The Provision of Incentives in Durable Goods Firms*

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Abstract

This paper studies the importance of durability on the demand side for the determination of internal contractual incentives in the firm. The time-consistency problem induced by durability offers a heretofore unrecognized opportunity for deriving and testing a new set of implications of agency theory and incentive contracts. We find in the formal analysis that delegation of control and certain biases in the choice of managerial incentive contracts may be valuable as a commitment to a future schedule of production for sellers of durable goods in imperfectly competitive markets. The implications for incentive compensation contracts are then tested empirically using data on compensation of top executives at large corporations. Consistent with the predictions, we find that the time-consistency problem of durable goods firms induces certain compensation practices biased away from strict profit maximization. In particular, it induces indexing to both profits and sales, lower responsiveness 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 literature 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 literature 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 various 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 ..., [as a result] what we have is a very incomplete theory" (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]

This paper is concerned with the theoretical and empirical literature in these fields. The analysis focuses on an *observable* feature of the demand side which may induce such an important 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 of course the problem can be completely solved by some other means. In this sense, the analysis represents a potentially fruitful ground for developing and testing new implications of agency and contract theories. More precisely, this paper studies both theoretically and empirically a heretofore unrecognized link between product durability on the demand side and incentive 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 or not they can commit to a future schedule of production. If a commitment to future prices were

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

not possible, the time path of prices will generally not bring forth demands that maximize the present value of current and future net revenues. We find that the problem may be mitigated, at least in principle, by delegation of control and the strategic choice of managerial compensation incentives. In this sense, the effects of durability for the determination of incentive compensation schemes may be a useful source of new implications and testable predictions in the agency theory, incentive compensation, and durable goods literatures.

There are various advantages of bringing the role of durability to bear on these literatures that are worth mentioning. First, the consequences of this specific time-inconsistency problem for the firm can be extremely undesirable. In fact, 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 *ceteris paribus* executive's marginal contribution to production could have a greater impact. In this sense, the analysis brings to bear a previously unrecognized feature of the market where firms operate that is both observable and suitable for empirical analysis of agency theory. More importantly, 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 appear to be strongly supported 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 relevant. The time-consistency problem induced by durability represents a new aspect where the temporal dimension is also important. Lastly, the theoretical analysis 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 later, 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, and will also motivate further the study of their relationship.

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 and business practices that solve or mitigate the monopolist's problem, and that in turn confirm the actual empirical relevance of the durable-goods 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

[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: i. capacity restrictions (Bulow, 1982); ii. the establishment of exclusive contracts in servicing his product, that is, the transfer of his monopoly power to services, which are non-durable (Bulow, 1982); iii. "planned obsolescence," that is, choice of product durability (Bulow, 1986); iv. 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), and iv. the strategic use of debt (Chemla and Faure-Grimaud, 2001).

is typically observed in modern corporations—and by the strategic choice of managerial compensation incentives. Therefore, the time-consistency problem induced by durability offers a potentially fertile ground for developing and testing different implications of the literature on strategic delegation, executive compensation, and contract theory for the optimal incentive contracts for top executives.

The second strand of literature addressed in this paper is concerned with 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, and other variables. In fact, a significant amount of literature on strategic delegation has argued quite persuasively that the choice of managerial incentives may often include 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.[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, therefore, focuses on a specific promise or commitment problem. We will show that this problem may be formally solved by the separation of ownership from control and the appropriate choice of managerial incentive contracts. In particular, the managerial incentive schemes that we will examine are those indexed to profits and sales that have been studied and reported in the literatures on managerial compensation and contract theory, although other types of contracts may be considered as well.

Interestingly, the formal analysis is related to one of Coase's (1972) original ideas, one idea which somewhat surprisingly has not been pursued in the literature to date. Coase does not strictly indicate that durability may have an effect on 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, italics added) might solve the commitment problem of the monopolist. Such an arrangement is, in essence, very similar to the one that will be studied here which instead points to *internal* contractual relationships in the firm given a separation of ownership from control.[8]

Of course, besides the theoretical analysis, the empirical relevance of the problem will depend on the extent to which owners of durable good firms may be able to solve the problem more cheaply by some other means (for instance, by following the business practices mentioned earlier). This is an empirical question that we examine using data on compensation of executives at large corporations. Interestingly enough, consistent with the predictions of the analysis we find substantial empirical confirmation that the time-consistency problem of durable-goods firms induces *some* distortions or biases away from strict profit maximization. In particular, as predicted by the theory, durability induces longer term compensation incentives, indexing to profits and sales, lower responsiveness of compensation to size, greater pay-performance sensitivity, and greater relative performance evaluation. These results show how the returns to executive effort vary with product durability and support 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 enforceable.

In summary, the analysis brings an *observable* feature of markets to bear on the literatures on agency theory, contract economics, and executive compensation. This feature offers the opportunity to derive and test new predictions for the provision of incentives in the firm and the institutional structure of production.

