

# **PRODUCT MARKET COMPETITION AND AGENCY COSTS**

By

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# 1 Introduction

Economists have a “vague suspicion that competition is the enemy of sloth” (Caves, 1980, p. 88; cited in Nickell, 1996); yet the process through which competition improves managerial efficiency still is not fully understood. There are two primary ways to think about this process. Competition may put direct pressure on firms to increase quality (or decrease costs) - for example by increasing the marginal impact of such an increase in expected profits - a pressure that is passed on to agents through higher powered incentives. But competition may also reduce agency costs, making it “cheaper” for the principal to elicit more effort from the agent.<sup>1</sup> These two processes are difficult to disentangle, because in both cases competition leads to stronger incentives and higher managerial effort. The purpose of this paper is twofold. Theoretically, we isolate the *direct pressure effect* from the *agency effect*. We then measure the empirical impact of these effects on firms’ strategic choices, contractual incentives, and managerial effort.

In our theoretical model,<sup>2</sup> two firms are located at the extremities of a Hotelling (1929) line, and compete in quality and prices for consumers on that line. Competition is measured by the degree of substitutability between products, and agency problems arise as a result of a managerial wealth constraint. Both the direct pressure effect and the agency effect are themselves the result of the interaction between these two factors. First, competition reduces price-cost margins; we call this the *rent reduction effect*. Second, by making demand more elastic, competition increases the marginal (positive) impact of an increase in quality on the market share one can “steal” from a rival; we call this the *business stealing effect*.<sup>3</sup>

We show that business stealing puts direct pressure on firms to increase quality, because it increases the marginal impact of a quality increase in expected profits. In the other hand, rent reduction lowers the marginal impact of a quality increase on expected profits, and hence puts direct pressure to reduce quality. In our model, in equilibrium, business stealing and rent reduction exactly offset each other, and the direct pressure effect of competition is null.

In contrast, business stealing and rent reduction reinforce each other in reducing the marginal

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<sup>1</sup>We thank an anonymous referee for suggesting this motivation.

<sup>2</sup>The theoretical model presented in this paper builds on Bettignies (2004), which studies the effects of product market competition on the boundaries of the firm in an incomplete contract framework. Here we show that somewhat similar results can be obtained in a simple principal-agent model.

<sup>3</sup>The business stealing and rent reduction effects have been discussed previously in Anderson, de Palma and Thisse (1992, p. 230), Raith (2003), and de Bettignies (2004), in the context of a Logit framework, Salop (1979) circle, and Hotelling line, respectively.

agency cost of eliciting effort from the agent, which is the product of the increase in the fraction of expected profits that must be relinquished to the agent to elicit a marginal increase in effort, and expected profits. Business stealing has a motivating impact on the agent which reduces the first factor, while rent reduction, by lowering expected profits, reduces the second factor.

It then follows that:

1. When agency costs are nonexistent - as in small, entrepreneurial firms for example, where the owner and the manager are one and the same person - competition can only affect managerial incentives and effort through direct pressure, and has a zero net impact in equilibrium.

2. When agency costs are present - as in large or hierarchical firms for example, where the separation of ownership and control is likely to play an important role - two main results emerge. First, the importance firms (principals) place on quality improvements (or cost reductions), as well as managerial incentives and effort, are lower than in firms without agency costs. Second, and perhaps more interestingly, these variables increase with competition, via a decrease in the marginal agency cost of eliciting managerial effort.

Empirically, we exploit a detailed set of linked employer-employee data which allows us to observe simultaneously the presence (or absence) of agency costs in firms, the amount of competition firms face, the strategies they pursue, the types of contracts and incentives offered to their employees, as well as detailed information about individual employee effort. We isolate the agency effect of competition from the direct pressure effect, and determine their empirical significance. We find that:

- a) The importance firms place on quality improvements and cost reductions, the presence of contractual incentives, and the number of unpaid overtime hours employees work (our main measure of effort), are all *lower* when agency costs are present than when they are not.

- b) Competition does have *positive* direct pressure effect. Even in firms in which agency costs are absent, competition increases the importance firms place on quality improvements and cost reductions, incentives, and effort.

- c) Competition also has an agency effect. The positive impact of competition on these variables is even *larger* for firms that are subject to agency costs.

This paper contributes to the theoretical literature on competition and “x-inefficiencies” (Liebenstein, 1966) in at least two ways. First, we provide a more “applied” theoretical framework which can be more easily tested empirically. Most of the previous theoretical work has derived an explanation for Caves’ “vague suspicion” without imposing much structure on the competitive environment. In-

stead competition has been defined simply in terms of its potential effects, such as increased aggregate supply and lower market price (Hart, 1983; Scharfstein, 1988), reduced profits and changes in the “relative-value-of-managerial-actions” (Hermalin, 1992; Schmidt, 1997), or increased probability of liquidation (Schmidt, 1997), for example. The result is a series of models resting on general assumptions, but which yield ambiguous predictions<sup>4</sup> that are difficult to test empirically. In contrast, our model sacrifices generality to a small extent by imposing the competitive structure of a Hotelling line, but has the advantage of generating stark, unambiguous empirical predictions. In that regard, we follow Raith (2003) who also provides unambiguous predictions by adopting the competitive structure of a Salop (1979) circle.

Our second - but no less important - theoretical contribution comes from the fact that the papers cited above do not explicitly disentangle the effect of competition on agency costs from the direct pressure effect, and hence effectively treat them as one. Raith (2003), for example, elegantly shows that in a simple agency model with risk averse managers, competition affects incentives via changes in the equilibrium number of competitors in the industry. But it is not immediately clear whether this change in the number of rivals affects managerial incentives through a pure reduction in agency costs, or whether it affects firms even when agency costs are absent. Our model, by isolating agency effects from direct pressure effects, sheds light on the precise channels through which competition affects incentives.

The empirical literature does seem to confirm a positive impact of competition - measured in a variety of ways - on efficiency.<sup>5</sup> Increased number of competitors and lower levels of rents (Nickell, 1996), as well as lower industry concentration (Haskel, 1991), for example, are shown to significantly increase total factor productivity growth. Industry concentration has also been shown to reduce technical efficiency<sup>6</sup> (Caves and Barton, 1990; Green and Mayes, 1991; Caves et al., 1992). And Syverson (2001, 2003) recently showed that substitutability between products has a positive impact on average productivity levels.

Much less work has been done, however, to analyze empirically how - i.e. through which process -

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<sup>4</sup>Models of competition with hidden information, pioneered by Hart (1983) and Scharfstein (1988), show opposite effects of competition on managerial incentives. While Hart showed that competition reduces agency costs, Scharfstein demonstrated that this result could be reversed with slightly different assumptions about managerial preferences. With hidden action models (Hermalin, 1992; Schmidt, 1997), a consensus does seem to emerge, that competition overall has ambiguous effects on agency costs.

<sup>5</sup>With the exception of Aghion et al. (2002), the related literature on competition and innovation seems also to find evidence of a positive relationship between the two (e.g. Geroski, 1990; Bertschek, 1995; Blundell et al., 1999).

<sup>6</sup>Farrell (1957) defines technical inefficiency as suboptimal use of a given combination of inputs in production, in contrast to allocative inefficiency, which is a suboptimal combination of inputs to be used in production.

competition affects efficiency. Several papers have looked at pieces of this puzzle, including Burgess and Metcalfe (2000), Santalo (2002), and Cunat and Guadalupe (2003), who find evidence of a link between competition and managerial incentives, and Griffith (2001) who shows that competition increases productivity and that this effect is larger in firms where agency costs are present. Exploiting a more recent version of the survey data used by Santalo (2002), which includes a richer set of variables to choose from, we contribute to the empirical literature by providing a more accurate picture of the precise channels (direct pressure and agency costs) through which competition affects not only efficiency and managerial incentives, but also effort.

The paper is structured as follows. Section 2 presents our theoretical model and results. We describe the data in section 3, our econometric methodology in section 4, and our empirical results in section 5. Section 6 concludes.

## 2 Theoretical Model

### 2.1 Basic Structure

Two firms 1 and 2 are positioned at each end of a Hotelling (1929) line, with locations  $x_1 = 0$  and  $x_2 = 1$ , respectively. The two firms sell imperfectly substitutable products and compete on quality  $q$  and price  $p$ . A unique consumer, who is uniformly distributed along the line, purchases one unit of the product from either firm 1 or firm 2. Firms 1 and 2 know the location distribution for the consumer, but they do not know the actual location on the line, until the end of the game that is, when demands are realized (see timing below).

At location  $x$ , the consumer incurs a transport cost  $tx$  for travelling to firm 1, and a cost  $t(1 - x)$  to visit firm 2. The consumer enjoys conditional indirect utility  $U_1 = s + q_1 - p_1 - tx$  from product 1 and  $U_2 = s + q_2 - p_2 - t(1 - x)$  from product 2 (where  $s$  represents income), and simply chooses the product which gives the highest utility. The expected “total” demands for firms 1 and 2 are:

$$d_1(q_1, p_1, q_2, p_2, t) = x = \left( \frac{1}{2} + \frac{(p_2 - p_1) + (q_1 - q_2)}{2t} \right), \quad (1)$$

and  $d_2(q_2, p_2, q_1, p_1, t) = (1 - x)$ , respectively.<sup>7</sup>

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<sup>7</sup>A consumer located at  $x$  is indifferent between store 1 and 2 if and only if  $U_1 = U_2$ , or:

$$q_1 - p_1 - tx = q_2 - p_2 - t(1 - x). \quad (2)$$

Within each firm, we analyze a principal-agent relationship, which could be interpreted as the relationship between a board of directors and the chief executive officer (CEO) of the firm, or between a divisional manager and her subordinate, for example. For convenience we refer to the principal as female and to the agent as male.

### Timing of the Game

- Date 0: Principal  $i$ ,  $i = 1, 2$ , makes a take-it-or-leave-it<sup>8</sup> contractual offer to agent  $i$ . Offer  $i$  is only observable to agent  $i$  (and not to agent  $j$ ).<sup>9</sup> Both principals and agents are risk-neutral. Agents are wealth constrained with zero initial wealth, and their reservation wage is normalized to zero.
- Date 1: Agent  $i$  exerts effort  $e_i$  at cost  $K(e_i) = \frac{k}{2}e_i^2$ , where  $k$  is a measure productivity (we assume that agents 1 and 2 are identical in productivity<sup>10</sup>). The agent's effort determines the level of innovation undertaken by firm  $i$ , and the product quality  $q_i$  which results from it. For simplicity we set  $q_i = e_i$ ; and hereafter we tend to refer to  $q_i$  using agent effort, innovation, or product quality, interchangeably.
- Date 2: After observing  $q_i$  and  $q_j$ ,  $j \neq i$ , principal  $i$  chooses price  $p_i$ .<sup>11</sup>
- Date 3: Demands are realized, as the consumer chooses one of the products. Goods  $i$  and  $j$  are produced at marginal cost  $c_i = c_j = 0$ , and delivered. Profits are realized, and agent  $i$  receives payoff  $w_i$  according to the contract signed at date 0. Note that due to the agent's wealth constraint, his realized income  $w_i$  must be non-negative in all realized states of demand. The principal keeps the part of profits not paid out to the agent.

### Product Market Competition

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Solving for  $x$ , we get the expected demand for firm 1.

<sup>8</sup>Implicitly we assume that each principal has many agents to whom she can offer the contract, and thus a full ex-ante bargaining power.

<sup>9</sup>Aside from being more realistic - managers and employees typically do not know the exact conditions stipulated in the employment contract for the equivalent position in rival firms - this assumption is necessary for the existence of an equilibrium in effort choices. Indeed, it can be shown that when agents observe contractual conditions in rival firms before making their effort choices, no equilibrium exists.

<sup>10</sup>It would be easy to show that with asymmetric firms the productivity leader has higher equilibrium effort and quality than the laggard, and we report some empirical evidence of this below. In contrast, analyzing the effects of competition in an asymmetric model turns out to be quite messy; and the evidence suggests that the effects of competition we analyze in this paper are not significantly affected by firms' relative productivity positions in the industry. Thus, for reasons of tractability, and in light of the empirical evidence, we assume symmetric firms in our theoretical model.

<sup>11</sup>We assume that the principal chooses the price at date 2 for simplicity. This is without loss of generality: the same results apply if the pricing decision is given to the agent.

