Agency Theory and Durable Goods: Theory and Evidence from CEO Incentive Contracts

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Abstract

This paper uncovers a heretofore unrecognized link between durability on the demand side and agency theory. The time-consistency problem induced by durability represents an opportunity for deriving and testing new implications of agency theory and optimal incentive contracts on which the empirical literature has been only partially succesful. The arguments suggest that delegation of control and the appropriate choice of managerial incentive contract – in particular, long-term compensation incentive schemes based on profits and sales, not on profits alone – can provide explicit commitment to a future schedule of production for sellers of durable goods in imperfectly competitive markets. The analysis thus examines the importance of durability on the demand side for the determination of internal contractual relationships in this type of firm. In doing so it provides a link between two important but previously unrelated literatures. The empirical implications for optimal compensation contracts are tested using data on compensation of top executives at large corporations. Consistent with the predictions of the analysis we find that the time-consistency problem of durable goods firms induces compensation practices away from strict profit maximization. In particular, it induces indexing to both profits and sales, lower elasticity of compensation to sales, longer term compensation incentives (e.g., restricted stock and stock options), greater pay-performance sensitivity, and greater relative performance evaluation.

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1 Introduction

One important question that has received a great deal of attention in the theoretical and empirical literatures on agency theory and contract economics is whether executive efforts are directed towards the proper goals, that is, whether contracts are designed to induce executives to act in shareholders' interest. This question is considered to be a fundamental one in the literatures on agency theory, contract economics and the institutional structure of production. The reasons are "that most resources in the modern economic system are employed within firms, that the economic system depends to a very considerable extent on how these organizations conduct their affairs, particularly, of course, the modern corporation" (Coase, 1992), and that executives have a great deal of power to direct resources. Unfortunately, although there is little doubt that top executives' incomes vary with the fates of their firms, the empirical evidence is mixed relative to theory. There may be several reasons for this state of affairs, although undoubtedly "the main obstacles faced by researchers in these literatures is the lack of available data on contracts and activities of firms" (Coase, 1992). Moreover, as Prendergast (1999) remarks, "the true test of agency theory is not simply that agents respond to incentives, but that the contracts predicted by the theory are confirmed by the data."[1] The problem is that contracts themselves, typically, are not public information and, hence, because of the lack of empirical evidence "what we have is a very incomplete theory" (Coase, 1992).

This paper aims to contribute to the theoretical and empirical literatures in these fields. The analysis focuses on an *observable* feature of the demand side which may induce such a strong and relevant problem in the firm that we would expect it to have a significant and *predictable* impact on the incentive contracts that are designed for executives, unless the problem can be fully solved by some other means. The analysis, therefore, represents a potentially fruitful ground for testing specific implications of agency and contract theories. More precisely, this paper uncovers a heretofore unrecognized link between product durability on the demand side and specific incentive contracts and compensation practices within the firm. The well-known time-inconsistency problem induced by durability in firms that operate in imperfectly competitive markets rests on whether they can commit to a future schedule of pro-

[1]See Gibbons (1998), Lazear (1995), Murphy (1999), Prendergast (1999), Rosen (1992), Stole (1999), and the articles in Werin and Wijkander (1992) for excellent surveys and analyses of the literatures on executive compensation, agency theory and the economics of contracts.

duction. If a commitment to future prices were not possible, the time path of prices will generally not bring forth demands that maximize the present value of current and future net revenues. This paper argues that the problem may be mitigated, at least in principle, by delegation of control and the strategic choice of managerial compensation incentives. The analysis of the specific effects of durability for optimal compensation schemes, therefore, presents a novel and potentially productive ground for finding new testable predictions, as well as supportive empirical evidence, on some specific implications of agency theory.

The advantages of bringing the role of durability to bear on these literatures are distinct. First, the consequences of this specific time-inconsistency problem for the firm can be brutal: unless this problem is solved, firms will forfeit *all* their market power. Hence, given the significant power that executives have to direct resources and given that their remuneration is a function of their marginal contribution to production, it is difficult to find a case where executive's marginal contribution to production could *ceteris paribus* have a greater impact. The primary innovation of the analysis is that it brings a previously unrecognized feature of the market where firms operate that is both observable and suitable for empirical analysis of agency theory. Perhaps more importantly, and as an anticipation of the empirical results, the general type of contracts predicted by the theory in the presence of the commitment problem induced by durability are strongly confirmed by the data. Second, much of the literature has analyzed incentives in a timeless context. There are however a number of issues (e.g., career concerns, promotions, reputation, implicit and relational contracts) where the temporal dimension is most important. The time-consistency problem induced by durability represents a new issue where the temporal dimension could also be crucial. Lastly, the analysis also offers an alternative solution to the commitment problem of durable good firms in imperfectly competitive markets. In doing so, it links two previously unrelated literatures that are both theoretically and empirically important. As will be discussed below, this 'solution' (contractual commitment) offers some advantages over other previously suggested forms to mitigate the time-consistency problem in these firms.

The rest of the introduction will briefly describe in greater detail the relevant literature on durable goods firms, strategic delegation and managerial compensation incentives.

It is by now well known that the power held by a monopolist in the production and sale of a durable good can be substantial but is significantly less than the power held by a monopolist who produces a non-durable good. In a classic paper, Coase (1972) conjectures that a monopoly seller of an infinitely durable good cannot sell output at the static monopoly level. Once the initial quantity has been sold, more profits can be made by cutting price and increasing output. Profit opportunities are exhausted at the point at which prices have fallen to marginal cost. Without some commitment or restraints to limit future production the monopolist will forfeit all his monopoly power as the market is saturated with the competitive output "in the twinkling of an eye" (Coase, 1972, p. 143). We should therefore expect the firm to use every means at its disposal to reduce its commitment problem.[2]

The problem is that in a dynamic theory of the durable-goods monopoly, the time path of prices will generally not be the one which, if a commitment to future prices were possible, would generate demands that maximize the net present value of current and future cash flows. Such a dynamic theory must therefore take into account the extent to which the monopolist can guarantee that future prices of his output will be above some minimal level. Indeed, since durable-goods firms do not typically behave as competitors, they may somehow be able to commit not to behave competitively. Coase offers three possibilities in his original article.[3] The literature has also examined other possibilities which solve or mitigate the monopolist's problem.[4] This paper suggests that the special commitment problem of the durable good monopolist (or, more generally, of any durable good firm in imperfectly competitive markets) may be mitigated, or even solved, by making use of the separation of ownership and control—that is, of the delegation of control that is often observed in modern corporations—and by the strategic choice of specific managerial compensation incen-

[2] An important body of literature has been concerned with the question of whether and to what extent the Coase conjecture holds in different scenarios. See, for instance, Stokey (1981), Bond and Samuelson (1984), Gul, Sonnenschein and Wilson (1986), Kahn (1986), Ausubel and Deneckere (1989), Bagnoli, Salant and Swezbinski (1989), Olsen (1992), and Khun and Padilla (1996).

[3] These possibilities are: the monopolist can commit not to sell additional output; the good can be rented rather than sold; or the monopolist can enter into a repurchase agreement with the buyer whereby he will repurchase the good if ever a lower price is observed in the market.

[4] For instance: capacity restrictions (Bulow, 1982); the establishment of exclusive contracts in servicing his product, that is, the development or transfer of his monopoly power to services, which are non-durable (Bulow, 1982); "planned obsolescence," that is, choice of product durability (Bulow, 1986); and the use of best-price provisions that guarantee buyers that the prices they pay are the lowest available—if better terms are subsequently found, the monopolist must refund the difference between the original price and the new lower price (Butz, 1990).

tives. The relevance of the time-consistency problem induced by durability, therefore, offers a potentially fertile ground for testing specific implications of the literatures on strategic delegation, executive compensation, and contract theory for the optimal incentive contracts for top executives.

Economists have long debated about the objective function of corporations. Traditional economic theory treated firms as economic agents with the sole objective of profit maximization. However, during the last decades, as economists began to consider seriously the fact that the modern corporation is characterized by a separation of ownership and control, the analysis of the firm's objective function began to focus on managerial objectives and the owner-manager relationship. This relationship is typically described as a standard principal-agent problem where the manager's objective depends on the structure of incentives that his owner designs to motivate him. The incentive scheme often implies managerial incentives different than profit maximization as managerial compensation is usually indexed to profits, sales, relative performance, quality, and other variables. In fact, a significant amount of literature on strategic delegation has argued quite persuasively that the choice of managerial incentives often includes strategic elements, in addition to the standard incentive elements.[5] A principal may indeed benefit by hiring an agent and giving him incentives to maximize something other than the principal's payoff function when such an action creates strategic advantages (d'Aspremont and Gerard-Varet, 1980).[6] Vickers (1985) clearly states these points: "In fact the question of strategic delegation is equivalent to questions of strategic voting and incentive compatibility. ... The fact that delegation can have strategic advantages has a bearing on several issues on the theory of the firm. ... Indeed the separation [of ownership from control] may be in some cases essential for the credibility of some threats, promises and commitments."[7]

[5]See, for instance, Holmström (1979) on the standard incentives problems, where the principal is concerned only with the actions of his agent.

[6]This new angle on principal-agent models has generated a substantial body of theoretical and empirical literature and provides a new rationale for the existence of managers. The literature has examined the strategic value of publicly observable managerial incentive contracts based on sales and profits (not profits alone) and concludes that this class of incentive schemes can be used to change a firm's strategic position in the market. For instance, an owner's optimal choice of managerial incentives may depend on rival managers' choices, (e.g., in duopolistic markets (Fershtman (1985), Vickers (1985), Fershtman and Judd (1987a, 1987b), Sklivas (1987)), may serve to deter entry (Sen, 1993), or may serve to "create" leadership (Basu, 1995).

[7]See Basu (1993) for a review of this literature.

This paper focuses on a very specific promise or commitment problem which may indeed, at least theoretically, be solved by the separation of ownership from control and the appropriate choice of managerial incentive contracts. The managerial incentive schemes examined are those indexed to profits and sales that have been analyzed and reported in the literatures on managerial compensation and contract theory. Other types of contracts may certainly be considered as well. Of course, besides the theoretical relevance, the actual empirical relevance of the problem for these literatures clearly depends on the extent to which owners of durable good firms can solve the problem more cheaply by some other means. The analysis thus represents a valuable opportunity for testing specific implications for the determination of internal contractual relationships in these firms. Coase's (1972) original exposition does not quite suggest the effects that durability may have in the contractual arrangements *within* the firm. However, he was very close, as he does indeed suggest that turning control of quantities to a third *external* party "who is *less* concerned about money making than [the monopolist] is" (p.145) might solve the commitment problem of the monopolist. Such an arrangement is, in essence, very similar to the one examined here which instead points to *internal* contractual relationships in the firm.[8]

We test the predictions empirically using data on compensation of executives at large corporations. Consistent with the predictions of the analysis we find substantial empirical confirmation that the time-consistency, commitment problem of durable-goods firms induces some distortions away from strict profit maximization. In particular, as predicted by the theoretical analysis, it induces longer term compensation incentives (e.g., restricted stock and stock options), indexing to profits and sales, lower elasticity of compensation to size, greater pay-performance sensitivity, and greater relative performance evaluation. These results provide strong evidence as to how the returns to executive effort vary with product durability and demonstrate the empirical relevance of the Coase conjecture for managerial compensation. They also provide an endorsement of the principal-agent model of executive compensation for which, despite its central importance to the modern theory of the firm and corporate governance, existing empirical evidence is only weakly supportive.

[8]For instance, Coase suggests turning over control of quantities (of land in his example) to a third external disinterested party such as the government for public use. This and other types of arrangements, as he acknowledges, need to be legally enforceable (i.e., irreversible).

In summary, the analysis brings a novel, *observable* feature of markets to bear on the literatures on agency theory, contract economics, and executive compensation, a feature that gives us the opportunity to derive and test new predictions for agency theory and the institutional structure of production. The rest of the paper is organized as follows. Section 2 is devoted to the theoretical analysis. It is divided into three subsections. In the first one we set out a Bulow-type model for the case of a durable-goods monopolist and solve for the optimal managerial incentive scheme that will commit the firm to a future schedule of production that will guarantee the profits of a monopolist renter. This allows us to generate in a transparent way the qualitative nature of the main insights of the analysis. In the second subsection we provide a brief discussion of the main features of the results and their theoretical and empirical implications. In the last subsection we extend the theoretical analysis to a simple oligopolistic model of strategic competition in order to examine how strategic competition may interact with the problems induced by durability in the design of incentive contracts and derive additional empirical predictions. In Section 3 we test the predictions empirically using data on compensation of executives at large corporations and discuss in detail the findings and their implications. Section 4 concludes with a brief summary and some possible extensions of the analysis.