The rest of the paper is organized as follows. Section 2 is concerned with the theoretical analysis. It is divided into three subsections. We begin in the first one by setting out a Bulow-type model for the case of a durable-goods monopolist and solving 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 some of the main insights of the analysis. In the second subsection we provide a brief discussion and intuition for the main features of the results and their implications. In the third subsection we extend the theoretical analysis to a simple oligopolistic model of strategic competition in order to study how strategic competition may interact with the consistency problem induced by durability in the design of incentive contracts. We also derive additional empirical predictions. In Section 3 we test the predictions empirically using data on compensation of executives at large corporations. Section 4 concludes with a brief summary and 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 basic 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

[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.

profits 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 results 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 that the good yields 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 our 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:

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

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

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 only consider 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. The model must thus be solved by backward induction. The monopolist will 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 literature 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 by the monopolist seller in period 1 and the cumulative production in period 2 will always be greater than those that he would produce if he behaved as a competitive firm. 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 establishes 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, except for the manager's compensation, will be equal to those of the monopolist renter.

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

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. See also the analysis in Goering (1994). 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 solves:

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

subject to

$$x_2 \geq x_1.$$

From the first order condition of this problem,

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

we have 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 solves for the x_1 that maximizes the present value of his compensation, so he solves 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 shows 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 shown 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 may arise after the contract has been signed. This is the reason why the contract has to be irreversible, 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 a number of cases we may expect that incentive-contract commitments will be valuable. For instance, Pareto-improving renegotiations may simply not be incentive compatible, as in cases of incomplete information (see e.g., Dewatripont (1988)). In other cases, "golden parachutes" for managers that are laid off may preclude renegotiation. If renegotiations are observable and firms have reputational concerns, these concerns may be sufficient to preclude renegotiations. The commitment problem may also 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. *Any* of these reasons would be sufficient for precluding renegotiation.

To be sure, and more importantly, for the purposes of the cross-sectional empirical implications for durability, precluding renegotiation in each and very firm is entirely unnnecessary. It is simply necessary that the ability to renegotiate contracts is *not perfect* in each and *every* firm. Clearly, this is a mild requirement. Put it differently, the empirical evidence should show that incentive-contract biases have *some* value at

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

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

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

the margin as commitments, except in the case in which contracting parties in each and every firm in the data can perfectly and costlessly renegotiate.

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.[17] The formal analysis above offers a new potential reason for the use of long-term contracts in agency theory, namely, their ability to provide a commitment to a future schedule of production in durable-goods firms.[18] This result suggests that the greater the durability *ceteris paribus* the longer the term of the compensation incentives that should be observed empirically.

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 conditioning on sales and a negative sensitivity to sales conditioning on profits. 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 the 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

[17]See, for instance, Williamson (1985), Crawford (1988), Fudenberg, Holmström, and Milgrom (1990), Rey and Salanie (1990), Sen (1993), and Bárcena and Espinosa (1996).

[18]In general, the optimal compensation contracts will always last for the two periods. Intertemporal consistency implies that no contract lasting for period 1 only can be optimal. However, incentive contracts lasting for only period 2 can be optimal provided 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 (i.e., $\alpha_2^* = 1$). In this sense, even such a contract for period 2 only may still be considered long-term. The incentive parameter in this case would still be α_2^*, the optimal solution of the proposition, since the monopolist would have already produced x_1^R in period 1.

than c_2. Note that the problem the manager solves is identical to 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. This "high-cost strategy" will also be useful for oligopolists of durable goods. Sklivas (1987) and Fershtman and Judd (1987a, 1987b) obtain in a static framework that in duopolies of non-durable goods, under Cournot competition, *strategic* delegation to managers induces an $\alpha^* < 1$ in this class of contracts. It is not difficult to show that if, instead, their firms were durable goods duopolies and we considered a simple dynamic framework, then the effect of durability would induce a *greater* α_2^* than in the non-durable good case. The effect of durability may be stronger than the strategic motive effect and hence result in a α_2^* that is greater than 1. This issue is examined in the next subsection where we generalize the analysis to a simple model of durable-goods oligopolists.

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 above and in the introduction, we would expect that the impact of durability on observed incentive compensation schemes will be empirically relevant iff the time consistency problem cannot be *completely* solved more cheaply 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 have already been hired because of their skills, knowledge, and abilities.[19] This form of commitment would then require some *biasing* of incentives, that is some "distortion" of the usual incentives. Moreover, contractual arrangements are not subject to the special conditions frequently required by other solutions to be empirically 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.[20] Contractual commitment can also be a profitable strategy

[19]Also, as indicated earlier (footnote 13), we do not need to rely on contracts being strictly observable since even unobservable contracts may serve as precommitments (see, for example, Katz (1991), Aggarwal and Samwick (1999a), Koçkensen and Ok (2002) and other references therein).

[20]Also, as Coase (1972, p. 147) observed, "some of these arrangements may not be legally enforceable." Obviously, contractual commitment, as all quantity commitments, is less attractive when

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. Also, product-market commitment devices may not solve the problem *completely* if there is non-contractible uncertainty (e.g., due to technological change) that affects second-period prices and quantities. Therefore, under durability *some* biases or *some* distortions in incentive contracts may be valuable at the margin to help maintain market power in a number of different circumstances, in addition to other commitments that may be available in the product market. Yet, whether or not durability induces these biases is entirely an empirical question, which we will study later.

