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by Jen Baggs and Jean-Etienne de Bettignies

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## *Table of Contents*

## *Abstract*

We model the effects of product market competition on agency costs, and develop two main empirical predictions. First, competition, by reducing agency costs, unambiguously increases the importance firms place on quality improvements. This leads to higher powered incentives, and in turn to increased effort and quality. Second, these effects are increasing in the severity of agency problems, and should be stronger in large, hierarchical corporations (where agency problems are more severe) than in entrepreneurial firms. We test the predictions of our model using a unique dataset with both firm and employee characteristics.

**JEL Classification:** L13, L15, M52.

**Keywords:** competition, incentives, agency costs, entrepreneurial firms and large corporations.

## *Executive summary*

Economists have long held the belief that competition improves efficiency. One of the mechanisms suggested is that product market competition alleviates agency costs, which in turn may enable firms to induce higher effort and greater efficiency from their managers. In this way, competition mitigates what Leibenstein (1966) called "X-inefficiencies." Despite growing interest, an unambiguous theoretical formulation for this "vague suspicion" has proved difficult to obtain. In this paper we examine the impact of competition on efficiency both theoretically and empirically.

The main theoretical contribution of this paper is to show that product market competition can have a *direct*, and *ambiguously positive* effect on managerial incentives. In our model, 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. Within this framework, the following results apply:

1. 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—competition *unambiguously* and "*directly*" lowers the shareholders' marginal cost of inducing effort by the manager. In equilibrium, this leads to higher powered incentives, higher managerial effort, and increased product quality (or reduced costs).

2. 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 has no impact on quality-improving effort by the manager. Note that consistent with economists' belief, and in contrast to previous work, here the unambiguous effects of competition arise specifically through a reduction in agency costs, and are absent in a first-best world.

Our empirical contribution comes from our ability to analyze comprehensively both whether competition affects firm behaviour, in terms of quality improvements, costs reductions and other efficiency-related outcomes, and the process through which this might occur. We exploit the Workplace and Employee Survey (WES) data set, a detailed set of linked employer-employee data, which allows us to observe simultaneously 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. This allows us to test empirically all aspects of our theoretical model, analyzing the effect competition has on the importance firms place on quality (or cost), their use of incentive-based contracting, as well as agent effort. We find that the predictions of our model are consistent with the data. Mainly:

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, all *increase* with product market competition.
b) The effects of competition on these three variables are generally *larger* for firms with *more* employees and/or more hierarchical structures, where agency costs are more likely to be present.
c) We also observe these effects *sequentially*. Competition increases the importance firms place on quality improvements, which is, in turn, positively associated with greater reliance on incentive contracts, while incentive-based contracts lead to higher effort exertion.

Our results yield an interesting policy implication: competition policy that is focused on large corporations in which agency problems play a large role, may be more beneficial to efficiency improvements.

## *1. Introduction*

Whenever a firm justifies an important strategic decision, "product market competition," or "increased competitive pressure" features near the top on the list of reasons. Recently for example, American Telephone and Telegraph Co. (AT&T) announced a cost-cutting strategy in response to intensifying competition for long-distance telephone services,[1] and Microsoft's new $1 billion target cost reduction is said to come "against a background of concerns about […] competition from Linux, the open source operating system."[2] Similar reactions can be observed in the banking industry: Antonio Horta Osorio, Chairman of the Totta Group, noted that "financial products are becoming increasingly standardized and more easily copied. […] To keep ahead of the competition, banks need to have lower cost structures, innovative products and high quality service."[3]

These examples yield two interesting questions. First, are the effects of product market competition on firms' cost-cutting and quality-enhancing strategies merely anecdotal evidence, or are they empirically verified facts? The second question is theoretical: what is the process through which competition induces firms to reduce costs or increase quality? This paper sheds light on these issues. We argue that agency costs play an important role in this process, and we develop a simple theoretical model to describe the effect of competition on agency costs, contractual incentives, effort and product quality. We then test our model empirically using a unique set of linked data, providing information on both the firm and its employees.