2 Theoretical Analysis

2.1 Durable Goods Monopolists

It is well known in the literature that, in general, when the monopolist seller of a durable good can commit to a future schedule of production, benefits are greater than when he cannot, and that when such a commitment is possible he produces the same quantities as a monopolist renter.[9] The purpose of this section is to show that there exists an incentive compensation scheme that the monopolist of a durable good can offer to a manager so that he can commit to the same schedule of production as in the case in which the good can be rented, thereby guaranteeing himself the same profits

[9] This is not always the case. Bucovetsky and Chilton (1986) and Bhatt (1989), for example, examine certain cases in which the monopolist with commitment ability does not behave as a monopolist renter. In the model analyzed in this paper, when the monopolist has the ability to commit to a future schedule of production, he produces the quantities that would be produced by the monopolist renter. For this reason, we will refer to this case hereafter as the monopolist renter and to the monopolist without commitment ability as the monopolist seller.

as the monopolist renter, except for the compensation he will pay the manager. The strategy for the proof is as follows. We start by presenting the differences between the monopolist seller and the monopolist renter. First, the model is solved in the case in which the monopolist is able to commit to a future schedule of production or, equivalently, when he is able to rent his product rather than sell it. Second, the model is solved when the monopolist has no ability to commit to a future schedule of production and hence behaves as a seller. The quantities in the case where the monopolist can commit are then used to determine the optimal incentive contract that may be offered to the manager.

The model is a version of the standard two-period model of Bulow (1982) which is often employed in the literature on the durable-goods monopolist. The main virtue of the model is its tractability and transparency to generate in a clear way the qualitative nature of the theoretical insights of the analysis.[10] The good produced is assumed to be perfectly divisible and does not depreciate over time. Purchasers are price takers and have perfect foresight. There is perfect and complete information about the demand and production costs. A perfect second-hand market exists. The inverse demand for the services yielded by the good is constant and equal to $p = e - fx$, where $e > f > 0$ are constants, x denotes the cumulative quantity of the good produced to date, and p denotes the one-period rental price. There are two discrete periods of time, $t = 1, 2$, and production occurs only at the beginning of each period. The monopolist produces at a marginal cost c_t in period t, and marginal costs can decrease over time, that is, $c_1 \geq c_2$.[11] The discount factor is denoted by v, and $0 < v \leq 1$. Let x_1^i denote the quantity produced by the monopolist renter ($i = R$) and by the monopolist seller ($i = S$) in period 1, and x_2^i the cumulative production level, that is the quantity produced in period 1 plus the quantity produced in period 2, of the monopolist renter ($i = R$) and the monopolist seller ($i = S$). Next, two cases are considered. We consider first the case of the monopolist renter and second the case of the monopolist seller.

A. Monopolist Renter:

This type of monopolist can commit to a future schedule of production and hence

[10] See the discussion in Bulow (1982) for the particular advantages and inconveniences with this two-period model which, however, will not affect the qualitative nature of the results.

[11] This assumption can be justified by technological progress.

will produce the quantities that solve the following problem:

$$\max_{x_1,x_2} \left[e - fx_1 + v(e - fx_2) - c_1\right] x_1 + v(e - fx_2 - c_2)(x_2 - x_1)$$

subject to

$$x_2 \geq x_1.$$

The production in the first period, x_1^R, and the cumulative production in the second period, x_2^R, that solve this problem are:

$$x_1^R = \frac{e-c_1+vc_2}{2f}\ ;\ x_2^R = \frac{e-c_2}{2f} \qquad \text{if } c_1 \geq (1+v)c_2,$$

$$x_1^R = x_2^R = \frac{(1+v)e-c_1}{2f(1+v)} \qquad \text{if } c_1 < (1+v)c_2.$$

In the first case, the decrease in marginal costs is such that the monopolist renter finds it optimal to produce more units in the second period and to decrease the price ($x_2^R > x_1^R$). We will consider only parameters so that the monopolist is interested in producing in the first period since, otherwise, there is no commitment problem. That is, we will restrict our attention to the cases in which $e - c_1 + vc_2 > 0$ and $(1 + v)e - c_1 > 0$, respectively.

B. Monopolist Seller:

This type of monopolist cannot commit to a future schedule of production, so he chooses the intertemporally consistent plan of production that maximizes the present value of revenues minus costs. Therefore, the model must be solved by backward induction. The monopolist will thus solve sequentially the following problems. First find at time $t = 2$ the x_2 that, given x_1, maximizes the profits of that period:

$$\max_{x_2}\ (e - fx_2 - c_2)(x_2 - x_1)$$

subject to

$$x_2 \geq x_1.$$

Then, at time $t = 1$, find the x_1 that maximizes the present value of total profits, that is:

$$\max_{x_1}\ \left[e - fx_1 + v(e - fx_2(x_1)) - c_1\right] x_1 + v[e - fx_2(x_1) - c_2](x_2(x_1) - x_1).$$

Simple algebra shows that the solutions, x_1^S and x_2^S, to these problems are:

Case I: If $0 \leq (1+\frac{v}{2})e + c_1 - (2+\frac{3v}{2})c_2$, then:

$$x_1^S = \frac{2(e - c_1 + vc_2)}{f(4+v)};\ x_2^S = \frac{(6+v)e - 2c_1 - (4-v)c_2}{2f(4+v)}.$$

Case II: If $(1+\frac{v}{2})e + c_1 - (2+\frac{3v}{2})c_2 \leq 0 \leq (1+v)e + c_1 - 2(1+v)c_2$, then:

$$x_1^S = x_2^S = \frac{e - c_2}{f}.$$

Case III: If $(1+v)e + c_1 - 2(1+v)c_2 \leq 0$, then:

$$x_1^S = x_2^S = \frac{(1+v)e - c_1}{2f(1+v)}.$$

In Case III, as $x_1^R = x_1^S$ and $x_2^R = x_2^S$, no manager needs to be hired nor does the monopolist need to take any other measure. The reason is that there is no commitment problem and the monopolist seller can obtain the same profits as the renter. Note also that Case I includes those cases in which $c_1 \geq (1+v)c_2$, and that in Cases I and II the total production of the seller is greater than that of the renter.[12] Obviously, the profits of the monopolist who can commit are greater than the profits of the monopolist who cannot. Therefore, the monopolist seller would like to produce the same levels as the renter.

Next, given the evidence from the theoretical and empirical literatures on delegation of control and managerial compensation incentives, we consider linear incentive compensation contracts that are a function of profits π_t and sales s_t, and not a function of profits alone, which the monopolist can offer a manager to attain the output and profit levels that would be obtained if he were able to rent his product. The contract has to be legally enforceable, irreversible and observable. This is the typical type of contract that is analyzed in the literature on the strategic design of management compensation incentives (e.g., Vickers (1985), Fershtman and Judd (1987a),

[12]Because of the nature of the model both the quantities produced in period 1 and the cumulative production in period 2 will always be greater if the monopolist behaved as a competitive firm than the quantities produced by the monopolist seller. In other words, because of the nature of the model, the monopolist seller does not quite behave as he would if he were perfectly competitive. The competitive quantities are $x_1 = \frac{e-c_1+vc_2}{f}$ and $x_2 = \frac{e-c_2}{f}$ if $c_1 \geq (1+v)c_2$, and $x_1 = x_2 = \frac{(1+v)e-c_1}{f(1+v)}$ if $c_1 < (1+v)c_2$.

Sklivas (1987), Sen (1993), Basu (1995), Bárcena and Espinosa (1996)).[13]

The contract is such that the monopolist will pay the manager the quantity $A_t + B\Phi_t$ in period t, $t = 1, 2$, where A_t and B are constants, $B > 0$, and $\Phi_t = \alpha_t \pi_t + (1 - \alpha_t)\ s_t = \alpha_t(p_t - c_t)(x_t - x_{t-1}) + (1 - \alpha_t)p_t(x_t - x_{t-1})$ with $x_0 = 0$. This type of contract is denoted by $(A_1 + B\Phi_1,\ A_2 + B\Phi_2)$, and the manager is assumed to maximize the present value of his compensation in each period.[14]

The following proposition proves the existence of contracts of this kind that solve the commitment problem of the monopolist seller (in Case III the problem does not exist), in the sense that the quantities produced by the monopolist seller, and hence his profits, will be equal to those of the monopolist renter, except for the manager's compensation.

PROPOSITION. *There exists a contract $(A_1 + B\Phi_1,\ A_2 + B\Phi_2)$ that can be offered to a manager such that, except for the manager's compensation, a monopolist seller of a durable good will guarantee himself the benefits of a monopolist renter.*

Proof: Each period the manager maximizes the present discounted value of his compensation. That is, at $t = 1$ he maximizes $A_1 + B\Phi_1 + v[A_2 + B\Phi_2]$, and at $t = 2$ he maximizes $A_2 + B\Phi_2$. Equivalently, as A_1, A_2 and $B > 0$ are constants, he maximizes the value of $\Phi_1 + v\Phi_2$ at $t = 1$ and the value of Φ_2 at $t = 2$. Therefore, the manager is subject to the same problem of intertemporal inconsistency as the monopolist.[15]

[13] As Fershtman and Judd (1987a, 1987b) and Holmström and Milgrom (1987) argue, the restriction to linear contracts is not unreasonable and the qualitative nature of the results of their papers, as well as of this paper, is unaffected by it. With regard to the public availability, observability, or common knowledge, of the managerial contract, this assumption is a natural one since the "owner will want its manager's incentives to be common knowledge" (Fershtman and Judd, 1987a, p. 930). Katz (1991) and Aggarwal and Samwick (1999a) analyze the extent to which even unobservable contracts can also serve as precommitments.

[14] The monopolist calculates the optimal values of α_1 and α_2, α_1^* and α_2^*, yielding the optimal values of Φ_1 and Φ_2. He then determines the constants A_1, A_2 and B such that the manager's compensation evaluated at α_1^* and α_2^* equals the manager's opportunity cost in each period and, hence, the present discounted value of his reservation wages in each period. As a result, when the owner offers such an incentive scheme in a take-it-or-leave-it fashion, he is able to get all the rents from his relationship with the manager.

[15] As is well known, if the monopolist seller overproduces at time $t = 2$, losses are suffered by the purchasers of the first period, whereas if the monopolist renter overproduces he suffers the losses

We need to show that there exists at least one incentive contract, indexed to profits and sales, that may be offered to the manager so that the present discounted value of the manager's compensation is maximized at the amounts of output that would be chosen by a monopolist renter, and that this schedule of production is intertemporally consistent for the manager. The problem thus amounts to finding the incentive parameters α_1^* and α_2^* such that the manager will choose to sell the quantities of the monopolist renter and, therefore, that will generate to the firm the same benefits as those of the rental case. In order to find the α_1^* and α_2^* that characterize the optimal incentive compensation scheme, we need to solve the problem by backward induction. At time $t = 2$, given x_1, the manager will solve:

$$\max_{x_2} \ \alpha_2[(e - fx_2 - c_2)(x_2 - x_1)] + (1 - \alpha_2)[(e - fx_2)(x_2 - x_1)]$$

subject to

$$x_2 \geq x_1.$$

From the first order condition of this problem,

$$e - 2fx_2 + fx_1 - \alpha_2 c_2 + \lambda = 0,$$

it can be shown that:

- If $c_1 \geq (1 + v)c_2$, since $x_1^R = \frac{e - c_1 + vc_2}{2f}$ and $x_2^R = \frac{e - c_2}{2f}$ then

$$(1 - \alpha_2^*)c_2 + f\frac{e - c_1 + vc_2}{2f} = 0 \ \Rightarrow \ \alpha_2^* = \frac{e - c_1 + (2 + v)c_2}{2c_2} > 1.$$

- If, on the other hand, $c_1 < (1 + v)c_2$, since $x_1^R = x_2^R = \frac{(1+v)e - c_1}{2f(1+v)}$, then intertemporal consistency requires a scheme of sales such that

$$\frac{e - \alpha_2 c_2}{2f} + \frac{x_1^R}{2} \leq x_1^R.$$

  If, for instance, we consider the case in which the equality holds (that is, when $\lambda = 0$), we have that

$$\alpha_2^* = \frac{(1 + v)e + c_1}{2(1 + v)c_2} > 1.$$

on old units himself. Therefore, the monopolist seller is not subject to losses from overproduction, while the monopolist renter is. Consumers, however, will take into account any incentives for overproduction the monopolist may have when determining the price they will pay for the good and, hence, they will force the monopolist to internalize the effects of overproduction.