As noted earlier, the features of this two-period model do not affect the qualitative nature of the results. We emphasize that the main purposes of the theoretical analysis are to show that contractual biases or arrangements of the type suggested here are a feasible way of achieving a monopoly price and to derive the basic empirical predictions that these biases imply. These biases may also be quite natural and straightforward to implement since, given a separation of ownership from control, compensation contracts for managers have 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)).[21] With a greater number of periods (or, in the limit, in continuous time) the need to commit increases, although the firm may be less likely to entrench its manager for the life of a long-lived durable good.

The first empirical implications that arise from the theoretical analysis are that unless *complete* commitment has been achieved by other means, we should observe that durability biases the form of executive compensation in such a way that it induces: (a) lower responsiveness of compensation to sales, (b) longer-term compensation schemes, and (c) 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 formal analysis to the case of a duopoly model of durable goods where, in addition to the time-consistency

future contingencies are difficult to ascertain.

[21]For instance, a plausible setting for the two-period Bulow model 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.

problem induced by durability, *strategic* competition also plays a role in the design of incentive contracts. This allows us to obtain additional empirical implications.

2.3 Durable-Goods Oligopolists

This extension is relevant because even when goods are non-durable, strategic competition may already have an impact on the form of internal contractual arrangements in the firm. Fershtman and Judd (1987a) and other authors 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) may not be indexed solely to realized profits.[22] 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. There are two stages. In the first one, 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 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 its 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 $\Phi_t^i = \alpha_t^i \pi_t^i + (1 - \alpha_t^i)\, s_t^i$. 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 managers choose quantities. We assume that the managerial labor market is competitive and

[22]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 shows that, while this statement is valid for non-durable goods monopolists, the special commitment problem in durable-goods monopolists can make the strategic use of incentives also very important.

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 for monopolists. We next consider long-run incentive contracts in two different cases: duopolist renter and duopolist seller. We also assume the conditions that guarantee interior solutions, namely $e > c_1 - vc_2$ and $c_1 > (1+v)c_2$.[23]

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:

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

[23]Durability raises an interesting issue for oligopoly theory in that strategic interaction provides a possible reason why a durable good oligopolist might prefer to sell some of its output rather than rent it. It may be shown, however, that in a model where the choice between leasing and selling is endogenous, if $e > c_1$ durable goods duopolists will strictly prefer renting over selling, with and without strategic delegation.

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:

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

See Fershtman 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 the "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

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

In this case, it can be shown after some algebra that:

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

where α_2^{ds}can be greater than 1 and where α_t^{ms} corresponds to the incentive parameters obtained for the monopolist seller case. The force that drives α_2^{ds} to be less than α_2^{ms} is that the durable-goods duopolist wants to commit to a large quantity of output in the second period to try to achieve a Stackelberg leader effect. Moreover, it can also be shown that:

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

It is important to note the following empirical implications in this case. The sensitivity of compensation to profits: (i) increases with the concentration of the industry $\left(\alpha_t^{ms} > \alpha_t^{ds}\right)$,[24] 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 perhaps 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 implications are not an artifact of the model as it is not difficult to obtain the same results in a model where goods are not perfectly durable and where durability is modeled explicitly as in Bulow (1986). Let $\delta \in [0, 1]$ 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 shown (see the Appendix) that:

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

[24]Since in a perfectly competitive industry $\alpha_t = 1$, $\forall t$, 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.

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

$$\frac{d\alpha_2^{ds}(\delta)}{d\delta} > 0, \forall\delta \text{ and } \frac{d\alpha_t^{ms}(\delta)}{d\delta} > 0, \forall\delta, \forall t = 1, 2.$$

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

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, as in Bulow's (1986) analysis of the oligopoly case, to increase the marginal costs of production which in the first period might, for instance, be $c_1(1 + \delta)$.

Lastly, the analysis in this subsection has considered contracts in which managers can be compensated on their own performance and own sales. 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 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.[25] 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 is then possible to conjecture that when firms are subject to the time-consistency 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 two forces: (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. We will also study this conjecture empirically.

[25] 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 aggressive 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 chief executive officers at large corporations in the U.S.

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.[26] 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 median individual level, long-term compensation accounts for about 34 percent for CEOs and 30 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,* 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 good

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

that is produced. 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 (with similar but different number of firms) as Q1, Q2, Q3 and Q4 respectively. This normalization will allow for an easy interpretation of the parameters in the regression specifications.[27]

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) and other authors, 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:

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

[27] Details can be found in Publication 946 of the IRS (Section 3, *Table of Class Lives and Recovery Periods* of Appendix B). We also implemented the different regression analyses 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. Although some multiproduct firms could be assigned to different product classes, we found that few of them could be assigned to more than one durability quartile (e.g., IBM sells both computers (quartile 2) and business services (quartile 1)). The results that will be presented remain largely unchanged when considering the different quartiles for these firms.

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 $F(H)$.[28] 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.[29] Just as an example, we report in Table 2 the 4-digit SIC concentration ratios for manufacturing firms along with the median years of durability (property class) according to the *MACRS* by 2-digit SIC codes.

[Table 2 here]

3.2 Testing the Empirical Implications

The theoretical results indicate that unless full commitment has been *completely* achieved by other means and firms *never* have any reasons that preclude renegotiation, then we should expect the following biases: durable-goods firms will *tend* to structure compensation in a way 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 for these four general implications next.