Economists have a "vague suspicion that competition is the enemy of sloth" (Caves, 1980, p. 88; cited in Nickell, 1996): product market competition alleviates agency costs, which in turn may enable firms to induce higher effort and greater efficiency from their managers. It mitigates what Liebenstein (1966) called "X-inefficiencies." Despite growing interest, an unambiguous theoretical formulation for this "vague suspicion" has proved difficult to obtain. Most of the literature on the subject has derived an explanation without imposing much structure on the competitive environment. Instead 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 yielding *unambiguous* predictions about the effects of competition on agency costs and managerial incentives.[4] Raith (2003) successfully gets around this

1. Financial Times, Japan Edition, July 25, 2003.

2. Financial Times, July 7, 2004.

3. Financial Times, June 3, 2002.

4. 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.

issue, and provides an unambiguous justification for the economists' belief, by adopting the competitive structure of a Salop (1979) circle with free entry/exit. In a simple agency model with risk averse managers, Raith shows that competition affects incentives *indirectly*, via changes in the equilibrium number of competitors in the industry.[5]

The main theoretical contribution of this paper is to show that product market competition can have a *direct* and *ambiguously positive* effect on managerial incentives. In our model,[6] 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.[7] Within this framework, the following results apply:

1. 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—competition *unambiguously* and "*directly*" lowers the shareholders' marginal cost of inducing effort by the manager. In equilibrium, this leads to higher powered incentives, higher managerial effort, and increased product quality (or reduced costs).

2. 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 has no impact on quality-improving effort by the manager. Note that consistent with the economists' belief, and in contrast to previous work,[8] here the unambiguous effects of competition arise specifically through a reduction in agency costs, and are absent in a first best-world.

The existing empirical literature does seem to confirm a positive impact of competition—measured in a variety of ways—on efficiency. 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[9] (Caves and Barton, 1990; Green and Mayes, 1991; and Caves and associates, 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), competition affects efficiency. Several papers have looked at pieces of this puzzle, including both Cunat and Guadalupe (2003) and Santaló (2002) who find evidence of a link between competition

5. Specifically, increased competition leads some firms to exit, leaving the surviving firms with increased market shares and more incentives to reduce costs.
6. In de Bettignies (2004), which studies the effects of product market competition on the boundaries of the firm in an incomplete contract framework, an extension to the basic set-up develops a simple principal-agent model to show that the intuitions and results can be adapted to analyze managerial incentives. The model presented here builds on that extension.
7. Schmidt (1997) also assumes a risk-neutral but wealth constrained agent. In his model, competition affects incentives through an unambiguous (but exogenous) increase in the agent's expected cost of liquidation, and through an ambiguous "value-of-a-cost-reduction" effect, thus leading to an ambiguous net effect.
8. The unambiguous effect of reduced profits in Hermalin (1992), of higher probability of liquidation in Schmidt (1997) and of a fall in the industry equilibrium number of firms in Raith (2003), for example, are not specific to agency costs and could be obtained in a first-best world.
9. Farrrell (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.

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. Our empirical contribution comes from our ability to analyze comprehensively both whether competition affects firm behaviour, in terms of quality improvements, costs reductions and other efficiency related outcomes, and the process through which this might occur. We exploit a detailed set of linked employer-employee data which allows us to observe simultaneously 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—including the number of hours they work, and different measures of agency costs—such as the number of employees, and the hierarchical structure of the organization. This allows us to test empirically all aspects of our theoretical model, analyzing the effect competition has on the importance firms place on quality (or cost), their use of incentive-based contracting, as well as agent effort. We find that the predictions of our model are consistent with the data. Mainly:

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, all *increase* with product market competition.

b) The effects of competition on these three variables are generally *larger* for firms with *more* employees and/or more hierarchical structures.

c) We also observe these effects *sequentially*. Competition increases the importance firms place on quality improvements, which is in turn positively associated with greater reliance on incentive contracts, while incentive-based contracts lead to higher effort exertion.