At time $t = 1$ the manager will solve for the x_1 that maximizes the present value of his compensation, so he will solve the following problem:

$$\max_{x_1} \alpha_1 \left[e - fx_1 + v(e - fx_2(x_1)) - c_1\right] x_1 + (1-\alpha_1) \left[e - fx_1 + v(e - fx_2(x_1))\right] x_1$$
$$+ v\alpha_2[e - fx_2(x_1) - c_2][x_2(x_1) - x_1] + v(1 - \alpha_2)[e - fx_2(x_1)][x_2(x_1) - x_1].$$

Using the envelope theorem, we have that when $\lambda = 0$:

$$e - 2fx_1 - \alpha_1 c_1 - vfx_1 \frac{dx_2}{dx_1} + v\alpha_2 c_2 = 0.$$

Therefore,

- If $c_1 \geq (1 + v)c_2$, since $x_1^R = \frac{e - c_1 + vc_2}{2f}$, $\alpha_2^* = \frac{e - c_1 + (2+v)c_2}{2c_2}$, and $\frac{dx_2}{dx_1} = \frac{1}{2}$, then we obtain that
$$\alpha_1^* = \frac{ve + (4 - v)c_1 + v^2 c_2}{4c_1} > 1.$$
- If $c_1 < (1 + v)c_2$, since $x_1^R = \frac{(1+v)e - c_1}{2f(1+v)}$, and $\alpha_2^* = \frac{(1+v)e + c_1}{2(1+v)c_2}$ with $\frac{dx_2}{dx_1} = \frac{1}{2}$ we obtain
$$\alpha_1^* = \frac{v(1 + v)e + (4 + 3v)c_1}{4(1 + v)c_1} > 1. \blacksquare$$

This proposition has proven that there is a linear compensation scheme based on profits and sales that may be offered to a manager so that the durable-good monopolist will commit to the production schedule of the monopolist renter, and that as a result he will be able to obtain the maximum possible profits, except for the manager's compensation. If $c_1 \geq (1 + v)c_2$ then the incentive parameters of this scheme are both greater than one and equal to

$$(\alpha_1^*, \alpha_2^*) = \left(\frac{ve + (4 - v)c_1 + v^2 c_2}{4c_1}, \frac{e - c_1 + (2 + v)c_2}{2c_2}\right)$$

If, on the other hand, $c_1 < (1 + v)c_2$ then the incentive parameters

$$(\alpha_1^*, \alpha_2^*) = \left(\frac{v(1 + v)e + (4 + 3v)c_1}{4(1 + v)c_1}, \frac{(1 + v)e + c_1}{2(1 + v)c_2}\right)$$

will guarantee to the monopolist the maximum possible profits.[16]

[16] Note that these incentive parameters are not unique in this case as it can be proven that when

2.2 Discussion

It is worthwhile to analyze in more detail some of the features of the incentive compensation contract and to discuss some initial empirical implications of the analysis.

First, commitment has been achieved by an irreversible managerial contract. The general purpose of contractual commitment is simply to make announced strategies compulsory *ex post*. The usefulness of contracts thus often requires, in addition, the ability of the contracting parties to commit to abstain from taking advantage of Pareto-improving renegotiations that might arise after the contract has been signed. This is the reason why the contract has to be irreversible (renegotiation-proof), that is either renegotiations are not feasible or are costly enough (in monetary penalties or in reputation terms) to be rendered unprofitable to the parties. In some cases, Pareto-improving renegotiations may simply not be incentive compatible, especially in cases of incomplete information (see the analysis in Dewatripont (1988)). In other cases, the commitment problem may be solved or mitigated, as Shleifer and Summers (1988) suggest, by hiring an *honest* manager who wants to honor the firm's contracts and then entrenching the manager to preclude any renegotiation of the incentive contract *ex post*. As a result, shareholders cannot renegotiate the contract (because of managerial entrenchment it is renegotiation-proof) and the *honest* manager does not want to renegotiate.[17]

Second, the contract must be long-term insofar as it will last for the two periods (the durability of the good being produced) as opposed to short-term (for only one period). Long-term contracts are valuable when optimal contracting requires commitment to a plan today that would not otherwise be adopted tomorrow. Contract theory offers several reasons for the use of long-term instead of short-term contracts.[18]

$\lambda > 0$ the following set of parameters will also guarantee the same profits to the monopolist:

$$(\alpha_1^*, \alpha_2^*) = \begin{cases} \alpha_1^* \in \left[1, \frac{v(1+v)e+(4+3v)c_1}{4(1+v)c_1}\right] \\ \alpha_2^* = \begin{cases} \frac{(1+v)e+c_1}{2(1+v)c_2} & \text{if } \alpha_1^* > 1 \\ \frac{(1+v)e+c_1}{2(1+v)c_2} + \varepsilon, \ \varepsilon \geq 0 & \text{if } \alpha_1^* = 1 \end{cases} \end{cases}$$

Obviously, the monopolist, the manager and consumers are indifferent among any of these incentive parameters.

[17] As Shleifer and Summers (1988) acknowledge, an effective market for corporate control may undermine this incentive scheme.

[18] See, for instance, Williamson (1985), Crawford (1988), Fudenberg, Holmström, and Milgrom

This analysis offers an additional, novel reason for the possible use of long-term contracts in agency theory, namely, their ability to provide a commitment to a future schedule of production for durable goods monopolists.[19] As an empirical implication, this result suggests that the greater the durability *ceteris paribus* the longer the term of the compensation incentives should be observed.

Third, the incentive parameter of the contract for the first period, α_1^*, is greater than or equal to one, and for the second period, α_2^*, is always greater than one. This means a positive sensitivity to profits and, conditioning on it, a negative sensitivity to sales. The rationale behind this result is as follows. The problem of the monopolist seller is that he cannot commit to limiting his production in the future. As Bulow (1982, pp. 321-23) remarks, a form of mitigating his commitment problem is to choose technologies in which he spends "too little" on fixed costs and "too much" on marginal costs relative to the monopolist renter. High marginal costs are a signal of lower future output and thus of high prices. As a result, "this high-cost strategy is still more profitable because a commitment to hold down future output is effectively developed" and "the firm is therefore willing to sacrifice efficiency to achieve this result." The solution suggested in our analysis is, in essence, very similar to this one, as the monopolist would be able to produce x_1^R and x_2^R only if he could credibly behave *as if* his marginal costs in the second period were greater than c_2. Note that the problem the manager solves is the same as the one that would be credibly solved by the monopolist himself *if* his marginal costs were $\alpha_1^* c_1$ and $\alpha_2^* c_2$. As $\alpha_2^* > 1$, high marginal costs in the second period act as a commitment to lower future output and thus higher prices. As a result, by offering such an incentive compensation scheme to the manager, the monopolist is able to *behave as* he would in a "high-cost strategy" with no need to actually sacrifice efficiency in production.

(1990), Rey and Salanie (1990), Sen (1993), and Bárcena and Espinosa (1996).

[19] In general, the optimal compensation contracts will always last for the two periods. Obviously, intertemporal consistency guarantees that no contract lasting only for period 1 can be optimal as it would not solve the monopolist's commitment problem. However, compensation contracts lasting for only period 2 can be optimal providing that they are credible. Credibility will in general require that the contract be signed before period 1 starts. If it were to be signed between periods 1 and 2 it would not be credible, since after the first-period production has taken place it is never optimal for the monopolist to hire a manager. In this sense, even such a contract for period 2 only may still be considered long-term. The incentive parameter of the typical contract for only period 2 would still be α_2^*, the optimal solution of the proposition, since the monopolist would have already produced x_1^R in period 1.

As mentioned in the introduction, the importance of durability on the demand side for the determination of internal contractual arrangements in the firm is, of course, not exclusive to durable-good monopolies. This "high-cost strategy" will also be useful for oligopolists of durable goods. Sklivas (1987) and Fershtman and Judd (1987a, 1987b) obtain that in duopolies of non-durable goods, under Cournot competition, *strategic* delegation to managers induces in this class of contracts an $\alpha_t^* < 1$, $t = 1, 2$. It is not difficult to show that if, instead, their firms were durable goods duopolies, the effect of durability would induce a greater α_2^* than for the non-durable good case, and that this effect may even be stronger than the strategic motive effect and thus result in a final α_2^* greater than 1. This issue is examined in the next subsection where we generalize the analysis to a simple model of durable-goods oligopolists.

It can also be easily shown that in this model social welfare, defined as the sum of the present value of monopolist's profits (gross of the manager's compensation) plus the present value of consumer surplus, is lower when the monopolist hires a manager and produces the quantities of a renter than when he acts as a seller.[20]

Of course, irreversible incentive contracts are not the only means by which commitment can be achieved. Other means such as sunk costs, reputation effects and those discussed in the literature (see footnotes 3 and 4) may also be feasible and even preferred. As discussed in the introduction, the analysis of the impact of durability for optimal compensation schemes is meaningful and empirically relevant only insofar as the time consistency problem cannot be completely solved by other means. In principle, however, one of the virtues of contractual commitment is its wide potential applicability, especially given the fact that top executives are typically hired because of their skills, knowledge and abilities. This form of commitment would require only a specific choice of incentives, that is a specific "distortion" of the usual incentives. Moreover, contractual arrangements are not subject to the special conditions frequently required by other solutions to be practical. For instance, Bulow (1982) and Butz (1990) discuss several instances in which goods cannot be rented and others in which repurchase agreements and best-price provisions are not feasible.[21] This type

[20]This result, however, is not robust as the literature on the durable goods monopolist has examined several scenarios in which social welfare may increase when the monopolist is able to commit to a future schedule of production. See, for example, the analyses in Bulow (1982), Malueg and Solow (1987, 1989) and Saracho (1997).

[21]Also, as Coase (1972, p. 147) observed, "some of these arrangements may not be legally en-

of contractual commitment can also be a profitable strategy relative to other means of commitment, when for example technology does not allow for sunk costs or makes them too expensive, and when reputations cannot be built because the "game" is not repeated over time or is too infrequently repeated. Under durability, therefore, *some* contractual arrangement or *some* distortion of the kind discussed here may be a less costly way of maintaining market power, one whose empirical relevance must be evaluated.

As noted earlier, the features of this two-period model do not affect the qualitative nature of the results. We emphasize that the main aim of the theoretical analysis is to show that contractual arrangements of the type suggested here are a feasible, and perhaps less costly, way of achieving a monopoly price.[22] Given an existing separation of ownership from control, compensation contracts need to be specified in any event. Note also that the two-period limitation (versus some larger number of shorter periods) may cause the theoretical results to be understated. The reason is that a significant amount of commitment is already implied by this two-period framework (see the discussion in Bulow (1986)). With a greater number of periods (or, in the limit, in continuous time) the need to commit increases but the firm may be less likely to entrench its manager for the life of a long-lived durable good.

The main empirical implications that can be derived and emphasized from the theoretical analysis, however, are that by appropriately conditioning on all other relevant aspects, we may observe that durability is an important determinant of the form of executive compensation which (a) implies a greater responsiveness (elasticity) of compensation to sales, (b) induces longer-term compensation schemes, and (c) induces a greater positive sensitivity of compensation to profits and, conditioning on profits, a negative sensitivity to sales. As a prelude to the empirical analysis in Section 4, we extend in the next subsection the theoretical analysis to the case of an oligopolistic model of durable goods where, in addition to the time-consistency problem induced by durability, *strategic* competition also plays a role in the design of incentive contracts. This allows us to obtain additional empirical implications.

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forceable." Obviously, contractual commitment, as all quantity commitments, is less attractive when future contingencies are difficult to ascertain.

[22] A plausible setting for the specific two-period Bulow model considered in the previous subsection may involve a less-than-infinitely durable good sold over only a brief period. Such a short time frame makes it unlikely that the monopolist could ever renegotiate its contract with the manager ex post and also makes it unnecessary to entrench the manager for years on end.

2.3 Durable-Goods Oligopolists

The analysis in the first subsection is extended to the case of durable-good oligopolists who compete strategically in markets. The reason is that, as shown in the literature, even when goods are non-durable, strategic competition may have an impact on the form of internal contractual arrangements in the firm. Fershtman and Judd (1987a) and others have examined the managerial compensation incentives that owners of competing firms in oligopolistic markets give their managers and show that, for strategic reasons, the incentive contract that owners (principals) will choose for their managers (agents) is not indexed solely to realized profits.[23] It is thus important to examine the simultaneous impact that both strategic considerations and the time-consistency problem induced by durability may have on executive incentive contracts.