1. Compensation Tied to Sales. We first study whether durable good's firms tend to 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

[28] 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.

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

economics. We estimate the derivative and the elasticity of compensation to size for the different firms according to their durability quartile.

[Table 3 here]

The estimated pay-sales derivatives range between 0.021 and 0.051 for salary plus bonus (short-term compensation), and between 0.030 and 0.070 for total compensation (short-term plus long-term compensation) from durable to non-durable property. These sensitivities imply an increase between 2.1 cents and 5.1 cents in short-term compensation, and between 3 cents and 7 cents in total compensation, for every $1,000 of increased firm revenues. The estimated pay-sales elasticities range between .151 and .307 for salary plus bonus, and between .198 and .359 for total compensation. Murphy (1999) finds a similar range for short-term compensation in the mid-1990s.[30] More importantly, the Wald tests reject the hypothesis of equality of pay-sales responsiveness (derivative and elasticity) across durability quartiles in all cases.[31] These results, therefore, indicate that both the estimated derivative and elasticity of CEO compensation with respect to firm revenues *decrease* with durability. Hence, these initial results are consistent both with previous findings in the literature and with the theoretical implications of the principal-agent durable-goods model.

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]

[30]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.

[31]The rejections are a bit stronger for Total Compensation. Note also that the strict prediction of the model is that the derivative of pay with respect to sales should decrease with durability. The fact that the cross-sectional elasticity of pay with respect to sales also decreases may indicate that, to the extent that the level of pay is determined by the value of the executive's outside opportunity, outside opportunities increase more slowly with the size of the current employer in durable-goods firms than in nondurable-goods firms.

[32]An alternative way would be to examine whether vesting is longer in durable goods firms. Unfortunately, however, the data is not in *ExecuComp*. If the data were available, it could also be relevant, 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.

Table 4 reports the results of robust regressions (Hamilton (1991)) 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 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. F-tests and Wald tests confirm the significance of the increase across durability quartiles, especially for CEOs.

3. Higher Pay-Performance Sensitivity. An empirical implication of the model is that the sensitivity of compensation to profits, conditional on sales, should increase with durability. In Table 5 we test this prediction by examining how the pay-performance sensitivity conditional on sales, 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 about 0.13 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, more importantly, 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-performance relationship, and continue to increase with durability. The pay-performance sensitivity comes mostly from contemporaneous performance, and is about 0.192 for the less durable firms and 0.357 for the more durable firms.[33]

Lastly, the analysis is repeated in the last four columns for Total Wealth (defined as Total Compensation plus 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-performance sensitivity increases by a very large factor. Hence, it is relevant to examine the implications of durability for this measure of pay.[34] 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-performance sensitivity is about 0.091 for the less durable firms and 0.225 for the more durable firms.

We conclude from the evidence that the results are consistent with the predictions of the theoretical analysis: durability induces certain compensation practices away from strict profit maximization, longer-term compensation, and higher pay-performance sensitivity.

4. Relative Performance Evaluation. Lastly, we evaluate the implications of 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. This 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.[35]

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

[34]Interestingly, 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.

[35]For instance, Jensen and Murphy (1990) find that relative performance does not appear to be an

The following three empirical results can be anticipated. First, we find 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, 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, durability may help to explain, at least in part, the 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 both for the principal-agent model and for 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 strategic competition induces *greater* relative performance evaluation, especially in long-term compensation data. These results are taken to support the conjecture discussed at the end of Section 2.

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:

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

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.

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. 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.

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.[36] The third regression considers the effects of durability and strategic competition simultaneously. 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.[37] The advantage of running OLS and median regressions is that the results can be readily compared with previous findings in the literature. 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.

[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 significant and 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

[36] 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.

[37] There are other alternative ways of dealing with outliers. 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.

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, although they appear to be significant only for total compensation. As found earlier, durable-goods firms have a greater incentive to write long-term compensation contracts to mitigate the time-inconsistency problem induced by durability. The coefficients for the Herfindahl percentiles, alone and interacted with performance and sales, are significant in all cases, except when interacted with sales in short-term compensation data. The positive and highly significant coefficient for Durability interacted with Herfindahl means that durable goods producers especially benefit from incentive-contract commitments when they have potential market power.

In the second columns, both total and short-term compensation 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 supports the arguments that the effects of durability may be mitigated by longer-term incentive compensation schemes 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, relative pay-performance compensation increases with durability. As to the Herfindahl percentile, the results from column 1 are maintained. In particular, incentive commitments are particularly useful to durable goods producers when they have market power. When Herfindahl 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.

[Tables 8A and 8B here]

In Tables 8A and 8B all variables are in differences. Again, the qualitative nature of the findings is 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. When durability and sales are ignored the results show support for the Bertrand model of competition.[38] 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 considered. Interestingly, the results are qualitatively similar to those found in the median regressions. Given that outliers occupy a more prominent role in these regressions, the estimates tend to be less significant.

[38] 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.

[Table 10 here]

Lastly, 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 complete regression specification for the durable goods and the non-durable goods cases. 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 also indicate that a greater amount of incentives than those previously found in the literature are being provided to executives.