The purpose of this model is to provide a convincing explanation for the belief, commonly held among economists, that competition leads to efficiency gains through a reduction in agency costs. As mentioned in the introduction, previous work has shown that when no structure is imposed other than exogenously specifying characteristics of competition (e.g. reduction in profits), an unambiguous explanation for the economists’ belief is hard to come by. Modelling competition with a Hotelling line enables us to get around that issue and to provide a clear, unambiguous explanation for this “vague suspicion” economists are said to have, which we can then take to the data.

Using a Hotelling line also has the advantage of placing strategic interaction at the forefront of the analysis, and of allowing us to focus on the actual competitive process, rather than on particular characteristics of competition as was done previously in the literature.<sup>12</sup>

Finally, amongst strategic models of competition, the Hotelling line yields two advantages. First, given our ultimate purpose - comparative statics on the degree of competition - the transport cost  $t$  associated with location models, which measures the degree of horizontal product differentiation, is an ideal parameter to represent toughness of competition (or rather lack thereof) in the industry, to use Sutton’s (1992, p.9) terminology. The second advantage of the Hotelling line relative to other strategic models is its simplicity. Although we believe that somewhat similar results could be obtained in other demand systems (see discussion in subsection 2.5 below), in such models the analysis would be much less tractable and clarity would have to be sacrificed.

As shall become clear below, in order to ensure strict concavity of objective functions, and non-negative effort levels in both firms, we restrict our attention to value of  $t \in \left( \frac{4/3}{9k}, \frac{2}{9k} \right]$ . Throughout the paper, an increase in product market competition is represented by a decrease in  $t$ .

### Remarks about Contracts

We assume that total revenues, and hence profits, are contractible. Demands and prices, on the other hand, are assumed not to be verifiable (though observable). This assumption helps us keep the analysis simple by generating second-best equilibrium contracts that are contingent only on profits.<sup>13</sup> However we could also justify this assumption on practical grounds, in the following way. In order for sales and price of a product to be verifiable in a court of law, the nature of that product must be described *ex-ante* in a way which allows a judge to match products with sales and prices. In practice firms sell not one, but a variety of products, the nature of which changes enormously over

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<sup>12</sup>See examples mentioned in the introduction.

<sup>13</sup>Relaxing this assumption, we may get optimal contracts that depends on realized demands as well as profits; a complication that brings no benefits. Given non-verifiable demands, non-verifiable prices are necessary for consistency: otherwise, demands could be deduced from revenue/profits.

time, depending on contingencies such as R&D or market conditions for example. We argue that these products cannot be unambiguously described *ex-ante*, and hence contracts cannot be made contingent on associated sales or prices. Finally, we assume that product quality (effort) may or may not be verifiable, for similar reasons: to paraphrase Hart and Holmstrom (1987, p.134), the multidimensionality of quality may make it difficult to describe precisely *ex-ante* in a contract. We analyze both possibilities. The case where quality is verifiable corresponds to our benchmark, first-best (FB) scenario. The case with non-verifiable quality corresponds to the second-best (SB) scenario, in which agency costs are present.

The optimal contract may thus be contingent on profits and/or product quality:  $w_i = w_i(\Pi_i, q_i)$ , where  $\Pi_i$  represent realized profits for firm  $i$ . Three conditions must hold for any contract to be feasible:

1) Incentive Compatibility (IC) constraint: agent  $i$  exerts effort  $\hat{q}_i$  which maximizes his expected net payoff:

$$\hat{q}_i \in \arg \max [w_i(\Pi_i, q_i) - K_i(q_i)]. \quad (3)$$

2) Individual Rationality (IR) constraint: for the agent to participate, his expected payoff must be weakly larger than his reservation wage. We can express this condition as follows:

$$E(w_i(\Pi_i, \hat{q}_i)) \geq 0, \quad (4)$$

where  $E(w_i(\Pi_i, \hat{q}_i))$  represents the agent's expected payoff.

2) Wealth (W) constraint: by assumption the agent is wealth constrained with zero initial wealth, and thus his payoff must be non-negative in all states of the world:

$$w_i(\Pi_i, \hat{q}_i) \geq 0 \text{ for all realized values of profits } \Pi_i. \quad (5)$$

## 2.2 Benchmark Case (First-Best): Verifiable Quality

Let us assume first that quality is verifiable; we call this the first-best scenario, because under this condition there are no agency problems, and the optimal outcome is achieved in equilibrium, for example with the following contract.

### Contractual Form

If principal  $i$  wants to induce effort  $\hat{q}_i = q_i^*$  from agent  $i$ , at date 0 she offers him the following

contract:

The agent is to receive wage  $w_i(q_i^*) = K_i(q_i) = \frac{k}{2}q_i^{*2}$  at date 3 if quality is verified to be  $q_i = q_i^*$ , and  $w_i = 0$  otherwise.

Note that the IC constraint (3), the IR constraint (4), and the W constraint (5) all hold (and bind) under the conditions of this contract. This contract will be accepted by the agent, and will induce him to exert the equilibrium effort  $q_i^*$  chosen by the principal.

Note also that the cost of innovation (effort) to the principal simply equals the agent's cost of effort:  $w_i(q_i^*) = K_i(q_i^*)$ . There is no agency cost here.

### Backward Induction (Subgame Perfect Nash Equilibrium)

At date 3, principal  $i$  receives the realized profit, minus the payment made to the agent:  $\Pi_i(q_i, p_i, q_j, p_j, t) - w_i(q_i)$ , with  $w_i(q_i) = K_i(q_i)$ .

At date 2, principal  $i$  observes product qualities  $q_i$  and  $q_j$ ,  $j \neq i$ , and then chooses  $p_i$  so as to maximize her expected payoff:

$$\max_{p_i} \pi_i(q_i, p_i, q_j, p_j, t) - w_i(q_i), \quad (6)$$

where  $\pi_i(q_i, p_i, q_j, p_j, t) = p_i d_i(q_i, p_i, q_j, p_j, t)$  is firm  $i$ 's expected profit at date 2. Substituting the expressions of expected demands defined above in (6), taking the first-order conditions (FOCs) with respect to price for  $i = 1, 2$ , and solving the resulting system of two equations yields the equilibrium price for firm  $i$ :<sup>14</sup>

$$p_i = t + \frac{q_i - q_j}{3}. \quad (7)$$

Substituting equilibrium prices back into the expected demand, we obtain an expression for expected profit  $\pi_i = \pi_i(q_i, q_j, t)$  for firm  $i$ , given qualities  $q_i$  and  $q_j$ .

$$\pi_i(q_i, q_j, t) = \left[ t + \frac{q_i - q_j}{3} \right] \left[ \frac{1}{2} + \frac{q_i - q_j}{6t} \right] n, \quad (8)$$

where  $d_i = \left[ \frac{1}{2} + \frac{q_i - q_j}{6t} \right] n$ , is the equilibrium expected demand for firm  $i$ .

*Remark:* Throughout this theoretical section, we assume for simplicity that managerial effort affects only product quality. Marginal costs are exogenous and normalized to zero. We could assume that effort reduces the marginal cost instead of increasing quality, or that it affects both cost and quality. If, for example, we were to ignore quality and assume that the marginal cost for firm  $i$ ,

<sup>14</sup>The second order condition can be verified to hold:  $\frac{\partial^2 \pi_i}{\partial p_i^2} = -\frac{1}{t} < 0$ .

$i = 1, 2$ , is  $c_i = a - e_i$ , expressions (3), (4), (5), (6) and (8) would still hold, if we replaced  $q_i$  by  $e_i$ . All of the theoretical results of the paper would still hold. This is confirmed empirically below, where we show that the results are similar for quality-enhancing and cost-reducing investments.

At date 1, agent  $i$  exerts the effort  $e_i^* = q_i^*$ , with  $q_i^*$  determined in the initial contract offered by the principal at date 0.

At date 0, principal  $i$  chooses the level of effort  $q_i^*$  she wants the agent to exert at date 1, taking principal  $j$ 's contractual choice (and hence product  $j$ 's quality) as given. This equilibrium level of effort maximizes the principal's net benefit,  $A_i^{FB}(q_i, q_j, t) = \pi_i(q_i, q_j, t) - K_i(q_i)$ . More formally,  $q_i^* \in \arg \max A_i^{FB}(q_i, q_j, t)$ . Taking the FOC,<sup>15</sup> we obtain  $q_i^*$  which solves:

$$\frac{\partial \pi_i(q_i, q_j, t)}{\partial q_i} - \frac{\partial K_i(q_i)}{\partial q_i} = 0. \quad (9)$$

The left-hand side of (9), which can be expressed as  $\frac{\partial A_i^{FB}(q_i, q_j, t)}{\partial q_i}$ , is the principal's net marginal benefit from eliciting an increase in effort from the agent. In equilibrium, the principal elicits an effort level such that, given rival effort  $q_j$ , the net marginal benefit from an increase in effort equals zero.

For reasons that will become clear in the empirical part of the paper, we interpret the principal's net marginal benefit from eliciting an increase in effort from the agent (for a given  $q_i, q_j$ ) as "the importance firms place on a quality improvement." Clearly, the higher the principal's net marginal benefit from a quality increase, the more "important" that quality increase will be for her. Assuming that the principals' choices "permeate" throughout the firm, and that strategic priorities at the level of the firm reflect these choices, then "the importance firms place on a quality improvement" should be a good measure of principals net benefit from a quality increase. Importantly, note that for a given  $q_i, q_j$ , if a parameter, say  $t$ , increases the importance principal  $i$  places on a quality increase, then that principal elicits a higher effort level from the agent in equilibrium (for a given  $q_j$ ). Conversely, if  $t$  has no impact on the principal's net benefit from a quality increase, then competition will have no effect on equilibrium effort.

It can be shown that  $\frac{\partial^2 A_i^{FB}}{\partial q_i^2} = -\frac{1}{t} < 0$ , and that  $\frac{\partial^2 A_i^{FB}}{\partial q_i^2} + \left| \frac{\partial^2 A_i^{FB}}{\partial q_i \partial q_j} \right| = -k < 0$ . The first inequality ensures a unique  $q_i^*$  maximizing  $A_i^{FB}(q_i, q_j, t)$  for a given  $q_j$ , while the second inequality ensures a unique Nash equilibrium (NE) in effort.<sup>16</sup> The symmetric equilibrium (provided it exists) must

<sup>15</sup>The second-order condition (SOC),  $\frac{1}{9t} - k < 0$ , can be verified to be strictly negative for all values of  $t \in \left(\frac{4/3}{9k}, \frac{2}{9k}\right]$ . Note that the expected profits function is convex in quality ( $\frac{1}{9t} > 0$ ), though less convex than the cost of effort (hence the SOC holds).

<sup>16</sup>For an excellent review of uniqueness conditions for NE, see Vives (1999), pp. 47-48.

therefore be the unique NE for this game. To obtain the symmetric equilibrium, we need only substitute  $q_i^* = q_j^* = q^*$  into (9): we obtain  $\frac{1}{3} = kq^*$ , or  $q_i^* = q_j^* = q^* = \frac{1}{3k}$ .

Note that even in the case without agency costs, in our duopoly setting there are simultaneous moves at every stage (from the rival firms), and hence a Subgame Perfect Nash Equilibrium (SPNE) must be determined.

*In the first-best, the SPNE is the following:* both principals choose to induce their own agent to exert effort  $q^* = \frac{1}{3k}$ . In order to induce this effort, they offer the contract described above, with a wage contingent on quality:  $w_i(q^*) = \frac{k}{2}q^{*2}$ . As a consequence, both agents indeed choose effort  $q^*$ . After observing qualities, prices are chosen following (7): in equilibrium,  $p_i^* = p_j^* = t$ . Finally, demands are then realized<sup>17</sup> and profits are distributed according to the original contract.

### Product Market Competition in the First-Best

In the first-best, there are no agency costs, and therefore the effects of competition, if any, must belong to the direct pressure effect category mentioned in the introduction. To derive the direct pressure effect, we return to our equilibrium condition (9) and analyze how competition affects the importance firms place on quality improvements.

The first-best marginal cost of inducing effort is unaffected by competition:  $MC^{FB} = \frac{\partial K(q_i)}{\partial q_i} = kq_i$  is independent of  $t$ . However, the effects of competition on the principal's marginal benefit from inducing effort  $MB^{FB} = \frac{\partial \pi_i}{\partial q_i}$  - which corresponds to the marginal impact of an increase in effort on expected profits, or marginal product of effort - are more subtle. Let us rewrite the expression for the marginal product of effort as follows:

$$\frac{\partial \pi_i}{\partial q_i} = p_i \frac{\partial d_i}{\partial q_i} + d_i \frac{\partial p_i}{\partial q_i} = p_i \frac{1}{6t} + d_i \frac{1}{3}. \quad (10)$$

Increasing effort/quality had two effects on expected profits, *ceteris paribus*: it increases the firms expected demand ( $\frac{\partial d_i}{\partial q_i} p_i > 0$ ), and it enables the firm to charge a higher price, to account for the higher quality ( $\frac{\partial p_i}{\partial q_i} d_i > 0$ ).