The paper is structured as follows. Section 2 presents our theoretical model. We describe the data in Section 3, and our empirical results in Section 4. We discuss extensions and robustness issues in Section 5, and 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 $p$. Each one of the $n$ consumers in the model purchases one unit of the product from either firm 1 or firm 2. Consumers are independently and uniformly distributed along that line. Firms 1 and 2 know the location distribution for each consumer, but they do not know their actual location on the line, until the end of the game, that is, when demands are realized (see timing below).

A consumer located at $x$ incurs a transport cost $tx$ for travelling to retailer 1, and a cost $t(1-x)$ to visit store 2. That 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:

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

and $d_2(q_2, p_2, q_1, p_1, t) = n(1-x)$, respectively.[10]
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[11] contractual offer to agent $i$. Both principals and agents are risk-neutral. Moreover, 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 $K_i(e_i) = \frac{k_i}{2} e_i^2$, where $k_i$ is a measure of agent $i$'s productivity. We assume that agents 1 and 2 are identical in productivity:[12] $k_1 = k_2 = k$. 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 $p_i$.[13]
- Date 3: Demands are realized, each 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***

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

10. A consumer located at $x$ is indifferent between store 1 and store 2 if and only if $U_1 = U_2$, or
$$q_1 - p_1 - tx = q_2 - p_2 - t(1-x). \qquad (2)$$
Solving for $x$, and multiplying by $n$ (since the $n$ consumers are independently and identically distributed [$i.i.d.$]), we get the expected demand for firm $i$.

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

12. 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.

13. 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.

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 apply 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.[14]

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 is an ideal parameter to measure substitutability between products (or rather lack thereof), and thus toughness of competition, to use Sutton's (1991, p. 9) terminology. When $t$ is high, it is costly for a consumer to travel (products are horizontally differentiated), and he cares relatively more about distance to a firm than about the dimensions in which the rivals compete, namely quality and price. Consequently, the degree of competition is low. Conversely, when the transport cost is low (products are highly substitutable), the consumer cares less about distance relative to quality and price, and it becomes more beneficial for competitors to try and attract the consumer through quality and price; in that case the degree of competition is high.

The second advantage of the Hotelling line relative to other strategic models is its simplicity. Although our results are quite general and (we believe) could be derived from logit or linear demand with differentiated products models for example, in such models the analysis would be much less tractable and clarity would have to be sacrificed.

As shall become clear (see equation [8] below), in order to ensure strict concavity of objective functions, and positive effort levels, we restrict our attention to $t \in \left(\frac{1}{9k}, \frac{2}{9k}\right)$. 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 to keep the analysis simple by generating second-best equilibrium contracts that are contingent only on profits.[15] 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 time, depending on contingencies such as research and development (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

14. See examples mentioned in the third paragraph of the introduction.

15. Relaxing this assumption, we may get optimal contracts that depend 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.

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 continent on profits and/or product quality: $w_i = w_i(\prod_i, q_i)$, where $\prod_i$ represents 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:

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

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:

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

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

3) 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:

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

### *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: $\prod_i(q_i, p_i, q_j, p_j, t) - w_i(q_i)$, with $w_i = K_i(q_i)$.

*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:

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

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 equation (6), taking the first-order conditions (FOC) with respect to price for $i = 1, 2$, and solving the resulting system of two equations yields the equilibrium price for firm $i$:

$$p_i = t + \frac{q_i - q_j}{3}. \tag{7}$$

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 $q_j$:

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

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 $i$, $i = 1, 2$, is $c_i = a - e_i$, expressions (3), (4), (5), (6) and (8) would still hold, as well as all the theoretical results of the paper, if we replaced $q_i$ by $e_i$. 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: $q_i^* \in \arg\max\left[\pi_i\left(q_i, q_j, t\right) - K_i\left(q_i\right)\right]$. Taking the first-order condition (FOC),[16] we obtain

$$\frac{\partial \pi_i\left(q_i^*, q_j, t\right)}{\partial q_i} = \frac{\partial K_i\left(q_i^*\right)}{\partial q_i}. \tag{9}$$

In other words, the principal chooses to induce an effort level such that, given rival effort $q_j$, the marginal benefit from an increase in effort equals the agent's marginal cost of effort.