Consider, for instance, the following simple contracting model. There are two firms in the industry, E and F, that engage in differentiated Cournot competition. The model has two stages. In the first, the owners of the firms write contracts with their managers. In the second, managers engage in differentiated Cournot competition. Contracts can be made contingent on own profits and sales, which are assumed to be observable. The demand for the services yielded by the good is constant and equal to $p^i(x^i, x^j) = e - fx^i - gx^j$, where x^i and x^j denote the cumulative quantity of the good produced to date, f and g are constants, and $i, j \in \{E, F\}$, $i \neq j$. We assume $f > g > 0$, so that the manager's action has a greater impact on the demand for his own product than does his rival's action. The contract is such that firm i will pay the manager the quantity $A_t^i + B^i \Phi_t^i$ in period t, $t = 1, 2$, where A_t^i and B^i are constants, $B^i > 0$, and $\Phi_t^i = \alpha_t^i \pi_t^i + (1 - \alpha_t^i)\ s_t^i$. The managers are assumed to maximize the present value of their compensation in each period. In the model, each owner first chooses the contract, the contract is then revealed to both managers, and then the managers choose quantities. We assume that the managerial labor market is competitive and that A_t^i , $t = 1, 2$, are chosen so that managers are always held to their reservation wages. The analysis is otherwise similar to that in Section 2.1

[23] They also remark that "in the case of a monopoly firm, the optimal [managerial] incentive structure is obviously the regular principal-agent problem since there are no opponents and in the absence of risk-sharing and asymmetric information considerations, such an owner will motivate his manager to maximize profits" (Fershtman and Judd, 1987a, p. 928). The analysis in the previous sections has shown that, while this statement is valid for non-durable goods monopolists, there is one important class of monopolies, that of durable goods, in which their particular commitment problem can make the strategic use of incentives also very important.

for monopolists. We next consider long-run incentive contracts in two different cases: duopolist renter and duopolist seller.[24]

A. Duopolist Renter

In this case, the manager of firm i solves

$$\max_{\{x_1^i, x_2^i\}} \left[e - fx_1^i - gx_1^j - \alpha_1^i c_1 + v\alpha_2^i c_2\right] x_1^i + v\left[e - fx_2^i - gx_2^j - \alpha_2^i c_2\right] x_2^i.$$

The first order conditions imply that the optimal production levels for firm i, as a function of its contracts, are such that:

$$\begin{aligned} x_1^i &= -\frac{2\alpha_1^i c_1 f - 2ef - \alpha_1^j c_1 g + eg - 2\alpha_2^i c_2 f v + vg\alpha_2^j c_2}{4f^2 - g^2}, \\ x_2^i &= -\frac{2\alpha_2^i c_2 f - 2ef - \alpha_2^j c_2 g + eg}{4f^2 - g^2}. \end{aligned}$$

Holding the managers to their reservation wages yields the following program for the firm:

$$\max_{\{\alpha_1^i, \alpha_2^i\}} \left[e - fx_1^i - gx_1^j - c_1 + vc_2\right] x_1^i + v\left[e - fx_2^i - gx_2^j - c_2\right] x_2^i$$

subject to:

$$\begin{aligned} x_1^i &= -\frac{2\alpha_1^i c_1 f - 2ef - \alpha_1^j c_1 g + eg - 2\alpha_2^i c_2 f v + vg\alpha_2^j c_2}{4f^2 - g^2}, \\ x_2^i &= -\frac{2\alpha_2^i c_2 f - 2ef - \alpha_2^j c_2 g + eg}{4f^2 - g^2}. \end{aligned}$$

The first order conditions of this problem imply that the optimal incentive parameters for the manager, α_t^{dr}, where dr denotes "duopolist renter," are:

$$\begin{aligned} \alpha_2^{dr} &= -\frac{-4c_2 f^2 - 2c_2 fg + eg^2}{(4f^2 + 2fg - g^2)\, c_2} < 1, \\ \alpha_1^{dr} &= -\frac{-4c_1 f^2 - 2c_1 fg + eg^2 + veg^2}{(4f^2 + 2fg - g^2)\, c_1} < 1. \end{aligned}$$

[24] We assume in what follows the conditions that guarantee interior solutions. These conditions imply $e > c_2$ and $e > c_1 - vc_2$.

Note that α_2^{dr} coincides with that of the case in which *ceteris paribus* the good being produced were non-durable $\left(\alpha_2^{nd}\right)$, and that α_1^{dr}would only coincide with α_1^{nd} when $v = 0$ since

$$\alpha_1^{nd} = -\frac{-4c_1 f^2 - 2c_1 fg + eg^2}{\left(4f^2 + 2fg - g^2\right) c_1}.$$

See Fershtam and Judd (1987a). Given that the durable-good duopolist renter can commit to a future schedule of production, this difference in the incentive parameters with respect to those of the non-durable good duopolist reflects "technological" aspect of durability *per se* (the amounts rented in the first period can be rented again in the second period at no cost) rather than the commitment problem that durability implies. If $f = g$, we would then be in the typical homogeneous good case.

B. Duopolist Seller

We start by analyzing the choices of each firm's managers in the differentiated Cournot game. The problem must be solved by backward induction. The manager will solve at $t = 2$:

$$\max_{\{x_2^i\}} \left[e - fx_2^i - gx_2^j - \alpha_2^i c_2\right] \left(x_2^i - x_1^i\right).$$

From the first order condition we obtain

$$x_2^i = -\frac{2\alpha_2^i c_2 f - 2ef - \alpha_2^j c_2 g + eg - 2f^2 x_1^i + fgx_1^j}{4f^2 - g^2}.$$

Then, at time $t = 1$, the manager will solve for the x_1^i such that

$$\max_{\{x_1^i\}} \left[e - fx_1^i - gx_1^j - \alpha_1^i c_1 + v\alpha_2^i c_2\right] x_1^i + v\left[e - fx_2^i - gx_2^j - \alpha_2^i c_2\right] x_2^i,$$

with

$$x_2^i = -\frac{2\alpha_2^i c_2 f - 2ef - \alpha_2^j c_2 g + eg - 2f^2 x_1^i + fgx_1^j}{4f^2 - g^2}.$$

Solving the first-order conditions for the optimal production levels as functions of contracts for firm i, we can then solve for the first stage. Firm i will choose $\{\alpha_1^i, \alpha_2^i\}$ to maximize the present value of its total profits:

$$\max_{\{\alpha_1^i, \alpha_2^i\}} \left[e - fx_1^i - gx_1^j - c_1 + vc_2\right] x_1^i + v\left[e - fx_2^i - gx_2^j - c_2\right] x_2^i.$$

If, for simplicity, we restrict our attention to the case in which $f = g$, we obtain that the optimal incentive parameters, α^{ds}, where ds denotes "duopolist seller," are

$$\alpha_2^{ds} = \frac{-27c_1 + 90c_2 + 12e - 7vc_1 + 51vc_2 + 4ve + 7c_2v^2}{3c_2\left(25 + 7v\right)},$$
$$\alpha_1^{ds} = -\frac{-270c_1 + 45e - 41c_1v + 3c_2v + 20ev + 7c_1v^2 - 28c_2v^2 - ev^2 - 7c_2v^3}{9c_1\left(25 + 7v\right)}.$$

In this case, it can be proven after some algebra that

$$\alpha_2^{ms} > \alpha_2^{ds} > \alpha_2^{dr},$$

where α_2^{ds}can be greater than one, and that

$$\alpha_1^{ms} > 1 > \alpha_1^{ds} > \alpha_1^{dr},$$

where α_t^{ms} corresponds to the incentive parameters found for the monopolist seller case. It is important to note that the empirical implications are that the sensitivity of compensation to profits (i) increases with the concentration of the industry $\left(\alpha_t^{ms} > \alpha_t^{ds}\right)$ [25] and (ii) is greater the greater the time-consistency problem induced by durability $\left(\alpha_t^{ds} > \alpha_t^{dr}\right)$. The differences between α_t^{ds} and α_t^{dr} , $t = 1, 2$, reflect the time-consistency problem induced by durability, which the duopolist renter does not face because he is able to commit, possibly by some of the means discussed by Coase and in the literature (see footnotes 3 and 4). (The resolution for the more general case where $f \neq g$ yields no different results and is available upon request.)

These results can also be obtained in a model where goods are not perfectly durable and where durability is modeled explicitly as in Bulow (1986). Let δ denote the durability of the good being produced ($\delta = 0$ for non-durable goods and $\delta = 1$ for perfectly durables) and consider $\delta > 0$. It can then be proven (see the Appendix) that:

$$\alpha_1^{ms}(\delta) > 1 > \alpha_1^{ds}(\delta) > \alpha_1^{dr}(\delta), \quad \forall\delta$$
$$\alpha_2^{ms}(\delta) > \alpha_2^{ds}(\delta) > \alpha_2^{dr}(\delta), \qquad \forall\delta,$$

where $\alpha_2^{ms}(\delta) > 1$ and $\alpha_2^{ds}(\delta)$ may be greater than 1, and that

$$\frac{d\alpha_2^{\mathrm{ds}}(\delta)}{d\delta} > 0, \quad \forall\delta,$$

[25] Since in a perfectly competitive industry $\alpha_{\mathrm{t}} = 1$, $\forall t$, then α_1 and α_2 must decrease at some point with concentration in the industry for the renter, and possibly for the seller as well. This holds for any given durability, that is for any given positive depreciation rate.

$$\frac{d\alpha_t^{\mathsf{ms}}(\delta)}{d\delta} > 0, \quad \forall\delta,\ \forall t = 1, 2.$$

Of course, $\frac{d\alpha_2^{\mathsf{dr}}(\delta)}{d\delta} = 0$ and $\frac{d\alpha_1^{\mathsf{dr}}(\delta)}{d\delta} < 0$.

Note that the assumption that durability does not affect the costs of production can be relaxed in several ways and all the results are still maintained. For instance, durability may be assumed to have an effect on the fixed costs of production or to increase the marginal costs of production as in Bulow's (1986) analysis of the oligopoly case, that is the marginal cost of production in the first period is $c_1(1 + \delta)$.

Lastly, the analysis in this subsection has considered contracts in which managers can be compensated on their own performance and own sales. Of course, other contracts may also be considered as well. For instance, it can be assumed that managers can be compensated both on their own and rival's performance and sales, in the presence of the time-consistency problem induced by durability. The results for the simpler case with non-durable goods in which managers can be compensated only on their own and rival's performance, but not on sales, is already available in the literature. Aggarwal and Samwick (1999a) examine the role that strategic interactions among firms may play for optimal compensation contracts for managers in such a case.[26] They find evidence of a positive sensitivity of compensation to rival performance which is increasing in the degree of competition in the firm's industry. It can be proven that when firms are subject to the time-consistency, commitment problem induced by durability and contracts can be written both on own and rival profits and sales, then the results will generally correspond to the "product" of the effects of durability found above and their effects, that is: (1) when firm outputs are strategic substitutes (complements), the level of compensation will tend to increase with own profits, decrease with own sales, and decrease (increase) with rival profits; (2) these effects increase in absolute terms with durability and concentration in the industry. The empirical analysis will allow contracts to be written on rival profits and sales as well. We turn to it next.

[26] They find that when outputs are strategic complements (substitutes), as in the differentiated Bertrand (Cournot) model, the level of compensation under the optimal contract increases with own-firm performance and increases (decreases) with rival-firm performance. When outputs are strategic complements, relative performance encourages more aggresive price settings, whereas when outputs are strategic substitutes the optimal contract resembles relative performance pay but is motivated by the nature of the strategic interaction.

3 Empirical Evidence

In this section we test the predictions empirically using data on compensation of executives, particularly chief executive officers at large corporations.

3.1 Data

We combine compensation data from the *Standard and Poor's Compustat ExecuComp* database with product market data from the Commerce Department's *Census of Manufactures* to test the predictions of our analysis. Other firm performance data are taken from the standard *CRSP* and *Compustat* sources. The *ExecuComp* dataset compiled by *Standard and Poor's* includes data on total compensation for the top five executives, ranked annually by salary and bonus, at each of the firms in the *S&P 500*, *S&P Midcap 400*, and *S&P SmallCap 600*. In addition to short-term compensation measures such as salary and bonus, *ExecuComp* contains data on long-term compensation such as restricted stock, stock options, stock appreciation rights, and long-term incentive plans.[27] We use the *ExecuComp* data for 1993-95 which are virtually complete.

[Table 1 here]

Table 1 provides some descriptive statistics on the components of executive compensation for all executives in the *ExecuComp* sample for 1995. At the individual level, long-term compensation accounts for about 35 percent for CEOs and 33 percent for non-CEOs of their total compensation. In the aggregate, however, long-term compensation accounts for about 52 percent of total compensation for CEOs and 49 percent for non-CEOs. This difference reflects the skewness in the distribution of long-term compensation, especially of stock options which are the most important component.

Product market competition is characterized using the Herfindahl Index industry concentration ratios which are constructed from the *1992 Census of Manufactures,*

[27]See Standard and Poor's (1995) for how the value of stock options granted is estimated by a proprietary modified Black-Scholes formula.

conducted by the Bureau of the Census as part of the quinquennial Economic Censuses. The data and documentation of the concentration ratios are found in Bureau of the Census (1996). Durability is measured by the estimated useful life of the asset. In particular we follow the estimations of the *MACRS* (*Modified Accelerated Cost Recovery System*) of the Internal Revenue Service to assign assets into one of ten "property classes." Under the *General Depreciation System* (GDS) of *MACRS* goods are assigned into one of eight property classes, defined by the number of years over which the basis of property can be recovered. These are: 3-year property, 5-year property, 7-year property, 10-year property, 15-year property, 20-year property, and residential and non-residential rental property. In addition to these, we add the perfectly non-durable (0-year) and perfectly durable properties. We then group these properties into four quartiles: non-durable property, 3-5-7 year properties, 10-15 year properties, and 20-year and perfectly durable properties. We denote these quartiles as Q1, Q2, Q3 and Q4 respectively. This normalization will allow for an easy interpretation of the parameters in the regression specifications.[28]

Profits for firm i, π_i, are defined as the present discounted value of all future cash flows that will accrue to the firm as a result of the executive's action. Following Jensen and Murphy (1990), we use the market's estimate of the total real dollar returns to shareholders on their holdings at the beginning of the period. Own performance for firm i is defined as

$$\pi_{it}^{o} = \theta_{it} V_{i,t-1},$$

where θ_{it} is the total inflation-adjusted return to shareholders and $V_{i,t-1}$ is the beginning of period market value of firm i. The total inflation-adjusted return to shareholders of rival firms k in the same SIC code is defined as

$$\theta_{-i,t} = \frac{\sum_{k \neq i} \theta_{kt} V_{k,t-1}}{\sum_{k \neq i} V_{k,t-1}}.$$

[28] Details can be found in Publication 946 of the IRS, especially in Section 3 and in its Table of Class Lives and Recovery Periods of Appendix B. We also implemented our regressions using the number of years of the corresponding Class Lives and using deciles rather than quartiles. The qualitative nature of the results remained unchanged. Some representative industries on the basis of 4-digit SIC codes within each quartile are the following. For non-durable property (Q1): Business Services, Personal Services, Food Products, Petroleum and Natural Gas; for 3-5-7 year property (Q2): Computers, Textiles, Medical Equipment; for 10-15 year property (Q3): Automobile and Trucks, Defense, Rubber and Plastic Products; for 20-year and durable property (Q4): Precious Metals; Steel Works; Construction and Construction Material.