3.3 Robustness of the Empirical Results

A number of additional estimations and robustness checks have been examined. The regressions were also estimated using the 3-digit SIC codes and using differences from means.[39] As mentioned earlier, robust regressions were also implemented. The results confirm the findings presented here and do not appear to uncover any additional effects. In order to eliminate possible omitted variable biases we also considered the debt/equity ratio (Chemla and Faure-Grimaud (2001)) and variables that proxy for the importance of decisions that are strategic substitutes such as capital intensity and the R&D-sales ratio that could affect the optimal incentive for sales (as in Fershtman and Judd (1987a)), the use of stock-based compensation and perhaps even relative performance evaluation as well. None of the results obtained above experience any relevant changes when these variables are considered. Given that the model makes predictions about pay-sensitivity to flow profits we also considered using accounting profits, rather than the market value added. The results were very similar. We also considered the robustness to other proxies of imperfect competition such as accounting profitability and the modified Herfindahl index suggested in Bresnahan and Salop (1986), instead of the Herfindahl of 4-digit SIC industries. The results were again very similar.

We conclude from the empirical analysis that durable-goods firms do tend to structure compensation in such a way 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. In this sense, the results lend valuable support to

[39]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.

the idea that durability on the demand side has relevant effects for the determination of internal contractual relationships in the firm.

4 Concluding Remarks

We have studied a heretofore unrecognized relationship between durability on the demand side and agency theory. We argued that the distinct problem induced by durability represents a valuable opportunity for testing whether the general type of compensation practices and incentives contracts predicted by agency theory are confirmed by the data. This is an aspect where past empirical literature has had mixed success relative to the theory. In this sense, the analysis recognizes the opportunity provided by the body of theoretical and empirical literature on durable-goods firms to examine both theoretically and empirically the implications of durability for agency theory, contract theory, and the literature on corporate governance.

From the theoretical perspective, delegation of control and managerial incentive schemes away from strict profit maximization emerge as a source of commitment in these firms. In this sense, the analysis offers a new solution to the commitment problem of durable-goods firms along the lines of an early insight in Coase's (1972) original exposition. This insight, perhaps somewhat surprisingly, has not been pursued in the literature to date. It also provides a new reason for incentive schemes not based on profits alone that have been reported in the literature on management compensation, and 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 "some distortion" of manager's incentives is a potentially important instrument for owners of durable goods firms, and that this general implication will continue to hold in more general frameworks. With durability *some* biases in contractual commitments may be a less costly way to help maintaining market power—especially when control is already delegated to managers because of their knowledge, abilities, skills and other reasons—and thus of alleviating the otherwise fatal consequences of durability on the demand side. Yet, this is an empirical question that would only be relevant when commitment to a future schedule of production cannot be completely achieved more cheaply by other forms of commitment and when the ability to renegotiate contracts is not perfect in each and every firm.[40]

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." Also, as indicated earlier, even though a necessary ingredient for successful testing of agency theory is that agents respond to incentives, the true test of the theory is whether compensation practices and the incentive contracts offered to agents reflect agency concerns. In this sense, the analysis brings an observable feature to bear on the literature on the separation of ownership and control which figures prominently in the economic theory of organizations. This allows us to make a number of testable predictions which find valuable empirical support. The empirical evidence also includes support for the principal-agent model of executive compensation, in particular the strategic substitutes Cournot model of price competition. This model is of central importance to the modern theory of the firm and corporate governance, but has been only weakly supported by previous empirical evidence.

Extensions of the empirical analysis may include the study of the impact of risk, other aspects of firm size, and the quality of firm governance on executive compensation.[41] It will also be worthwhile to examine in more 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. It would surely be important to obtain evidence on incentive compensation sensitivities for other countries as well.[42] Lastly, the use of incentives may not only take place at the executive level but also at other levels. Anecdotal evidence suggests, for instance, that firms may bias salesforce incentives against pushing older durable products and using these incentives to sell the product to early adopters.

[40]Contractual commitment 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)).

[41]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 (2001) on the impact of the quality of governance.

[42]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 Concentration Ratios by 2-digit SIC Code in Manufacturing

2-Digit SIC Code and Description	Number of 4-digit SICs	Herfindahl of constituent 4-digit SICs Mean	Min.	Max.	Median number of years of property class
20. Food and kindred products	22	1076.1	181	2253	0
21. Tobacco products	2	2090.6	1923	2175	0
22. Textile mill products	8	740.7	243	1679	5
23. Apparel and other textile products	8	805.3	61	2338	5
24. Lumber and wood products	5	283.6	78	491	15
25. Furniture and fixtures	5	521.7	167	1043	10
26. Paper and allied products	5	453.9	143	1451	3
27. Printing and publishing	8	404.2	19	2922	7
28. Chemicals and allied products	22	640.4	190	2999	0
29. Petroleum and Coal products	2	414.8	414	431	0
30. Rubber and miscellns. plastic products	7	386.2	15	1743	15
31. Leather and leather products	3	786.0	513	1401	15
32. Stone clay and glass products	5	891.3	472	1765	15
33. Primary metal industries	11	859.0	201	2827	20
34. Fabricated metal products	16	348.7	31	1457	20
35. Industrial machinery and equipment	24	660.5	80	2549	20
36. Electronic and other electric equipment	26	745.5	180	2929	10
37. Transportation equipment	11	1538.7	428	2717	20
38. Instruments and related products	15	467.3	148	2408	10
39. Miscellaneous manufacturing industries	6	265.8	74	808	7
All Manufacturing Industries	211	699.1	15	2999	10

Notes: Tabulations of *1992 Census of Manufactures* and *ExecuComp* datasets. 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. The median number of years of the property class is the median number of years over which the basis of property can be recovered for the sample firms at the 4-digit SIC level under the General Depreciation System of MACRS.