Now let us differentiate the marginal product of effort<sup>18</sup> with respect to  $t$ :

$$\frac{\partial^2 \pi_i}{\partial q_i \partial t} = \frac{\partial p_i}{\partial t} \frac{\partial d_i}{\partial q_i} + \frac{\partial^2 d_i}{\partial q_i \partial t} p_i + \frac{\partial d_i}{\partial t} \frac{\partial p_i}{\partial q_i}. \quad (11)$$

<sup>17</sup>Prior to their realization, expected demands in equilibrium equal  $d_i^* = d_j^* = \frac{1}{2}$ .

<sup>18</sup>Note that  $\frac{\partial^2 p_i}{\partial q_i \partial t} = 0$ .

An increase in product market competition has two effects here. First, it lowers firms' price-cost margins, a measure of their market power. As the transport cost falls and consumers can travel more easily, they become more sensitive to prices and qualities, thus forcing firms to compete more fiercely and to lower their margins. We call this the *rent-reduction effect* of competition. This effect, represented by the first term on the right-hand side of (11),  $\frac{\partial p_i}{\partial t} \frac{\partial d_i}{\partial q_i} = \frac{1}{6t} > 0$ , has a negative impact on  $MB^{FB}$ .

Competition also generates a *business stealing effect*, represented by the second and third terms on the right-hand of (11). By making demand more elastic, competition increases the marginal (positive) impact of an increase in quality on the market share one can "steal" from a rival:  $\frac{\partial^2 d_i}{\partial q_i \partial t} p_i = -\frac{1}{6t^2} p_i < 0$ . Moreover, when competing firms offer different qualities and the superior firm dominates the market, increased competition, by making consumers more sensitive to quality and price advantages, increases that demand advantage. It allows the superior firm to "steal" more from its rival. More formally,  $\frac{\partial d_i}{\partial t} \frac{\partial p_i}{\partial q_i} = -\frac{q_i - q_j}{6t^2} \frac{1}{3} < 0$  if and only if  $q_i > q_j$ . In equilibrium, however, firms choose identical strategies, and the third factor in (11) vanishes:  $\frac{\partial d_i}{\partial t} \frac{\partial p_i}{\partial q_i} = 0$ .

Competition affects the importance firms place on quality improvements in two conflicting ways:  $MB^{FB}$  is negatively affected by rent reduction, but positively affected by business stealing. In this model the two effects exactly offset each other in equilibrium, hence the zero net effect. As a result, neither equilibrium effort, nor realized qualities, are affected by competition.

We summarize these results in proposition 1:

**Proposition 1** *In the first-best, product market competition has no effect on the importance firms place on quality improvements, and hence it affects neither effort exertion nor realized qualities. In other words, the direct pressure effect of competition is null.*

**Proof.** Follows directly from above. ■

This zero direct pressure effect works to our advantage: it will allow us to clearly see what agency costs bring to the relationship between competition and the importance of quality improvements.

With that goal in mind, let us make two additional points about rent reduction and business stealing; these remarks will facilitate our explanation of the effects of competition on agency costs below. First, note that the rent reduction effect of competition reduces expected profits in equilibrium. Looking back at (8) we see that both price and expected demand depend on  $t$ :  $\frac{\partial \pi_i}{\partial t} = \frac{\partial p_i}{\partial t} d_i + \frac{\partial d_i}{\partial t} p_i$ , where the first and second factors represent rent-reduction and business stealing effects, respectively.

Note that in equilibrium both firms offer the same quality. As a result, the business stealing effect disappears, and only rent reduction, which tends to decrease profits, remains:  $\frac{\partial \pi_i}{\partial t} = \frac{\partial p_i}{\partial t} d_i = \frac{1}{2} > 0$ .

Second, note that business stealing augments the impact of an effort increase on the marginal product of effort. In other words, competition increases the convexity of expected profits as a function of effort. To see this, simply differentiate (10) with respect to  $q_i$ :

$$\frac{\partial^2 \pi_i}{\partial q_i^2} = \frac{\partial p_i}{\partial q_i} \frac{\partial d_i}{\partial q_i} + p_i \frac{\partial^2 d_i}{\partial q_i^2} + \frac{\partial d_i}{\partial q_i} \frac{\partial p_i}{\partial q_i} + d_i \frac{\partial^2 p_i}{\partial q_i^2} = 2 \frac{\partial d_i}{\partial q_i} \frac{\partial p_i}{\partial q_i} > 0, \quad (12)$$

since, looking back at (8), we see that  $\frac{\partial p_i}{\partial q_i} = \frac{1}{3}$ ,  $\frac{\partial d_i}{\partial q_i} = \frac{1}{6t}$ , and  $\frac{\partial^2 d_i}{\partial q_i^2} = \frac{\partial^2 p_i}{\partial q_i^2} = 0$ . Clearly, since the marginal impact of an increase in effort on price,  $\frac{\partial p_i}{\partial q_i}$ , and on expected demand,  $\frac{\partial d_i}{\partial q_i}$ , are positive, profits must be a convex function of effort. Moreover, while  $\frac{\partial p_i}{\partial q_i}$  is independent of  $t$ , the business stealing effect of competition increases  $\frac{\partial d_i}{\partial q_i}$ , and hence  $\frac{\partial^2 \pi_i}{\partial q_i^2}$ . Formally,  $\frac{\partial^3 \pi_i}{\partial q_i^2 \partial t} = -\frac{1}{9t^2} < 0$ .

### 2.3 Introducing Agency Costs: Non-Verifiable Quality

Let us now assume that product quality, though observable,<sup>19</sup> is not verifiable.<sup>20</sup> Note that quality cannot be “pinned down,” indirectly through other variables: due to the uncertainty about the consumer’s location and demands, neither realized profits, nor realized demand (if it were verifiable) contain enough information to derive quality. It thus cannot be contracted upon, and the optimal contract can be only be made contingent on profits. We focus on linear contracts where the agent’s payoff is of the form  $w = \alpha \Pi + \beta$ .

#### Backward Induction

*At date 3*, principal  $i$  receives the following payoff:  $(1 - \alpha_i) \Pi_i(q_i, p_i, q_j, p_j, t) - \beta_i$ .

*At date 2*, principal  $i$  observes product qualities  $\hat{q}_i = q_i^{**}$  and  $\hat{q}_j = q_j^{**}$ ,  $j \neq i$ , and then chooses  $p_i$  so as to maximize her expected payoff,  $(1 - \alpha_i) \pi_i(q_i, p_i, q_j, p_j, t) - \beta_i$ . This maximization yields the same equilibrium prices as the maximization described in (6), and hence expected profits as a function

<sup>19</sup>This assumption of non-observable quality is necessary in our model: it can be shown that no second-best equilibrium exists if we assume non-observable quality instead.

<sup>20</sup>In the classic principal-agent model, the agent is risk averse and the principal must trade off the benefit from providing more incentives to her agent against the cost that these incentives impose on the agent in terms of risk. Hermalin and Katz (1991) have shown that in such a framework, even if effort is non-verifiable and hence cannot be contracted upon ex-ante, the first-best outcome can be reached when effort is observable. The reason is that the principal can design an initial contract giving optimal incentives, which is then renegotiated after effort exertion, in an attempt to eliminate compensation risk for the agent. Although in our model quality (effort) is observable but not verifiable, the renegotiation proposed by Hermalin and Katz cannot occur. In our model, agency arises due to agent wealth constraint rather than risk aversion. Here agents are risk neutral and the provision of insurance in renegotiation would have no impact on ex-ante effort choices.

of product qualities correspond to (8).

At date 1, agent  $i$  chooses quality  $\hat{q}_i = q_i^{**}$  to maximize his expected payoff  $\alpha_i \pi_i(q_i, q_j, t) + \beta_i - K_i(q_i)$ , taking the terms of his contract  $(\alpha_i, \beta_i)$ , and quality  $q_j$ , as given. The agent chooses quality  $q_i$  such that:<sup>21</sup>

$$\alpha_i \frac{\partial \pi_i(q_i, q_j, t)}{\partial q_i} = \frac{\partial K_i(q_i)}{\partial q_i}, \quad (13)$$

where condition (13) is the agent's incentive compatibility (IC) constraint.

At date 0, principal  $i$  offers contract  $(\alpha_i^{**}, \beta_i^{**})$  to agent  $i$ . In order to determine the optimal contract, the principal maximizes the following program:

$$\underset{q_i, \alpha_i, \beta_i}{Max} \pi_i - (\alpha_i \pi_i + \beta_i), \text{ subject to:} \quad (14)$$

the individual rationality, wealth, and incentive compatibility constraints described in (4), (5), (15), respectively.

Recall that  $\pi_i$  and  $\Pi_i$  represent expected and realized profits, respectively. Since  $\Pi_i$  may equal zero (if no consumer buys the product),  $\beta_i$  cannot be negative, otherwise (W) would not hold in all states of the world. Moreover, since  $\beta_i$  has a negative effect on the principal's objective function and does not affect the (IC), it is optimal to set  $\beta_i^{**} = 0$ . Note that this is the source of agency costs in the model: if the agent were not wealth constrained, or if his initial wealth were sufficiently large, the principal could set  $\beta_i$  sufficiently negative for the agent to be willing to exert the first best effort. But because  $\beta_i$  must be set to zero, the only way for the principal to incentivize the agent is by increasing  $\alpha_i$ , which is costly, so costly in fact that the level of  $\alpha_i$  that would be required to generate the FB effort is suboptimally high, and as we shall see, the principal prefers to offer a lower alpha, even if it means that only a second-best effort level is exerted.

Since (W) can be replaced by  $\beta_i = 0$ , and since (IR) does not bind (as long as  $\alpha_i \geq 0$ ), the principal's program simplifies as follows:  $\underset{q_i, \alpha_i}{Max} \pi_i(q_i, q_j, t) - \alpha_i \pi_i(q_i, q_j, t)$ , subject to IC constraint (13).

If the principal wants the agent to exert effort  $q_i^{**}$ , she must set  $\alpha_i$  such that (13) holds for  $q_i = q_i^{**}$ .

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<sup>21</sup>The second-order condition can be shown to be  $\frac{\alpha_i}{9t} - k < 0$ , which is strictly negative for all values of  $t \in \left(\frac{4/3}{9k}, \frac{2}{9k}\right]$  when  $0 < \alpha_i < 1$ .

In other words, she must choose  $\alpha_i^{**}$  such that:

$$\alpha_i^{**}(q_i^{**}, q_j, t) = \frac{\frac{\partial K_i(q_i^{**})}{\partial q_i}}{\frac{\partial \pi_i(q_i^{**}, q_j, t)}{\partial q_i}} = \frac{MC_i^{FB}(q_i^{**})}{MB_i^{FB}(q_i^{**}, q_j, t)} = \frac{kq_i^{**}}{\frac{1}{3} + \frac{(q_i^{**} - q_j)}{9t}}. \quad (15)$$

Substituting  $\alpha_i^{**}(q_i, q_j, t)$  into the objective function, the principal chooses the effort level  $q_i^{**}$  which maximizes  $A^{SB}(q_i, q_j, t) = \pi_i(q_i, q_j, t) - \alpha_i^{**}(q_i, q_j, t) \pi_i(q_i, q_j, t)$ . She does this by equating her marginal benefit ( $MB_i^{SB}$ ) and her marginal cost ( $MC_i^{SB}$ ):<sup>22</sup>

$$\frac{\partial \pi_i(q_i^{**}, q_j, t)}{\partial q_i} = \frac{\partial [\alpha_i^{**}(q_i^{**}, q_j, t) \pi_i(q_i^{**}, q_j, t)]}{\partial q_i}. \quad (16)$$

It can be shown that  $\frac{\partial^2 A_i^{SB}}{\partial q_i^2} < 0$  for all  $t > \frac{1}{9k}$ , and that  $\frac{\partial^2 A_i^{SB}}{\partial q_i^2} + \left| \frac{\partial^2 A_i^{SB}}{\partial q_i \partial q_j} \right| < 0$  for all  $t > \frac{4/3}{9k}$ . There is thus a unique NE for all  $t > \frac{4/3}{9k}$ .<sup>23</sup> Substituting  $q_i^{**} = q_j^{**} = q^{**}$  into (16), the right-hand side simplifies to  $MB_i^{SB} = \frac{1}{3}$ , and the left-hand side reduces to  $MC_i^{SB} = kq^{**} + \frac{k}{2}(3t - q^{**})$ . Equating marginal benefit and marginal cost yields the unique SB equilibrium effort:  $q^{**} = \frac{2}{3k} - 3t$ . We therefore have a unique and non-negative equilibrium effort level in both firms for all values of  $t \in \left( \frac{4/3}{9k}, \frac{2}{9k} \right]$ .