To obtain the industry equilibrium, one need only note that by symmetry we must have $q_{,}^* = q_j^* = q^*$. Substituting this into (9), we obtain $\frac{1}{3} = kq^*$, or $q_i^* = q_j^* = q^* = \frac{1}{3k}$.

The Subgame Perfect Nash Equilibrium (SPNE) in the first-best is the following: both principals choose to induce their own agent to exert effort $q^* = \frac{1}{3k}$. We interpret the principals' choice as "the importance firms place on quality" (this interpretation will be useful in our empirical section). In order to induce this effort, they offer the contract described above, with a wage contingent on quality: $w_i\left(q^*\right) = \frac{k}{2}q^{*2}$. As a consequence, both agents indeed choose effort $q^*$. After observing qualities, prices are chosen following equation (7): in equilibrium, $p_i^* = p_j^* = t$. Finally, demands are then realized[17] and profits are distributed according to the original contract.

***Product market competition in the first-best***

Looking at the expressions for the first-best levels of effort just derived, the effects of competition are quite clear:

**Proposition 1.** *In the first-best, product market competition has no effect on the importance firms place on quality improvements, incentives, and effort exertion.*

**Proof.** Follows directly from above.

To understand this, let us return to our equilibrium condition (9). The effects of competition on the first-best marginal cost of inducing effort are null: $MC^{FB} = \frac{\partial K_i\left(q_i\right)}{\partial q_i} = kq_i$ is independent of $t$.

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

17. Prior to their realization, expected demands in equilibrium equal $d_i^* = d_j^* = \frac{n}{2}$.

The effects of competition on the marginal benefit from inducing effort $MB^{FB} = \frac{\partial \pi_i}{\partial q_i}$, are more subtle. Let us rewrite the expression for the marginal benefit from effort as follows:

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

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

Now let us differentiate the marginal benefit[18] with respect to $t$:

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

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: $\frac{\partial d_i}{\partial t} \frac{\partial p_i}{\partial q_i} = 0$.

Proposition 1 can thus be understood as follows. Competition affects the marginal benefit from inducing effort in two conflicting ways: $MB^{FB}$ is negatively affected by rent reduction, but

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

positively affected by business stealing. In this model, the two effects exactly offset each other in equilibrium, hence the zero net effect.[19] This zero net effect in the FB really 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.

### *2.3 Introducing agency costs: non-verifiable quality*

Let us now assume that product quality, though observable, is not verifiable. Note that quality cannot be "pinned down," indirectly through other variables: due to the uncertainty about consumer locations 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 made contingent on profits. We focus on linear contracts where the agent's payoff is of the form $w = \alpha \prod + \beta$.

#### *Backward induction*

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

*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 of product qualities correspond to equation (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:

$$\alpha_i \frac{\partial \pi_i(q_i, q_j, t)}{\partial q_i} = \frac{\partial K_i(q_i)}{\partial q_i}. \qquad (12)$$

Condition (12) is the agent's incentive compatibility (IC) constraint; if the principal wants the agent to exert effort $q_i^{**}$, she must set $\alpha_i$ such that (12) holds for $q_i = q_i^{**}$. In other words, she must choose $\alpha_i^{**}$ such that:

$$\alpha_i^{**}(q_i^{**}, q_j, t) = \frac{\dfrac{\partial K_i(q_i^{**})}{\partial q_i}}{\dfrac{\partial \pi_i(q_i^{**}, q_j, t)}{\partial q_i}} = \frac{MC_i^{FB}(q_i^{**})}{MB_i^{FB}(q_i^{**}, q_j, t)} = \frac{kq_i^{**}}{\dfrac{1}{3} + \dfrac{(q_i^{**} - q_j)}{9t}}. \qquad (13)$$

19. This zero net effect is robust to other strategic models of competition with identical firms: the same results would be obtained in a Logit framework, for example. Symmetry is what matters here, and with asymmetric productivities, the net effect of competition would be positive for the productivity leader, but negative for the laggard. See our symmetric productivity assumption and the associated footnote in subsection 2.1 for additional details.