The measure of rival-firm performance is

$$\pi_{it}^r = \theta_{-i,t} V_{i,t-1}.$$

Rival-firm performance is the hypothetical dollar return to shareholders of firm i if it experienced the value-weighted average return of other firms in its industry. Own sales are denoted by S_{it}^o and rival sales, which are also calculated in a value-weighted fashion, by S_{it}^r. Industry concentration is measured by the sample cumulative distribution of the Herfindahl index across 4-digit SICs, denoted by $F(H)$.[29] In the sample, the Herfindahl index for the least concentrated industry is 15, for the median industry it is 491, and the maximum Herfindahl is 2999. Therefore, we use the normalization $F(15) = 0$, $F(491) = 0.50$ and $F(2999) = 1$. This normalization also allows for an easy interpretation of the parameters in the regression specifications.[30] Table 2 provides 4-digit SIC concentration ratios by 2-digit SIC codes for manufacturing firms.

[Table 2 here]

3.2 Testing the Empirical Implications

The theoretical results in the previous section show that *ceteris paribus* durable goods firms would want to structure compensation that (1) is more tied to profits *and* sales, (2) is longer-term, (3) has greater pay-performance sensitivity, and (4) has greater relative performance evaluation. We test these four general implications next.

1. **Compensation Tied to Sales.** We first examine whether durable good's firms have *lower* responses to own sales. It is well documented that there is a strong and robust relationship between compensation and sales (both cross sectional and over time, however measured and in every possible specification). Indeed, Murphy (1999) refers to this relationship as one of the most robust empirical findings in labor economics. We test the elasticity of compensation to size for the different types of firms according to their durability quartile.

[Table 3 here]

[29] As Scharfstein (1998) notes, there are instances in Compustat when similar firms have different 4-digit SIC codes and when the converse is also true. For this reason all classifications using SIC codes have been manually inspected.

[30] See Bresnahan and Salop (1986) for a modified Herfindahl index as a measure of the degree of competition.

The estimated pay-sales elasticities range between .151 and .307 for salary and bonus (short-term compensation), and between .198 and .359 for long-term compensation. Murphy (1999) finds a similar range for short-term compensation in the mid-1990s.[31] Interestingly, the estimated elasticity of CEO compensation with respect to firm revenues *decreases* with durability, and the "explanatory power" of firm sales, as suggested by the bracketed R-squares, increases with durability. Hence, the initial results in this table are consistent with both previous findings in the literature and, more importantly, with the theoretical implications of the principal-agent durable-goods model in this paper.

2. Longer-Term Compensation. One way to test this proposition is to examine whether durable-goods firms have more stock and stock options as a percentage of pay, controlling for all other possible determinants.[32]

[Table 4 here]

Table 4 reports the results of robust regressions where the dependent variable is the proportion of long-term compensation in total compensation on durability quartiles controlling for size, performance, industry concentration, years and 2-digit SICs. The regressions are implemented for CEOs and non-CEOs separately. Consistent with the theoretical implications of the model we find that durability is a significant determinant of the proportion of long-term compensation for CEO. In particular, the coefficient estimates on durability quartiles are *positive*, highly significant, and *increase* with the extent of durability. For instance, the proportion of long-term compensation for CEOs in the second durability quartile firms (3-5-7 year property) is 9 percent greater than in non-durable goods firms, and in durable-good firms it is 17 percent greater than in non-durable goods firms. For non-CEOs the estimates are also significantly positive and increase across durability quartiles, although their size is slightly smaller than for CEOs.[33]

[31] He also finds that the relationship between CEO cash compensation and company size (revenues) has weakened over time, which in large part is attributable to the fact that stock options have replaced base salaries as the single largest component of compensation in most sectors. This may also explain why the estimated elasticities are slightly larger for long-term compensation data.

[32] It would also be possible to examine this implication by examining whether vesting is longer in durable goods firms. Unfortunately, however, the data is not in ExecuComp. Also, it could be relevant, at least in principle, to examine the variation in option maturities which is another way that firms might try to influence the length of the link between pay and performance.

[33] Robust regressions are OLS regressions with downweights for outliers (Hamilton, 1991). F-tests confirm the significance of the increase across durability quartiles for both CEOs and non-CEOs.

3. Higher Pay-to-Performance Sensitivity. An empirical implication of the model is that the sensitivity of compensation to profits should increase with durability. In Table 5 we test this prediction by examining how the pay-to-performance sensitivity, for different compensation measures, differs between durable goods and other firms.

[Table 5 here]

The first panel (first four columns) explores the relationship between salary and bonus and firm performance. Following Hall and Liebman (1998), the log *difference* of salary and bonus is regressed on the percentage change in firm value during the current and previous fiscal year. Consistent with the implications of the model, the elasticity with respect to changes in firm value *increases* with durability, ranging from 0.10 to 0.21. The elasticity with respect to the lagged firm value is smaller, ranging from 0.03 and 0.08, and also increases with durability. These results imply that the pay-to-performance sensitivity, adding the coefficients on current and lagged performance, is 0.138 for the less durable firms and 0.29 for the more durable firms. The range of sensitivities is very much consistent with previous findings in the literature and clearly increases with durability.

This basic finding is confirmed in the next sets of regressions. The analysis is repeated in the next four columns for Total Compensation (defined as salary, bonus and long-term compensation but *not* the revaluation of stock and stock option holdings). The estimates are slightly larger, suggesting that stock option grants are important driving forces behind the pay-to-performance relationship, and continue to increase with durability. The pay-to-performance sensitivity comes mostly from contemporaneous performance, and is about 0.204 for the less durable firms and 0.361 for the more durable firms.[34]

Lastly, the analysis is repeated in the last four columns for Total Wealth (defined as Total Compensation *and* the revaluation of stock and stock option holdings). A number of authors (e.g., Jensen and Murphy (1990), Hall and Liebman (1998)) have shown that stock and stock option holdings create virtually all of the pay-performance sensitivity for top executives. In other words, when the revaluation of stock and options is included as compensation, then the pay-to-performance sensitivity increases

[34] The coefficient estimates for lagged performance are negative but not significant.

by a very large factor. Hence, it is relevant to examine the implications of durability for this measure of pay.[35] The specification uses Total Wealth rather than log difference Total Wealth given that in some cases this number is negative. The results show that the responsiveness of Total Wealth compensation with respect to firm performance is much greater than that found for previous measures and continue to increase with durability. The pay-to-performance sensitivity is about 0.102 for the less durable firms and 0.218 for the more durable firms.

We conclude that the results in this table are both consistent with previous findings in the literature (see, for instance, Hall and Liebman (1998)) and, more importantly, with the theoretical implications of the analysis in this paper.

4. Relative Performance Evaluation. Lastly, we evaluate the implications of the time-consistency problem induced by durability for the typical principal-agent (relative performance evaluation) model and the strategic complements/substitutes models (differentiated Cournot/Bertrand models) of price competition examined in the literature. The typical principal-agent model predicts that an executive will receive lower compensation when other firms in the industry fare better. This prediction has found some, but not resounding, support in the empirical literature.[36] Three main results of the empirical analysis can be anticipated:

First, we find substantial evidence that durability has an important effect on the form of executive compensation, and that both profits and sales are important determinants of top-managers compensation, especially for long-term compensation and for the top executive in each firm.

Second, as predicted by the analysis, the sensitivity of profits (sales) is positive (negative), increases (decreases) with the durability of the good being produced and is greater in absolute terms in more concentrated industries.

Third, the time-consistency problem induced by durability may help explain the

[35]Interestingly enough, including the revaluation of stock and stock option holdings in the analysis of Table 4 reinforces the result that the proportion of long-term compensation increases with durability.

[36]For instance, Jensen and Murphy (1990) find that relative performance does not appear to be an important source of managerial incentives. Antle and Smith (1986) and Gibbons and Murphy (1990), who test more directly for relative performance pay, find that *ceteris paribus* a greater value-weighted industry rate of return lowers the growth of CEO pay in a given firm. Recently, Aggarwal and Samwick (1999a) consider the possibility that rival firms in an industry are also strategic competitors. They find a positive rival-firm pay-performance sensitivity in total compensation. Hubbard and Palia (1994) and Bertrand and Mullainathan (1998) test whether compensation incentives "substitute" for other disciplining devices such as competition (market deregulation) and takeovers, respectively.

mixed evidence in favor of relative performance evaluation in executive compensation contracts found in the literature. Once durability and own and rival sales are introduced into the analysis, substantial empirical support is found for both the principal-agent model and the strategic substitutes model of price competition. We find that relative performance evaluation *may* be limited by strategic competition for non-durable good firms in short-term compensation data. However, for durable-good firms, especially in long-term compensation data, strategic competition is found to induce *greater* relative performance evaluation.

We consider that a firm's rivals are all other firms in the same 4-digit SIC code, which is the finest level of disaggregation in the data. Profits and sales, both own and rival, are interacted with $F(H_i)$ and with durability, denoted by D_i. The most general equation we estimate is the following:

$$\begin{aligned} w_{it}^e &= \alpha_0 + \alpha_1 \pi_{it}^o + \alpha_2 \pi_{it}^r + \alpha_3 F(H_i)\pi_{it}^o + \alpha_4 F(H_i)\pi_{it}^r + \alpha_5 F(H_i) + \\ &\quad + \alpha_6 CEO_{it}^e + +\alpha_7 D_{it} + \alpha_8 S_{it}^o + \alpha_9 S_{it}^r + \alpha_{10} D_{it} S_{it}^o + \alpha_{11} D_{it} S_{it}^r + \\ &\quad + \alpha_{12} D_{it} S_{it}^o + \alpha_{14} D_{it} S_{it}^r + \alpha_{15} F(H_i) S_{it}^o + \alpha_{16} F(H_i) S_{it}^r + \sum_{k=21}^{39} \lambda_{ik} + \sum_{t=94}^{95} \psi_t + \varepsilon_{ijt}, \end{aligned}$$

where w_{it}^e is the compensation of executive e in firm i at time t and CEO_{it}^e is a dummy variable for whether executive e is the top ranked executive in firm i. The terms λ_{ik} are indicator variables for whether firm i is in the 2-digit SIC k. The terms ψ_t are dummy variables for time period.

Two different sets of regressions are implemented: one for all compensation and one for short-term compensation. For each set we examine three different regressions. The first one accounts for durability, own profits and sales, and also includes the CEO dummy and the Herfindahl percentile of the firm's industry. It ignores strategic competition insofar as it does not include rival profits and sales. The second one ignores the role of durability and sales and exclusively examines the role of strategic competition within the industry when managers can be compensated on their own and their rival's performance.[37] The third regression includes all effects simultaneously: the time-consistency problem induced by durability and the possibility that managers

[37] It follows the analysis of Aggarwal and Samwick (1999a), who examine the extent to which strategic interactions among firms can explain the lack of strong performance-based incentives. Note that their results are replicated quite closely here.

can be compensated on own and rivals' profit and sales. In all three regressions we consider the dependent variable both in levels and in differences, as well as the dependent and all independent variables in differences. Lastly, we implement both median regressions and OLS regressions. Median regressions are estimated because the skewness of the distribution of executive compensation (especially in long-term compensation data) documented in Table 1 suggests that there may be several outliers in the data. Median regressions, which minimize the sum of absolute deviations rather than the sum of squared deviations, are less sensitive to outliers than are the OLS regressions. There are other alternative ways of dealing with outliers.[38] However, the advantage of running OLS and median regressions is that the results can be readily compared with previous findings in the literature (e.g., Aggarwal and Samwick (1999a)). The inconvenience is that it is somewhat more cumbersome as a large number of regression specifications needs to be reported. The results for median regressions are presented in Tables 6A-6B to 8A-8B, and for the OLS regressions in Tables 9A-9B. "A" refers to total compensation and "B" to short-term compensation. In Table 10 we also test the null hypothesis of the significance of sensitivities to own and rival profits and sales at the median industry concentration, $F(H) = 0.50$, for the median regressions.