*The SPNE in the second-best is the following:* both principals choose to induce their own agent to exert effort  $q^{**} = \frac{2}{3k} - 3t$ . To do that they offer a profit sharing contract which gives a fraction  $\alpha^{**} = 3kq^{**}(t)$  to the agent.<sup>24</sup> As a consequence, both agents choose effort  $q^{**}$ . After observing qualities, prices are chosen following (7): in equilibrium,  $p_i^{**} = p_j^{**} = t$ . Demands are then realized,<sup>25</sup> and profits are distributed according to the original contract.

## Second-Best Versus First-Best Effort

One implication of the above analysis is the following:

**Proposition 2** *In the second-best, the importance firms place on quality improvement, and hence equilibrium effort and quality, are lower than in the first-best:  $q^{**} < q^*$  for all  $t \in \left( \frac{4/3}{9k}, \frac{2}{9k} \right]$ .*

<sup>22</sup>Another way of solving this program is to solve (13) for  $q_i^{**}(\alpha_i, q_j)$ , to substitute  $q_i^{**}(\alpha_i, q_j)$  into the objective function, and to maximize with respect to  $\alpha_i$ :  $\max_{\alpha_i} \pi_i(q_i^{**}(\alpha_i, q_j), q_j, t) - \alpha_i \pi_i(q_i^{**}(\alpha_i, q_j), q_j, t)$ . While the two methods are formally equivalent, here we use the former because it presents the SB problem in terms of optimal effort to be elicited from the agent, which can more easily be compared with the optimal effort elicited in the FB. In contrast, presenting the equilibrium results in terms of optimal share of profits to be allocated to the agent is not conducive to comparisons between FB and SB, since in the FB there are no  $\alpha$ 's (the principals contract directly on effort).

<sup>23</sup>Note that, at  $t = \frac{4/3}{9k}$  there is no NE, and for all  $t \in \left( \frac{1}{9k}, \frac{4/3}{9k} \right)$  there are two NE, each one with one of the agents exerting strictly negative effort. We therefore restrict our attention to values of  $t > \frac{4/3}{9k}$ .

<sup>24</sup>One can obtain  $\alpha^{**}$  immediately by substituting  $q_i^{**} = q_j^{**}$  into (15). As expected,  $\alpha^{**} \in (0, 1)$  for all  $t \in \left( \frac{4/3}{9k}, \frac{2}{9k} \right]$ .

<sup>25</sup>Prior to their realization, expected demands in equilibrium equal  $d_i^{**} = d_j^{**} = \frac{1}{2}$ .

**Proof.** We have shown that in the second-best,  $q^{**} = \frac{2}{3k} - 3t$ . Thus, for all  $t \in \left(\frac{4/3}{9k}, \frac{2}{9k}\right]$  we must have  $q^{**} \in \left(0, \frac{1}{3k}\right)$ . Since  $q^* = \frac{1}{3k}$ , this implies  $q^{**} < q^*$ . ■

To understand the intuition behind proposition 2, let us return to equilibrium condition (16), which we can express as follows:

$$\frac{\partial \pi_i}{\partial q_i} = \alpha_i^{**} \frac{\partial \pi_i}{\partial q_i} + \pi_i \frac{\partial \alpha_i^{**}}{\partial q_i}. \quad (17)$$

The marginal benefit from eliciting an increase in effort, on the left-hand side of (17), is the same as in the first-best:  $MB_i^{SB} = \partial \pi_i(q_i^{**}, q_j, t) / \partial q_i = MB_i^{FB}$ .

The difference with the first-best comes from the marginal cost of inducing effort, represented on the right-hand side of (17). The first term actually represents the first-best marginal cost of effort,  $MC_i^{FB}$ . To see this, recall from (15) that  $\alpha_i^{**} = \frac{\partial K_i}{\partial q_i} / \frac{\partial \pi_i}{\partial q_i}$ . Substituting this in, the first term can be expressed as:  $\alpha_i^{**} \frac{\partial \pi_i}{\partial q_i} = \frac{\partial K_i}{\partial q_i} = MC_i^{FB}$ .

The second term on the right-hand side of (17) represents the marginal agency cost of inducing effort,  $MC_i^{AG}$ . It measures the increase in the fraction of profits which must be paid out to the agent, to induce him to increase effort. It is easy to show that the marginal agency cost simplifies to  $MC_i^{AG} = \frac{k}{2}(3t - q_j)$ , which is strictly positive.<sup>26</sup> Thus, the marginal cost of inducing effort is the sum of the first best marginal cost and the (positive) marginal agency cost:  $MC_i^{SB} = MC_i^{FB} + MC_i^{AG}$ .

This explains proposition 2: for a given effort  $q_j$  induced in rival firm  $j$ , the marginal cost of inducing effort is higher in the second-best than in the first-best, and hence the optimal effort principal  $i$  chooses to induce her agent to exert is lower. In other words, principal  $i$ 's reaction curve shifts down. By symmetry, principal  $j$ 's reaction curve shifts in the same way, and in equilibrium the two principals induce a lower effort from their agents.

### Determinants of the Marginal Agency Cost

The marginal agency cost is the increase in the fraction of profits that must be relinquished to the agent to elicit an increase in effort,  $\partial \alpha_i^{**} / \partial q_i$ , weighted by expected profits,  $\pi_i$ . To understand this, recall the IC condition:  $\alpha_i \frac{\partial \pi_i}{\partial q_i} = \partial K_i / \partial q_i$ . The agent chooses his effort such that his marginal cost of effort,  $\partial K_i / \partial q_i$ , exactly equals his expected marginal benefit from exerting that effort,  $\alpha_i \frac{\partial \pi_i}{\partial q_i}$ . Inducing an increase in effort means that the agent's marginal cost of effort rises by  $\partial^2 K_i / \partial q_i^2$ , and hence his expected marginal benefit must rise by the same amount. This can only happen if the

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<sup>26</sup> Looking back at our simplified expression  $\alpha_i^{**} = \frac{9ktq_i^{**}}{3t + (q_i^{**} - q_j)}$  from (15), it becomes evident that  $3t - q_j > 0$ . Otherwise,  $\alpha_i^{**} > 1$  for all  $t \in \left(\frac{4/3}{9k}, \frac{2}{9k}\right]$ , which is not feasible.  $3t - q_j > 0$  implies  $MC^{AG} > 0$ .

principal increases incentives  $\alpha_i^{**}$ ,<sup>27</sup> and  $\partial\alpha_i^{**}/\partial q_i$  represents that increase.

The size of this necessary increase,  $\partial\alpha_i^{**}/\partial q_i$ , depends on the convexity of expected profits,<sup>28</sup>  $\partial^2\pi_i/\partial q_i^2$ , relative to that of the cost of effort,  $\partial^2K_i/\partial q_i^2$ .<sup>29</sup> Indeed, when increasing effort, the agent is compensated for the increase in marginal cost of effort in two ways. First, the market “rewards” the agent directly through an increase in the marginal product of effort, and this is measured by  $\partial^2\pi_i/\partial q_i^2$ . This does not compensate the agent fully for the increase in marginal cost, and hence he must also be compensated through an increase in incentives, measured by  $\partial\alpha_i^{**}/\partial q_i$ . Clearly, *ceteris paribus*, the more convex the expected profits function, the larger the market reward for increasing effort, and the smaller the increase in incentives needed to elicit more effort. In other words, as the convexity of profits increases, the agent essentially substitutes explicit incentives from the principal for direct market reward, and hence  $\partial\alpha_i^{**}/\partial q_i$  falls: it becomes cheaper for the principal to elicit an increase in effort.

This dependence on second-order differentials (convexity) is not surprising. In the SB, the principal’s maximization program is subject to the agent’s IC constraint, which itself is the result of a maximization, and hence contains first-order differentials. Including that constraint into the principal’s program and differentiating for optimization therefore generates second-order differentials.

In sum, whereas in the FB the importance firms (principals) place on quality improvements depends *only* on the marginal product of effort and on the marginal cost of exerting it, in the SB it depends *also* on the marginal agency cost. This marginal agency cost itself depends on the convexity of expected profits relative to that of cost of effort; and expected profits. This interpretation will be useful in the next subsection.

## 2.4 Product Market Competition in the Second-Best

To analyze the effects of competition on the importance firms place on quality improvements, let us return to condition (17). As shown in our analysis of the first-best, the direct pressure effect is null, and competition has a zero net impact on the marginal benefit from eliciting an increase in effort (left-hand side of (17)) and on the first best marginal cost (first factor on the right-hand side). Therefore the effects of competition in the second best, if any, must be an agency effect, and *must*

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<sup>27</sup>Since 1)  $\alpha_i < 1$ , and 2) the FB second-order condition implies that  $\partial^2\pi_i/\partial q_i^2 < \partial^2K_i/\partial q_i^2$ , the only way  $\alpha_i \frac{\partial\pi_i}{\partial q_i}$  can be increased by an amount equal to  $\partial^2K_i/\partial q_i^2$  is by increasing  $\alpha_i^{**}$ .

<sup>28</sup>Recall from (12) that expected profits are convex in effort.

<sup>29</sup>More formally, using the implicit function theorem it can be shown that  $\frac{\partial\alpha_i^{**}}{\partial q_i} = -\frac{\alpha_i^{**}\partial^2\pi_i/\partial q_i^2 - \partial^2K_i/\partial q_i^2}{\partial\pi_i/\partial q_i}$ .

occur through a change in the marginal agency cost (second factor on the right-hand side).

We have shown that the marginal agency cost depends on the convexity of expected profits relative to that of cost of effort; and expected profits. In subsection 2.2, we made two points on the impact of competition on these factors. First, we noted that the rent reduction effect of competition reduces expected profits,  $\pi_i$ . Second, we remarked that the business stealing effect of competition increases the convexity of expected profits. Business stealing thus increases the “market reward” that the agent receives when increasing effort, and reduces the increase in incentives  $\partial\alpha_i^{**}/\partial q_i$  necessary to compensate him for the resulting increase in marginal cost of exerting effort. Hence, both  $\pi_i$  and  $\partial\alpha_i^{**}/\partial q_i$  fall with competition, reducing the principal’s marginal agency cost of eliciting effort.

For a given effort  $q_j$  induced in rival firm  $j$ , competition reduces principal  $i$ ’s marginal cost of eliciting an increase in effort, and hence increases the importance she places on a quality increase. As a result, the optimal effort she chooses to elicit is higher. In other words, principal  $i$ ’s reaction curve shifts up. By symmetry, principal  $j$ ’s reaction curve shifts up in the same way, and in equilibrium the two principals induce a higher effort from their agents.

We summarize these results in the following proposition:

**Proposition 3** *In the second-best, competition has a positive agency effect: it strictly increases the importance firms place on quality improvements, and hence equilibrium effort and quality.*

**Proof.** The effects of competition on the the importance firms place on quality improvements follow directly from the above. Moreover, we have shown that in the second-best,  $q^{**} = \frac{2}{3k} - 3t$ , which is strictly decreasing in  $t$ , and thus strictly increases in the degree of competition. ■

The key intuition for proposition 3 can be captured simply as follows. When the principal elicits an increase in effort, the agent’s marginal cost of effort rises and he must be compensated. The agent, who is paid a fraction of profits, is compensated for his higher marginal cost in two ways: partially through a rise in  $\alpha$ , and partially through a rise in the marginal impact of his effort on expected profits. The business stealing effect of competition, by increasing the impact of an effort increase on the agent’s marginal product of effort, rewards the agent directly, and hence reduces the compensation that must come from the principal in the form of a higher  $\alpha_i$ .<sup>30</sup> Thus, eliciting an increase in quality becomes cheaper for the principal, and competition yields higher quality/effort in equilibrium.

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<sup>30</sup>Note that this effect of competition is not dependent on the convexity of expected profits with respect to effort, but rather on the positive impact of business stealing on that convexity. The same effect would obtain with concave expected profits, as long as competition reduces the concavity (i.e. increases the convexity) of expected profits.