*At date 0*, principal $i$ maximizes the following program:

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

the individual rationality, wealth, and incentive compatibility constraints described in equations (4), (5) and (13), respectively.

Recall that $\pi_i$ and $\prod_i$ represent expected and realized profits, respectively. Since $\prod_i$ 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 $\beta_1 = 0$. Note that this is the source of agency costs in the model: if the agent were not wealth constraint, 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 (SB) 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: $\underset{q_i}{Max}\ \pi_i(q_i, q_j, t) - \alpha_i^{**}(q_i, q_j, t)\,\pi_i(q_i, q_j, t)$, with $\alpha_i^{**}(q_i, q_j, t)$ defined as in equation (13). The principal chooses effort level $q_i^{**}$ she wants to elicit from the agent by equating her marginal benefit $(MB_i^{SB})$ and her marginal cost $(MC_i^{SB})$:[20]

$$\frac{\partial \pi_i(q_i^{**}, q_j, t)}{\partial q_i} = \frac{\partial\left[\alpha_i^{**}(q_i^{**}, q_j, t)\,\pi_i(q_i^{**}, q_j, t)\right]}{\partial q_i}. \tag{15}$$

By symmetry, we know that in equilibrium the two principals make identical choices: $q_i^{**} = q_j^{**} = q^{**}$. Substituting this into (15), 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 SB equilibrium effort: $q^{**} = \frac{2}{3k} - 3t$.

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

20. The second-order condition can be shown to be the same as in the first-best, $\frac{1}{9t} - k < 0$, which is strictly negative for all values of $t \in \left(\frac{1}{9k}, \frac{2}{9k}\right)$.

$\alpha^{**} = 3kq^{**}(t)$ to the agent.[21] 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,[22] and profits are distributed according to the original contract.

***Second-best versus first-best effort***

The main implication of the above analysis is the following:

**Proposition 2.** *In the second-best, the importance firms place on quality (and hence equilibrium effort and quality) are lower than in the first-best:* $q^{**} < q^{*}$ *for all* $t \in \left(\frac{1}{9k}, \frac{2}{9k}\right)$.

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

To understand the intuition behind proposition 2, let us return to condition (15). The marginal benefit from inducing effort by the agent is the same as in the first-best: $MB_i^{SB} = \partial \pi_i\left(q_i^{**}, q_j, t\right) / \partial q_i = MB_i^{FB}$.

The difference with the first-best comes from the marginal cost of inducing effort, which can be rewritten as follows:

$$\frac{\partial\left[\alpha_i^{**}\pi_i\right]}{\partial q_i} = \alpha_i^{**}\frac{\partial \pi_i}{\partial q_i} + \pi_i \frac{\partial \alpha_i^{**}}{\partial q_i}. \qquad (16)$$

The first term on the right-hand side of (16) actually represents the first-best marginal cost of effort, $MC_i^{FB}$. To see this, recall from (13) that $\alpha_i^{**} = \frac{\partial K_i}{\partial q_i} / \frac{\partial \pi_i}{\partial q}$. Substituting this in, the first term can be expressed as:

$$\alpha_i^{**}\frac{\partial \pi_i}{\partial q_i} = \frac{\partial K_i}{\partial q_i} = MC_i^{FB}. \qquad (17)$$

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21. One can obtain $\alpha^{**}$ immediately by substituting $q_i^{**} = q_j^{**}$ into (13). As expected, $\alpha^{**} \in (0,1)$ for all $t \in \left(\frac{1}{9k}, \frac{2}{9k}\right)$.