[Tables 6A and 6B here]

Tables 6A and 6B present the dependent variable in levels. First, in column 1, own performance and both durability and sales (alone and interacted with performance) are found to be significant and their effects to have the signs predicted by the theoretical analysis. This is especially the case for total compensation data; that is, when long-term compensation is added to salary, bonus and other annual compensation. For short-term compensation data, the significance of the estimates decreases. The importance of own performance is greater for total compensation than for short-term compensation, and increases with industry concentration and durability. Likewise, as found by Jensen and Murphy (1990), CEOs receive pay *cuts* for own sales. These cuts increase with durability and are significant for both total and short-term compensation. They also increase with concentration in the industry but they appear to be significant only for total compensation. As found earlier and predicted by the analysis, durable-goods firms are found to have a greater incentive to write long-term

[38]For instance, robust regressions, which are OLS regressions with downweights for outliers (Hamilton, 1991), have also been estimated and are available upon request. The results are similar.

compensation contracts to mitigate the time-inconsistency problem induced by durability. The coefficients for the Herfindahl industry concentration percentiles, alone and interacted with performance and sales, are significant in all cases, except when interacted with sales in short-term compensation data.

In the second columns, both total and short-term compensation are found to have a positive sensitivity to own and rival firm performances. The sensitivity of compensation to own (rivals') performance increases with concentration (competition) in the industry. These results support the Bertrand model of strategic competition, where the need to soften product market competition generates an optimal compensation contract that gives a positive weight to both own and rival firm performance. Interestingly enough, when sales and durability are taken into account these findings vanish: when both own and rival firm performance and sales are considered, in addition to durability, the estimates show a positive sensitivity of compensation to own performance and to rival sales, as well as a *negative* sensitivity to rival firm performance and own sales. These results provide support for the Cournot model of strategic competition. The negative weight on rival firm performance is also consistent with the principal-agent model of executive compensation for which, despite its central importance to the modern theory of the firm and corporate governance, existing empirical evidence is only weakly supportive. The coefficient for rival performance is always negative and significant in total compensation regressions. These results lend support to relative pay-performance compensation models for long-term compensation data. The support is weaker for short-run compensation data: although the signs of the coefficients tend to be maintained, their significance is substantially lower. Negative rival-firm performance sensitivity also appears to increase with concentration in the industry. The negative weight on own sales lends support to the arguments of this paper: durability induces a time-consistency problem for these firms which may be mitigated by appropriately choosing incentive compensation schemes; in particular, by choosing long-term incentives based on profits and sales. The sensitivity of compensation to durability continues to be positive and significant in column 3 (especially for total compensation data), increasing with own performance and decreasing with own sales. It also decreases with rival-firm performance and increases with rival sales. Interestingly enough, relative pay-performance compensation increases with durability. As to the Herfindahl percentile, the results from column 1 are maintained. When the Herfindahl percentile is interacted with rival sales it is never significant.

[Tables 7A and 7B here]

Tables 7A and 7B collect the estimates for the case in which total and short-term compensation data are in differences. In general, the qualitative nature of the results is maintained. Not surprisingly, both the size and the standard deviation of the estimates decrease. The significance of the parameters also tends to decrease, especially for short-term compensation data. Interestingly, the negative sensitivity to rival-firm performance was not significant for short-term compensation data in Table 6B and becomes significant now. The pseudo R-squares of the regressions decrease substantially.

[Tables 8A and 8B here]

In Tables 8A and 8B all variables are in differences. Again, the qualitative nature of the findings appears to be maintained. The coefficients tend to increase slightly, in absolute terms, but tend to be less precisely estimated. When durability is introduced into the analysis the results continue to support relative-performance evaluation, that is the principal-agent model and the Cournot model of strategic competition, while when the roles of durability and sales are ignored the results show support for the Bertrand model of competition.[39] Industry concentration interacted with sales is never significant.

[Tables 9A and 9B here]

Tables 9A and 9B collect the results for the OLS regressions of durability and pay-performance sensitivity, for total and short-term compensation, when all variables are included in the regression (third column in Tables 3 to 5). Interestingly, the results are qualitatively similar to those found in the median regressions. Given that, as expected, outliers occupy a more prominent role in this type of regression, the estimates tend to be less significant.

[Table 10 here]

[39] Even in this case, support is found for relative-performance evaluation in short-run compensation data, for which the support becomes stronger when sales and durability are included.

In Table 10 we test for the significance of short-term and total compensation sensitivities to own and rival performance and sales at the median industry concentration for the full regression (third columns in Tables 6 to 8) for the durable goods and the non-durable goods cases. As predicted by the theoretical analysis, own and rival performances are significant in all cases, and own sales are significant as well. Rival sales are found to have much weaker effects. The absolute values of the coefficients appear to indicate that a greater amount of incentives than those previously found in the literature are being provided to executives.

Lastly, a number of additional estimations have been examined. The regressions were also estimated using the 3-digit SIC codes and using differences from means.[40] As mentioned earlier, robust regressions were also implemented. The results confirm the findings presented here and do not appear to uncover any additional effects.

3.3 Summary

The empirical analysis uncovers the importance of durability on the demand side for the determination of internal contractual relationships in the firm. The empirical implications for compensation contracts have been tested using data on compensation of top executives at large corporations and find substantial support in the data.

These findings may be important for several reasons. First, a necessary but not sufficient ingredient for successful testing of agency theory is that agents respond to incentives. However, the true test of the theory is whether compensation practices and the incentive contracts offered to agents reflect agency concerns. The theoretical and empirical analysis in this paper, therefore, brings to bear on the literature a factor that it is novel, whose effects are *predictable*, and that is both *observable* (often many relevant factors are unobserved) and empirically relevant.[41] In doing so it provides evidence about how the returns to executive effort vary with durability, profits and sales. Also, the available empirical evidence on contracts does not yet provide a ringing endorsement of the importance of relative performance evaluation. The empirical evidence in this analysis provides support for this theory, in particular

[40] The use of first-differences removes firm-level heterogeneity while causing autocorrelation. For this reason, as Griliches and Hausman (1993) suggest, differences from means may be a better methodology. The results using this methodology are extremely similar.

[41] The service flow of durable goods is considered to be about 86 percent of personal consumption expenditures in a given year, that is about 60 percent of GDP.

for the strategic substitutes Cournot model of price competition. Lastly, these findings also have important implications for the literature on the effect of competition on agency problems.[42]

4 Concluding Remarks

We uncover a heretofore unrecognized link between durability on the demand side and agency theory. The time-consistency problem induced by durability represents a valuable opportunity for testing agency theory, in particular for testing whether the compensation practices and incentives contracts predicted by the theory are confirmed by observed data, an issue where the empirical literature has found important difficulties. The analysis recognizes the significant opportunity provided by the substantial body of theoretical and empirical literature on durable-goods firms to examine both theoretically and empirically the specific implications of durability for agency theory, contract theory and the literature on corporate governance. Delegation and the appropriate choice of managerial incentive schemes away from strict profit maximization emerge as one source of credible commitment in these firms although, of course, need not be the only form of commitment. The arguments in the analysis also point to a new, independent reason for incentive schemes not based on profits alone that have been reported in the literature on management compensation. In doing so, the analysis also yields a novel solution to the commitment problem of durable-goods firms and provides a new justification for the existence of long-term contracts.

The theoretical analysis has made some simplifying assumptions such as linear payoffs to managers indexed to profits and sales, and absence of uncertainty and moral hazard problems. Further research may generalize the analysis in this direction. However, it seems clear from the basic intuition that delegation of control and 'distortion' of manager's incentives are potentially important instruments for owners of durable goods firms, and that this general implication will continue to hold in more

[42] In this case, the nature of the demand is such that competition is induced not against other firms in the industry but against one's own firm. Hart (1983), Scharfstein (1988), and Hermalin (1992) examine whether market competition induces managers to run their firms more efficiently. These models predict that the own-firm pay-performance sensitivity is positive (Hart, 1983) and increasing with industry concentration (Scharfstein, 1988). As we have seen, these predictions are also borne out by the data in our analysis.

general frameworks. With durability *some* contractual commitment or distortion of this type may be a less costly way of maintaining market power—especially when control is already delegated to managers because of their knowledge, abilities, skills or other reasons—and thus of mitigating, or perhaps even avoiding, the otherwise fatal consequences of durability on the demand side. By no means, however, we wish to suggest that this form of commitment is the only way a firm can commit to a future schedule of production.[43]

The empirical implications for optimal compensation contracts have been tested using data on compensation of top executives at large corporations. As Prendergast (1999, p.7) remarks, "incentives are the essence of economics, but despite many wide-ranging claims about the supposed importance, there has been little empirical assessment of incentive provision for workers." The primary innovation of the analysis is that it brings a previously unrecognized observable feature of markets to bear on the literature on the separation of ownership and control which figures prominently in the economic theory of organizations, and in so doing merges two important but previously unrelated literatures. This allows us to make a number of testable predictions which have found substantial support in empirical work, namely that *ceteris paribus* durable goods firms would want to offer longer term compensation incentives (e.g., restricted stock and stock options) indexed to profits and sales, choose a lower elasticity of compensation to sales, choose greater pay-performance sensitivity, and choose greater relative performance evaluation. The results support the principal-agent model of executive compensation, a model which is of central importance to the modern theory of the firm and corporate governance, but which has been only weakly supported by empirical evidence.

Extensions of the empirical analysis of the durable-goods models may include the study of the impact of risk, other aspects of firm size and the quality of firm governance on executive compensation.[44] It will also be worthwhile to examine in more

[43]While contractual commitment when facing a time-consistency problem is different from other forms of commitment, it may be related to other ways that firms can commit for reasons other than the time-consistency problem (for instance, see the role of debt (e.g., Jensen (1986), Garvey (1997)), corporate control (e.g., Shleifer and Vishny (1997)), large shareholders (e.g., Shleifer and Vishny (1986)), and board of directors (e.g., Hermalin and Weisbach (1998)).

[44]See Aggarwal and Samwick (1999b) and Garen (1994) on the impact of risk, Baker and Hall (1998) and Schaeffer (1998) on the impact of firm size, and Bertrand and Mullainathan (2000) on the impact of the quality of governance, respectively.

detail other sources of data on executive stock option contracts to determine the incentives they create in the context of the time-inconsistency aspect examined here. Lastly, it would surely be important and relevant to compare the contractual commitments and incentive compensation sensitivities examined here across countries.[45]

[45] See, for instance, Gibbons and Murphy (1992), Hall (1998), Hall and Leibman (1998), and Rose and Shepard (1997) for analyses of executive stock options, and Conyon and Murphy (2000), Kaplan (1994) and Zhou (1999) for evidence on executive compensation practices in other countries.

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APPENDIX

Let δ denote durability or the probability that a unit produced in period 1 will remain in period 2. We assume in what follows the conditions that guarantee interior solutions.[1] Then, we have the following two problems:

A. Duopolist Renter

In this case, the manager of firm i solves

$$\max_{\{x_1^i, x_2^i\}} \left[e - f x_1^i - g x_1^j - \alpha_1^i c_1 + v \alpha_2^i \delta c_2 \right] x_1^i + v \left[e - f x_2^i - g x_2^j - \alpha_2^i c_2 \right] x_2^i .$$

The first order conditions imply the optimal production levels for firm i:

$$x_1^i = -\frac{2\alpha_1^i c_1 f - 2ef - \alpha_1^j c_1 g + eg - 2\alpha_2^i c_2 f v \delta + v g \alpha_2^j c_2 \delta}{4f^2 - g^2}, \tag{1}$$

$$x_2^i = -\frac{2\alpha_2^i c_2 f - 2ef - \alpha_2^j c_2 g + eg}{4f^2 - g^2}. \tag{2}$$

Holding the managers to their reservation wages yields the following program for the firm:

$$\max_{\{\alpha_1^i, \alpha_2^i\}} \left[e - f x_1^i - g x_1^j - c_1 + v \delta c_2 \right] x_1^i + v \left[e - f x_2^i - g x_2^j - c_2 \right] x_2^i$$

subject to (1) and (2). The first order conditions of this problem imply that the optimal incentive parameters for the manager are:

$$\begin{aligned} \alpha_2^{dr}(\delta) &= -\frac{-4c_2 f^2 - 2c_2 f g + e g^2}{(4f^2 + 2fg - g^2)\, c_2} < 1, \\ \alpha_1^{dr}(\delta) &= -\frac{-4c_1 f^2 - 2c_1 f g + e g^2 + v e g^2 \delta}{(4f^2 + 2fg - g^2)\, c_1} < 1. \end{aligned}$$

B. Duopolist Seller

In the differentiated Cournot game the manager solves at $t = 2$:

$$\max_{\{x_2^i\}} \left[e - f x_2^i - g x_2^j - \alpha_2^i c_2 \right] \left(x_2^i - \delta x_1^i \right).$$

From the first order condition we obtain

$$x_2^i = -\frac{2\alpha_2^i c_2 f - 2ef - \alpha_2^j c_2 g + eg - 2f^2 x_1^i \delta + f g x_1^j \delta}{4f^2 - g^2}. \tag{3}$$

[1] These conditions imply $e > c_2$ and $e > c_1 - v\delta c_2$.