## 2.5 Discussion of the Theoretical Results and Empirical Implications

Three stark, unambiguous empirical predictions emerge from our model (they are represented graphically in figure 1):

*Prediction 1:* Proposition 2 implies that the importance firms place on quality improvements and effort exerted by agents should be lower in firms that are plagued by agency costs than in firms that are not.

*Prediction 2:* Proposition 1 implies that the direct pressure effect of competition is null. In firms where agency costs are absent, competition has no impact on the importance firms place on quality improvements and hence on incentives and effort.

*Prediction 3:* Proposition 3 implies that competition has a positive agency cost effect which is present *only* in firms that are plagued by agency costs. In such firms, competition increases the importance firms place on quality improvements, incentives and effort.

These predictions, and the key theoretical results of the paper, hinge on 4 conditions.<sup>31</sup>

1) The direct pressure effect of competition is a function of the effect of competition on the marginal impact of effort on expected profits,  $\frac{\partial^2 \pi_i}{\partial q_i \partial t}$ . In our Hotelling model,  $\frac{\partial^2 \pi_i}{\partial q_i \partial t} = 0$  in equilibrium (condition 1), and this is why the direct pressure effect is null. As shown in recent work by Vives (2004) on competition and innovation (without agency costs), the direct pressure effect is also null in Salop circle and Logit models, but positive in linear<sup>32</sup>, CES, and constant expenditure models. This positive impact is not inconsistent with the more general implication of our model; it suggests that in these demand systems,  $\frac{\partial^2 \pi_i}{\partial q_i \partial t} < 0$ , which is likely due to the dominance of business stealing over rent reduction in these other demand specifications.

2) For the agency cost effect of competition to have a positive impact on managerial effort, three conditions must be met: i) Competition must increase the convexity of expected profits as a function of effort,  $\frac{\partial^3 \pi_i}{\partial q_i^2 \partial t} < 0$ . ii) Competition must decrease expected profits,  $\frac{\partial \pi_i}{\partial t} > 0$ . And iii), the agent's compensation must be contingent on realized profits. Conditions 2i), 2ii), and 2iii) ensure that competition reduces the marginal agency cost of an effort increase, via the “market reward” to the agent.

As mentioned in the introduction, other papers in the literature do not explicitly isolate the agency

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<sup>31</sup>This is conditional on the existence and uniqueness of a SPNE, which in our model requires  $t \in \left(\frac{4/3}{9k}, \frac{2}{9k}\right]$ , and assumptions about non-observability of the rival contractual offer, and observability of quality (see footnotes 9 and 19 for details).

<sup>32</sup>To be precise, Vives finds a positive impact of competition with Shapley/Shubik linear demands, but a negative impact with Bowley linear demands.

effect of competition from the direct pressure effect, and can therefore neither confirm nor contradict our empirical predictions. Aside from that, these models differ mainly in that they do not verify the conditions just presented. Hart (1983), Scharfstein (1988), and Hermalin (1992), for example, use very different models of agency and competition, and none of the above 4 conditions hold. While Hart’s (1983) and Scharfstein’s (1988) models have the interesting particularity of relying on hidden information rather than hidden action, Hermalin (1992) looks at the effect of competition when the manager, rather than the shareholders, have *ex-ante* bargaining power.

Schmidt (1997) uses a model similar to ours, with a risk-neutral but wealth constrained agent, but offers different results for two reasons. First, due to the generality of his assumptions about the competitive environment, he cannot sign his “relative-value-of-managerial-actions” effect, which is related to our direct pressure effect. More importantly, his model does not yield an agency effect of competition, because in his binomial framework, the agent’s compensation is contingent on the state of the world (good or bad) rather than on realized profits, and hence condition 2iii) stated above does not hold.

Raith (2003) also offers different predictions, despite a similar model of competition (Salop circle) which satisfies our conditions 1 ( $\frac{\partial^2 \pi_i}{\partial q_i \partial t} = 0$ ), 2i) and 2ii). In his model, the effects of competition occur exclusively through a change in the number of rivals in the industry, and hence require the assumption of free entry. If instead our (implicit) assumption of barriers to entry and a fixed number of firms is made, competition has no impact in his framework. This may result from his use of a “classic” agency model with risk-averse agents and a tradeoff between incentives and insurance. But it is likely also due to his assumption that the agent’s effort affects cost and that agent compensation is cost-contingent rather than profit-contingent; i.e. to the fact that our condition 2iii) does not hold in his model.<sup>33</sup>

We now turn to the data and test the empirical validity of the predictions of our model.

### 3 Data

We are fortunate to have access to a unique dataset that includes several measures of product market competition, indications of firm’s choices of quality, the structure of employee contracts and

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<sup>33</sup>Note that in our model the agency effect of competition would still arise even if the agent’s effort affects the cost of production as in Raith, as long as costs are assumed to be non-verifiable and the agent’s compensation must be made contingent on profits.

employee level measures of effort, providing us with an excellent opportunity to test our theoretical predictions. The Workplace and Employee Survey (WES) - conducted by Statistics Canada with the support of Human Resources Development Canada – is a very rich longitudinal data set that consists of two components. 1) The workplace survey of approximately 6300 firms provides information on workforce characteristics, work organization and organizational change, competitive environment, business strategy, innovation, and firm performance. 2) The employee survey of approximately 25000 employees in the same workplaces, which contains information on compensation, human capital, training, work hours and arrangements, and promotions. Taken together, these two components generate approximately 1000 firm and employee specific variables and an unprecedented opportunity to examine the connection between competition, contractual incentives and effort. To the best of our knowledge, a comparable data set does not exist anywhere in the world. The WES data is relatively new, and to date has been predominantly used within Statistics Canada and by a small group of labour economists, though its potential for other applications is tremendous.

WES was first conducted in 1999 with the intention of generating a longitudinal data set by annually re-administering the survey to the selected cohort of firms for the next six years. WES is a linked employer-employee file. Employers are sampled by physical locations—the statistical unit that comes the closest to the concept of a workplace in which employer and employee activities can be linked. Employees are then sampled from employer-provided lists within each location. The survey covers all industries except farming, fishing, trapping and public administration and all regions of Canada with the exception of the arctic territories (the Yukon, Northwest Territories and Nunavut). Currently, data for 1999, 2000 and 2001 are available for analysis, and the response rate for workplaces in each of these years is over 95%. The questions about firm strategy, which are used to construct our measures of the emphasis firms place on quality improvements, were asked in 1999 and 2001 but not in 2000. In addition, our empirical model incorporates control variables from  $t-1$ , eliminating the use of strategy responses from 1999 as dependent variables. As a result, our main set of dependent variables is derived from the 2001 WES, with independent variables drawn from both 2001 and 2000.

The process of sample selection for WES stratified businesses in Canada into relatively homogeneous groups which were then used for sample allocation and selection. Businesses were classified by fourteen industry classifications, six regional classifications and three employment size categories, resulting in 252 possible strata. The strata were constructed so as to maximize variation between strata and minimize variation within strata. Firms are sampled using Neyman allocation, meaning

firms are sample randomly from within each strata, however, the choice of how many firms to sample from each strata depends not just on how many firms are in the strata (a strata with 10% of the population does not necessarily have 10% of the sample) but on how much variation there is within the strata. More firms are sampled from strata with higher variances and fewer from strata with lower variances. To compensate for the uneven number sampled, each sampled units is assigned a sampling weight based on its probability of selection. For example, if three workplaces were selected at random and with equal probability from a population of thirty workplaces, then the selected workplaces would represent ten units in the population and be assigned a sampling weight of ten. Using these strata and weighting techniques, the survey was designed in such a way as to make it possible to estimate unbiased parameters which reflect the underlying population, despite the fact that each workplace in Canada did not have an equal probability of selection.<sup>34</sup>

All of our analysis is conducted with techniques expressly designed for surveys. Specifically, we control econometrically for selection - each observation did not have an equal probability of selection, for clustering - observations at the employee level are not sampled independently from the population of Canadian workers, they are chosen from within the surveyed firms, and for stratification - in our case firms were sampled from 252 strata based on size, region and industry, and sampling within each strata was random, but unequal across strata. Statistics Canada has calculated survey weights for each observation based on probability of selection, sample clustering and stratification, and these weights are used in all of our analysis. In addition, in all regressions, bootstrapping is used to correct standard errors for the survey design.<sup>35</sup>

This paper uses survey data which has many advantages, but suffers from some lack of objectivity. While the considerable care and attention that went into the construction and validation of WES has minimized many of the problems faced by surveys conducted without the expertise and financial backing of a national statistical agency, this may not have resolved all possible forms of bias. A common criticism of this type of data is that firm's self reports will be systematically biased - over reporting profits and under reporting costs, for example. While this may well be the case, we find no reason to suggest that an upward bias in, for example, the firm's self report of the importance

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<sup>34</sup>see the Guide to the Analysis of the Workplace and Employment Survey for further details

<sup>35</sup>To compute the variances for estimates based on samples coming from finite populations, it is important to account for the sample design. Estimation using only weights, without accounting for design, results in the underestimation of the variance. This could have dire consequences for hypothesis testing and for constructing confidence intervals. Accordingly, a bootstrapping procedure is required. This technique is based on re-sampling. Using the original sample, from which a simple random sample is selected with replacement of as many units there were at the outset. This procedure is repeated many times to guarantee consistency. We use these bootstrap weights in all analysis.

of quality improvements, would be correlated with our measures of competition. Another potential bias introduced by the use of survey data occurs because the individuals completing the survey have different scaling attitudes. Some tend to consistently use higher ratings and others lower ratings - this increases the “noise” in our data and likely inflates our standard errors. Following Cooper and Emory (1995), we note that differences in scaling attitudes do not introduce a systematic bias, and if anything, by increasing standard errors, lead to more conservative results.

In this paper we are able to take advantage of the linked nature of the WES data to simultaneously analyze both the characteristics of a given firm and the characteristics of that firm’s employees, providing us with an excellent opportunity to test our theoretical model.

## 4 Methodology

### 4.1 Firm Strategy

The theoretical structure developed above suggests that competition affects firms’ strategies by changing the net marginal benefit from eliciting an increase in effort (quality) from their employees; and this in turn leads to higher powered incentives and to higher employee effort. In this subsection we examine the first step, i.e. the impact of competition on the net marginal benefit from a quality increase, and the resulting impact on incentives and effort is analyzed in the next subsection.

As discussed in the theory section, *the importance firms place on quality improvements* is a good measure of firms’ net marginal benefit from eliciting an increase quality, and hence we use it as our main dependent variables in this subsection. Consider the basic regression equation:

$$q = \alpha + \beta c + \lambda h + \theta h * c + \gamma x + \epsilon. \tag{18}$$

Variable  $q$  represents the importance a firm places on quality improvements,  $c$  describes the degree of competition in that firm’s product market, where  $c$  is akin to our competition measure  $\frac{1}{t}$  from the previous section,  $h$  measures whether or not agency costs are present in the firm,  $x$  is a vector of control variables and  $\epsilon$  is an error term. Equation (18) allows us to look at how competition affects the firms’ provision of quality, and whether that effect is tempered by the presence or absence of agency costs. We obtain our measures of  $q, h, c$  and  $x$  from the WES data set.

#### **Importance of Quality Improvements (and of Cost Reductions)**

Variable  $q$  is measured using a question asking firms to rank the relative importance of improving

product or service quality in their workplace’s general business strategy. Firms rank the importance of quality as either 1 for “not applicable,” or describe the strategy’s importance on a scale of 2 to 6 where 2 is “not important” and 6 is “crucial.”. The same question is asked with regards to the importance of cost reduction and other strategies.

As noted in subsection 2.2, our the model predicts the same effects of competition on cost reduction as it does on quality improvement and we use these questions to test both outcomes. In some of our specifications,  $q$  may therefore represent the importance of cost reductions rather than the importance of quality improvements. The specific wording of these, and all other questions used in this paper, can be found in the appendix.

### **Product Market Competition**

Recall from our theory section that in markets with lower unit transport cost  $t$ , products are more substitutable - indicating more intense competition. We are fortunate that WES provides us with a measure of competition which closely mirrors our theoretical structure. We measure competition,  $c$ , using firm’s self report as to what extent different classifications of firms offer “significant” competition (again on a scale of 2 to 6) to their business, where significant competition refers to “a situation where other firms market products/services similar to your own which might be purchased by your customers.” Firms are asked to rank the significance of competition, as described above, from four types of firms: i) locally owned, ii) Canadian owned, iii) American owned, and iv) internationally owned firms. The value of  $c$  is set to one for firms indicating they face no competition from other firms. For all other firms,  $c$  is set to the *maximum* level of competition indicated from *any* type of firm. For example, if a firm indicates no competition from American or Internationally owned firms, but indicates that the competition created by Canadian owned firms is “important” (4) and that competition from locally owned firms is “crucially” significant (6), then that firm’s value of  $c$  is 6.<sup>36</sup>

Our theoretical model gives no indication that the source of competition, in terms of the geographic ownership of competing firms, should alter the effects of competition. Consider a firm that reports “important” competition to its business, because other firms are marketing products and services similar to its own, which might be purchased by its customers. Whether these “other” firms are Canadian owned or American owned is irrelevant to the model we are testing. We are interested in the substitutability of products and services, regardless of who owns the firms producing those

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<sup>36</sup> While competition is a categorical variable (equaling 1, 2, 3, 4, 5 or 6), it has been included directly on the right hand side rather than as a set of dummy variables for ease of interpretation. However, all specifications were re-estimated with dummy variables and our results were consistent with the slope suggested by the direct inclusion of the categorical competition variable.

products/services. Accordingly, we use the firm’s rating of competition from *any* type of competitor.

It does not matter which firms, or how many types of firms, offer little competition. We are interested in the general level of competition faced by the firm, which we must infer from the four WES questions regarding competition from firms of ownership types i-iv described above. If firms were asked the more general question: “To what extent do you face significant competition to your business,” we would expect firms to report the competition level they faced based on their most important competitors. So, if a sawmill faced “slightly important” (3) competition from locally and Canadian owned firms but “crucial” competition from American firms, we would expect the Sawmill to rank its overall level of competition as “crucial,” not as the mean or median of the level of competition from all ownership types. Accordingly, we measure competition as the maximum reported level rather than the mean, median, or some other measure.<sup>37</sup>

### **Agency Costs**

The measurement of agency costs is notoriously difficult. While recognizing that we do not have a perfect measure of agency costs, the WES data set does provide us with some excellent proxies for the importance of agency costs within a firm (variable  $h$  in equation (18)). Our primary measure is a variable which equals 1 if the firm has more than one employee and 0 if the firm has only one employee. In this manner, we separate entrepreneurial firms, where the owner, manager and employee are one in the same, from larger firms where decisions are made by at least one person in addition to the owner. This effectively divides our sample into firms with no agency costs and firms with at least some agency costs. 6% of firms (which represents approximately 335 firms) in our sample have only one employee, while the remainder have more than one employee.

Recognizing that agency costs are difficult to capture, we used alternative measures to evaluate the robustness of our criteria. One alternative measure of agency that we use is “decision hierarchy.” This variable is measured using a variable which equals 1 if decisions regarding follow-up results (alternately specified using decisions regarding: daily planning, or quality control) were made by either the manager/owner or by an individual or group outside the workplace. Decision hierarchy equals 0 if decisions regarding follow up results were made by non-managers, work groups, or work supervisors. This measure of agency cost captures the idea that the “higher up,” or further away from the individual employee, decisions are made or results are supervised, the larger the agency cost.

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<sup>37</sup>All of our specifications were also estimated with alternative measures of competition, including the average level of competition faced by a firm across all markets and firms and the median level of competition. To provide a more objective measure of competition, we used another Statistics Canada data source, the T2-LEAP file, to construct a CR4 by industry and region. In all cases, the results were consistent with those reported below.

If an agent's performance is evaluated directly by his or her immediate supervisor, their ability to verify the effort of the agent is likely greater than if performance is evaluated by a principal with less direct contact with the agent. Accordingly, the "further away" supervision is from the agent, the more agency costs we expect.

Second, though unreported, we also directly used the number of employees as a measure of agency costs. It is generally accepted that separation of ownership and control - the source of agency costs - is far more prevalent in larger firms, where managers own only a small fraction, if anything, of the firm's equity.<sup>38</sup> While size is arguably a good proxy for agency costs, it may also capture other effects, such as increasing returns to scale for example. Although we might expect other aspects of size to influence the importance firms place on quality, we have no reason to suggest that those other aspects temper the effect *competition* has on the firm's provision of quality. Our results show a positive and significant direct effect of size, while the competition variable and the interaction between size and competition are of the same sign and significance as when using our other measures of agency costs. Accordingly, in all measures of agency costs the results concerning competition, and the mitigating effect of agency costs on competition, are consistent.

#### **Firm level control variables**

The firm level control variables,  $x$ , are included to compensate for a number of alternative influences on the quality and cost choices of a firm. We control for the size of the firm using the natural log of employees as we may expect scale to influence strategic choices. Firm profits, as well as whether or not the firm experienced an increase in sales during the previous year are included as the availability of cash may influence investments in quality improvements, or alter the urgency of cost reductions.

We also control for "industry leaders" - defined as the one third of firm's whose self report of productivity is "better" or "much better" than their competitors. For tractability reasons, our theoretical model assumed symmetric firms with identical productivity levels. However, it could easily be shown that with asymmetric firms, the productivity "leader" would place more importance on quality than its less productive competitor, and accordingly we control for relative productivity. Our final control variables are previous year quality increases and cost decreases. These variables are included as it is reasonable to suggest that a workplace's choice of quality improvements or cost reductions in one year will be subject to their actions in the previous year. Some firms may embark on an investment or

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<sup>38</sup>We are not the first to use a measure of firm size as proxy for the prevalence of agency costs inside the firm. Griffith (2001), for example, distinguishes between managerial (multi-plant) establishments, which are affected by agency costs, from entrepreneurial (single-plant) establishments, which are not.

strategic plan with a time horizon greater than one year, leading quality improvements in the previous year to be positively associated with quality improvements in the current year. On the other hand, quality improvements made in previous years may continue to be beneficial in the current year, thereby reducing incentives for additional investments in the current year.

## 4.2 Incentives and Effort

Our theoretical model suggests that as a result of its impact on principals’ net marginal benefit from quality improvements, firms offer stronger incentives to their employees (agents), who in turn exert more effort. In this subsection we examine the impact of competition on contractual incentives and employee effort. We are fortunate to be able to match our firm level quality and cost data to employee level data for incentives and effort to test these predictions as well. Modifying equation (18) for estimation at the employee level gives:

$$q = \alpha + \beta c + \lambda h + \theta h * c + \gamma x + \delta y + \epsilon, \quad (19)$$

where  $q$  in this case represents either the incentives offered to employees or employee effort,  $c$ ,  $h$ ,  $x$  and  $\epsilon$  are as described above, and  $y$  is a vector of employee specific control variables.

### Incentives

We measure the incentives offered to agents as the share of total remuneration each employee derives from “variable” sources. These variable sources include commissions, tips, profit sharing, productivity bonuses and piecework. This incentive measure captures the *intensity* of incentive based pay in an employee’s total remuneration. It depends on both the structure of the contract offered to the agent, as well as the performance of the firm and industry. Ideally, to correspond with our theoretical model, we would have a measure of incentives that reflected only the intensity of incentives *offered* to the agent in his or her contract rather than the realization of incentives which is influenced by both the contract and other factors. Unfortunately, such a measure is not available. We compensate for the effect of firm and industry on realized incentives by controlling for firm level performance (profits, sales increases, etc) and with industry fixed effects. We examine the robustness of our results by replacing the dependent variable with a dummy variable equaling 1 if the employee reported *any* variable pay and 0 otherwise (estimation by probit), as well as a firm level regression where the dependent variable equals 1 if the firm *offers* any type of incentive based contracts and 0 otherwise. We also used the

*total* amount of variable pay (instead of the share of variable pay) as the dependent variable. In all cases, the results for competition, agency costs, and the interaction between competition and agency are of the same sign, significance and relative magnitude as those reported with our main measure.

### **Effort**

Any measure of the amount of effort an employee exerts in his or her job is by nature somewhat subjective. We choose to measure the effort exerted by an agent using the most objective measure available to us - the employee's self report of the number of hours of *unpaid* overtime, he or she usually worked per week. Admittedly, "effort" and "number of hours" are not necessarily equivalent. An employee does not need to work for more hours to work harder, however, we would expect considerable positive correlation between effort and hours of unpaid overtime. Unpaid overtime is predominantly voluntary, and not contracted by the employer. Employees who choose to work overtime hours for which they are not paid, are effectively *choosing* to put more effort into their job. Accordingly, we view the number of hours of unpaid overtime worked as a reasonable proxy for effort. In our sample, 24% of employees report some unpaid overtime, with the remainder indicating no hours of unpaid overtime. For robustness, we repeated our estimation using only those employees that worked unpaid overtime. We also replaced the dependent variable with a dummy variable equaling 1 if the employee reported any unpaid overtime and 0 otherwise (estimation by probit), as well as using the *total* number of hours an employee worked as the dependent variable. Our results were consistent.

### **Employee specific control variables**

The employee specific control variables,  $y$ , are included to compensate individual characteristics which may influence effort or variable pay. We control for the employees level of education, age, gender, marital status and whether he or she has dependent children. We also control for whether he or she supervises other employees, or is a member of a collective bargaining agreement.

### **Endogeneity Issues**

One of the key difficulties in determining the effects of competition on firm strategy or performance is that these effects are to some degree endogeneous. We expect that not only will competition affect firm behaviour, but that in some cases, the behaviour of firms will have some affect on the amount of competition in the product market. We have compensated for this issue in estimation in several ways. First and foremost, our measure of competition both theoretically and empirically captures the degree of substitutability between products, not the competitive behaviour of the firm. While the importance of quality improvements, incentives, and effort may lead to a more or less aggressive

competitive behaviour amongst rivals, it is less clear that they will affect the degree of substitutability between products.

Second, we have used measures of the level of competition in the previous year to determine strategies, incentives and effort in the current year. While it is certainly possible that a firm's quality improvements in one year will affect the level of competition in future periods, it is much less clear that quality in the current year affects competition in the previous year.

Third, we have used industry and regional fixed effects in all specifications. This controls for any industry specific trends which might influence competition - for example industries which, as a result of some external factor, have similar incentive based pay systems across firms, or an industry wide trend toward cost reduction.

Fourth, our sample is composed primarily of small firms operating in large markets. Some 40% of the firms in our sample have more than 20 competitors in their *local* market, and 72% of firms report that at least one ownership grouping of firms offering "important" competition to their businesses. In addition, 43% of firms in our sample have less than 20 employees and 70% have less than 100 employees. Small firms are less likely to have significant market power, particularly in more competitive markets, and it is accordingly less likely for the actions of those firms to significantly affect the amount of competition in the product market. Since this type of firm dominates our sample, we expect fewer issues of endogeneity at the firm level. To further confirm the robustness of our results, we re-ran all of our specifications for the subsample of firms with less than 20 employees and more than 20 firms in their local market, and our findings were consistent with those reported above.

Despite our best efforts, it remains a possibility that our competition measure is somewhat upwardly biased due to endogeneity. It is possible that the importance of quality improvements and of cost reductions lead to more competition or that more incentives and effort may also increase competition amongst firms. While our results should be viewed with some caution as a result, we remain confident that the precautions described above have to a large degree compensated for endogeneity.

## 5 Main Empirical Results

Some descriptive statistics for our main variables of interest can be found in Table 1. The table is self explanatory; but note however that both the number of employees and profits are highly skewed, resulting in our use of the log of these variables empirically.

**Table 1**  
**Descriptive Statistics**

Firm Survey			Employee Survey	
	Mean	Median		
Level of Competition	4.5	5	Percentage of employees with <i>any</i> incentive based pay	35%
Importance of Quality Enhancement	4.3	5	Mean share of income derived from variable sources (all employees)	20%
Importance of Cost Reduction	4.2	4	Mean share of income derived from variable sources (only employees <i>with</i> incentive pay)	57%
Number of Employees	125	29	Mean hours of unpaid overtime (all employees)	2
Profits	\$2,974,472	\$137,568	Mean hours of unpaid overtime (only employees working overtime)	7.4

## 5.1 Competition and Firm Strategy

We begin by estimating equation (18) by ordered probit, with each observation weighted using the survey weights described in the previous section, to provide unbiased point estimates. Ordered probit is used as our dependent variable is categorical - taking on values from 2 to 6, and ordinal - the importance of quality improvements (or cost reductions) increases with higher numbers. Columns 1 and 3, and 2 and 4, refer to specifications with the dependent variable being the importance of quality improvements and the importance of quality reductions, respectively. Columns 1 and 2 use our base measure of agency, while columns 3 and 4 use our hierarchical measure.

Our main empirical results can be found in Table 2. We consider the effect of competition and agency in turn.

### Effects of Competition

To analyze the effect of a change in competition on the importance firms place on quality improvements and cost reduction, we differentiate  $q$  with respect to  $c$  in (18). This gives:  $\frac{\partial q}{\partial c} = \beta + \theta h$ .

Since both of our measures of agency costs used in columns 1-4 are dummy variables, the empirical predictions of our theoretical model, concerning the effects of competition, can be neatly cast in terms of the coefficients  $\beta$  and  $\theta$ .

Prediction 2 states that, due to a zero direct pressure effect, when agency costs are absent ( $h = 0$ ) competition should have no impact on the importance firms place on quality improvements and cost reductions. The implication in our specification is therefore that  $\beta$  should not be significantly different

**Table 2**  
**Importance of Strategies: Quality Improvement, Cost Reduction**

	1	2	3	4
<i>Dependent Variable</i>	<i>Quality</i>	<i>Cost</i>	<i>Quality</i>	<i>Cost</i>
Level of Competition =intensity of competition (scale of 2 to 6)	0.242** (0.084)	0.226** (0.077)	0.334** (0.105)	0.056** (0.017)
Agency Cost =1 if firm has more than one employee, 0 otherwise	-0.681* (0.331)	-1.882** (0.620)		
Competition * Agency =level of competition * agency cost	0.165* (0.084)	0.166** (0.048)		
Decision Hierarchy =1 if results supervised at higher level 0 otherwise			-1.111* (0.561)	-0.172 (0.102)
Competition*Decision Hierarchy =level of competition*Decision Hierarchy			0.197 (0.116)	0.052* (0.021)
Firm Size =ln(total employees)	0.193** (0.031)	0.221** (0.033)	0.269** (0.044)	0.144** (0.009)
Profits =ln(revenues less expenditures)	0.001 (0.001)	0.002* (0.001)	0.001* (0.0004)	0.001 (0.001)
Industry Leader =1 if productivity in top third of firms 0 otherwise	0.378** (0.077)	0.081 (0.075)	0.164** (0.030)	0.003 (0.030)
Sales Increase in Previous Year =1 if sales growth increased in t-1 0 otherwise	0.212** (0.077)	-0.651** (0.187)	0.100** (0.032)	-0.045 (0.032)
Quality Increase in Previous Year =1 if product quality increased in t-1 0 otherwise	-0.046 (0.092)	0.691** (0.202)	0.172 (0.135)	0.038** (0.004)
Cost Decrease in Previous Year =1 if unit production costs fell in t-1 0 otherwise	0.008 (0.105)	-0.577** (0.186)	-0.058 (0.046)	0.176** (0.044)
Industry and Region Fixed Effects	YES	YES	YES	YES
Log Likelihood				
Number of Observations	4732	4541	4732	4541

\*\*=significant at 1%, \*=significant at 5%. Standard errors in parentheses.

from zero. This prediction is not supported by the data: the coefficient of the level of competition variable is significantly positive at the 1% level in all four specifications, which suggests that empirically the direct pressure effect of competition is positive, rather than null.

We conjecture that the discrepancy between the prediction 2 and the data comes from the specificity of the Hotelling model. As discussed in subsection 2.5, our theoretical framework can be readily generalized to other demand systems in which the direct pressure effect of competition, which depends on the marginal impact of managerial effort on expected profits, is positive. This is the case, for example, of some linear models, as well as CES, and constant expenditure models (Vives, 2004). Thus, the positive significance of  $\beta$  is not necessarily inconsistent with the more general implication of our model. It may result from a positive marginal impact of effort on profits, likely due to the dominance of business stealing over rent reduction, and perhaps better captured in other demand systems such as the ones mentioned above.

Prediction 3 of our theoretical model states that there exists a positive agency effect of competition which appears only in firms plagued by agency costs. In other words,  $\theta$  should be significantly positive. Prediction 3 is consistent with the data. The coefficient of the competition/agency interaction in table 2 is positive and significant at least at the 5% level in all columns except the third (the specification with quality enhancement and our hierarchical measure of agency), where  $\theta$  is significant at the 10% level.

Note that previous theoretical literature, since it does not disentangle the agency effect from the direct pressure effect of competition, remains silent about the sign of  $\beta$  and  $\theta$ .

### **Effects of Agency**

Turning to the effect of agency on the importance firms place on quality improvements and cost reduction, we differentiate  $q$  with respect to  $h$  in (18). This gives:  $\frac{\partial q}{\partial h} = \lambda + \theta c$ .

Prediction 1 from our theoretical model states that the importance firms place on quality improvement and on cost reductions should be lower in firms that are subject to agency costs than in firms that are not. This “direct effect” of agency costs is perhaps best captured by  $\lambda$ , and consistent with the prediction, the coefficient of the agency dummy is positive and significant at least at the 5% level in all columns except the fourth, where  $\lambda$  is significant at the 10% level.

Prediction 1 also implies that the impact of agency costs should be true for any given degree of competition in the industry. Empirically, this implies that the sum  $\lambda + \theta c$  should be significantly negative for possible values of  $c$  (from 1 to 6). In other words, the direct negative impact of agency costs

$\lambda$  should always dominate the positive indirect impact of agency through competition,  $\theta c$ . Looking back at table 2, this prediction is consistent with the data in specifications 2 and 3, where the total impact of agency costs  $\lambda + \theta c$  is negative for all possible values of  $c$ . In specifications 1 and 4, the total impact of agency is negative at low levels of competition, but does not appear to be significantly different from zero when  $c$  is high. In other words, empirically the positive impact of competition on  $q$  when agency costs are present is so strong that at high level of competition it may offset the direct negative impact of agency. Note that these results hold when controlling for firm size.

### **Control Variables**

In terms of control variables, profits have a positive impact on the importance firms place on quality improvements and cost reductions, though this effect is significantly different from 0 at the 5% level only in columns 2 and 3. A sales increase in the previous year is shown to have a significant positive effect on quality improvements, and a significantly negative effect on cost reductions (though not in column 4). These two results seem intuitively consistent: cash rich firms (from previous year sales) can afford to make quality improvements, which may require large initial capital investments; in contrast, cash poor firms may focus on less “expensive” cost-cutting strategies. Relative to weaker firms, the importance of quality improvement in a firm’s business strategy is higher “industry leaders”. The same result holds if industry leader is measured by sales or profit performance instead of productivity. These results are consistent with theoretical predictions of de Bettignies (2004) for example. Our final control variables are previous year quality increases and cost decreases. When quality is the dependent variable, these variables are both in fact insignificant, possibly because in aggregate they cancel each other out. For cost reductions, however, potentially costly quality improvements from the previous year are positively associated with the importance of cost reduction in the current year, while cost decreases in the previous year are negatively associated with the importance further cost reductions in the current year.

## **5.2 Competition, Incentives and Effort**

So far, our empirical results have indicated a link between competition and the importance firms place on quality improvements and cost reductions, and supported a theoretical structure which includes agency costs. To further test our theory, we now turn our attention to testing the consequences of the impact of competition on the importance of such strategies, namely contractual incentives and agent effort.

We estimate equation (19), where  $q$  is either the share of pay derived from variable sources, or the number of hours of unpaid overtime an employee worked. Estimation is by GLS, with standard errors robust clustered at the firm level, again adjusted for survey data. The results are found in Table 3, which represents incentives in columns 1 and 2, and effort in columns 3 and 4. Columns 1 and 3, and 2 and 4, use the base measure and the hierarchical measure of agency, respectively.

### **Effects of Competition**

When compared with the results in Table 2, the coefficients of our main variables of interest are consistent in sign and significance in all 4 specifications. We confirm that competition has a positive impact on the intensity of incentive based compensation and the amount of unpaid overtime agents work, and again see that these effects are larger for firms with agency costs. This suggests that empirically, the impact of competition on incentives and effort is channeled through both an agency cost effect (which is consistent with prediction 3), and a direct pressure effect (which is not directly consistent with prediction 2, but could perhaps be explained if our model were applied to other demand systems).

### **Effects of Agency**

The impact of agency costs on incentives and effort are also similar to their effects on firms' strategic priorities depicted in table 2, even stronger: in all 4 specifications the direct agency effect  $\lambda$  on incentives and effort is significantly negative, and the total impact of agency costs,  $h + \theta c$ , is negative for all levels of competition  $c$ . Employees working for firms subject to agency costs worked fewer hours of unpaid overtime and earned a lower share of their income from variable than workers in firms without agency costs. Moreover, this holds for all levels of competition. This again is perfectly consistent with prediction 1 of our model.

### **Control Variables**

Control variables in table 3 also suggest a number of interesting implications. First, firm profits, and the relative productivity level of the firm, have a significant positive effect on the share of variable pay in total pay but an insignificant effect on unpaid overtime.

Moreover, firm size, measured by the natural log of total employees, is insignificant in determining variable pay, consistent with Baker and Hall (2004) who find that the CEO incentives are either unrelated or slightly negatively related to size. We find a similar result looking at the intensity of incentives for all types of employees. In contrast, firm size has a positive impact on unpaid overtime, even though this effect is significant only at 10% in column 4.

**Table 3**  
**Incentives & Effort: Share of Variable Pay and Hours of Unpaid Overtime**

<i>Dependent Variable</i>	1	2	3	4
	<i>Variable Pay</i>	<i>Variable Pay</i>	<i>Unpaid Overtime</i>	<i>Unpaid Overtime</i>
Level of Competition =intensity of competition (scale of 1 to 6)	0.038* (0.018)	0.011** (0.001)	0.113* (0.039)	0.071* (0.024)
Agency Cost =1 if firm has more than one employee, 0 otherwise	-0.186** (0.053)		-0.169* (0.079)	
Competition*Agency =level of competition * agency cost	0.025* (0.012)		0.081* (0.036)	
Decision Hierarchy =1 if results supervised at higher level, 0 otherwise		-0.022** (0.007)		-0.192** (0.075)
Competition*Decision Hierarchy =level of competition * decision hierarchy		0.001* (0.0004)		0.022* (0.009)
Firm Size =ln(total employees)	0.002 (0.007)	0.002 (0.006)	0.107 (0.063)	0.046* (0.022)
Profits =revenues less expenditures in millions of dollars	0.001* (0.0002)	0.001** (0.0002)	0.001 (0.001)	0.001 (0.001)
Industry Leader =1 if productivity in top third of firms, 0 otherwise	0.078** (0.019)	0.037** (0.005)	0.124 (0.157)	0.016 (0.063)
Supervisor =1 if supervises other employees, 0 otherwise	0.004 (0.020)	0.007 (0.006)	1.754** (0.183)	1.996** (0.067)
Education =employees highest educational attainment	0.005 (0.006)	0.014** (0.001)	0.404** (0.048)	0.444** (0.023)
Unionized =1 if employee is a member of a collective bargaining agreement	0.045* (0.023)	0.018** (0.006)	-0.748** (0.183)	-1.429** (0.077)
Age =age of employee in years	-0.001 (0.001)	-0.001 (0.001)	0.015** (0.006)	0.018** (0.003)
Gender =1 if employee is female, 0 otherwise	-0.003 (0.019)	-0.032** (0.005)	-0.546** (0.146)	-0.479** (0.064)
Industry & Region Fixed Effects	YES	YES	YES	YES
R <sup>2</sup>	0.03	0.02	0.09	0.12
Number of Observations	19147	19147	19147	19147

\*\*=significant at 1%, \*=significant at 5%. Standard errors in parentheses.

Incentives are positively affected by education and unionization, negatively affected by age and significantly lower if the employee is female. Unpaid overtime significantly increases with age and education, and is also higher for employees that supervise others. However, it decreases if the employee is a member of a collective bargaining agreement and if the employee is female.

Interestingly, while these coefficients are not reported in Table 3, the amount of unpaid overtime worked by employees with dependent children was insignificantly different from those without children, while employees who were married or living in common-law relationships worked significantly more than their single counterparts, though only at the 10% level.

All of the specifications in Table 3 were re-estimated using different control variables, various subsets of employees and variations in the dependent variables. We also re-ran all regressions using only the subset of employees who were managers, as well as managers and professionals. In all cases, the results for competition, agency cost or reduction in agency cost and the interaction between competition and agency are of the same sign, significance and relative magnitude as those reported in Table 3.