22. Prior to their realization, expected demands in equilibrium equal $d_i^{**} = d_j^{**} = \frac{n}{2}$.

The second term on the right-hand side of (16) 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.[23] 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 induce him to increase effort, $\partial \alpha_i^{**} / \partial q_i$, weighted by expected profits, $\pi_i$. 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. We know however that: 1) $\alpha_i < 1$, and 2) the FB second-order condition implies that $\partial^2 \pi_i / \partial q_i^2 < \partial^2 K_i / \partial q_i^2$. Hence the only way $\alpha_i \frac{\partial \pi_i}{\partial q_i}$ can be increased by an amount equal to $\partial^2 K_i / \partial q_i^2$ is by increasing the fraction of profits to be forfeited to the agent, $\alpha_u^{**}$. The size of this necessary increase, $\partial \alpha_i^{**} / \partial q_i$, depends on the convexity of the cost of effort, $\partial^2 K_i / \partial q_i^2$, relative to that of expected profits, $\partial^2 \pi_i / \partial q_i^2$. The faster marginal expected profits rise[24] relative to marginal costs, the "easier" it is to induce the agent to increase effort, and the lower the marginal agency cost $\partial \alpha_i^{**} / \partial q_i$.

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23. Looking back at our simplified expression $\alpha_i^{**} = \frac{9ktq_i^{**}}{3t + (q_i^{**} - q_j)}$ from (13), it becomes evident that $et - q_j > 0$. Otherwise, $\alpha_i^{**} > 1$ for all $t \in \left(\frac{1}{9k}, \frac{2}{9k}\right)$, which is not feasible. $3t - q_j > 0$ implies $MC^{AG} > 0$.

24. Recall from the footnote associated with condition (9) that expected profits are convex in quality.

In sum, the marginal agency cost depends mainly on two factors: the convexity of the cost of effort relative to that of expected profits, and expected profits. This interpretation will be useful in the next subsection to understand the effects of competition.

### *2.4 Product market competition in the second-best*

The foregoing analysis, and in particular proposition 2, immediately implies the following result about product market competition:

**Proposition 3.** *In the second-best, product market competition strictly increases the importance firms place on quality (and hence, equilibrium effort and quality).*

**Proof.** 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 intuition behind proposition 3 is the following: for a given effect $q_j$ induced in rival firm $j$, competition reduces principal $i$'s marginal cost of inducing effort, and hence the optimal effort she chooses to induce her agent to exert is lower. 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.

But why does competition reduce the principals' marginal cost of inducing effort? To see this, let us go back to equations (15) and (16), taking into account the fact that in equilibrium $q_i^{**} = q_j^{**}$. As discussed, the marginal benefit from inducing effort (right-hand side of [15]), and the non-agency part of the marginal cost of delegation (first term on the left-hand side of [16]) are equivalent to the first-best marginal benefit and first-best marginal cost, respectively, and we know that in equilibrium, they are not affected by competition.

However, competition does affect the marginal agency cost, $MC^{AG} = \pi_i \frac{\partial \alpha_i^{**}}{\partial q_i}$. As discussed above, two factors determine marginal agency costs: the convexity of the cost of effort relative to that of expected profits; and expected profits. Unsurprisingly, expected profits fall with competition. 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 the rent reduction effect of competition, which tends to decrease profits, remains: $\frac{\partial \pi_i}{\partial t} = \frac{\partial p_i}{\partial t} d_i = \frac{1}{2}$.

The convexity of the cost of effort is independent of $t$: $\partial^2 K_i / \partial q_i^2 = k$. In contrast, it can easily be shown that competition increases the convexity of expected profits, differentiating (10) with respect to effort $q_i$ we obtain:

$$\frac{\partial MB_i^{FB}}{\partial q_i} = 2\frac{\partial p_i}{\partial q_i}\frac{\partial d_i}{\partial q_i} = \frac{1}{9t}.$$

Looking back at (8), we immediately see that $\frac{\partial p_i}{\partial q_i}$ is independent of $t$. On the other hand, competition increases the marginal impact of an increase in $q_i$ on expected demand, $\frac{\partial d_i}{\partial q_i}$: this is the business stealing effect once again, which increases the convexity of expected profits. Therefore, competition increases the convexity of expected profits relative to that of the cost of effort, and hence decreases $\frac{\partial \alpha_i^{**}}{\partial q_i}$.

Both determinants of the marginal agency cost are affected. Expected profits fall with competition due to the rent-reduction effect. And the marginal impact of effort on incentives falls with competition due to the business stealing effect. Both effects work to reduce the marginal agency cost to the principal, leading to the aforementioned increases in incentives and effort.

### *2.5 Empirical implications*

Our theoretical model contains several assertions, presented in the propositions above. Four main empirical predictions emerge from these results:

*Prediction 1:* Proposition 2 implies that the degree to which a firm is plagued by agency costs should have a negative impact on the importance firms place on quality improvements and effort exerted by agents.

*Prediction 2:* Noting that in practice, all firms are plagued by agency costs, at least to some degree, proposition 3 implies that competition should increase the importance firms place on quality improvements, the propensity to use incentive-based contracts, and effort exerted by agents.

*Prediction 3:* Propositions 1 and 3 taken together imply that the positive effects of competition on the importance firms place on quality improvements, contractual incentives, and managerial effort, are increasing in the importance of agency problems inside the firm.

*Prediction 4:* Our SPNE in the case with agency costs, implies the following sequentiality: competition increases the importance firms place on quality improvements; as a consequence, principals provide higher powered incentives to their agents, who, in turn, exert higher efforts and improve quality.

Predictions 1 to 3 are depicted graphically in Figure 1, which 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 $t_{\min} = \frac{1}{9k}$ and $t_{\max} = \frac{2}{9k}$. 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 2), while the FB equilibrium remains unchanged at A, which implies prediction 3.

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

## *3. Data*

We are fortunate to have access to a unique dataset with which 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 6,300 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 25,000 employees in the same workplaces, provides information on compensation, human capital, training, work hours and arrangements, and promotions. Taken together, these two components generate approximately 1,000 firm and employee specific variables and an unprecedented opportunity to examine the connection between competition, contractual incentives, effort and innovation.[25] To the best of our knowledge, a comparable data set does not exist anywhere in the world.

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 importance of 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 are 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 14 industry classifications, 6 regional classifications and 3 employment size categories, resulting in 252 possible strata. From these strata, the sample was then selected using Neyman allocation. All sampled units were assigned a sampling weight based on their different probabilities of selection. For example, if 3 workplaces were selected at random and with equal probability from

25. This paper has used survey data which have many advantages, but which perhaps suffer from a 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 underreporting 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 of research and development would be correlated with our measures of competition.

a population of 30 workplaces, then the selected workplaces would represent 10 units in the population and be assigned a sampling weight of 10. 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.[26]

In this paper, we are able to take advantage of the linked nature of these data to simultaneously analyze both the characteristics of a given firm and the characteristics of that firm's employees. The workplace component of WES allows us to measure the amount of product market competition firms face, in terms of the geographic location of competitors, the intensity of competition from different groups of firms, and the number of firms competing in the firm's most important market. The availability of such a wide variety of measures allows us to consider how robust our results are to different types of changes in competition. WES also includes a wealth of information on other aspects of the firm. We have information on the importance a firm places on quality enhancement, cost reduction and other strategies, its financial performance and initial competitive position, the types of contracts offered to employees, productivity, production costs, investments and technology adoption. The employee component of WES includes measures of the number of hours an employee worked, and the incentive structures in their contracts, such as productivity or profitability related bonuses. The linkage of the two components provides an excellent opportunity to examine how competition affects the emphasis firms place on product quality, the existence of incentive-based compensation, and the effort exerted by employees.