TABLE 3

Estimated Sensitivity and Elasticity of CEO Salary plus Bonus, and Total Compensation with Respect to Firm Revenues
(*t* statistics in parentheses)

	dpay / dsales (x 1,000)		*Elasticity*	
	Salary plus Bonus	Total Compensation	Salary plus Bonus	Total Compensation
<u>Durability</u>				
Quartile Q1	0.051	0.070	0.307	0.359
(Non-durable property)	(4.27)	(3.02)	(3.18)	(4.15)
	R^2 = 0.12	R^2 = 0.11	R^2 = 0.12	R^2 = 0.11
Quartile Q2	0.040	0.057	0.227	0.317
(3-5-7 year property)	(3.82)	(5.60)	(2.81)	(3.82)
	R^2 = 0.15	R^2 = 0.20	R^2 = 0.15	R^2 = 0.20
Quartile Q3	0.035	0.043	0.182	0.237
(10-15 year property)	(5.01)	(2.87)	(3.60)	(2.96)
	R^2 = 0.20	R^2 = 0.27	R^2 = 0.20	R^2 = 0.27
Quartile Q4	0.021	0.030	0.151	0.198
(20-year and durable property)	(2.17)	(3.50)	(5.21)	(3.29)
	R^2 = 0.23	R^2 = 0.34	R^2 = 0.23	R^2 = 0.27

Wald Tests for the Equality of Slopes Across Durability Quartiles (*p* values in parentheses)

	Q1 vs Q2	Q2 vs Q3	Q3 vs Q4
dpay/dsales			
Salary plus Bonus	7.55 (0.006)	4.17 (0.041)	6.22 (0.012)
Total Compensation	9.23 (0.002)	4.63 (0.031)	7.17 (0.007)
Elasticity			
Salary plus Bonus	5.88 (0.015)	4.57 (0.032)	4.61 (0.031)
Total Compensation	6.08 (0.013)	5.40 (0.022)	8.77 (0.003)

NOTES: Sensitivities are computed from regressions of Salary plus Bonus on Sales, and Total Compensation on Sales, respectively. Elasticities are computed from regressions of Log (Salary plus 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 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.

Panel A

		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)		

Panel B: Testing for the Equality of Slopes Across Durability Quartiles

	Q1 vs Q2	Q2 vs Q3	Q3 vs Q4
CEOs			
F statistic (*p* value)	7.48 (0.006)	4.87 (0.027)	6.47 (0.011)
Wald statistic (*p* value)	9.08 (0.002)	5.20 (0.022)	7.32 (0.006)
Non-CEOs			
F statistic (*p* value)	4.09 (0.043)	4.58 (0.032)	5.92 (0.015)
Wald statistic (*p* value)	6.60 (0.010)	4.20 (0.040)	4.71 (0.029)

NOTES:
1. 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.
2. The *F* tests assume equality of variances, an assumption that is not rejected by the Goldfeld-Quandt test and Breusch-Pagan Lagrange multiplier tests. The Wald test allows for differences in variances. Given the large sample size this test is valid whether or not the disturbance variances are the same.

TABLE 5

Differences in CEO Pay-Performance Sensitivity Across Durability Quartiles Conditional on Sales

	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	0.102 (0.017)	0.143 (0.021)	0.166 (0.010)	0.217 (0.021)	0.192 (0.039)	0.239 (0.038)	0.277 (0.041)	0.357 (0.040)	0.091 (0.004)	0.122 (0.003)	0.156 (0.007)	0.153 (0.007)
Firm return in previous year	0.032 (0.010)	0.053 (0.015)	0.077 (0.012)	0.082 (0.017)	-0.027 (0.028)	-0.017 (0.022)	-0.020 (0.027)	-0.031 (0.018)	0.010 (0.010)	0.006 (0.010)	0.025 (0.007)	0.032 (0.008)
R^2	0.06	0.06	0.05	0.05	0.06	0.05	0.05	0.04	0.09	0.07	0.04	0.07

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), respectively, conditional on sales, 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. In the last panel (4 columns), Total CEO wealth, which includes total compensation plus changes in the value of stock holdings and stock option holdings is regressed on firm's returns in current and previous year conditional on sales. 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	0.0412 (0.0071)	0.0178 (0.0096)	0.0520 (0.0029)
Rival Performance		0.1782 (0.0103)	-0.0270 (0.0079)
Own Performance x Herfindahl percentile	0.1528 (0.0098)	0.1602 (0.0140)	0.1611 (0.0122)
Rival Performance x Herfindahl percentile		-0.1552 (0.0141)	-0.0941 (0.0674)
Herfindahl percentile	182.1342 (15.2312)	171.5220 (23.9632)	180.1582 (18.4092)
CEO Dummy	792.4076 (17.3303)	717.2623 (13.0302)	851.328 (26.5051)
Durability Quartile	0.0004 (0.0001)		0.0004 (0.0001)
Durability x Herfindahl	36.4202 (10.3271)		37.2133 (11.4202)
Own Sales	-0.0068 (0.0020)		-0.0062 (0.0012)
Rival Sales			0.0008 (0.0002)
Durability Quartile x Own Sales	-0.0388 (0.0080)		-0.0432 (0.0065)
Durability Quartile x Rival Sales			0.0204 (0.0024)
Durability Quartile x Own Performance	0.0619 (0.0015)		0.0630 (0.0044)
Durability Quartile x Rival Performance			-0.0436 (0.0094)
Own Sales x Herfindahl	-0.0008 (0.0003)		-0.0024 (0.0008)
Rival Sales x Herfindahl			-0.0003 (0.0001)
Pseudo R-squared	0.33	0.14	0.48

Note: Regressions include dummy variables for years and for 2-digit SICs. Std. dev in parenthesis.

TABLE 6B

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

Regression Coefficients	Dependent Variable in Levels		
Own Performance	0.0307 (0.0051)	0.0369 (0.0035)	0.0643 (0.0078)
Rival Performance		0.0450 (0.0063)	-0.0023 (0.0061)
Own Performance x Herfindahl percentile	0.0817 (0.0130)	0.0380 (0.0086)	0.0598 (0.0117)
Rival Performance x Herfindahl percentile		-0.0172 (0.0132)	-0.0403 (0.0310)
Herfindahl percentile	57.2472 (12.3120)	56.9623 (15.0430)	66.1356 (9.2802)
CEO Dummy	428.0017 (11.8928)	394.0428 (8.1906)	500.3027 (25.9090)
Durability Quartile	0.0003 (0.0001)		0.0002 (0.0000)
Durability x Herfindahl	9.8722 (2.0260)		14.2366 (3.4080)
Own Sales	-0.0029 (0.0010)		-0.0043 (0.0016)
Rival Sales			-0.0004 (0.0007)
Durability Quartile x Own Sales	-0.0184 (0.0059)		-0.0207 (0.0090)
Durability Quartile x Rival Sales			-0.0071 (0.0024)
Durability Quartile x Own Performance	0.0327 (0.0080)		0.0292 (0.0088)
Durability Quartile x Rival Performance			0.0050 (0.0034)
Own Sales x Herfindahl	-0.0002 (0.0016)		-0.0022 (0.0011)
Rival Sales x Herfindahl			-0.0002 (0.0001)
Pseudo R-squared	0.26	0.16	0.36

Note: Regressions include dummy variables for years and for 2-digit SICs. Std. dev in parenthesis.

TABLE 7A

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

Regression Coefficients	Dependent Variable in Differences		
Own Performance	0.0117 (0.0032)	0.0051 (0.0053)	0.0145 (0.0040)
Rival Performance		0.0411 (0.0060)	-0.0113 (0.0026)
Own Performance x Herfindahl percentile	0.0489 (0.0080)	0.0446 (0.0075)	0.0564 (0.0107)
Rival Performance x Herfindahl percentile		-0.0546 (0.0080)	-0.0239 (0.0086)
Herfindahl percentile	38.3276 (6.8021)	35.4608 (10.3290)	36.1270 (5.8020)
CEO Dummy	36.1217 (9.482)	37.4774 (6.9144)	37.9204 (8.1717)
Durability Quartile	0.0006 (0.0001)		0.0004 (0.0001)
Durability x Herfindahl	7.5245 (1.7172)		6.8202 (2.0341)
Own Sales	-0.0020 (0.0007)		-0.0028 (0.0007)
Rival Sales			0.0004 (0.0001)
Durability Quartile x Own Sales	-0.0153 (0.0035)		-0.0259 (0.0051)
Durability Quartile x Rival Sales			0.0102 (0.0033)
Durability Quartile x Own Performance	0.0425 (0.0044)		0.0550 (0.0071)
Durability Quartile x Rival Performance			-0.0154 (0.0041)
Own Sales x Herfindahl	-0.0008 (0.0003)		-0.0012 (0.0005)
Rival Sales x Herfindahl			-0.0009 (0.0012)
Pseudo R-squared	0.10	0.0153	0.18

Note: Regressions include dummy variables for years. Std. dev in parenthesis.

TABLE 7B

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

Regression Coefficients	Dependent Variable in Differences		
Own Performance	0.0117 (0.0030)	0.0151 (0.0014)	0.0235 (0.0043)
Rival Performance		-0.0030 (0.0015)	-0.0030 (0.0014)
Own Performance x Herfindahl percentile	0.0148 (0.0043)	0.0066 (0.0020)	0.0114 (0.0036)
Rival Performance x Herfindahl percentile		-0.0039 (0.0020)	-0.0202 (0.0057)
Herfindahl percentile	8.8317 (2.0106)	4.2562 (3.0917)	15.7302 (4.3072)
CEO Dummy	38.3232 (7.5026)	28.7702 (2.0826)	42.3281 (6.1378)
Durability Quartile	0.0003 (0.0002)		0.0003 (0.0001)
Durability x Herfindahl	1.6326 (0.3802)		3.1726 (0.7230)
Own Sales	-0.0009 (0.0011)		-0.0016 (0.0004)
Rival Sales			-0.0004 (0.0004)
Durability Quartile x Own Sales	-0.0087 (0.0020)		-0.0106 (0.0032)
Durability Quartile x Rival Sales			-0.0042 (0.0017)
Durability Quartile x Own Performance	0.0144 (0.0052)		0.0092 (0.0027)
Durability Quartile x Rival Performance			0.0037 (0.0022)
Own Sales x Herfindahl	-0.0002 (0.0027)		-0.0019 (0.0010)
Rival Sales x Herfindahl			-0.0006 (0.0011)
Pseudo R-squared	0.09	0.0261	0.22

Note: Regressions include dummy variables for years. Std. dev in parenthesis.

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. Std. dev in parenthesis.

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. Std. dev in parenthesis.

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	0.0572 (0.0173)	0.0428 (0.0108)	0.0562 (0.0257)
Rival Performance	-0.0880 (0.0304)	-0.0526 (0.0180)	-0.0492 (0.0192)
Own Performance x Herfindahl percentile	0.2138 (0.0820)	-0.0869 (0.0294)	0.0402 (0.0262)
Rival Performance x Herfindahl percentile	-0.1205 (0.0888)	-0.0830 (0.0266)	-0.0292 (0.0181)
Herfindahl percentile	430.2820 (67.1288)	142.3579 (43.6681)	_______
CEO Dummy	917.2633 (119.0064)	129.2260 (50.0268)	73.2216 (40.2643)
Durability Quartile	0.0024 (0.0009)	0.0014 (0.0003)	_______
Durability x Herfindahl	78.1248 (21.4260)	20.4284 (5.0732)	_______
Own Sales	-0.0090 (0.0030)	-0.0065 (0.0027)	-0.0082 (0.0036)
Rival Sales	-0.0028 (0.0022)	0.0016 (0.0010)	0.0029 (0.0006)
Durability Quartile x Own Sales	-0.0930 (0.0190)	-0.0330 (0.0092)	-0.0127 (0.0062)
Durability Quartile x Rival Sales	0.0414 (0.0120)	0.0204 (0.0150)	0.0299 (0.0132)
Durability Quartile x Own Performance	0.0614 (0.0117)	0.1016 (0.0251)	0.0599 (0.0327)
Durability Quartile x Rival Performance	-0.0647 (0.0260)	-0.0328 (0.0114)	-0.0296 (0.0272)
Own Sales x Herfindahl	-0.0081 (0.0035)	-0.0056 (0.0016)	-0.0018 (0.0066)
Rival Sales x Herfindahl	-0.0010 (0.0023)	0.0049 (0.0022)	-0.0043 (0.0060)
Adjusted R-squared	0.29	0.18	0.05

Note: Regressions include dummy variables for years. Std. dev in parenthesis.

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	0.0522 (0.0160)	0.0257 (0.0146)	0.0246 (0.0080)
Rival Performance	-0.0076 (0.0041)	-0.0022 (0.0046)	-0.0070 (0.0036)
Own Performance x Herfindahl percentile	0.0918 (0.0263)	0.0228 (0.0096)	0.0042 (0.0020)
Rival Performance x Herfindahl percentile	-0.0631 (0.0175)	-0.0821 (0.0189)	-0.0199 (0.0177)
Herfindahl percentile	168.2426 (34.4266)	80.4202 (17.0324)	----------
CEO Dummy	668.3422 (42.0028)	158.0350 (42.0402)	83.2612 (40.0212)
Durability Quartile	0.0006 (0.0002)	0.0008 (0.0003)	----------
Durability x Herfindahl	36.4202 (10.3271)	17.1070 (4.6082)	37.2133 (11.4202)
Own Sales	-0.0069 (0.0021)	-0.0040 (0.0025)	-0.0020 (0.0009)
Rival Sales	-0.0012 (0.0005)	-0.0012 (0.0010)	0.0031 (0.0088)
Durability Quartile x Own Sales	-0.0340 (0.0150)	0.0420 (0.0166)	-0.0062 (0.0029)
Durability Quartile x Rival Sales	-0.0098 (0.0038)	-0.0020 (0.0132)	-0.0010 (0.0022)
Durability Quartile x Own Performance	0.0414 (0.0180)	0.0071 (0.0065)	0.0182 (0.0117)
Durability Quartile x Rival Performance	0.0117 (0.0048)	0.0058 (0.0062)	-0.0017 (0.0166)
Own Sales x Herfindahl	-0.0038 (0.0022)	-0.0022 (0.0019)	0.0162 (0.0133)
Rival Sales x Herfindahl	-0.0007 (0.0002)	0.0011 (0.0080)	0.0021 (0.0066)
Adjusted R-squared	0.22	0.11	0.04

Note: Regressions include dummy variables for years. Std. dev in parenthesis.

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). Std. dev in parenthesis.