### 5.3 Discussion of Empirical Results

Our results from table 2 - on the positive impact of competition on the importance of quality improvements and cost reductions - are broadly consistent with the empirical literatures on competition and productivity, and on competition and innovation discussed in the introduction, with the exception of Aghion et al. (2002), who find an inverted U relationship.

Similarly, our results on contractual incentives are consistent with, among others, Cunat and Guadalupe (2003), who find that competition increases the steepness of performance pay contracts, and Burgess and Metcalfe (2000), who find the likelihood of performance related pay increases with competition. Burgess and Metcalfe (2000) use a British survey similar to the WES, and measure competition using a firm's qualitative rating of the "degree of competition" they face, making their results directly comparable to, and consistent with, ours.

Santalo (2002) finds a *negative* correlation between the number of competitors and incentives, and we pay particular attention to these results as he also uses a portion of the WES data set. Our empirical methodology and results differ sharply from his for several reasons. First, he uses the 1999 version of WES data set, data we do not use, because our dependent variables are lagged to compensate for endogeneity, and because for our purpose later years offer a richer set of variables to choose from.

Second, our measure of competition, which is based on the degree of substitutability between products, is quite different from his measure, number of competitors. Substitutability between products has the advantage of being a better proxy for our theoretical measure of competition. It is also less vulnerable to assumptions about barriers to entry, and (as discussed in subsection 4.2) to endogeneity issues.<sup>39</sup> Finally, our empirical approach differs from Santalo’s, as well as from the papers cited above, in our use of a reliable proxy for agency costs, which allows us to empirically isolate the agency costs effects of competition from the direct pressure effects. To our knowledge, this is one of the first empirical studies to isolate these factors. In that regard, our paper is closer to Griffith (2001) who finds that competition has no impact on efficiency in plants without agency costs, and a positive impact in plants with agency costs. Interestingly, her results suggest a zero direct pressure effect of competition, and hence are even more consistent with our theoretical predictions than our own empirical analysis. Griffith (2001) however looks exclusively at productivity and is silent about contractual incentives and effort.

## 6 Conclusion

Despite much interest in the subject, the belief that “competition is the enemy of sloth” has proved difficult to justify theoretically. The model developed in this paper provides a simple justification for this belief, by isolating the agency effect of competition from the direct pressure effect.

Using a unique set of Canadian data which allows us to simultaneously observe the characteristics of firms as well as their employees, we then evaluate the empirical significance for these two effects. We find that competition has a significant direct pressure effect which occurs whether or not firms are subject to agency costs, as well as a significant agency effect, which occurs only in firms plagued by agency. Both effects increase the importance firms place on quality improvements and on cost reductions, as well as contractual incentives and employee effort.

Our results yield an interesting policy implication: governments should (continue to) focus their competition policy effort on large corporations in which agency problems play a large role, and where the impact of their policies is likely to be larger.

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<sup>39</sup>As a measure of competition, number of competitors is difficult to interpret. In markets with free entry, as in Raith’s (2003) model which Santalo is testing, competition is usually associated with a decrease in competitors. In contrast, it is associated with an increase in the number of rivals in market with barriers to entry (Vives, 2004). Moreover, the number of competitor may itself be endogenous, thus making the econometric specification vulnerable to endogeneity.

## 7 Data Appendix

What follows are the specific wordings of the questions in WES used to construct our dependent and independent variables:

**Firm Strategy** is measured using these 15 questions, each of which was ranked by the firm as: 1: Not Applicable; 2: Not Important; 3: Slightly Important; 4: Important; 5: Very Important; 6: Crucial.

*Please rate the following factors with respect to their relative importance in your workplace's general business strategy:*

1. Undertaking research and development;
2. Developing new products/services;
3. Developing new production/operating techniques;
4. Expanding into new geographic markets;
5. Total quality management;
6. Improving product/service quality;
7. Reducing labour costs;
8. Using more part-time, temporary or contract workers;
9. Reducing other operating costs;
10. Reorganizing the work process;
11. Enhancing labour-management cooperation;
12. Increasing employee skill;
13. Increasing employee involvement/participation;
14. Improving co-ordination with customers and suppliers;
15. Improving measures of performance.

**Competition** was measured using these 4 questions, each of which was ranked by firms as:

1: Not Applicable; 2: Not Important; 3: Slightly Important; 4: Important; 5: Very Important; 6: Crucial.

*To what extent do these firms offer significant competition to your business? Significant competition refers to a situation where other firms market products/services similar to your own which might be purchased by your customers:*

1. Locally-owned firms;
2. Canadian-owned firms;
3. American-owned firms;
4. Internationally-owned firms.

**Firm size, and which firms had only one employee**, was measured using the following question:

*In the last pay period of March this year, how many people were employed at this location?*

**Profits** were measured as the difference between revenues and expenditures as derived from these two questions: *For this fiscal year, what was the gross operating revenue from the sale or rental of all products and services for this location? What were the gross operating expenditures for this location for the most recently completed fiscal year?*

**Whether a firm's costs decreased, quality increased or sales increased in the previous year** was measured using 3 questions, each of which was ranked by firms as: 1: Increased; 2: Remained the same; 3: Decreased.

*How has your workplace's performance in each of the following areas changed between April 1 last year and March 31 this year?*

1. Unit Production Costs;
2. Sales Growth;
3. Product Quality

**The existence of incentive based compensation at the firm level** was measured using the following 4 questions, each of which was answered "yes" or "no" by the firm. If a firm answered "yes" to any ONE question they were coded as having incentive based compensation.

*Does your compensation system include the following incentives?*

1. Individual incentive systems (bonuses, piece rate, commissions and stock options).
2. Productivity/quality gain sharing and other group incentives (benefits to employees for gains realized by increased productivity). Commonly, these benefits can be in the form of money payments in the

primary industries. 3. Profit sharing plan (any plan by which employees receive a share of the profits from the workplace). 4. Merit pay and skill based pay (a reward or honour given for superior qualities, great abilities or expertness that comes from training, practice, etc.).

**The share of incentive based pay in total pay at the employee level** was constructed using these four questions:

1. *In your current job, what is your usual wage or salary before taxes and other deductions?*
2. *In the past twelve months did you earn any commissions, tips, bonuses, paid overtime or any other types of variable pay such as profit sharing, productivity bonuses (gain sharing), or piecework?*
3. *Where these commissions, tips, bonuses, paid overtime or other types of variable pay included in the wage or salary reported in (question 1)?*
4. *What were your total earnings from commissions, tips, bonuses or variable pay in the past 12 months?*

**The number of hours of unpaid overtime employees worked** was measured using the following question: *How many hours of unpaid overtime do you usually work per week?*

The following questions were used to measure **the number of hours employees worked** in robustness checks:

1. *Excluding all overtime, how many paid hours do you usually work per week at this job?*
2. *How many hours of paid overtime do you usually work per week?*
3. *Not counting overtime, how many paid hours on average do you work per week at this job?*
4. *Over the past 12 months, not counting overtime, what was the maximum number of paid hours you worked per week at this job?*
5. *Over the past 12 months, not counting overtime, what was the minimum number of paid hours you worked per week at this job (exclude the hours when you were on paid vacation or sick leave)?*

The following questions from the employee portion of the survey were used as **controls** in the employee level regressions:

1. *In what year were you born?*
2. *Gender (check box for male or female).*
3. *What is your current legal marital status?*
  - 1: Legally married (and not separated); 2: Legally married and separated; 3: Divorced; 4: Widowed; 5: Single (never married).
4. *Are you currently living with a common-law partner? (yes/no)*
5. *Do you have any dependent children? (yes/no)*
6. *About how many people do you directly and indirectly supervise on a day to day basis?*
7. *Did you graduate from highschool?*
8. *In your current job, are you a member of a union or covered by a collective bargaining agreement?*
9. *Have you recieved any other education? What was that education?*
  1. Trade or vocational diploma or certificate;
  2. Some college, CEGEP, Inst. of techn. or Nursing school;
  3. Some University; 4. Teacher's College; 5. University certificate or diploma below bachelor level;
  6. Bachelor or undergraduate degree; 7. University certificate or diploma above bachelor level;
  8. Master's degree; 9. Degree in Medicine, Dentistry, Veterinary Medicine, Law, Optometry or Theology, or 1-year B.Ed after another bachelor's degree;
  10. Earned Doctorate.

**Decision Hierarchy** was measured using: *Who normally makes decisions with respect to the following activities:*

1. Follow-up results; 2. Daily planning of individual work; 3. Quality Control

Each of the above was indicated as being made by:

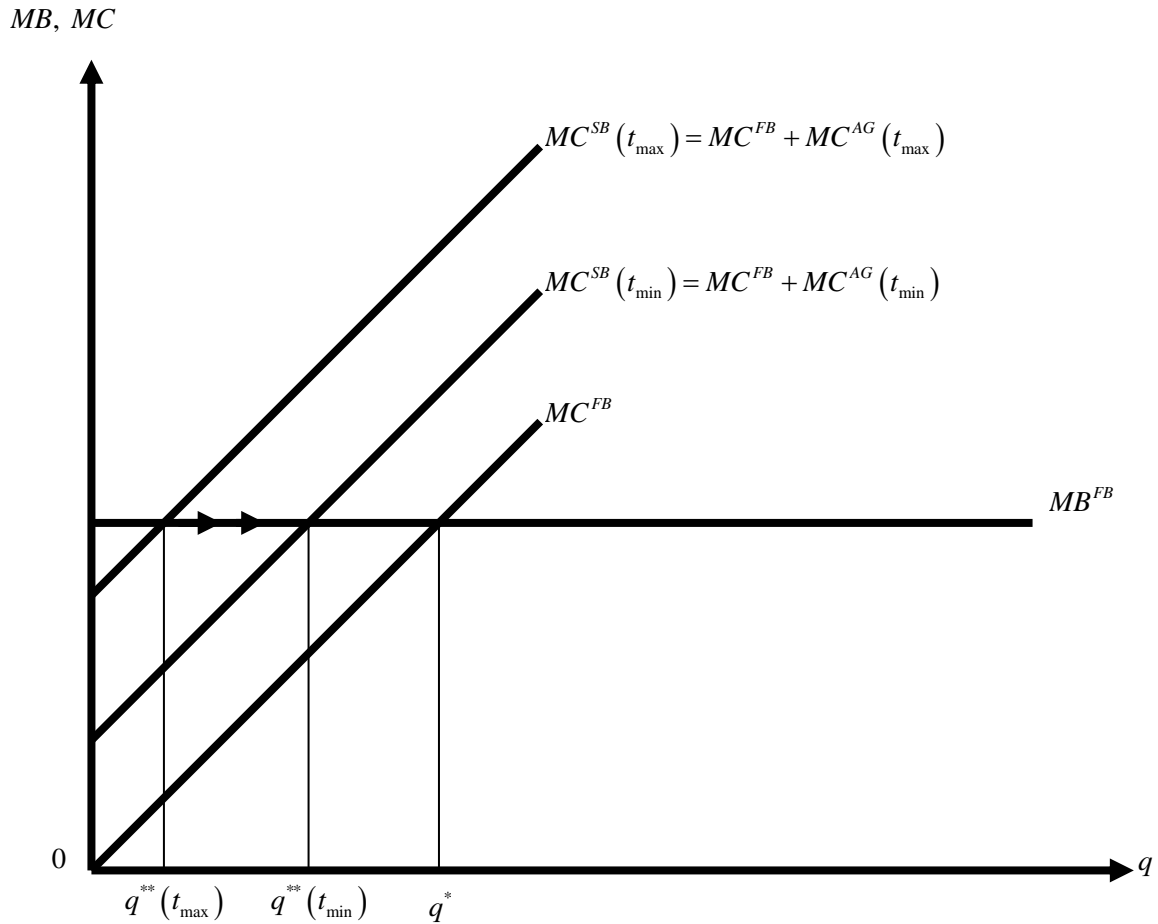
1. Non-managerial employees; 2. Work Group; 3. Work Supervisor
4. Senior Manager/Business Owner; 5. Individual or group outside the workplace

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Figure 1: Equilibrium Effort Levels



**Figure 1:** Represents first-best and second-best marginal benefit and marginal costs, in equilibrium (i.e when quality for the two principals are the same). Point A represents the FB equilibrium, while points B and C, as well as the points between them, represent SB outcomes for values of  $t$  between  $t(\min)$  and  $t(\max)$ . As expected, SB outcomes all yield a lower quality than in the FB (prediction 1). Moreover, as competition increases the SB equilibrium gradually moves from B to C and quality improves (prediction 3), while the FB equilibrium remains unchanged at A (prediction 2).