Then, at time $t = 1$, the manager will solve for the x_1^i such that

$$\max_{\{x_1^i\}} \left[e - fx_1^i - gx_1^j - \alpha_1^i c_1 + v\alpha_2^i \delta c_2 \right] x_1^i + v \left[e - fx_2^i - gx_2^j - \alpha_2^i c_2 \right] x_2^i,$$

subject to (3). Solving the first-order conditions for the optimal production levels as functions of contracts for firm i, we can then solve for the first stage. Firm i will choose $\{\alpha_1^i(\delta), \alpha_2^i(\delta)\}$ to maximize the present value of its total profits:

$$\max_{\{\alpha_1^i, \alpha_2^i\}} \left[e - fx_1^i - gx_1^j - c_1 + v\delta c_2 \right] x_1^i + v \left[e - fx_2^i - gx_2^j - c_2 \right] x_2^i.$$

Restricting our attention to the case in which $f = g$, we obtain that the incentive parameters are:

$$\alpha_2^{ds}(\delta) = \frac{-c_1\delta(27 - 7v\delta^2) + c_2(51v\delta^2 + 7v^2\delta^2 + 90) + e(7\delta^3 v - 3v\delta^2 + 27\delta - 15)}{3c_2\,(25 + 7v)},$$

$$\alpha_1^{ds}(\delta) = \frac{v\delta c_2\mathcal{A} - e\mathcal{B} + c_1\mathcal{C}}{9c_1\,(25 + 7v\delta^2)},$$

with $\mathcal{A} = 7v^2\delta^2 + 28v\delta^2 - 3$, $\mathcal{B} = 45 + 42v\delta - 22v\delta^2 + 6v^2\delta^3 - 7v^2\delta^4$, $\mathcal{C} = 270 + 41v\delta^2 - 7v^2\delta^4$. It can be shown that:

$$\frac{d\alpha_2^{ds}(\delta)}{d\delta} > 0, \forall\delta.$$

Lastly, the incentive parameters for the monopolist seller can be obtained in a similar fashion. They are:

$$\alpha_2^{ms}(\delta) = \frac{\delta(e - c_1) + c_2(2 + v\delta^2)}{2c_2} > 1,\ \forall\delta$$

$$\alpha_1^{ms}(\delta) = \frac{v\delta^2 e + c_1(4 - v\delta^2) + v^2\delta^3 c_2}{4c_1} > 1,\ \forall\delta$$

It can be shown that:

$$\frac{d\alpha_t^{ms}(\delta)}{d\delta} > 0,\ \forall\delta,\ \forall t = 1, 2.$$

and

$$\alpha_t^{ms}(\delta) > \alpha_t^{ms}(\delta),\ \forall\delta,\ \forall t = 1, 2.$$

TABLE 1

Components of Executive Compensation in 1995

Payment Category (Thousands of Dollars)	Mean	Standard Deviation	Median
CEOs (N = 1519)			
Total Compensation	2205	3446	1276
Short Term Compensation	1060	1882	770
Salary	535	299	475
Bonus	491	1794	250
All Other Annual	33	139	0
Long-Term Compensation	1146	2497	438
Restricted Stock Granted	152	638	0
Stock Options Granted	793	2148	244
Long Term Incentive Plan Payouts	116	529	0
All Other Long-Term	84	326	17
Non-CEOs (N = 6305)			
Total Compensation	927	1353	550
Short-Term Compensation	464	441	355
Salary	275	150	238
Bonus	183	336	100
All Other Annual	16	92	0
Long-Term Compensation	454	1089	162
Restricted Stock Granted	58	271	0
Stock Options Granted	298	891	92
Long Term Incentive Plan Payouts	47	211	0
All Other Long-Term	51	377	9

Notes:
1. Source: Tabulations of Standard and Poor's *ExecuComp* dataset.
2. CEOs are those executives at each company that held the CEO position for the majority of the year. Non-CEOs are the other four highest paid executives at each company ranked by salary plus bonus.

TABLE 2
4-digit SIC Concentration Ratios by 2-digit SIC Code, 1992

2-Digit SIC Code and Description		Number of 4-digit SICs	Herfindahls of Constituent 4-digit SICs		
			Average	Minimum	Maximum
20:	Food and kindred products	22	1076.1	181	2253
21:	Tobacco products	2	2090.6	1923	2175
22:	Textile mill products	8	740.7	243	1679
23:	Apparel and other textile products	8	805.3	61	2338
24:	Lumber and wood products	5	283.6	78	491
25:	Furniture and fixtures	5	521.7	167	1043
26:	Paper and allied products	5	453.9	143	1451
27:	Printing and publishing	8	404.2	19	2922
28:	Chemicals and allied products	22	640.4	190	2999
29:	Petroleum and Coal products	2	414.8	414	431
30:	Rubber and miscellaneous plastic products	7	386.2	15	1743
31:	Leather and leather products	3	786.0	513	1401
32:	Stone clay and glass products	5	891.3	472	1765
33:	Primary metal industries	11	859.0	201	2827
34:	Fabricated metal products	16	348.7	31	1457
35:	Industrial machinery and equipment	24	660.5	80	2549
36:	Electronic and other electric equipment	26	745.5	180	2929
37:	Transportation equipment	11	1538.7	428	2717
38:	Instruments and related products	15	467.3	148	2408
39:	Miscellaneous manufacturing industries	6	265.8	74	808
	All Manufacturing Industries	211	699.1	15	2999

Notes:

1. Source: Aggarwal and Samwick (1999a, Table 2a) tabulations of *1992 Census of Manufactures* and *ExecuComp* datasets.
2. The average Herfindahl index for each 2-digit SIC is the average of the Herfindahl indexes (defined at the 4-digit SIC level) for the sample firms in that 2-digit SIC.

TABLE 3

Estimated Elasticity of CEO Salary plus Bonus, and Total Compensation with Respect to Firm Revenues

	Salary plus Bonus	Total Compensation
Durability Quartile Q1 (Non-durable property)	0.307 [R^2 = 0.12]	0.359 [R^2 = 0.11]
Durability Quartile Q2 (3-5-7 year property)	0.227 [R^2 = 0.15]	0.317 [R^2 = 0.20]
Durability Quartile Q3 (10-15 year property)	0.182 [R^2 = 0.20]	0.237 [R^2 = 0.27]
Durability Quartile Q4 (20-year and Durable property)	0.151 [R^2 = 0.23]	0.198 [R^2 = 0.34]

Notes: Elasticities are computed from regressions of Log (Salary and Bonus) on Log (Sales), and Log (Total Compensation) on Log (Sales), respectively. Total Compensation is defined as the sum of Salary, Bonus and Long-Term Compensation. Compensation is denominated in thousands of dollars and firm performance in millions of constant 1995 dollars. R^2 is in brackets. Durability is measured following the property classes used by the General Depreciation System of the Internal Revenue System. Durability quartiles are defined as follows: Q1: non-durable property, Q2: 3-5-7 year property; Q3: 10-15 year property; Q4: 20-year and durable property.

TABLE 4

Longer-Term Compensation in Durable Goods Firms

This table reports the result of robust regressions where the dependent variable is the proportion of long-term compensation in total compensation. Robust regressions are OLS regressions which lower the weight on observations with large residuals (Hamilton, 1991). Long-term compensation includes restricted stock-options granted (valued at face value), stock options (valued at grant date using *ExecuComp*'s modified Black-Scholes formula), long-term incentive plan payouts and all other long-term compensation. In addition to dummy variables for durability quartiles, the regressions include controls for size, performance, industry concentration index, and dummy variables for years and for 2-digit SICs. *t*-statistics are in parenthesis.

		Durability Quartile				
	Intercept	Quartile Q2	Quartile Q3	Quartile Q4	*N*	R^2
CEOs						
	.27	.09	.12	.17	1,519	.57
	(4.01)	(2.11)	(2.02)	(3.17)		
Non-CEOs						
	.23	.06	.10	.15	6,305	.51
	(4.37)	(3.02)	(2.27)	(2.23)		

Notes: Durability is measured following the property classes used by the General Depreciation System of the Internal Revenue System. Durability quartiles are defined as follows: Q1: non-durable property, Q2: 3-5-7 year property; Q3: 10-15 year property; Q4: 20-year and durable property. Firm performance is in millions of constant 1995 dollars.

TABLE 5

Differences in CEO Pay-Performance Sensitivity across Durability Quartiles

	Ln (Salary plus Bonus)				Ln (Total Compensation)				Total Wealth CEO Change			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4 .
Firm return in current year	0.108 (0.012)	0.143 (0.019)	0.166 (0.017)	0.214 (0.018)	0.204 (0.029)	0.253 (0.038)	0.282 (0.040)	0.361 (0.030)	0.102 (0.004)	0.121 (0.003)	0.146 (0.004)	0.188 (0.005)
Firm return in previous year	0.030 (0.010)	0.052 (0.015)	0.077 (0.016)	0.080 (0.016)	-0.025 (0.023)	-0.019 (0.020)	-0.022 (0.026)	-0.033 (0.018)	0.010 (0.008)	0.008 (0.009)	0.025 (0.007)	0.030 (0.009)
R^2	0.05	0.05	0.04	0.04	0.05	0.04	0.04	0.03	0.07	0.05	0.03	0.05

Notes: The log difference of two pay measures is regressed on firm's returns in current and previous year in the first two panels (eight columns) for given durability quartile. Durability is measured following the property classes used by the General Depreciation System of the Internal Revenue System. Durability quartiles are defined as follows: Q1: non-durable property, Q2: 3-5-7 year property; Q3: 10-15 year property; Q4: 20-year and durable property. Total compensation is short-term plus long-term compensation, and does *not* include the revaluation of stock and stock option holdings. The last panel (4 columns) uses Total CEO wealth, which includes total compensation plus changes in the value of stock holdings and stock option holdings. Compensation is denominated in thousands of dollars and firm performance in millions of constant 1995 dollars. Regressions are robust regressions, and include year dummies. We use the STATA version 5 rreg command which uses Huber weight iterations followed by biweight iterations (Hamilton (1991)). In parenthesis are Huber-White robust standard errors that allow for autocorrelation in the errors among observations for each CEO. Returns are calculated as changes in firm market value over the firm's fiscal year.

TABLE 6A

Median Regressions of Durability and Pay-Performance Sensitivity
Dependent Variable: Total Compensation

Regression Coefficients	Dependent Variable in Levels		
Own Performance	0.0407 (0.0071)	0.0178 (0.0096)	0.0517 (0.0030)
Rival Performance		0.1782 (0.0103)	-0.0272 (0.0078)
Own Performance x Herfindahl percentile	0.1539 (0.0097)	0.1602 (0.0140)	0.1617 (0.0101)
Rival Performance x Herfindahl percentile		-0.1552 (0.0141)	-0.0932 (0.0662)
Herfindahl percentile	189.2333 (17.2936)	171.5220 (23.9632)	183.4277 (20.2321)
CEO Dummy	793.4288 (17.2602)	717.2623 (13.0302)	852.2661 (26.9177)
Durability Quartile	0.0007 (0.0001)		0.0006 (0.0002)
Own Sales	-0.0069 (0.0021)		-0.0063 (0.0014)
Rival Sales			0.0009 (0.0003)
Durability Quartile x Own Sales	-0.0393 (0.0081)		-0.0427 (0.0063)
Durability Quartile x Rival Sales			0.0201 (0.0026)
Durability Quartile x Own Performance	0.0617 (0.0014)		0.0633 (0.0045)
Durability Quartile x Rival Performance			-0.0432 (0.0091)
Own Sales x Herfindahl	-0.0008 (0.0003)		-0.0023 (0.0009)
Rival Sales x Herfindahl			-0.0003 (0.0001)
Pseudo R-squared	0.31	0.14	0.47

Note: Regressions include dummy variables for years and for 2-digit SICs.

TABLE 6B

Median Regressions of Durability and Pay-Performance Sensitivity
Dependent Variable: Short-Term Compensation

Regression Coefficients	Dependent Variable in Levels		
Own Performance	0.0329 (0.0052)	0.0369 (0.0035)	0.0644 (0.0080)
Rival Performance		0.0450 (0.0063)	-0.0022 (0.0063)
Own Performance x Herfindahl percentile	0.0821 (0.0123)	0.0380 (0.0086)	0.0623 (0.0121)
Rival Performance x Herfindahl percentile		-0.0172 (0.0132)	-0.0401 (0.0321)
Herfindahl percentile	63.2612 (14.2611)	56.9623 (15.0430)	72.2681 (10.4261)
CEO Dummy	427.7310 (12.2611)	394.0428 (8.1906)	501.2612 (26.3292)
Durability Quartile	0.0006 (0.0001)		0.0004 (0.0001)
Own Sales	-0.0028 (0.0011)		-0.0043 (0.0017)
Rival Sales			-0.0004 (0.0006)
Durability Quartile x Own Sales	-0.0182 (0.0062)		-0.0201 (0.0093)
Durability Quartile x Rival Sales			-0.0072 (0.0026)
Durability Quartile x Own Performance	0.0326 (0.0082)		0.0288 (0.0091)
Durability Quartile x Rival Performance			0.0052 (0.0031)
Own Sales x Herfindahl	-0.0002 (0.0015)		-0.0023 (0.0014)
Rival Sales x Herfindahl			-0.0002 (0.0001)
Pseudo R-squared	0.25	0.16	0.35

Note: Regressions include dummy variables for years and for 2-digit SICs.

TABLE 7A

Median Regressions of Durability and Pay-Performance Sensitivity
Dependent Variable: Total Compensation

Regression Coefficients	Dependent Variable in Differences		
Own Performance	0.0116 (0.0033)	0.0051 (0.0053)	0.0144 (0.0042)
Rival Performance		0.0411 (0.0060)	-0.0112 (0.0027)
Own Performance x Herfindahl percentile	0.0496 (0.0082)	0.0446 (0.0075)	0.0572 (0.0111)
Rival Performance x Herfindahl percentile		-0.0546 (0.0080)	-0.0244 (0.0091)
Herfindahl percentile	40.0171 (7.3261)	35.4608 (10.3290)	36.4290 (6.010)
CEO Dummy	36.8522 (9.724)	37.4774 (6.9144)	39.2629 (8.4221)
Durability Quartile	0.0008 (0.0001)		0.0005 (0.0001)
Own Sales	-0.0020 (0.0007)		-0.0027 (0.0007)
Rival Sales			0.0004 (0.0001)
Durability Quartile x Own Sales	-0.0152 (0.0036)		-0.0261 (0.0049)
Durability Quartile x Rival Sales			0.0100 (0.0032)
Durability Quartile x Own Performance	0.0421 (0.0046)		0.0552 (0.0073)
Durability Quartile x Rival Performance			-0.0156 (0.0042)
Own Sales x Herfindahl	-0.0007 (0.0003)		-0.0012 (0.0005)
Rival Sales x Herfindahl			-0.0008 (0.0014)
Pseudo R-squared	0.09	0.0153	0.17

Note: Regressions include dummy variables for years.

TABLE 7B

Median Regressions of Durability and Pay-Performance Sensitivity
Dependent Variable: Short-Term Compensation

Regression Coefficients	Dependent Variable in Differences		
Own Performance	0.0116 (0.0031)	0.0151 (0.0014)	0.0236 (0.0044)
Rival Performance		-0.0030 (0.0015)	-0.0030 (0.0014)
Own Performance x Herfindahl percentile	0.0152 (0.0044)	0.0066 (0.0020)	0.0117 (0.0038)
Rival Performance x Herfindahl percentile		-0.0039 (0.0020)	-0.0201 (0.0058)
Herfindahl percentile	10.2617 (2.2709)	4.2562 (3.0917)	17.2727 (4.4040)
CEO Dummy	37.2717 (7.7720)	28.7702 (2.0826)	41.4923 (6.2612)
Durability Quartile	0.0004 (0.0003)		0.0003 (0.0001)
Own Sales	-0.0009 (0.0010)		-0.0015 (0.0004)
Rival Sales			-0.0004 (0.0004)
Durability Quartile x Own Sales	-0.0087 (0.0021)		-0.0103 (0.0031)
Durability Quartile x Rival Sales			-0.0041 (0.0019)
Durability Quartile x Own Performance	0.0144 (0.0051)		0.0091 (0.0026)
Durability Quartile x Rival Performance			0.0037 (0.0022)
Own Sales x Herfindahl	-0.0002 (0.0026)		-0.0018 (0.0010)
Rival Sales x Herfindahl			-0.0006 (0.0010)
Pseudo R-squared	0.08	0.0261	0.21

Note: Regressions include dummy variables for years.

TABLE 8A

Median Regressions of Durability and Pay-Performance Sensitivity
Dependent Variable: Total Compensation

Regression Coefficients	All Variables in Differences		
Own Performance	0.0169 (0.0062)	0.0092 (0.0032)	0.0211 (0.0050)
Rival Performance		0.0352 (0.0034)	-0.0166 (0.0066)
Own Performance x Herfindahl percentile	0.0028 (0.0041)	-0.0046 (0.0047)	0.0061 (0.0027)
Rival Performance x Herfindahl percentile		-0.0501 (0.0051)	-0.0310 (0.0101)
Herfindahl percentile	-----------	-----------	-----------
CEO Dummy	62.1161 (30.4121)	-9.1066 (28.3582)	50.0321 (12.0992)
Durability Quartile	-----------	-----------	-----------
Own Sales	-0.0014 (0.0003)		-0.0030 (0.0009)
Rival Sales			0.0012 (0.0004)
Durability Quartile x Own Sales	-0.0092 (0.0032)		-0.0088 (0.0023)
Durability Quartile x Rival Sales			0.0144 (0.0051)
Durability Quartile x Own Performance	0.0601 (0.0213)		0.0441 (0.0108)
Durability Quartile x Rival Performance			-0.0217 (0.0080)
Own Sales x Herfindahl	-0.0021 (0.0037)		-0.0002 (0.0032)
Rival Sales x Herfindahl			-0.0011 (0.0051)
Pseudo R-squared	0.07	0.0038	0.09

Note: Regressions include dummy variables for years.

TABLE 8B

Median Regressions of Durability and Pay-Performance Sensitivity
Dependent Variable: Short-Term Compensation

Regression Coefficients	All Variables in Differences		
Own Performance	0.0082 (0.0030)	0.0102 (0.0014)	0.0167 (0.0022)
Rival Performance		-0.0012 (0.0012)	-0.0017 (0.0010)
Own Performance x Herfindahl percentile	0.0012 (0.0004)	0.0092 (0.0020)	0.0010 (0.0002)
Rival Performance x Herfindahl percentile		-0.0032 (0.0018)	-0.0172 (0.0201)
Herfindahl percentile	-----------	-----------	-----------
CEO Dummy	27.7210 (8.8231)	126.4026 (11.3410)	91.3211 (14.0021)
Durability Quartile	-----------	-----------	-----------
Own Sales	-0.0007 (0.0005)		-0.0024 (0.0007)
Rival Sales			-0.0005 (0.0002)
Durability Quartile x Own Sales	-0.0049 (0.0030)		-0.0070 (0.0017)
Durability Quartile x Rival Sales			-0.0006 (0.0000)
Durability Quartile x Own Performance	0.0401 (0.0117)		0.0217 (0.0091)
Durability Quartile x Rival Performance			0.0008 (0.0042)
Own Sales x Herfindahl	-0.0014 (0.0010)		-0.0039 (0.0028)
Rival Sales x Herfindahl			-0.0002 (0.0011)
Pseudo R-squared	0.06	0.0075	0.08

Note: Regressions include dummy variables for years.

TABLE 9A

OLS Regressions of Durability and Pay-Performance Sensitivity
Dependent Variable: Total Compensation

Regression Coefficients	Dependent Variable in Levels	Dependent Variable in Differences	All Variables in Differences
Own Performance	0.0569 (0.0184)	0.0432 (0.0112)	0.0562 (0.0257)
Rival Performance	-0.0881 (0.0301)	-0.0525 (0.0181)	-0.0492 (0.0192)
Own Performance x Herfindahl percentile	0.2132 (0.0822)	-0.0877 (0.0291)	0.0402 (0.0262)
Rival Performance x Herfindahl percentile	-0.1222 (0.0916)	-0.0821 (0.0272)	-0.0292 (0.0181)
Herfindahl percentile	449.2612 (68.2311)	158.2310 (54.2001)	----------
CEO Dummy	926.3126 (128.2727)	131.2874 (56.3117)	73.2216 (40.2643)
Durability Quartile	0.0028 (0.0010)	0.0016 (0.0004)	----------
Own Sales	-0.0099 (0.0031)	-0.0066 (0.0028)	-0.0082 (0.0036)
Rival Sales	-0.0027 (0.0021)	0.0015 (0.0010)	0.0029 (0.0006)
Durability Quartile x Own Sales	-0.0921 (0.0182)	-0.0326 (0.0097)	-0.0127 (0.0062)
Durability Quartile x Rival Sales	0.0411 (0.0121)	0.0201 (0.0153)	0.0299 (0.0132)
Durability Quartile x Own Performance	0.0612 (0.0128)	0.1010 (0.0260)	0.0599 (0.0327)
Durability Quartile x Rival Performance	-0.0617 (0.0271)	-0.0317 (0.0122)	-0.0296 (0.0272)
Own Sales x Herfindahl	-0.0079 (0.0036)	-0.0055 (0.0017)	-0.0018 (0.0066)
Rival Sales x Herfindahl	-0.0010 (0.0022)	0.0049 (0.0026)	-0.0043 (0.0060)
Adjusted R-squared	0.27	0.17	0.05

Note: Regressions include dummy variables for years.

TABLE 9B

OLS Regressions of Durability and Pay-Performance Sensitivity
Dependent Variable: Short-Term Compensation

Regression Coefficients	Dependent Variable in Levels	Dependent Variable in Differences	All Variables in Differences
Own Performance	0.0526 (0.0161)	0.0261 (0.0151)	0.0246 (0.0080)
Rival Performance	-0.0076 (0.0041)	-0.0020 (0.0042)	-0.0070 (0.0036)
Own Performance x Herfindahl percentile	0.0926 (0.0269)	0.0231 (0.0097)	0.0042 (0.0020)
Rival Performance x Herfindahl percentile	-0.0632 (0.0182)	-0.0820 (0.0201)	-0.0199 (0.0177)
Herfindahl percentile	188.8218 (42.3617)	92.1210 (21.0077)	----------
CEO Dummy	671.2612 (41.1274)	160.0202 (44.1234)	83.2612 (40.0212)
Durability Quartile	0.0008 (0.0003)	0.0010 (0.0003)	----------
Own Sales	-0.0066 (0.0020)	-0.0040 (0.0024)	-0.0020 (0.0009)
Rival Sales	-0.0012 (0.0005)	-0.0012 (0.0017)	0.0031 (0.0088)
Durability Quartile x Own Sales	-0.0333 (0.0144)	0.0411 (0.0180)	-0.0062 (0.0029)
Durability Quartile x Rival Sales	-0.0101 (0.0040)	-0.0017 (0.0121)	-0.0010 (0.0022)
Durability Quartile x Own Performance	0.0417 (0.0182)	0.0072 (0.0070)	0.0182 (0.0117)
Durability Quartile x Rival Performance	0.0117 (0.0044)	0.0052 (0.0060)	-0.0017 (0.0166)
Own Sales x Herfindahl	-0.0037 (0.0021)	-0.0021 (0.0017)	0.0162 (0.0133)
Rival Sales x Herfindahl	-0.0006 (0.0002)	0.0012 (0.0088)	0.0021 (0.0066)
Adjusted R-squared	0.20	0.11	0.04

Note: Regressions include dummy variables for years.

TABLE 10

Hypothesis Tests at the Median Industry Concentration for Median Regressions of Pay-Performance Sensitivity

	NON-DURABLE GOODS (D=0)		DURABLE GOODS (D=1)	
	Total Compensation	Short-Term Compensation	Total Compensation	Short-Term Compensation
		Dependent Variable in Levels		
Own Performance	.1325	.0955	.1958	.1243
(*p* value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Rival Performance	-.0738	-.0222	-.1170	-.0170
(*p* value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Own Sales	-.0074	-.0054	-.0501	-.0255
(*p* value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Rival Sales	.0007	-.0005	.0208	-.0077
(*p* value)	(0.0202)	(0.0262)	(0.0000)	(0.0000)
		Dependent Variable in Differences		
Own Performance	.0429	.0294	.0981	.0385
(*p* value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Rival Performance	-.0234	-.0130	-.0390	-.0093
(*p* value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Own Sales	-.0033	-.0024	-.0294	-.0127
(*p* value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Rival Sales	.0000	-.0007	.0100	-.0048
(*p* value)	(0.2632)	(0.1017)	(0.0000)	(0.0000)
Δ Own Performance	.0241	.0172	.0682	.0389
(*p* value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Δ Rival Performance	-.0321	-.0103	-.0538	-.0095
(*p* value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Δ Own Sales	-.0031	-.0043	-.0119	-.0113
(*p* value)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Δ Rival Sales	.0006	-.0006	.0150	-.0012
(*p* value)	(0.0512)	(0.0510)	(0.0000)	(0.0127)

Notes: The regressions include own and rival performances and sales, all interacted with the Herfindahl percentile and the Durability quartile, and a CEO dummy (column 3 in Tables 6A/B – 8A/B).