## *4. Estimation and results*

### *4.1 Methodology*

In this section, we test our theoretical findings empirically. Specifically, we use the Workplace and Employee Survey (WES) data set to examine how competition affects the importance firms place on quality improvements and other strategies, the propensity for firms to offer incentive-based contracts to employees, and the number of unpaid overtime hours employees work.

The theoretical structure developed above suggests that competition affects the emphasis firms place on product quality through the mechanisms of contractual incentives and agent effort. We begin by examining what effect, if any, does competition have on the importance forms place on quality improvements, and then turn our attention to verifying the consequences of this effect. Note that we use *the importance firms place on quality* here. This is meant to capture the quality level the principal wishes the agent to exert, which is decided at date 0, rather than actual quality, which is the result of the principal's initial choice, and the consequent incentives and effort by the agent.

Consider the basic regression equation

$$q = \alpha + \beta c + \lambda h + \theta h * c + \gamma x + \in , \qquad (18)$$

where $q$ represents the importance a firm places on quality, $c$ describes the competition in that firm's product market, where $c$ is akin to our competition measure $\frac{1}{t}$ from the previous section, $h$ measures the degree to which that firm is afflicted by agency costs, $x$ is a vector of control variables and $\in$ is an error term. Equation (18) allows us to look at how competition affects the

26. See the Guide to the Analysis of the Workplace and Employee Survey for further details.

firm's provision of quality, and if 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***

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 specific wording of this, and all other questions used in this paper, can be found in the data 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 the 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. 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.[27]

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 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) to 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

27. 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.

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. As discussed in subsection 5, our results are also robust to several other measures of competition.

***Agency costs***

The variable $h$, or the importance of agency costs within the firm, is measured by the natural log of the firm's total number of employees. 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. In contrast, in small, entrepreneurial firms the manager owns a comparatively larger fraction of the firm's equity, and thus separation of ownership and control, and the consequent agency costs, are less prevalent. Accordingly, we use size, measured by the natural log of the firm's total number of employees, as a proxy for the importance of agency costs.[28] 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. Accordingly, size is included both directly and as an interaction with competition. The direct effect of size captures the general effect of all aspects of size, while the interaction term presents a cleaner measure of how agency costs temper the effect of competition on the firm's choice or product or service quality.[29]

Equation (18) is estimated using the survey version of generalized least squares (GLS) in STATA.[30] Sampling weights are applied to each observation, as described in the previous section, which allow our point estimates to be unbiased. We account for sample stratification by industry, region and size, which corrects our standard errors appropriately.

### *4.2 Main empirical results*

***Competition and firm strategy***

The main results of our estimation can be found in Table 1. Consider first columns 1 to 3, where the dependent variable is the importance firms place on improving product or service quality, as described above. Our sample in these 3 columns consists of the 4,732 firms that ranked the importance of improving product or service quality to their business. To obtain the effect of a change in competition on the propensity to invest in quality improvements, we take the derivative of equation (18) with respect to $c$. This gives:

$$\frac{\partial q}{\partial c} = \beta + \theta h \,. \qquad (19)$$

28. 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.
29. To compensate for the considerable skewness of our employment data (mean of 29, median of 194 and standard deviation of 630), we use the natural log of employment as our measure of firm size.

30. See Stata Reference Manual, Release 7, Volume 4, pages 18 to 101.

**Table 1 Importance of strategies — Quality improvement, cost reduction, research and development**

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Dependent variable** | **Quality** | **Quality** | **Quality** | **Cost** | **R&D[1]** |
| Level of competition equals intensity of competition (scale of 1 to 6) | 0.240** *(0.067)* | 0.223** *(0.068)* | 0.225** *(0.062)* | 0.104** *(0.038)* | 0.171** *(0.046)* |
| Firm size equals ln (total employees) | ... ... | 0.376** *(0.063)* | 0.312** *(0.058)* | 0.055** *(0.022)* | 0.230** *(0.064)* |
| Competition* size equals level of competition* firm size | ... ... | 0.029* *(0.011)* | 0.023* *(0.011)* | 0.017* *(0.007)* | 0.035** *(0.013)* |
| