hand-collected dataset comprising over 600 observations on 200 Swiss firms over the 2002–2005 period. Our results suggest that, consistent with the implications of our model, the relation between product market competition and managerial intensive schemes is convex indicating that above a certain level of intensity in product market competition, the marginal effect of competition...
on the strength of the incentive schemes increases in the level of competition. Moreover, competition is associated with lower firm values. These results are robust to accounting for a potential endogeneity of managerial incentives and firm value in a simultaneous equations framework.

**Keywords:** product market competition, strategic interaction, principal agent relationship, managerial incentives, firm valuation

**JEL classification:** G30, J33, L1

1. Introduction

What are the effects of product market competition on managerial incentives? Do managers work harder when the firm’s environment is more competitive, i.e., do competition and incentive schemes substitute each other? And what are the impacts on firm value? While these and related questions are at the heart of an ongoing debate about corporate governance issues, the underlying mechanisms are only partly understood, and there is a serious lack of empirical evidence on these issues.

The aim of our paper is to contribute to the still very small empirical literature on the relationship between product market competition and managerial incentives. Based on the predictions from a theoretical model that incorporates both strategic interaction between firms and a principal agent relationship, we empirically investigate the relationship between product market competition, incentive schemes, and firm valuation for a large and representative sample of Swiss companies.

The effects of competition on incentive schemes and firm valuation are not only interesting from a purely academic point of view. These issues are also highly relevant for public policy makers. During the last decade, there has been an increasing influence of governments and non-governmental organisations on corporate governance rules.¹ Much of the attention has focused on the firms and the regulations that protect shareholder rights and govern the conduct of management. However, the environment in which business is conducted, such as the degree of competition among firms, entry and exit rules, and the openness of the economy, requires close consideration. Competition has the potential to facilitate the effectiveness of a culture of good corporate governance. Moreover, competition policy may help to increase efficiency, reduce price distortions, lower the risk of poor investment decisions, promote greater accountability and transparency in business decisions, and lead to better corporate governance. Consequently,

¹ In 2004, the OECD has published its revised Principles of Corporate Governance that were adopted in 1999. In the USA, the Sarbanes-Oxley Act, which reinforces the firms’ transparency requirements among other things with respect to executive compensation, came into effect in 2002. In Germany, the German Corporate Governance Code, a similar set of transparency rules that is however not compulsory, has recently been implemented by the German government. In Switzerland, the Swiss Code of Best Practice has become effective in 2002. The European Union approach to corporate governance is having a certain coordination of corporate governance codes rather than imposing a pan-European code of best practices. In 2004, the European Corporate Governance Forum was established in order to enhance the convergence of national codes of corporate governance and provide strategic advice to the Commission on policy issues in the field of corporate governance. The most common types of legislation are Directives, which provide the objectives of being achieved, but allow member states to chose the form and method of achieving those objectives.
the design of effective corporate governance rules necessarily has to take into account the competitiveness of markets.

The theoretical literature on the links between product market competition and managerial incentives can basically be divided into two main strands. A first strand analyses the effects of product market competition on managerial incentives, but compensation contracts are not allowed to affect competition. While the earlier literature informally argues that competition reduces managerial slack (e.g., Machlup, 1967), Hart (1983) is the first to formalise this idea by modelling the effect of competition on the agency problems between a firm’s owner and a manager. Subsequent research shows, however, that the relationship between competition and managers’ effort level is ambiguous (e.g., Scharfstein, 1988; Hermalin, 1992; Graziano and Parigi, 1998). ² While these studies rely on the information effect of competition, which means that competition induced by many firms in the market may give more precision to incentives based on relative performance evaluation, Schmidt (1997) uses the idea that more competition increases the probability of firms going bankrupt. He shows that the effects of competition on managers’ effort level and the strength of their incentive schemes are ambiguous and crucially depend on managers’ outside options. In particular, an increase in the product market competition is more likely to result in stronger incentives in case managers have good outside options. Raith (2003) examines how the degree of competition among firms in an industry affects the incentives for their managers. He studies a model of an oligopolistic industry in which firms provide incentives to managers to reduce marginal costs. In a situation with a fixed number of firms, the effects of competition on managerial incentives are ambiguous. With an endogenous market structure, more intensive product market competition, as measured by product substitutability, leads to stronger incentives for managers. When looking at other measures of competition such as changes in the market size and costs of entry, however, this result only holds under specific circumstances. To summarise, Raith (2003) finds an ambiguous relationship between the intensity of competition and the strength of incentives for managers in some of the considered frameworks only. Baggs and De Bettignies (2007) also model the effects of competition on managerial incentives. They isolate the agency effect of competition, which is only present in firms facing agency costs, from the direct pressure effect of competition, which is present in all firms. They find a positive effect of competition on the power of incentives, and this effect is even stronger for firms subject to agency costs. The second strand of the theoretical literature on competition and incentives is based on the idea that precommitment to managerial incentive contracts can alter the strategic competition between rivals. ³ Aggarwal and Samwick (1999) extend the literature by considering compensation contracts based on relative performance

² Scharfstein (1988) reconsiders Hart’s model while relaxing the assumption of infinitely risk-adverse managers. Hermalin (1992) considers additional effects of competition on the agency problem, all of which are of potentially ambiguous sign. Therefore, he concludes that theory cannot offer a definitive answer to the question of whether competition reduces managerial slack. Graziano and Parigi (1998) analyse the relationship between product market competition and managerial effort in a linear principal agent model. While increasing competition stemming from a lower degree of product market differentiation reduces the manager’s optimal effort level and the optimal piece-rate, an increase in the number of firms has an ambiguous effect on effort and piece-rate.

³ See, e.g., Vickers (1985), Fershtman and Judd (1987), Sklivas (1987) and Fumas (1992).
evaluation. Summarising, most prior studies find an ambiguous effect of competition on the strength of incentives.

The empirical papers that relate product market competition to compensation are not very numerous and are mostly in line with Aggarwal and Samwick (1999), Joh (1999), and Kedia (2006). These studies explicitly take into account strategic interactions between firms and the structure of product markets to explain managerial compensation contracts. In particular, they use these aspects to address the relative performance evaluation puzzle, which is the fact that empirical studies do not seem to find any role for relative performance evaluation in incentive contracts. Cuñat and Guadalupe (2005), for example, investigate how the sudden appreciation of the pound in 1996, which implies a change in competition at least for some sectors, affects the pay-for-performance sensitivities of compensation schemes for CEOs, executives and workers in a large sample of traded and non-traded UK firms. Based on their theoretical model, Baggs and De Bettignies (2007) use a unique set of Canadian data to empirically investigate the effects of competition on managerial efficiency by additionally isolating the agency effect of competition. Their results on the effect of competition on managerial incentives are consistent with, among others, Cuñat and Guadalupe (2005), who find that competition increases the steepness of performance pay contracts.

There is very little empirical evidence on the relation between product market competition and firm value. Griffith (2001) argues on page 1 that the direction of the effect that product market competition should have on firm value is ambiguous: ‘on the one hand increasing competition lowers a firm’s profits and thus reduces incentives to exert effort (the Schumpeterian effect), on the other hand it reduces agency costs (or increases the risk of bankruptcy) thus increasing incentives to exert effort’. However, the empirical literature is mainly concerned with the effect of product market competition on productivity growth instead of firm value. For example, Nickell et al. (1997) find that product market competition has a positive impact on total factor productivity. One exception is Habib and Ljungqvist (2005) investigating the effect of product market competition, as measured by a Herfindahl-Hirschman Index (HHI) based on four-digit SIC codes, on firm value. They provide evidence that firm value is positively related to product market competition.

In this paper, we consider a principal-agent model in a Cournot oligopoly setup. In a first stage, the firm owner hires a manager to reduce costs. In a second stage, the manager decides on his unobservable effort level, and in the last stage the firms compete with each other in output prices. Such a setup not only takes into account the classical moral hazard problem within the firm, which is induced by the unobservability of the manager’s effort, but it also incorporates strategic interaction between the firms.

The theoretical predictions of the model are threefold. First, the relationship between the strength of the incentive scheme and the intensity of competition depends on the
absolute level of competition. For low levels of competition, more competition leads to weaker incentives. For higher levels of competition, however, a higher intensity of competition results in stronger incentives. Second, the marginal effect of competition on the strength of the incentive schemes increases in the level of competition. Third, the effect of competition on firm value is negative, meaning that firms in more competitive environments realise lower profits. The last two findings are novel in the sense that they have not been investigated in previous theoretical models. Specifically, the theoretical contributions of our model are the following. First, our model expresses the relationship between the intensity of product market competition and the strength of incentives as a function of a single variable, namely the intensity of product market competition, and predicts a nonlinear relationship. In contrast, in other theoretical models (e.g., Schmidt, 1997; Graziano and Parigi, 1998; Raith, 2003), which also predict an ambiguous relationship between competition and incentives, the direction of this relationship depends on how competition is measured. Due to data limitations, however, this causes problems for empirical testing. Second, our model extends the scope of the analysis by not only investigating the relationship between the intensity of competition and the strength of incentives, but it takes the analysis one step further and provides theoretical predictions on the impact of product market competition on firm value. Given the ambiguous effects of competition on the strength of incentives, this additional dimension adds new insights to the problem and provides an opportunity for empirical testing.

To test the predictions of our model empirically, we use a unique and hand-collected dataset comprising over 600 observations on 200 Swiss firms over the 2002–2005 period. Our primary variable for measuring the intensity of competition on product markets is an industry-specific sales-based Herfindahl-Hirschman Index (HHI) which accounts for both listed and unlisted Swiss firms. The empirical results reveal that in general a more intense product market competition is associated with stronger incentive schemes for managers, where the strength of incentives is measured by the fraction of share-based to cash compensation or pay-for-performance sensitivity (i.e., the option delta scaled by the fraction of equity represented by the respective year’s award). This result is consistent with the first hypothesis of our theoretical model and suggests that firms are operating in competitive environments on average. Most importantly and consistent with our second hypothesis, we find a convex relation between incentive schemes and product market competition. To the best of our knowledge, such a nonlinearity in the relation between managerial incentives and competition has not been tested before and presents a new finding which suggests that the marginal effect of competition on managerial incentives is increasing in the intensity of product market competition once the intensity of competition reaches a certain level. Finally and consistent with the third hypothesis of our theoretical model, we find that a higher product market competition is associated with significantly lower firm values. Thus, the negative effect of lower economic rents seems to outweigh the positive effect of reducing managerial slack and increasing the managers’ effort by providing additional monitoring and increasing the threat of liquidation. These results are robust to the use of a number of alternatively defined proxies for product market competition and firm performance as well as to accounting for a potential endogeneity of managerial incentives and firm value in a simultaneous equations framework.

The paper is structured as follows. The theoretical model and our main hypotheses are in Section 2. Section 3 describes the data. The empirical analysis and a number of robustness tests are in Section 4. Section 5 concludes.
2. Theoretical Model and Main Hypotheses

2.1. The setup

The purpose of our model is to investigate the effects of product market competition on the incentive schemes for managers and the value of the firm when there are strategic interactions between the market players. We consider a principal-agent model within a Cournot oligopoly setup, where the owner of the firm hires a manager to reduce marginal costs. In contrast to other work, our model neither relies on the information effect of competition, nor on relative performance evaluation, which both impose rather strong constraints in terms of observability of certain variables. Our model is similar to Raith (2003), who also considers the effects of competition on incentives. However, there are several key differences to our setup. First, Raith uses a circular city model, whereas we work with a linear demand system. Second, firms are setting prices in Raith’s model, while in our model firms are choosing quantities as strategic variable. Third, in Raith’s model, a change in product market competition can take several forms, i.e., a change in product market substitutability, a price change, a change of the market size or the cost of entry. In our model, a change in the intensity of product market competition is uniquely driven by a change in the product substitutability. Finally, the market structure is endogenously determined by free entry and exit in Raith’s model, whereas we use a duopoly model and consider the market structure as fixed. Even though our setup is somehow simpler than Raith’s, it is more tractable and sufficiently complex to study the effects of competition on incentives and on firm value and to derive testable hypotheses, which is the main purpose of our paper.

Our model has three stages. At stage one, the owner of firm $i$ hires a manager who has to reduce the costs of the firm. At stage two, the manager provides effort that affects the firm’s marginal production cost. At stage three, the owner decides on the output level, profits are realised and the manager gets paid.

Each firm $i$ has constant marginal costs given by $c_i = (\bar{c} - e_i - u_i)$, where $\bar{c}$ is a constant, $e_i$ is the effort level exerted by the manager, and $u_i$ is a random term that is assumed to be normally distributed with zero mean, variance $\sigma^2$, and is independent of the other firms’ shocks. The manager’s effort level is not observable. The owner of the firm can only observe the realised costs $c_i$, which are also contractible. There are no fixed costs. The owner of the firm offers the manager a linear compensation scheme that is a function of the observed cost reduction, i.e.,

$$w_i = \alpha_i + \beta_i(\bar{c} - c_i)$$  \hspace{1cm} (1)

The parameter $\alpha_i$ denotes the fixed part of the salary, and $\beta_i$ is the piece rate that ties the manager’s wage to the performance of the company, and $(\bar{c} - c_i)$ is the observed cost reduction. Given that the cost reduction affects the profitability of the firm, we can interpret $\beta_i$ also as pay-for-performance sensitivity.

The utility of the manager is given by $-\exp\{-r[w_i - g(e_i)]\}$, where $r$, with $r > 0$, is the manager’s degree of risk aversion, which we assume to be constant, and

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6 Papers modelling the manager’s effort level as a cost reduction include, e.g., Graziano and Parigi (1998) and Raith (2003). Instead of reducing the costs, the manager’s unobservable effort level could also affect the demand schedule, i.e., the sales of the firm, which would lead to the inclusion of a random variable in the demand schedule. The compensation scheme for the manager would have to be adjusted accordingly.

7 See, e.g., Jensen and Murphy (1990) and Murphy (1999).
\( g(e_i) = ke_i^2/2 \) is his disutility of exerting effort, with \( k > 1 \). The expected value of the manager’s wage is thus \( \alpha_i + \beta_i e_i \) with variance of \( \beta_i^2 \sigma^2 \). Given the normal distribution of \( u_i \), the utility of the manager can be written as in (2), i.e.,

\[
U_i = \alpha_i + \beta_i e_i - \frac{r \beta_i^2 \sigma^2}{2} - \frac{ke_i^2}{2}
\]  

(2)

The manager accepts any contract \((\alpha_i, \beta_i)\) that gives him an expected utility of at least his reservation utility, which we normalise to zero. The inverse demand function of firm \( i \) is given by (3):

\[
p_i(q_i, q_{-i}) = a - bq_i - \sum_j d_j q_j, \quad i, j = 1, \ldots, N, i \neq j
\]  

(3)

where \( a \), with \( a > 0 \) and \( a > \bar{c} \), is the size of the market, \( b \) is a positive constant, and \( q_i \) is firm \( i \)'s output. The variable \( q_j \) is the output of firm \( i \)'s rival \( j \). The coefficient \( d_j \), with \( 0 < d_j < b \), captures the degree of substitutability between the products on the market. The larger \( d_j \), the closer substitutes the products are. The parameter \( d_j \) is commonly used to measure the degree of competition in a market, where higher values imply a more intensive competition.\(^8\)\(^9\) To keep things simple, we set \( b = 1 \) and \( d_i = d_j = d \), \( \forall i \neq j \). We further assume that there are only two firms in the market. In what follows, we are looking for the symmetric sub-game perfect equilibrium of the game. Therefore, we solve the model by backwards induction.

### 2.2. The firm’s output decision

At \( t = 3 \), the firms simultaneously choose their output levels. The profit of firm \( i \) gross of managerial compensation is given by (4).

\[
\pi_i = (p - c_i)q_i = (a - q_i - dq_j - c_i)q_i, \quad i, j = 1, 2
\]  

(4)

From maximising (4) with respect to \( q_i \) and solving for \( q_i \) we get the firms’ reaction function, i.e.,

\[
q_i(q_j) = \frac{a - c_i - dE(q_j)}{2}, \quad i, j = 1, 2
\]  

(5)

If firm \( i \)'s rival is expected to set a quantity of \( E(q_j) \), the resulting profit of firm \( i \) is as in (6).

\[
\pi_i(c_i, E(q_j)) = \left[ \frac{(a - c_i - dE(q_j))}{2} \right]^2, \quad i, j = 1, 2
\]  

(6)

Simultaneously solving the system of two equations as given by (5) yields the equilibrium quantities of the third stage as a function of the firm’s own marginal costs \( c_i \) and the rival’s expected costs \( E(c_j) \), i.e.,

\[
q_i^{***} = \frac{2(a - c_i) - d(a - E(c_j))}{(4 - d^2)}, \quad i, j = 1, 2
\]  

(7)

\(^8\) See, e.g., Graziano and Parigi (1998) and Raith (2003).

\(^9\) An alternative way to capture the degree of product market competition is to compare Cournot competition with Bertrand competition, where the latter is considered as the more competitive mode of competition in the duopoly case (e.g., see Singh and Vives, 1984). In our setup, however, a comparison of the two modes of competition with respect to the strength of the incentive parameter leads to ambiguous results.
From substituting (7) into (3) we obtain the equilibrium price given by (8) and can compute the expected gross profits as given by (9):

\[ p_{i}^{**} = \frac{2(a + c_i) - d(a - E(c_j)) - d^2c_i}{(4 - d^2)}, \quad i, j = 1, 2 \]  

\[ \pi_{i}^{**} = \left[ \frac{2(a - c_i) - d(a - E(c_j))}{(4 - d^2)} \right]^2, \quad i, j = 1, 2 \]  

### 2.3. The manager’s effort decision

At \( t = 2 \), the manager of firm \( i \) chooses his effort level by maximising his utility given in (2):

\[
\max_{e_i} U_i = \alpha_i + \beta_i e_i - \frac{1}{2}r \beta_i^2 \sigma^2 - \frac{k}{2} e_i^2 \quad i, j = 1, 2
\]  

Differentiating (10) with respect to \( e_i \) yields the effort level as a function of the compensation parameter \( \beta_i \), i.e.,

\[ e_i(\beta_i) = \frac{\beta_i}{k} \quad i, j = 1, 2 \]  

The individual rationality constraint (IRC) of the manager \( i \) is given by

\[ \alpha_i + \beta_i e_i - \frac{1}{2}r \beta_i^2 \sigma^2 - \frac{k}{2} e_i^2 \geq 0 \quad i, j = 1, 2 \]  

where the manager’s outside utility is normalised to zero. Assuming competitive labor markets, the (IRC) is binding, which also means that (12) holds with equality. This allows us to calculate the fixed salary component \( \alpha_i \) the manager has to be paid in order to have a reservation utility of zero.

\[ \alpha_i^{**}(\beta_i) = -\frac{\beta_i^2 (1 - kr \sigma^2)}{2k} \quad i, j = 1, 2 \]  

The manager’s wage as a function of \( \beta_i \) is then given by

\[ w_i^{**}(\beta_i) = -\frac{\beta_i^2 (1 - kr \sigma^2)}{2k} + \beta_i (\bar{c} - c_i) \quad i, j = 1, 2 \]  

### 2.4. The optimal incentive scheme

At the first stage of the game at \( t = 1 \), the owner of the firm chooses the incentive scheme for the manager. He maximises his expected profit net of the manager’s wage, which is given by (9) minus (14). Using \( (\bar{c} - c_i) = e_i + u_i, e_i(\beta_i) = \beta_i/k, \) and \( E(u_i) = 0 \), the net expected profit is given by (15).

\[
\pi_{net,i}(\beta_i) = \left[ \frac{2 \left( a - \left( \frac{\beta_i}{k} \right) \right) + d(E(c_j) - a)}{(4 - d^2)^2} \right]^2 + \frac{\beta_i^2 (1 - kr \sigma^2)}{2k} - \frac{\beta_i \beta_i}{k}, \quad i, j = 1, 2
\]
Differentiating (15) with respect to $\beta_i$ and solving for $\beta_i$ leads to

$$
\beta_i = \frac{4k(2(a - \bar{c}) + d(E(c_j) - a))}{(k + k^2 r \sigma^2)(4 - d^2)^2 - 8}, \quad i, j = 1, 2
$$

(16)

In a symmetric equilibrium, all firms choose the same piece rate $\beta$, and each manager chooses the same effort level $e$. Accordingly, $E(c_j) = \bar{c} - e = \bar{c} - \beta/k$. Substituting this expression into (16) and solving for $\beta$ leads to (17), the optimal incentive parameter.

$$
\beta^* = \frac{4k(a - \bar{c})}{(k + r \sigma^2 k^2)(-d^3 - 2d^2 + 4d + 8) - 4
$$

(17)

To find the equilibrium quantity and profit net of managerial compensation, we plug (17) into the corresponding second-stage equilibrium values, which yields the following results:

$$
q^* = \frac{(k + r \sigma^2 k^2)(4 - d^2)(a - \bar{c})}{(k + r \sigma^2 k^2)(-d^3 - 2d^2 + 4d + 8) - 4
$$

(18)

$$
\pi^*_{net} = \frac{(1 + r \sigma^2 k)(a - \bar{c})^2 k [(k^2 r \sigma^2 + k)(d^2 - 4)^2 - 8]}{[(k^2 r \sigma^2 + k)(d^3 + 2d^2 - 4d - 8) + 4]^2
$$

(19)

2.5. The effects of competition on the strength of incentive schemes and firm value

How does competition affect the optimal pay-for-performance sensitivity $\beta^*$ and firm value? Following Graziano and Parigi (1998), we use the degree of substitutability between products $d$ as a proxy for the intensity of competition. The larger $d$, the closer substitutes the products are, and the higher the intensity of competition. As to firm value, we look at the profit net of manager’s compensation.

From differentiating the optimal pay-for-performance sensitivity as given by (17) with respect to competition measure $d$, we obtain

$$
\frac{\partial \beta^*}{\partial d} = \frac{4k^2(a - \bar{c})(d + 2)(3d - 2)(kr \sigma^2 + 1)}{[(k^2 r \sigma^2 + k)(d^3 + 2d^2 - 4d - 8) + 4]^2
$$

(20)

To obtain the sign of this expression, we only need to look at the numerator since the denominator is always positive. Given that $a > \bar{c}$ by assumption, this expression is positive iff $d > 2/3$. It follows that the owner of the firm more closely ties the manager’s wage to the performance of the company once the intensity of product market competition has reached a certain level. This leads us to our first hypothesis.

**Hypothesis 1:** A higher intensity of product market competition, as measured by the degree of substitutability between products $d$, leads to weaker incentive schemes for the manager if the intensity of product market competition is weak, i.e., $\frac{\partial \beta^*}{\partial d} < 0$ for $d < 2/3$, and a higher intensity of product market competition leads to stronger incentive schemes for the manager in case the intensity of product market competition exceeds a certain level, i.e., $\frac{\partial \beta^*}{\partial d} > 0$ for $d > 2/3$.

Obviously, there are different effects at work. First, there is a business stealing effect: a higher value of $d$ implies a more elastic demand, which makes it easier for a firm with a cost advantage to take away business from its rival. Accordingly, for a given quantity of its rival, a more intensive competition increases a firm’s marginal benefit.
of reducing its costs. Given this first effect, the firm wants to give stronger incentives to its manager with increasing competition, leading to lower marginal costs. However, there is a second effect at work that can be denoted as a scale effect: a higher value of \( d \) also leads to a drop in firm \( i \)'s output.\(^{10}\) This decreases the firm’s gain from reducing its costs and leads the firm to give weaker incentives to the manager when competition is increasing. While the second effect, the scale effect, is dominating for lower values of \( d \), the formerly described business stealing effect starts to dominate once the degree of competition has reached a certain level, i.e., for values of \( d > 2/3 \). Accordingly, for lower values of \( d \), the incentive parameter \( \beta \) is decreasing when the intensity of competition is increasing; for higher values of \( d \), in contrast, the incentive parameter \( \beta \) is increasing in the intensity of the competition parameter. In other words: For values of \( d < 2/3 \), firms provide weaker managerial incentives because greater competition decreases the value of putting a lot of effort into the decisions, while for values of \( d > 2/3 \), firms provide stronger managerial incentives because greater competition increases the value of making good decisions.

To understand the underlying mechanisms from a formal point of view, we best look at firm \( i \)'s marginal gain of reducing its costs, i.e., we differentiate (9) with respect to \( c_i \):

\[
\frac{\partial \pi^{***}_i}{\partial c_i} = -\frac{4[2(a-c_i) - d(a - E(c_j))]}{(d - 2)^2(d + 2)^2} \quad (21)
\]

In a symmetric equilibrium, expression (21) is clearly negative. This reflects the fact that the firm can increase its profit by lowering its costs. To see how the marginal profit of a cost reduction moves with the intensity of competition, which is our main interest, we go one step further and differentiate (21) with respect to the degree of substitutability between products \( d \). This yields (22):

\[
\frac{\partial}{\partial d} \left[ \frac{\partial \pi^{***}_i}{\partial c_i} \right] = \frac{4 \left[ (3d^2 + 4)(E(c_j) - a) + 8d(a - c_i) \right]}{(d - 2)^3(d + 2)^3} \quad (22)
\]

In a symmetric equilibrium expression (22) is positive for \( d < 2/3 \), whereas (22) is negative for \( d > 2/3 \). A positive sign of (22) means that the marginal profit of a cost reduction, which is a negative value, becomes less negative and thus smaller in absolute terms when \( d \) is increasing. This reflects the fact that the scale effect is dominating and the firm lowers the incentive parameter \( \beta \) when the intensity of product market competition is increasing. The negative sign of expression (22) for \( d > 2/3 \), in contrast, mirrors the dominance of the business stealing effect: The marginal profit of a cost reduction becomes larger in absolute terms with a higher intensity of competition \( d \), and this induces the firm to give stronger incentives to its manager.

To see how the relationship between the incentive parameter \( \beta \) and \( d \) changes with different levels of competition, we go another step further and differentiate (20) with

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\(^{10}\) This can best be seen by differentiating the equilibrium output level as given by (18) with respect to \( d \), which is clearly negative. From an economic point of view, the willingness to pay for the product of firm \( i \) decreases with a higher value of \( d \), i.e., the closer substitutes the products are. As we can see from firm \( i \)'s reaction function as given by (5), a higher value of \( d \) leads to a lower output for firm \( i \). This is to compensate the fall in profits due to the lower price.
Expression (23) is positive, which also means that the marginal effect of competition on the incentive parameter becomes stronger with increasing competition. To see this, we only need to look at the square brackets in the numerator since all other expressions including the denominator are positive, given that \( d < 1 \). Within the square bracket, the product is always equal to or bigger than 16, since \( k \) is equal to or bigger than one and \( r \) is positive. Therefore, the considered expression in the square brackets is positive for all values of \( d \) (to remember: \( 0 \leq d \leq 1 \)). This expression becomes even larger with higher values of \( k \). These considerations lead us to our second hypothesis:

**Hypothesis 2:** The marginal effect of competition on the incentive parameter \( \beta^* \) increases with the intensity of product market competition, as measured by the degree of substitutability between products \( d \), i.e., \( \frac{\partial(\beta^*/d)}{\partial d} > 0 \) \( \forall d \).

Hypothesis 1 and hypothesis 2 jointly imply that there exists a convex relationship between \( d \) and \( \beta^* \). This relationship is displayed in Figure 1.

Let us now consider the effect of competition on firm value. For this purpose we differentiate the net profit as given by (19) with respect to \( d \), which yields (24).

\[
\frac{\partial \pi^*_{\text{net}}}{\partial d} = \frac{2(1 + r^2 k^2)(a - \bar{c})^2(2d + 2)^2 [(k^2 r^2 + k)(d^4 - 4d^3 + 16d - 16) - 8d + 8]}{[(k^2 r^2 + k)(-d^3 - 2d^2 + 4d + 8) - 4]^3}
\]

(24)

**Fig. 1.** Relationship between the optimal incentive parameter \( \beta^* \) and the degree of substitutability between products \( d \).
Expression (24) is clearly negative: From before, we know that the denominator is always positive. As to the numerator, we only need to look at the expressions in the square brackets since all other expressions are positive. Within the square bracket, the product is always equal to or bigger than \(-16\), since \(k\) is equal to or bigger than one and \(r\) is positive. Since \(k > 1\) and \((8d + 8)\) is equal or smaller than 8 for all values of \(d\), the expression in the square bracket is always negative. These considerations lead us to our third hypothesis.

**Hypothesis 3**: A higher intensity of product market competition, as measured by the degree of substitutability between products \(d\), leads to a lower net profit, i.e. \(\frac{\partial \pi^*_\text{net}}{\partial d} < 0\) \(\forall d\).

The explanation of this result is straightforward and stands in line with standard oligopoly models. The closer we move to perfect competition in terms of having more homogenous products, c.p., the lower the profits of the firms are.

The hypotheses derived from our theoretical model are subject of our empirical tests in Section 4.

3. Data and sample

3.1. Definition of variables

3.1.1. **Product market competition.** Recent US studies in general use the Herfindahl-Hirschman Index (HHI) from the Census of Manufacturers as a proxy for product market competition (e.g., Aggarwal and Samwick, 1999; Campello, 2006; Grullon and Michaely, 2007). The US Census calculates this index by summing up the squares of the individual market shares for the 50 largest firms in the industry (or all firms if there are less than 50 firms in the industry). As no comparable measure is readily available for Switzerland, we attempt to construct a similar measure which is based on both listed and non-listed firms. To construct our proxies for product market competition, we use Bureau van Dijk’s Amadeus database which contains a variety of data items on both listed and non-listed companies.

Our standard measure of product market competition is a sales-based HHI, \(HHI_{Sales}\), which is calculated as follows:

\[
HHI_{Sales} = \sum_{i=1}^{N_j} \left( \frac{SA_{ij}}{\sum_{i=1}^{N_j} SA_{ij}} \right)^2,
\]

where \(SA_{ij}\) is the sales attributable to firm \(i\) in industry \(j\), where industries are based on the first digit of the SIC codes.\(^{11}\) Each industry group comprises all listed and unlisted Swiss firms with data coverage on Amadeus and not only the firms in our sample. \(HHI_{Sales}\) is based on 2,945 firm-years on 824 firms as compared to the 676 firm-years on 217 listed firms contained in our sample. As the data coverage is somewhat better for total assets (3,528 firm-years on 1,021 firms) and substantially better for employees (23,686 firm-years on 8,477 firms) than for sales, we alternatively use a HHI based on total

\(^{11}\) We chose a one-digit SIC classification to obtain a sufficient number of firms per industry. However, when we alternatively use a two-digit SIC classification where possible, the results remain qualitatively unchanged.
assets, \(HHI_{\text{Assets}}\), and a HHI based on employees, \(HHI_{\text{Employees}}\), in the robustness section (Section 4.3).

Notwithstanding their wide use, these HHI-based measures of product market competition are not undisputable for at least three reasons. First, the HHI-based measures do not take into account foreign competitors, a problem which is likely to be especially severe in a small open economy as Switzerland. Second, the classification of industries based on SIC-codes may not represent anything like the relevant product market for the firms included in the respective industries. Third, actual as well as potential competition influences the market power of firms within an industry, and these measures clearly do not take into account the latter.

Hence, as a further robustness check, we employ two alternative measures of product market competition which are less afflicted with these problems. The first, the industry median net profit margin, \(\text{Med(EBEI/Sales)}\), is based on Gompers et al. (2003) and Cremers et al. (2008) and defined as the median income before extraordinary items divided by sales for the firms within the same industry. The industries are again based on the first digit of the SIC codes (and alternatively the first two digits of the SIC codes) and data is available on 2,931 listed and unlisted firm-years. The second measure of product market competition, \(Rents\), is based on Nickell (1996) and Nickell et al. (1997) and reflects the firms’ rents from production and other business activities. The motivation for using this measure is that firms operating in less competitive markets should be able to sell their products well above marginal costs and, therefore, earn higher rents after covering their expenses. We define \(Rents\) as profits before interest payments, tax, and depreciation (\(EBITDA\)) minus the costs of capital (\(cc\)) multiplied by total assets (\(TA\)) and standardised by the company’s sales (\(SA\)):

\[
Rents = \frac{EBITDA - cc \cdot TA}{SA}.
\]

The costs of capital (\(cc\)) are defined as follows:

\[
cc = r_f + \delta + \lambda \cdot \beta (r_m - r_f),
\]

where \(r_f\) is the risk free rate, \(\delta\) is the rate of depreciation, \(\lambda\) is equal to the equity ratio of the firm, \(\beta\) is the estimated market beta of the firm’s stock, and \(r_m\) is the return to a broad market index. The risk free rate is calculated as the average one month Swiss Interbank Rate over the past 60 monthly values. Following Nickell (1996), the depreciation rate is assumed to be constant at 4 percent. The equity ratio, \(\lambda\), is calculated as 1 minus the ratio of total (non-equity) liabilities to total assets. The market beta, \(\beta\), is estimated by regressing the firm’s monthly stock returns over the past five years on the respective returns of the market as proxied by the Swiss Performance Index (SPI). The risk

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12 Total assets as well as employees are highly positively correlated with sales: The correlation coefficient is 0.88 between total assets and sales for the 2,832 firm-years with both data items available and 0.90 between employees and sales for the 2,324 firm-years with both data items available.

13 Alternatively, to test the robustness of our results to this assumption, we apply a second measure of rents based on a rate of depreciation of 8 percent and find the results to change only immaterially.

14 Following Nickell (1996), we also apply an alternative measure of rents where \(\lambda\) is set equal to one. Unreported robustness checks reveal that the results remain basically unchanged.

15 For firms with more than one share category all variables related to stock return data are weighted based on nominal values. Firms with return data not available for the full period
premium is equal to the average return of the Pictet-Rätzer Index, a broad Swiss stock market index, less the average short-term interest rate (the one month Swiss Interbank Rate).

The main drawback of this measure of ex post monopoly power is that it is strongly correlated not only with market power, but also with profitability, whatever the precise definition chosen (see also Nickell, 1996). Since we analyse the impact of product market competition on firm valuation and firm value is expected to be positively correlated with profitability, we may obtain a positive bias in our results. To mitigate this potential bias, we control for the effect of firm size and growth opportunities on Tobin’s Q. To cope with a potential endogeneity problem related to Rents, we use lagged values for Rents.

3.1.2. Measuring incentives for managers. To measure the incentive schemes provided to managers, we use the percentage value of share-based to cash compensation paid out during the respective year to the firm’s officers and directors in total, Soratio. Share-based compensation includes stocks and options, whereas the value of stocks is calculated by multiplying the number of stocks allotted during a business year by the market price of these stocks as of the year end. The valuation of options is based on Black-Scholes (1973), as modified by Merton (1973) to account for dividend payments.

Alternatively, we calculate the pay-for-performance sensitivity, Payperf, as suggested by Jensen and Murphy (1990). Specifically, we calculate Payperf as the Black-Scholes formula’s (as modified by Merton (1973) to account for dividend payments) partial derivative with respect to stock price (i.e., the option delta) times the fraction of equity represented by the respective year’s award (e.g., see Yermack, 1995; Guay, 1999; Coles et al., 2006).

Besides these two incentive-related variables, this paper considers four additional corporate governance mechanisms, which are assumed to provide incentives to managers and therefore alleviate the agency problems between managers and shareholders (see Beiner et al., 2006). Stocksod is the sum of all shares owned by officers and executive as well as non-executive members of the board divided by the total number of shares outstanding. Blocko denotes the percentage of cumulated voting rights exercised by large outside investors with voting rights exceeding 5%. Outsider refers to the percentage of board seats held by independent directors without any executive function. Leverage denotes firm leverage and is calculated as the ratio of total (non-equity) liabilities to total assets.

3.1.3. Control variables. Besides these corporate governance mechanisms, we employ seven different control variables in this paper. Firm size is measured by the natural logarithm of total assets and is labeled Lnassets. As a measure of profitability, we include the return on assets, ROA, which is calculated as operating profit divided of 60 months are not excluded from our sample if return data could be obtained for at least 9 months.

16 In Switzerland, the ‘Directive on Information Relating to Corporate Governance’ became effective as of July 2002. It requires listed Swiss firms to disclose information about the level and structure of compensation as well as the ownership of share and options of top management and the board of directors on an aggregate level.
by the average of the respective and last year’s value of total assets. $P_{\text{growth}}$ is the average annual sales growth over the past three years. As it is standard in the literature on the relationship between pay and performance, we use the change in shareholder value, $CSV$, as a measure of firm performance in our investigations related to $Soratio$. Following Jensen and Murphy (1990), we define $CSV$ as the return on equity multiplied by the market value of equity in the previous period. $Stdv$ is the standard deviation of 60 monthly returns of a firm’s stock. $Beta$ is the market beta estimated by regressing the firm’s monthly stock returns over the past five years on the respective returns of the market as proxied by the Swiss Performance Index (SPI). $CEOP$ is a dummy variable which is equal to one if the CEO is also president of the board of directors and zero otherwise.

Finally, our measure of firm valuation is Tobin’s $Q$, alternatively simply labeled as $Q$. As suggested by Chung and Pruitt (1994), Perfect and Wiles (1994), Agrawal and Knoeber (1996), and Loderer and Peyer (2002), among others, Tobin’s $Q$ is estimated as the ratio of the market value of equity plus the book value of debt to the book value of total assets. To avoid that fluctuations in the market value of firms’ equity influence our results, we follow Beiner et al. (2006) and compute the market value of equity as the mean of daily observations during 2002. Definitions of all variables employed in this study are also provided in Table 1.

3.2. Sample description

As a starting point, we target all firms quoted at the Swiss Exchange (SWX) during our sample period from 2002 to 2005. We exclude all investment companies and ADRs leaving a sample of 699 firm-years. Complete compensation data ($Soratio$, $Payperf$, $Stocksold$) is available for 658 firm-years. To control for outliers, we winsorise the variable $Rents$ at the 1% and 99% level and $Soratio$ and $Payperf$ at the 99% level. Finally, we exclude all observations with leverage ratios smaller than zero or exceeding one (18) and $Q$-values larger than six (5). Our final sample comprises between 640 and 676 observations in the univariate analyses and between 600 and 635 observations on 199 to 204 firms in the multivariate panel regressions.

Data has been collected from different sources. The necessary data to compute the HHI- and industry-based measures of competition ($HHI_{Sales}$, $HHI_{Employees}$, $HHI_{Assets}$, Med(EBEI/Sales)) were obtained from Bureau van Dijk’s Amadeus database. $Rents$, $Q$, $Leverage$, $Lnassets$, $ROA$, $P_{\text{growth}}$, $CSV$, $Stdv$, and $Beta$ were obtained from Thomson Financial’s Datastream and Worldscope. Data for the variables $Blocko$, $Bsize$, $Outsider$, and $CEOP$ stem from the website of ‘Finanz & Wirtschaft’.

17 The main reasons for missing or incomplete compensation data are that 1) there is either no information on compensation or ownership in the corporate governance report or the corporate governance report is missing altogether and 2) data on the options granted to officers and directors is incomplete which makes it impossible to calculate Black-Scholes values.

18 When we use the rents-based measure of competition, $Rents$, the sample size is substantially smaller as compared to the HHI-based measures of competition as there is no data on $Rents$ for 33 firm-years.

19 The website of ‘Finanz und Wirtschaft’, Switzerland’s major financial newspaper, is: www.finanzinfo.ch.
The table reports definitions of all variables included in the empirical analyses of this study (Sections 4 and 5). Alternative measures of product market competition are defined in Section 5 investigating the robustness of our results.

| Variable          | Definition                                                                 |
|-------------------|---------------------------------------------------------------------------|
| HHI_Sales         | A sales-based Herfindahl-Hirschman Index (HHI)                             |
| HHI_Employees     | An employee-based Herfindahl-Hirschman Index (HHI)                         |
| HHI_Assets        | A total assets-based Herfindahl-Hirschman Index (HHI)                      |
| Med(EBEI/Sales)   | Industry median net profit margin defined as income before extraordinary items divided by sales within the firm’s industry (as defined by the one-digit SIC code) |
| Rents             | Measure of ex-post monopoly power defined as profits before interest payments, tax, and depreciation minus the costs of capital multiplied by total assets and standardized by the company's sales |
| Q                 | Ratio of market value to book value of assets. Market value of assets is computed as market value of equity plus book value of assets minus book value of equity. |
| Soratio           | Fraction of share-based (including stocks and options) to cash compensation to the firm’s officers and directors |
| Payperf           | Pay-for-performance sensitivity calculated as the Black-Scholes formula’s partial derivative with respect to stock price (i.e., the option delta) times the fraction of equity represented by the respective year’s award to the firm’s officers and directors |
| Stocksod          | Percentage of equity owned by officers and directors                       |
| Blocko            | Percentage of cumulated voting rights exercised by large investors with >5% of voting rights (excluding officers, directors, and related persons) |
| Leverage          | Leverage, measured as the ratio of total (non-equity) liabilities to total assets |
| Outsider          | Outsider membership on the board, measured by the percentage of board seats held by non-officers without relationship to the founding family (if any) |
| Lnassets          | Firm size, measured by the natural logarithm of book value of total assets |
| Pgrowth           | Average annual growth of sales over the past three years (2000-2002)       |
| CSV               | Change in shareholder value in million CHF as measured by the return on equity multiplied by the market value of equity in the previous period |
| Stdv              | Standard deviation of stock returns, estimated from 60 monthly stock returns |
| Beta              | Beta, estimated from 60 monthly stock returns                              |
| CEOP              | 1, if the CEO is also the president of the board; 0 otherwise              |
| ROA               | Return on assets, defined as the ratio of operating income to total assets |

and the ‘Swiss Stock Guides of the respective years’. However, for most variables data was not available for all firms in our sample. Missing values were obtained from the companies’ annual reports. Soratio, Stocksod, and Payperf have been directly collected from the annual reports of the companies covered in this study.
3.3. Descriptive statistics

Panel A of Table 2 shows descriptive statistics of all variables included in our analysis for the full sample period. Most importantly, the distribution of the HHI-based measures as well as the industry median net profit margin, Med(EBEI/Sales), indicates that there is quite some variability in the degree of product market competition between industries in our sample. This applies to the last measure of product market competition, Rents, as well. In addition, the negative average value of Rents indicates that Swiss firms destroyed value over the 2002–2005 sample period, on average. However, the median value is positive and amounts to 5.2%. The average value of Tobin’s $Q$ is 1.42, and the median is 1.16, indicating that Swiss firms, on average, invest in positive NPV projects. Concerning our measure of incentive schemes provided to managers, Soratio, we find that total share-based compensation to officers and directors amounts to 18.2% of cash-based compensation, on average, while the median value of 4.6% is much lower. A decomposition of this variable into stock-based and option-based compensation reveals that the fraction of options (mean = 8.96%) is slightly higher on average than the fraction of stocks (mean = 8.21%). The number of firm-years observations in which stocks are allotted only amounts to 138 while in 109 firm-years only options are allotted. In 116 firm-years both stocks and options are paid out to the firms’ officers and/or directors. These relatively small values are not surprising as Murphy (1999) shows, that stock and option participation plans for the top management are relatively rare in Switzerland and account for a much smaller fraction of total compensation than in most other countries and especially as compared to the USA.

The mean value of Payperf shows that the wealth of the firms’ officers and directors changes by CHF 2.24 per CHF 1,000 change in the wealth of stockholders. While this value is somewhat higher than the figure reported by Yermack (1995) for the USA ($0.59 per $1,000 change in stockholder wealth), it is important to keep in mind that we calculate Payperf for the aggregate of all officers and directors and not the CEO only.

Panel A of Table 2 further shows several other interesting results, which we only briefly summarise: officers and directors hold on average 15.3% of the equity of a firm. However, the median of 2.5% is much smaller, indicating that there are some firms in our sample where officers and directors hold very large fractions of total equity. A comparison of these values to the samples of US firms used by Loderer and Martin (1997) and Anderson et al. (2000) confirms that average insider shareholdings are even slightly higher in Switzerland than in the USA. However, the median is a lot smaller in our sample and, hence, insider shareholdings are much more skewed in Switzerland. Many other firm characteristics are comparable to those reported by other studies in this area. However, the mean value of Blocko of 14.3% is much larger than the value of 7.6% reported by Anderson et al. (2000) for the USA. Similarly, the average value of Outsider is 87.7%, which strongly differs from the much lower values of 54% and 60% reported by Yermack (1996) and Barnhart et al. (1994), respectively, for US

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20 One possible reason for this somewhat surprising finding is that our measure of profits included in the calculation of Rents (EBITDA) contains a number of balance sheet items that can potentially distort the economic content of this variable, resulting in values of EBITDA that are downward-biased measures of raw operating surplus (e.g., see Januszewski et al., 2002).

21 Murphy (1999) compares the level and structure of CEO pay in 23 countries based on data reported in Towers Perrin’s 1997 ‘Worldwide Total Remuneration’ report.
Table 2  
Summary statistics of variables.

This table reports descriptive statistics of all variables included in the empirical analyses of this study (Section 4) for the full sample covering the four-year period from 2002 to 2005 (Panel A) and the four main variables for each sample year separately (Panels B to E).

| Panel A: Full sample | Mean (HHI_Sales) | Median (HHI_Employees) | Maximum (HHI_Assets) | Minimum (Med(EBEI/Sales)) | Std. Dev (Rents) | Obs (Q) |
|----------------------|------------------|------------------------|----------------------|---------------------------|-----------------|--------|
|                      | 0.148            | 0.065                  | 0.147                | 0.039                     | -0.007          | 1.421  |
|                      | 0.156            | 0.035                  | 0.092                | 0.040                     | 0.052           | 1.161  |
|                      | 0.564            | 0.440                  | 0.776                | 0.077                     | 0.339           | 5.774  |
|                      | 0.034            | 0.008                  | 0.039                | 0.000                     | -0.979          | 0.156  |
|                      | 0.072            | 0.075                  | 0.106                | 0.022                     | 0.240           | 0.741  |
|                      | 676              | 676                    | 676                  | 676                       | 676             | 676    |
|                      | 0.153            | 0.025                  | 0.143                | 0.055                     | 0.157           | 3.037  |
|                      | 0.000            | 0.000                  | 0.000                | 0.000                     | 0.000           | 0.000  |
|                      | 0.000            | 0.000                  | 0.000                | 0.000                     | 0.000           | 0.000  |
|                      | 0.213            | 0.357                  | 0.213                | 0.219                     | 0.240           | 0.712  |
|                      | 676              | 640                    | 676                  | 676                       | 676             | 676    |
|                      | 0.572            | 0.575                  | 0.991                | 0.002                     | 0.000           | 1.000  |
|                      | 0.077            | 0.000                  | 0.000                | 0.000                     | 0.000           | 0.000  |
|                      | 0.219            | 0.008                  | 0.219                | 0.385                     | 0.096           | 0.156  |
|                      | 676              | 649                    | 676                  | 676                       | 676             | 676    |
|                      | 0.877            | 0.889                  | 1.000                | 0.000                     | 0.000           | 1.000  |
|                      | 0.889            | 0.000                  | 0.000                | 0.000                     | 0.000           | 0.000  |
|                      | 0.156            | 0.370                  | 0.154                | 0.014                     | 0.041           | 1.195  |
|                      | 0.051            | 0.581                  | 0.000                | 0.000                     | 0.000           | 3.279  |
|                      | 0.072            | 0.763                  | 0.383                | 0.000                     | 0.208           | 2.049  |
|                      | 153              | 153                    | 153                  | 153                       | 153             | 153    |
|                      | 0.033            | 0.002                  | 0.044                | 0.000                     | 0.000           | 0.000  |
|                      | 0.041            | 0.000                  | 0.000                | 0.000                     | 0.000           | 0.224  |
|                      | 0.290            | 0.000                  | 0.000                | 0.000                     | 0.096           | 0.096  |
|                      | 0.041            | 0.000                  | 0.000                | 0.000                     | 0.000           | 0.000  |
|                      | 0.005            | 0.005                  | 0.000                | 0.000                     | 0.069           | 0.000  |
|                      | 675              | 675                    | 675                  | 675                       | 675             | 675    |
|                      | 147              | 156                    | 156                  | 156                       | 156             | 156    |
|                      | 147              | 156                    | 156                  | 156                       | 156             | 156    |
|                      | 156              | 156                    | 156                  | 156                       | 156             | 156    |
|                      | 156              | 156                    | 156                  | 156                       | 156             | 156    |

| Panel B: 2002 |
|------------------|------------------|------------------------|----------------------|---------------------------|-----------------|--------|
| HHI_Sales        | 0.159            | 0.189                  | 0.564                | 0.051                     | 0.072           | 1.421  |
| Q                | 1.370            | 1.128                  | 5.667                | 0.581                     | 0.763           | 1.195  |
| Soratio          | 0.178            | 0.014                  | 2.989                | 0.000                     | 0.383           | 3.279  |
| Payperf          | 0.001            | 0.000                  | 0.044                | 0.000                     | 0.005           | 0.000  |
|                  |                  |                        |                      |                            |                 |        |
| Panel C: 2003 |
| HHI_Sales        | 0.144            | 0.152                  | 0.543                | 0.041                     | 0.072           | 1.424  |
| Q                | 1.320            | 1.079                  | 5.774                | 0.156                     | 0.698           | 1.195  |
| Soratio          | 0.230            | 0.069                  | 2.698                | 0.000                     | 0.410           | 3.037  |
| Payperf          | 0.002            | 0.000                  | 0.095                | 0.000                     | 0.009           | 0.000  |
|                  |                  |                        |                      |                            |                 |        |
| Panel D: 2004 |
| HHI_Sales        | 0.138            | 0.151                  | 0.375                | 0.038                     | 0.057           | 1.424  |
| Q                | 1.424            | 1.154                  | 5.732                | 0.570                     | 0.741           | 1.195  |
| Soratio          | 0.188            | 0.044                  | 3.037                | 0.000                     | 0.344           | 3.037  |
| Payperf          | 0.001            | 0.000                  | 0.041                | 0.000                     | 0.005           | 0.000  |
|                  |                  |                        |                      |                            |                 |        |
| Panel E: 2005 |
| HHI_Sales        | 0.152            | 0.154                  | 0.499                | 0.034                     | 0.080           | 1.553  |
| Q                | 1.553            | 1.270                  | 4.388                | 0.554                     | 0.747           | 1.270  |
| Soratio          | 0.135            | 0.059                  | 3.022                | 0.000                     | 0.281           | 3.022  |
| Payperf          | 0.003            | 0.000                  | 0.119                | 0.000                     | 0.011           | 0.000  |
companies and 44% reported by Peasnell et al. (2003) for UK companies. This finding is especially surprising, because founding families are still regarded as an important factor in corporate Switzerland.

Panels B to E of Table 2 report the descriptive statistics on the four key variables \( (HHI_{Sales}, Q, Soratio, Payperf) \) for each sample year separately. Most importantly, there is no clear pattern in the two product market competition variables over the four sample years. However, there is an increase in mean and median \( Q \) over the second half of the sample period. Somewhat surprisingly, \( Soratio \) reaches a high in 2003 and decreases over the last two sample years. Finally, there is no clear trend in \( Payperf \) which remains fairly constant over all four sample years.

4. Empirical Analysis

4.1. Comparisons of firms operating in an intensive competition environment and other firms

We begin our empirical analysis by investigating whether there are systematic differences with respect to the variables employed in this study between firms operating in an intensive competition environment and firms which do not. Table 3 presents comparisons of mean and median values between firm-years with a value of \( HHI_{Sales} \) below the median value (competition firms) and firm-years with a value of \( HHI_{Sales} \) equal to or above the median value (non-competition firms).

Most importantly, we find that competition firms provide significantly stronger incentive schemes for managers as measured by the fraction of share-based to cash compensation, \( Soratio \). In contrast, there is no significant difference in the pay-for-performance sensitivity and Tobin’s \( Q \) between competition and non-competition firms.

Table 3 furthermore reveals a significantly higher profitability, as measured by \( ROA \), of non-competition firms. This result is consistent with the predictions from our theoretical model as firms operating in less competitive markets are expected to sell their products well above marginal costs and, therefore, earn higher rents after covering their expenses. This rationale also underlies the construction of two of our measures of product market competition, \( Med(EBEI/Sales) \) and \( Rents \). The finding of significantly higher leverage ratios of competition firms stands in line with Lord and McIntyre (2003), who provide evidence for leverage increasing with import competition in the textile and apparel industry.\(^{22}\) \( Stocksod \) is significantly higher in non-competition firms than in competition firms. This finding is in line with Kedia (2006), who provides evidence for higher CEO ownership in the firm in case firms don’t face competition. Finally, competition firms have significantly more outsiders on the board, lower mean and median values of \( Stdv \) and \( Beta \), higher values of \( CSV \), and are significantly larger as measured by the natural logarithm of total assets.

4.2. Multivariate analysis

In this section, we investigate the influence of product market competition on \( Soratio \), \( Payperf \), and Tobin’s \( Q \) by controlling for different governance mechanisms and control

\(^{22}\) Other work on the relationship between leverage and competition include Brander and Lewis (1986), Maksimovic (1988), Chevalier (1995), Kovenock and Phillips (1995), Phillips (1995) and Zingales (1998).
# Table 3

Comparisons of firms “operating in intensive competition environment” and other firms

This table reports a comparison of firm value, six corporate governance mechanisms, and additional characteristics between firms with a value of $HHI_{Sales}$ below the median value (competition firms) and firms with a value of $HHI_{Sales}$ equal to or above the median value (non-competition firms). Equality of means is tested using a standard $t$-test and equality of medians is tested using a Wilcoxon signed rank test. The table reports $p$-values. ***/**/* denotes statistical significance at the 1%/5%/10% level.

|                           | Competition firms | Non-competition firms | Difference | Difference |
|---------------------------|-------------------|-----------------------|------------|------------|
|                           | Mean   | Median  | Obs. | Mean   | Median  | Obs. | Mean | t-test | Median | Wilcoxon |
| $Q$                       | 1.434  | 1.134   | 326  | 1.410  | 1.186   | 350  | 0.024 | 0.683  | −0.052 | 0.638    |
| $Soratio$                 | 0.219  | 0.068   | 302  | 0.148  | 0.025   | 338  | 0.071 | 0.012** | 0.043  | 0.041**  |
| $Payperf$                 | 0.002  | 0.000   | 310  | 0.002  | 0.000   | 339  | −0.000 | 0.618  | 0.000  | 0.160    |
| $Stocksod$                | 0.121  | 0.006   | 326  | 0.182  | 0.069   | 350  | −0.061 | 0.000***| −0.063 | 0.000*** |
| $Blocko$                  | 0.157  | 0.057   | 320  | 0.129  | 0.052   | 350  | 0.028 | 0.088*  | 0.005  | 0.237    |
| $Leverage$                | 0.627  | 0.616   | 326  | 0.521  | 0.541   | 350  | 0.106 | 0.000***| 0.075  | 0.000*** |
| $Outsider$                | 0.901  | 1.000   | 326  | 0.854  | 0.857   | 350  | 0.046 | 0.000***| 0.143  | 0.000*** |
| $Beta$                   | 0.878  | 0.666   | 321  | 1.056  | 0.905   | 349  | −0.178 | 0.001***| −0.239 | 0.000*** |
| $CEOP$                   | 0.156  | 0.000   | 326  | 0.203  | 0.000   | 350  | −0.046 | 0.117  | 0.000  | 0.117    |
| $CSV$                    | 1,151,424 | 40,177 | 321   | 250,183 | 10,765 | 346 | 901,241 | 0.002*** | 29,412 | 0.002*** |
| $Lnassets$               | 14.466 | 14.325  | 326  | 13.220 | 13.053  | 350  | 1.246 | 0.000***| 1.272  | 0.000*** |
| $Pgrowth$                | 0.089  | 0.031   | 322  | 0.047  | 0.025   | 347  | 0.042 | 0.113  | 0.006  | 0.118    |
| $ROA$                    | 0.025  | 0.029   | 326  | 0.041  | 0.048   | 349  | −0.016 | 0.028** | −0.019 | 0.003*** |
| $Stdv$                   | 0.346  | 0.307   | 323  | 0.402  | 0.341   | 349  | −0.055 | 0.001***| −0.034 | 0.000*** |
variables in a multivariate regression framework. First, we motivate the regression equation aimed to investigate the determinants of $Soratio$ or alternatively $Payperf$ and report the results from robust fixed effects regressions and Tobit estimations. Then, we examine the effect of competition on Tobin’s $Q$.

4.2.1. The effect of product market competition on incentive schemes. Since our main interest is to investigate the effect of product market competition on incentive schemes, the dependent variable is $Soratio$ (or alternatively $Payperf$) and the explanatory variable of our main interest is our standard measure of product market competition, $HHI_{Sales}$. Because managers are more likely to accept share-based compensation when they are confident that their company will do well and it is beneficial for them to participate on this success, we include Tobin’s $Q$ as a forward-looking performance measure of the firm. To investigate whether there are any interrelations between $Soratio$ and other governance mechanisms (e.g., see Beiner et al., 2006), we also include $Stocksod$, $Blocko$, $Leverage$, and $Outsider$.

Besides the measure of product market competition and governance mechanisms, we include four control variables. The first is firm size, $Lnassets$. Because larger firms operating in an international environment are more likely to adopt share-based compensation, we expect $Soratio$ to be higher for larger firms. As it is standard in the literature on the relationship between pay and performance, we use the change in shareholder value, $CSV$, as an additional control variable. $CSV$ is expected to have a positive impact on $Soratio$.\(^{23}\) As a further control, we include the standard deviation of 60 monthly returns of a firm’s stock, $Stdv$. As there may be two opposite effects at work, our expectation for the sign of $Stdv$ is ambiguous. On the one hand, we expect a negative sign on $Stdv$ as a higher standard deviation makes stock holdings less attractive – especially for presumably poorly diversified managers. On the other hand, a higher standard deviation increases the value of options and makes them potentially more attractive to managers. The fourth control variable we include into our regression equation is $CEOP$. The concentration of power associated with a CEO who is by the same time president of the board may increase the demand for aligned interests. Thus, we expect managers and directors, but especially the CEO, to be compensated by a higher fraction of performance dependent wages. Summarising, the regression equation for $Soratio$ is:

$$Soratio_i = \alpha_0 + \alpha_1 \cdot HHI_{Sales_i} + \alpha_2 \cdot Q_i + \alpha_3 \cdot Stocksod_i + \alpha_4 \cdot Blocko_i + \alpha_5 \cdot Leverage_i + \alpha_6 \cdot Outsider_i + \alpha_7 \cdot Lnassets_i + \alpha_8 \cdot CSV_i + \alpha_9 \cdot Stdv_i + \alpha_{10} \cdot CEOP_i + \varepsilon_i$$

(4.1)

Alternatively, we estimate the same regression equation with $Payperf$ as dependent variable. In all regression equations we include firm and year fixed effects to control for unobserved variables which are either constant over firms or constant over time. In addition, to control for industry effects, we include industry dummy variables based on the one-digit SIC code in all regressions.\(^{24}\) Our standard error estimates are based on the cluster-robust variant of the Huber-White sandwich estimator which accounts for the

\(^{23}\) In the regression equations including $Rents$ as an explanatory variable, we additionally control for accounting profitability by including $ROA$. $ROA$ is always positive but never statistically significant and the results (not reported) remain basically unchanged.

\(^{24}\) However, due to the very limited time-variability of the industry dummy variables all but two of them (first-digit SIC codes of 2 and 3) drop out of all regression specifications.
dependence of observations within clusters (different year-observations for one specific firm).

The results obtained by estimating equation 4.1 are reported in Column 1 of Table 4. Consistent with our theoretical model, we find a negative and statistically significant coefficient on $HHI_{Sales}$. This indicates that a more intense product market competition is associated with stronger incentive schemes for managers as measured by the fraction of share-based to cash compensation. Therefore, firms operating in a competitive environment seem to provide stronger managerial incentives because competition raises the marginal cost of poor managerial decisions. Consistent with our conjecture that managers are more likely to accept share-based compensation when they expect their company to do well, the coefficient on $Q$ is positive and statistically significant. Out of the four corporate governance mechanisms, only $Stocksod$ and $Blocko$ exhibit a significant coefficient on $Soratio$. The positive and significant coefficient on $Stocksod$ indicates that firms with already high managerial ownership are more likely to pay a higher fraction of the salary in stocks and options. In contrast, firms with a concentrated ownership structure pay a smaller fraction of the salary in stocks and options.

With respect to the control variables only the coefficient on $Stdv$ is statistically significant. The positive and significant coefficient on $Stdv$ suggests that the increase in option value associated with a higher standard deviation outweighs the higher risk of stock holdings.

Hypotheses 1 and 2 suggest that the relationship between product market competition and managerial incentives is nonlinear. Specifically, our model predicts that the effect of competition on incentives is only prevalent in a competitive environment and becomes stronger with increasing competition. As our model does not specify the degree of competitiveness at which the effect of competition on incentives is prevalent, we estimate regressions including a quadratic term of the competition variable. Based on the predictions of our theoretical model, we expect a convex relation between $Soratio$ and $HHI_{Sales}$.

The results obtained by estimating regression 4.1 augmented by the quadratic term of $HHI_{Sales}$, $HHI_{Sales}^2$, are reported in Column 2 of Table 4. In fact, these results show a convex relation between $Soratio$ and $HHI_{Sales}$. The linear coefficient on the competition variable remains negative and significant at the 5% level while the quadratic term is positive and significant at the 10%.

As the value of $Soratio$ is equal to zero for a nontrivial fraction of our sample (in 272 cases or 43.3% of the observations), while it is roughly continuously distributed over positive values, an estimation technique which takes into account this censoring of the dependent variable might be important. Hence, we re-estimate the regression equation reported in Column 2 by using Tobit. This regression includes the year and industry dummy variables based on the one-digit SIC code but no firm fixed effects. The results are reported in Column 3 of Table 4. Most importantly, the coefficient on $HHI_{Sales}$ remains negative and statistically significant at the 5% level and the coefficient on $HHI_{Sales}^2$ positive and significant at the 5% level. The coefficients on all other variables remain basically unchanged with two exceptions: Consistent with our expectations, the sign on $Lnassets$ is positive indicating that larger firms are more likely to have share-based compensation. In addition, the positive and significant

when firm fixed effects are included. To check the robustness of our results with respect to industry effects, we therefore alternatively replace the firm by industry fixed effects (see Section 4.3).
This table reports fixed effects and Tobit regressions of alternative compensation measures on the measure of product market competition. Panel A reports estimates from fixed effects regressions (Columns 1 and 2) and from a Tobit regression (Column 3) of the percentage of share-based to cash compensation on the measure of product market competition, a sales-based Herfindahl index, and its quadratic term along with Tobin’s $Q$, four corporate governance mechanisms, and control variables. Panel B reports estimates from fixed effects regressions (Columns 4 and 5) and from a Tobit regression (Column 6) of pay-for-performance sensitivity on the measures of product market competition along with Tobin’s $Q$, four corporate governance mechanisms, and control variables. All regressions include year fixed effects and industry dummy variables based on the first-digit SIC code (the coefficients are not reported). Columns 1, 2, 4, and 5 additionally include firm fixed effects. The $t$-values in Columns 1, 2, 4, and 5 (in parentheses) are based on the cluster-robust variant of the Huber-White sandwich estimator, which accounts for the dependence of observations within clusters (different year-observations for one specific firm). ***/**/ denote statistical significance at the 1%/5%/10% level.

| Panel A: Dependent variable = Soratio | Panel B: Dependent variable = Payperf |
|--------------------------------------|--------------------------------------|
| (1)                                  | (2)                                  | (3)  | (4)  | (5)  | (6)  |
| Constant                             | 0.283                                | 0.357| −1.370* | 0.004| 0.008| −0.007|
|                                      | (0.362)                              | (0.441)| (−1.788)| (0.218)| (0.367)| (−0.482)|
| $HHI_{Sales}$                        | −0.540***                            | −1.356**| −3.839**| −0.023**| −0.060**| −0.263***|
|                                      | (−3.463)                             | (−2.439)| (−2.248)| (−2.115)| (−2.336)| (−2.307)|
| $HHI_{Sales2}$                       | 1.448*                               | 4.711**|          | 0.066**| 0.538* |
|                                      | (1.749)                               | (1.971)|          | (2.286) | (1.722)| |
| $Q$                                  | 0.157***                             | 0.157***| 0.140***| −0.000| −0.000| 0.002* |
|                                      | (3.688)                               | (3.723)| (4.965) | (−0.800)| (−0.725)| (1.790)|
| $Stocksod$                           | 0.152***                             | 0.152***| 0.190***| 0.001* | 0.002* | 0.003* |
|                                      | (6.035)                               | (6.008)| (3.866) | (1.748) | (1.726) | (1.858)|
| $Blocko$                             | −0.147***                            | −0.146***| −0.193*| 0.000  | 0.000  | −0.007*|
|                                      | (−2.980)                             | (−2.905)| (−1.828)| (0.515) | (0.520) | (−1.712)|
| Leverage                             | 0.120*                               | 0.121* | 0.227**| 0.003***| 0.003***| 0.004***|
|                                      | (1.936)                               | (1.933)| (1.808)| (2.659) | (2.560) | (2.263)|
| $Outsider$                           | −0.140                               | −0.143| 0.001  | −0.002 | −0.002 | −0.000 |
|                                      | (−1.415)                             | (−1.432)| (0.004) | (−1.475)| (−1.567)| (−0.051)|
| Lnassets                             | −0.019                               | −0.020| 0.149***| 0.000  | −0.000 | 0.002***|
|                                      | (−0.388)                             | (−0.409)| (10.390)| (0.021) | (−0.018)| (3.113)|
| CSV                                  | −0.000                               | −0.000| −0.000 | −0.000**| −0.000**| −0.000  |
|                                      | (−1.346)                             | (−1.355)| (−1.075)| (−2.599)| (−2.600)| (−0.010)|
| Stdv                                 | 0.251***                             | 0.248***| 0.271***| 0.004* | 0.004* | 0.015***|
|                                      | (2.593)                               | (2.617)| (2.379) | (1.789) | (1.879) | (3.656)|
| $CEOP$                               | −0.027                               | −0.027| 0.114**| 0.005  | 0.005  | 0.003  |
|                                      | (−0.933)                             | (−0.949)| (2.049) | (0.865) | (0.861) | (1.254)|
| $R^2$ (within)                       | 0.066                                | 0.067| –       | 0.032  | 0.034  | –       |
| Pseudo $R^2$                         | –                                   | –    | 0.232  | –      | –      | 0.095  |
| Obs.                                 | 628                                  | 628  | 628    | 635    | 635    | 635    |
| Firms                                | 205                                  | 205  | 205    | 204    | 204    | 204    |

coefficient on $CEOP$ may indicate that the concentration of power associated with the CEO being president of the board by the same time increases the demand for share-based compensation to align the interests between managers and shareholders.

In Panel B of Table 4, we check the robustness of these results with respect to our alternative measure of managerial incentives and repeat the analysis in Panel A.
with Payperf instead of Soratio as dependent variable. The results on the measure of product market competition are qualitatively similar: The coefficient on $HHI_{Sales}$ is significant at the 5% level in all three specifications while the coefficient on its quadratic term, $HHI_{Sales}^2$, is significant at the 5% and 10% level in Columns 5 and 6, respectively.

The empirical results of this section reveal that in general a more intense product market competition is associated with stronger incentive schemes for managers as measured by the fraction of share-based to cash compensation and pay-for-performance sensitivity. When we account for the nonlinearity in the relation between competition and incentives as predicted by our theoretical model, we find the relation between incentives and both competition variables to be convex. Hence, the results of this section are consistent with hypothesis 1, suggesting that firms operating in competitive environments on average provide stronger incentive schemes to managers. Moreover and consistent with hypothesis 2, we find that the marginal effect of competition on Soratio and Payperf is increasing in the intensity of product market competition once the intensity of competition reaches a certain level.

### 4.2.2. The effect of competition on firm value

To test our third hypothesis, which is to examine the effect of product market competition on firm value as measured by Tobin’s $Q$, we estimate similar fixed effects regressions of $Q$ on $HHI_{Sales}$ and a number of control variables. Since the additional monitoring of managers associated with a more intense product market competition may be a substitute for incentive schemes and other governance mechanisms, we include Soratio (or alternatively Payperf) and the four governance mechanisms, Stocksd, Blocko, Leverage, and Outsider into the regression equation. Finally, we include four control variables, $Lnassets$ and $Pgrowth$ aim to control for growth opportunities. Thus, we expect a positive relationship between $Pgrowth$ and $Q$ and a negative influence of $Lnassets$ on $Q$, because growth opportunities tend to be lower for larger firms. Based on simple valuation models, $Q$ may additionally depend on Beta. Summarising, the regression equation is:

$$Q_i = \alpha_0 + \alpha_1 \cdot HHI_{Sales}i + \alpha_2 \cdot Soratio_i + \alpha_3 \cdot Stocksd_i + \alpha_4 \cdot Blocko_i$$
$$+ \alpha_5 \cdot Leverage_i + \alpha_6 \cdot Outsider_i + \alpha_7 \cdot Lnassets_i + \alpha_8 \cdot Pgrowth_i + \alpha_9 \cdot Beta_i + \epsilon_i$$

The results of estimating equation 4.2 are reported in Column 1 of Table 5. Consistent with hypothesis 3, $HHI_{Sales}$ exhibits a positive and statistically significant effect on firm value indicating that a higher product market competition is associated with a lower firm value. The positive coefficient on $HHI_{Sales}$ indicates that the negative effect of lower economic rents seems to outweigh the positive effect of reducing managerial slack and increasing the managers’ effort by providing additional monitoring and increasing the threat of liquidation.\textsuperscript{25}

Although our model does not specifically predict a nonlinear relationship between Tobin’s $Q$ and the two measures of product market competition, we include a quadratic term of $HHI_{Sales}$ in Column 2. While the coefficient on $HHI_{Sales}$ remains positive and significant, the quadratic term, $HHI_{Sales}^2$, is estimated negative and significant. Hence, the relation between Tobin’s $Q$ and $HHI_{Sales}$ is concave.

\textsuperscript{25}In contrast, Habib and Ljungqvist (2005) provide evidence that firm value is positively related to product market competition.
Table 5
Results from fixed effects regressions of Tobin’s Q on the measure of product market competition.

This table reports estimates from fixed effects regressions of Tobin’s Q on the measure of product market competition, a sales-based Herfindahl index, and its quadratic term along with the percentage of share-based to cash compensation (Columns 1 and 2) or pay-for-performance sensitivity (Columns 3 and 4), four additional corporate governance mechanisms, and control variables. All regressions include firm and year fixed effects and industry dummy variables based on the first-digit SIC code (the coefficients are not reported). The t-values (in parentheses) are based on the cluster-robust variant of the Huber-White sandwich estimator, which accounts for the dependence of observations within clusters (different year-observations for one specific firm). ***/*** denotes statistical significance at the 1%/5%/10% level.

| Dependent variable: Tobin’s Q | (1) | (2) | (3) | (4) |
|------------------------------|-----|-----|-----|-----|
| Constant                     | −0.375*** | −0.476*** | 0.604* | 0.536* |
|                              | (−3.202) | (−3.426) | (1.950) | (1.803) |
| **HHI**_**Sales**            | 1.956*** | 4.031*** | 1.908*** | 3.582*** |
|                              | (5.837) | (4.380) | (3.967) | (3.160) |
| **HHI**_**Sales2**           | −3.746*** | −3.475** | −3.046** | −2.419 |
|                              | (−3.475) | (−3.475) | (−2.419) | (−2.419) |
| **Soratio**                  | 0.391*** | 0.391*** | 3.967*** | 3.870*** |
|                              | (12.177) | (12.195) | (2.929) | (2.880) |
| **Payperf**                  |         |       |       |       |
|                              |         |       |       |       |
|                              |         |       |       |       |
| **Stocksod**                 | 1.694*** | 1.703*** | 1.783*** | 1.787*** |
|                              | (8.723) | (8.599) | (8.046) | (7.989) |
| **Stocksod2**                | −2.145*** | −2.157*** | −2.319*** | −2.324*** |
|                              | (−5.022) | (−5.035) | (−4.875) | (−4.887) |
| **Blocko**                   | 0.072   | 0.072   | −0.022  | −0.022  |
|                              | (1.517) | (1.465) | (0.390) | (0.384) |
| **Leverage**                 | −0.457*** | −0.456*** | −0.532*** | −0.532*** |
|                              | (−3.184) | (−3.185) | (−4.130) | (−4.134) |
| **Outsider**                 | 0.072   | 0.074   | 0.013   | 0.014   |
|                              | (0.527) | (0.536) | (0.105) | (0.118) |
| **Lnassets**                 | 0.031*  | 0.032*  | 0.066*** | 0.067*** |
|                              | (1.900) | (1.932) | (3.330) | (3.357) |
| **Pgrowth**                  | 0.402*** | 0.403*** | 0.405*** | 0.405*** |
|                              | (15.639) | (15.905) | (16.409) | (16.831) |
| **Beta**                     | 0.147*** | 0.147*** | 0.160*** | 0.160*** |
|                              | (12.121) | (12.125) | (28.985) | (28.924) |
| **R² (within)**              | 0.267   | 0.268   | 0.240   | 0.240   |
|                              | 625     | 625     | 632     | 632     |
| **Firms**                    | 204     | 204     | 203     | 203     |

In Columns 3 and 4, we alternatively replace Soratio by Payperf as explanatory variable to measure the incentives provided to managers. Most importantly, the results with respect to HHI Sales and its quadratic term remain qualitatively unchanged (the only exception is the coefficient on HHI Sales2 in Column 4 which is now significant at the 5% level only instead of the 1% level).
Regarding the control variables, we find the coefficient on \( \text{Soratio} \) in Columns 1 and 2 and on \( \text{Payperf} \) in Columns 3 and 4 to be positive and significant indicating that share-based compensation is effective in aligning the interests of managers and shareholders. Similarly, the coefficient on \( \text{Stocksod} \) is positive and significant while its quadratic term is negative and significant in all four regression equations indicating that managerial share ownership is effective in aligning the interests of managers and shareholders up to a certain level. For higher holdings, the effect turns negative as managers might have enough (voting) power to expropriate minority shareholders and extract private benefits of control (e.g., Morck et al., 1988; McConnell and Servaes, 1990). Similar to Agrawal and Knoeber (1996), we find a negative effect of leverage on firm value, i.e. more debt financing leads to poorer firm performance. Theoretically, debt can be used to improve firm performance by inducing monitoring by lenders. As Agrawal and Knoeber (1996) argue, however, in case several control mechanisms exist, each might plausibly be used instead of another. An inspection of the control variables reveals, that all four of them are positive, while \( \ln \text{assets} \), \( \text{Pgrowth} \) and \( \text{Beta} \) are statistically significant.

Summarising, the empirical results with respect to our standard proxy for product market competition, \( \text{HHI}_{\text{Sales}} \), are consistent with hypothesis 3 of our theoretical model and indicate that a higher product market competition is associated with a lower firm value. Thus, the negative effect of lower economic rents seems to outweigh the positive effect of reducing managerial slack and increasing the managers’ effort by providing additional monitoring and increasing the threat of liquidation. When we include a quadratic term of \( \text{HHI}_{\text{Sales}} \), we find a concave relationship between firm value and competition indicating that there is a turning point at which the effect of competition on firm value turns positive.

### 4.3. Robustness tests

#### 4.3.1. Alternative measures of competition and performance.

In this section, we investigate the robustness of our empirical results with respect to the set of alternative measures of product market competition as defined in Section 3.1.1: a HHI based on employees, \( \text{HHI}_{\text{Employees}} \), a HHI based on total assets, \( \text{HHI}_{\text{Assets}} \), the industry median net profit margin, \( \text{Med(EBEI/Sales)} \), and the firms’ rents from production and other business activities, \( \text{Rents} \). In addition, we test the robustness of our results with respect to two alternative measures of firm performance, the market-to-book ratio and return on assets (ROA). Finally, as a further robustness check, we drop the firm fixed effects and only include industry and year dummy variables.

To investigate the robustness of our results with respect to these alternative definitions of our competition proxies, we reestimate the regression equations reported in Column 2 of Table 4 (\( \text{Soratio} \)) and Column 2 of Table 5 (\( Q \)) and include the alternative measures of product market competition along with their quadratic terms. The results in Table 6 reveal that our results with respect to \( \text{Soratio} \) are robust to replacing our standard competition variables by one of the alternatives. The coefficients on all linear specifications of the competition measures are negative and significant at the 5% level or better while the coefficients on the quadratic terms are all positive and significant at the 10% level or better. In Column 5, we simultaneously include \( \text{Rents} \) and \( \text{HHI}_{\text{Sales}} \) along with their quadratic terms as these alternative proxies for product market competition measure different aspects of competition and are afflicted with different problems. Again, the
Table 6
Robustness tests – fixed effects regressions of the percentage of share-based to cash compensation on different measures of product market competition.

This table reports estimates from fixed effects regressions of the percentage of share-based to cash compensation on alternative measures of product market competition as defined in Section 3.1.1 (and their quadratic terms) along with Tobin’s $Q$, four corporate governance mechanisms, and control variables. All regressions include firm and year fixed effects and industry dummy variables based on the first-digit SIC code (the coefficients are not reported). The $t$-values (in parentheses) are based on the cluster-robust variant of the Huber-White sandwich estimator, which accounts for the dependence of observations within clusters (different year-observations for one specific firm). ***/**/ denotes statistical significance at the 1%/5%/10% level.

| Dependent variable: Soratio |
|-----------------------------|
|                            | (1)       | (2)       | (3)       | (4)         | (5)         |
| Constant                   | 0.293     | 0.219     | 0.145     | 1.926**     | 2.149**     |
|                           | (0.361)   | (0.288)   | (0.203)   | (13.592)    | (13.191)    |
| $HHI_{Employees}$          | −3.457*** | −8.719    |           |             |             |
|                           | (−9.347)  | (−5.308)  |           |             |             |
| $HHI_{Employees2}$         | 9.431***  |           |           |             |             |
|                           | (9.394)   |           |           |             |             |
| $HHI_{Assets}$             |           | −1.083**  |           |             |             |
|                           |           | (−2.334)  |           |             |             |
| $HHI_{Assets2}$            |           | 1.227**   |           |             |             |
|                           |           | (2.433)   |           |             |             |
| Med($EBEI/Sales$)          | −10.509***|           | −5.690*** |             |
|                           | (6.769)   |           |           |             |
| Med($EBEI/Sales$)2         | 109.737***|           |           |             |
|                           | (6.769)   |           |           |             |
| Rents                      |           | −0.109*** | −0.086*** |             |
|                           |           | (−5.110)  | (−3.007)  |             |
| Rents2                     |           | 0.025***  | 0.047***  |             |
|                           |           | (3.428)   | (4.785)   |             |
| $HHI_{Sales}$              |           |           | −1.158*** |             |
|                           |           |           | (−3.790)  |             |
| $HHI_{Sales2}$             |           |           | 1.637***  |             |
|                           |           |           | (3.467)   |             |
| $Q$                        | 0.163***  | 0.155***  | 0.149***  | 0.161***    | 0.164***    |
|                           | (3.437)   | (3.621)   | (3.270)   | (2.866)     | (2.942)     |
| Stocksod                   | 0.146***  | 0.151***  | 0.157***  | 0.112***    | 0.114***    |
|                           | (5.357)   | (5.620)   | (5.314)   | (3.747)     | (3.780)     |
| Blocko                     | −0.145*** | −0.147*** | −0.164*** | −0.130***   | −0.132***   |
|                           | (−2.700)  | (−3.094)  | (−3.311)  | (−2.635)    | (−2.405)    |
| Leverage                   | 0.089     | 0.111*    | 0.169***  | 0.089       | 0.124       |
|                           | (1.332)   | (1.800)   | (2.694)   | (1.034)     | (1.373)     |
| Outsider                   | −0.142    | −0.143    | −0.133    | −0.106      | −0.110      |
|                           | (−1.520)  | (−1.417)  | (−1.450)  | (−0.960)    | (−1.003)    |
| Lnassets                   | −0.010    | −0.018    | −0.030    | −0.135***   | −0.144***   |
|                           | (−0.190)  | (−0.357)  | (−0.663)  | (−1.128)    | (−1.292)    |
| CSV                        | −0.000    | −0.000    | −0.000    | −0.000      | −0.000      |
|                           | (−1.413)  | (−1.330)  | (−1.324)  | (−1.030)    | (−1.032)    |
| Stdv                       | 0.059     | 0.244**   | 0.255***  | 0.315***    | 0.276***    |
|                           | (0.660)   | (2.133)   | (2.702)   | (5.966)     | (4.753)     |
| CEO                        | −0.020    | −0.027    | −0.032    | −0.006      | −0.015      |
|                           | (−0.843)  | (−0.869)  | (−1.110)  | (−0.169)    | (−0.391)    |
| $R^2$ (within)             | 0.088     | 0.065     | 0.074     | 0.084       | 0.087       |
| Obs.                       | 628       | 628       | 628       | 600         | 600         |
| Firms                      | 205       | 205       | 205       | 199         | 199         |

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results remain robust and the coefficients on $HHI_{\text{Sales}}$ and its quadratic term increase in significance as compared to Table 4. The coefficients on the additional governance and control variables remain basically unchanged as compared to Table 4.²⁶

Columns 1–5 of Table 7 reports the results with respect to Tobin’s $Q$. Again, the results are robust to the use of alternative definitions of the competition variables. The coefficients on the linear specifications are always positive and significant at the 5% level or better while the coefficients on the quadratic terms are always negative and significant at the 5% level or better. When we re-estimate the regressions in Table 7 by replacing $Soratio$ by $Payperf$, the results remain qualitatively unchanged (not reported in a table). In general, we conclude that our results are robust to the use of alternative definitions for our measures of product market competition.

As a second robustness check, we re-estimate the regression reported in Column 2 of Table 4 and replace Tobin’s $Q$ by alternative performance measures. The first of these alternative performance measures is the market-to-book ratio ($M/B$) defined as the ratio of the market value of equity to the book value of equity. The second alternative measure of performance is profitability as measured by the return on assets. In contrast to $Q$ and $M/B$, $ROA$ is not a forward-looking measure of performance. Hence, we use the first and second lead of ROA ($ROA_{t+1}$, $ROA_{t+2}$). The results on the market-to-book ratio in Column 6 are qualitatively unchanged as compared to those in Column 2 of Table 4. In contrast, when $ROA_{t+1}$ is the dependent variable, the coefficients on both $HHI_{\text{Sales}}$ and $HHI_{\text{Sales2}}$ are estimated insignificantly (Column 7).²⁷ However, when we use ROA with two leads, $ROA_{t+2}$ as dependent variable, the coefficient on $HHI_{\text{Sales}}$ is again positive and significant and the coefficient on $HHI_{\text{Sales2}}$ negative and significant indicating a concave relationship between profitability and competition (Column 8). Hence, as expected, it seems to take some time for the effect of competition to be reflected in the firms’ profitability.

As a final robustness check, we drop the firm fixed effects and only include industry and year dummy variables in our regression equations. As explained in Section 4.2.1, when firm fixed effects are included, all but two of the industry dummy variables based on the one-digit SIC code drop out of all regression specifications due to the limited time-variability of the industry dummy variables. First, we use seven industry dummy variables based on one-digit SIC codes. Second, we alternatively use 14 industry dummy variables which are based on the market sector classification of the Swiss Exchange (SWX). Again, the results remain qualitatively unchanged and, therefore, are not reported in a table.

### 4.3.2. The problem of endogeneity: a simultaneous equations analysis.

A possible concern with respect to our OLS results is that some of our right-hand-side variables are correlated with the error term of the respective equation and, thus, that our results are affected by a possible endogeneity of some of the variables included in our regression equations (e.g., see Agrawal and Knoeber, 1996; Beiner et al., 2006).²⁶ When we reestimate the regressions reported in Table 6 with $Payperf$ instead of $Soratio$ as dependent variable, the results remain qualitatively similar and even turn somewhat stronger in certain regressions. To save space, we do not report them in a table. However, they are available from the authors upon request.²⁷ Similarly, unreported tests show that the coefficients on $HHI_{\text{Sales}}$ and $HHI_{\text{Sales2}}$ are both insignificant when the contemporaneous ROA-measure is the dependent variable.

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²⁶ When we reestimate the regressions reported in Table 6 with $Payperf$ instead of $Soratio$ as dependent variable, the results remain qualitatively similar and even turn somewhat stronger in certain regressions. To save space, we do not report them in a table. However, they are available from the authors upon request.

²⁷ Similarly, unreported tests show that the coefficients on $HHI_{\text{Sales}}$ and $HHI_{\text{Sales2}}$ are both insignificant when the contemporaneous ROA-measure is the dependent variable.

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Table 7
Robustness tests – fixed effects regressions of Tobin’s Q on different measures of product market competition and the percentage of share-based to cash compensation.

This table reports estimates from fixed effects regressions of firm value on alternative measures of product market competition as defined in Section 3.1.1 (and their quadratic terms) along with the percentage of share-based to cash compensation, four additional corporate governance mechanisms, and control variables. The measure of firm value is Tobin’s Q in Columns 1 to 5, the market-to-book ratio (M/B) in Column 6, ROA with one lead (ROA_{t+1}) in Column 7, and ROA with two leads (ROA_{t+2}) in Column 8. All regressions include firm and year fixed effects and industry dummy variables based on the first-digit SIC code (the coefficients are not reported). The t-values (in parentheses) are based on the cluster-robust variant of the Huber-White sandwich estimator, which accounts for the dependence of observations within clusters (different year-observations for one specific firm). ***/** denotes statistical significance at the 1%/5%/10% level.

| Dep. variable: | Tobin’s Q | M/B | ROA_{t+1} | ROA_{t+2} |
|---------------|-----------|-----|-----------|-----------|
|               | (1)       | (2) | (3)       | (4)       | (5)       | (6)       | (7)       | (8)       |
| Constant      | 0.636***  | −0.092 | 0.529***  | 1.376***  | 1.537***  | −0.642 | 0.203 | 0.424*** |
|               | (5.989)   | (−2.347) | (7.675)   | (9.067)   | (8.776)   | (−0.271) | (0.810) | (3.693)   |
| HHI_Employees | 0.956**   | −1.310** | 1.167***  | −0.394**  |       |       |       |       |
|               | (2.347)   | (−2.354) | (3.494)   | (−2.287)  |       |       |       |       |
| HHI_Assets    |           |       |           |           |       |       |       |       |
| HHI_Assets2   |           |       |           |           |       |       |       |       |
| Med(EBEI/Sales)|           |       |           |           |       |       |       |       |
| Med(EBEI/Sales2)|           |       |           |           |       |       |       |       |
| Rents         |           |       |           |           |       |       |       |       |
| Rents2        |           |       |           |           |       |       |       |       |

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| Dep. variable: | Tobin's Q | M/B | ROA$_{t+1}$ | ROA$_{t+2}$ |
|--------------|-----------|-----|-------------|-------------|
| HHI_Sales    | (1)       | (2) | (3)         | (4)         |
|              | 1.855**   | 1.144** | 0.019  | 0.250***    |
|              | (2.164)   | (1.975) | (0.170) | (10.578)    |
| HHI_Sales2   | (5)       | (6)  | (7)         | (8)         |
|              | -1.454**  | -1.888* | -0.082 | -0.575***    |
|              | (-2.042)  | (-1.669) | (-0.597) | (-8.254)    |
| Soratio      | (11.775)  | (12.242) | (11.629) | (13.987)    |
|              | 0.394***  | 0.391*** | 0.389*** | 0.406***    |
|              | (11.249)  | (11.097) | (10.569) | (12.175)    |
| Stocksod     | (8.358)   | (8.344) | (8.113)    | (5.351)     |
|              | 1.676***  | 1.675*** | 1.662*** | 1.373***    |
|              | (1.975)   | (1.975) | (1.975)    | (1.975)     |
| Stocksod2    | (3.358)   | (3.344) | (3.113)    | (5.167)     |
|              | -2.123*** | -2.115*** | -2.099*** | -1.824***   |
|              | (-4.831)  | (-4.758) | (-4.662) | (-3.894)    |
| Blocko       | 0.070     | 0.069  | 0.059      | 0.009       |
|              | (1.466)   | (1.491) | (1.195)    | (0.204)     |
| Leverage     | -0.455*** | -0.457*** | -0.453*** | -0.298*     |
|              | (-3.131)  | (-3.199) | (-3.190) | (-1.788)    |
| Outsider     | 0.079     | 0.080  | 0.081      | 0.087       |
|              | (0.585)   | (0.601) | (0.607)    | (0.687)     |
| Lnassets     | 0.030*    | 0.031* | 0.031*     | 0.014       |
|              | (1.848)   | (1.843) | (1.850)    | (0.679)     |
| Pgrowth      | 0.399***  | 0.402*** | 0.400*** | 0.452***    |
|              | (14.612)  | (15.145) | (15.503) | (13.301)    |
| Beta         | 0.148***  | 0.148*** | 0.147*** | 0.166***    |
|              | (11.583)  | (11.901) | (12.434) | (10.323)    |
| R² (within)  | 0.266     | 0.266  | 0.266      | 0.263       |
| Obs.         | 625       | 625    | 625        | 600         |
| Firms        | 204       | 204    | 204        | 199         |
Specifically, the significant coefficients on $Q$ in the $Soratio$- and $Payperf$-equations and on $Soratio/Payperf$ in the $Q$-equations lead to the presumption that $Q$ might be endogenous in the $Soratio$- and $Payperf$-equations and $Soratio/Payperf$ in the $Q$-equations as there is reverse causality. To investigate whether our results in fact suffer from an endogeneity bias, we implement a Durbin-Wu-Hausman (DWH) test (e.g., see Hausman, 1978) on the endogeneity of $Soratio/Payperf$ and $Q$. In contrast, product market competition is no endogenous choice variable. Consequently our HHI-based measures of product market competition as well as the industry median net profit margin are exogenous variables by construction. However, $Rents$ might be endogenously determined as it is basically a measure of profitability. As already explained in Section 3.1.1., we use lagged values of $Rents$ to mitigate potential endogeneity problems. Unfortunately, we lack instruments to test (and account) for the endogeneity of $Rents$ in the $Q$-equation as all potential instruments are correlated with $Q$ as well. Consequently, we exclude $Rents$ from the analyses in this section and exclusively use the exogenous measures of competition.

The DWH test involves a two-stage procedure. In the first stage, each presumably endogenous variable (i.e., $Soratio/Payperf$ and $Q$) is regressed on all other variables included in the two regression equations, i.e., the $Soratio/-Payperf$- and the $Q$-regression. Then, predicted values for the dependent variables are calculated using the estimated coefficients from these first-stage regressions. In the second stage, each dependent variable is regressed on the predicted values of the presumably endogenous variable and the respective right-hand-side variables of that regression equation. The significance of the predicted right-hand-side dependent variable is then tested using a $t$-test with the null hypothesis of no endogeneity. For $Soratio$ and $Payperf$, the null hypothesis of no endogeneity is rejected at the 10% level indicating that $Soratio$ and $Payperf$ are endogeneously determined in the $Q$-equation. In contrast, the $t$-test cannot reject the null hypothesis for $Q$ in any of the tested specifications.

Consequently, we check the robustness of our results by estimating both regression equations simultaneously by three-stage least squares (3SLS) and accounting for a potential endogeneity of $Soratio/Payperf$ (and $Q$). The results are reported in Table 8. Panel A presents the estimates for the equation with $Soratio$ or $Payperf$ as dependent variable and Panel B those for the equation with $Q$ as dependent variable. The results from estimating simultaneously the two regression equations reported in Column 2 of Table 4 and Column 2 of Table 5 are reported in Columns 1 and 4. Columns 2 and 5 report the results from estimating the two regression equations reported in Column 5 of Table 4 and Column 4 of Table 5 simultaneously. Finally, in Columns 3 and 6, we

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28 In unreported tests, however, we find the results on $Rents$ to remain robust when we simultaneously estimate the regressions reported in Columns 5 (6) of Table 6 and Column 5 (6) of Table 7 by 3SLS and use the same instruments for $Soratio$ and $Q$ as used in Table 8.

29 Consequently, the instruments for $Q$ (in the $Soratio$- and $Payperf$-equation) are $Pgrowth$ and $Beta$ and the instruments for $Soratio/Payperf$ (in the $Q$-regression) are $CSV$, $Stdv$, and $CEOP$.

30 Alternatively, we simply instrument $Soratio$ in the $Q$-equation. The results are qualitatively identical to those obtained from estimating the system of two simultaneous equations. Therefore, we do not report them in a table for space reasons.

31 As in the DWH test, the instruments for $Q$ (in the $Soratio$- and $Payperf$-equations) are $Pgrowth$ and $Beta$ and the instruments for $Soratio/Payperf$ (in the $Q$-regression) are $CSV$, $Stdv$, and $CEOP$.
Table 8
3SLS estimates of a system of two simultaneous equations.

This table reports results from estimating variations of equations 4.1 (Panel A) and 4.2 (Panel B) simultaneously by three-stage least squares (3SLS). The instruments for $Q$ in the Soratio- and Payperf-equations (Columns 1 to 3) are $Pgrowth$ and $Beta$ and the instruments for Soratio/Payperf in the $Q$-regression (Columns 4 to 6) are CSV, Stdv, and CEOP. All regressions include year and industry dummy variables based on the first-digit SIC code (the coefficients are not reported). The numbers in parentheses are $t$-values based on two-sided tests. ***/**/* denotes statistical significance at the 1%/5%/10% level.

|                | A: Dependent variable = | B: Dependent variable = |
|----------------|------------------------|------------------------|
|                | Soratio (1)            | Payperf (2)            | Payperf (3)            | Tobin’s Q (4) | Tobin’s Q (5) | Tobin’s Q (6) |
| **Constant**   | -0.985***              | 0.024***              | 0.025***              | 3.186***      | 0.378        | 1.068         |
|                | (-4.991)                | (4.452)                | (4.080)                | (4.501)       | (0.469)      | (1.336)       |
| $HHL Sales$    | -1.652**               | -1.049**              |                       | 3.094***      | 6.092***     |               |
|                | (-2.335)                | (-2.179)               |                       | (3.685)       | (4.202)      |               |
| $HHL Sales2$   | 1.732**                | 1.057**               |                       | -2.502***     | -5.759***    |               |
|                | (2.234)                 | (2.315)                |                       | (-3.345)      | (-3.727)     |               |
| $HHL Employees$|                       | -1.033**              |                       |               |              |               |
|                |                       | (-2.294)               |                       |               |              |               |
| $HHL Employees2$|                      | 1.058**               |                       |               | -1.102***    |               |
|                |                       | (2.155)                |                       |               | (-3.412)     |               |
| $Q$            | 0.004**                | 0.003**               | 0.003**               |               |              |               |
|                | (2.184)                 | (2.077)                | (2.077)                |               |              |               |
| Soratio        |                       |                       |                       | 1.862***      |              |               |
|                |                       |                       |                       | (2.612)       |              |               |
| Payperf        |                       |                       |                       |               | 59.967**     | 43.275**      |
|                |                       |                       |                       |               | (2.101)      | (2.210)       |
| Stocksd        | -0.085                 | -0.000                | -0.001                | 1.332***      | 1.292***     | 1.403***      |
|                | (-1.276)                | (-0.160)               | (-0.327)               | (3.212)       | (2.555)      | (2.800)       |
| Stocksd2       | -0.208***              | -0.002                | -0.002                | 0.461**       | 0.064        | 0.112         |
|                | (-3.083)                | (-1.281)               | (-1.035)               | (2.174)       | (0.360)      | (0.703)       |
| Blocko         | -0.123                 | -0.003                | -0.003                | -0.355**      | -0.306**     | -0.397**      |
|                | (-1.481)                | (-1.232)               | (-1.284)               | (-2.143)      | (-2.090)     | (-2.213)      |
| Leverage       | -0.094                 | -0.000                | -0.001                | 0.061         | -0.120       | -0.137        |
|                | (-1.029)                | (-0.195)               | (-0.290)               | (0.256)       | (-0.531)     | (-0.650)      |
| Outsider       | -0.001                 | -0.000                | -0.000                | 0.035         | 0.029        | 0.033*        |
|                | (-0.862)                | (-0.495)               | (-0.597)               | (1.042)       | (1.332)      | (1.649)       |
| CSV            | 0.000                  | 0.000                 | 0.000                 |               |              |               |
|                | (1.054)                 | (0.416)                | (0.488)                |               |              |               |
| Stdv           | 0.106***               | 0.008***              | 0.007***              |               |              |               |
|                | (3.392)                 | (3.765)                | (3.758)                |               |              |               |
| CEOP           | 0.058*                 | 0.003***              | 0.003**               |               |              |               |
|                | (1.711)                 | (2.733)                | (3.164)                |               |              |               |
| $Pgrowth$      |                        |                       |                       | 0.402**       | 0.431**      | 0.387**       |
|                |                        |                       |                       | (2.224)       | (2.130)      | (2.293)       |
| $Beta$         |                        |                       |                       | 0.168***      | 0.188***     | 0.195***      |
|                |                        |                       |                       | (3.707)       | (3.637)      | (3.948)       |
| Obs.           | 204                    | 204                   | 203                    | 204           | 204          | 203           |
| Firms          | 626                    | 626                   | 633                    | 626           | 626          | 633           |
use an alternative measure of product market competition and replace \textit{HHI}\_\textit{Sales} by \textit{HHI}\_\textit{Employees}.

As a comparison with the OLS results reported in Tables 4 and 5 reveals, the simultaneous estimation of the two equations leaves the majority of the OLS results unchanged. Most importantly, the coefficients on \textit{HHI}\_\textit{Sales} and \textit{HHI}\_\textit{Employees} and their quadratic terms in the \textit{Soratio}- and \textit{Payperf}-regressions remain qualitatively unchanged (Columns 1–3) as compared to Table 4 and reveal a convex relationship between incentives and competition. In Panel B, the coefficients on \textit{HHI}\_\textit{Sales} and \textit{HHI}\_\textit{Employees} and their quadratic terms also remain qualitatively unchanged as compared to the respective OLS results in Table 5 and indicate a concave relationship between firm value and competition.

To test for the correctness of the specification of our system of two simultaneous equations, we apply the Hausman specification test (e.g., see Hausman, 1978, 1983). The test statistic is based on a comparison of the 2SLS and 3SLS estimates. Under the null hypothesis of no misspecification, the 3SLS results are consistent and efficient while the 2SLS results are consistent but not efficient. The test investigates for each equation whether the 3SLS results are inconsistent due to a misspecification in one of the other equations. Under 3SLS, the misspecification of one single equation is transmitted to all equations by the use of an inconsistently estimated covariance matrix in the third stage. In contrast, under 2SLS only the single equation that is misspecified is affected by the misspecification. Thus, the crucial assumption of the test is that at least one equation of the system is correctly specified (if this is not the case, 2SLS as well as 3SLS results are inconsistent and the Hausman specification test is not meaningful). If the null is rejected, there is a misspecification somewhere in the system. However, the test does not provide any suggestions about what has to be changed in the system. The Hausman test statistic is distributed Chi-squared with degrees of freedom equal to \( \min[k_i, p-p_i] \), where \( k_i \) denotes the number of all variables contained in equation \( i \), \( p_i \) is the number of additional exogenous variables that could be included into equation \( i \) to be exactly identified, and \( p \) is the sum of all \( p_i \)'s for all equations.

When applied to the three specifications reported in Table 8, the Hausman test statistic cannot be rejected at the 10% level for all equations of our system. Thus, under the assumption that at least one of the two equations is correctly specified, the specification of the system of two simultaneous equations cannot be rejected and hence the most efficient estimates can be obtained by applying 3SLS.

Summarising, the results in this section indicate that \textit{Soratio} and \textit{Payperf} are endogenously determined in the \textit{Q}-regression. When we account for this endogeneity and estimate a system of two simultaneous equations, we find our results to be robust. Specifically, we find a convex relation between incentives and competition and a concave relation between firm value and competition.

5. Conclusion

This paper is a further contribution to better understand the effects of competition on compensation schemes for managers and on firm valuation. While the theoretical literature offers some insights on this issue, the picture is far from being complete, and more research is clearly needed in this area. Given that the theoretical models often lead to ambiguous results, it seems especially important to provide further empirical evidence on these issues. This topic has become even more relevant with the increasing
influence of public organisations on corporate governance rules and the general insight that competition is necessary for a culture of good corporate governance. At last, increasing governmental interventions on corporate governance issues call for a good understanding of the role of public policy.

In the theoretical section we consider a principal-agent model within a Cournot setup where the manager provides unobservable effort to affect the firm’s marginal costs. The key features of our model are as follows: First, it relies neither on information effects of competition nor on relative performance evaluation. Second, it integrates strategic interaction on product markets between the firms. These features provide an accurate description of firm behaviour and lead to testable hypotheses in terms of observable variables.

The empirical part tests the main hypotheses of our theoretical model on the relationships between competition, managerial incentives and firm valuation using data on approximately 630 observations on 200 Swiss firms over the 2002–2005 period. In short, we find that a more intense product market competition as measured by a sales-based Herfindahl-Hirschman Index is associated with stronger incentive schemes for managers as measured by the fraction of share-based to cash compensation or pay-for-performance sensitivity. This result suggests that firms are operating in competitive environments on average. Moreover, we find the relation between managerial incentives and competition to be convex indicating that the marginal effect of competition on managerial incentives is increasing in the intensity of product market competition once the intensity of competition reaches a certain level. These results are consistent with hypothesis 1 and hypothesis 2 of our theoretical model. Finally and consistent with hypothesis 3 of our model, we find a negative and statistically significant effect of product market competition on firm value, indicating that a higher product market competition is associated with a lower firm value. Thus, the negative effect of lower economic rents seems to outweigh the positive effect of reducing managerial slack and increasing the managers’ effort by providing additional monitoring and increasing the threat of liquidation. Finally, when we account for a potential nonlinearity of the relationship, we find a concave relation between firm value and competition indicating that there is a turning point at which the effect of competition on firm value turns positive.

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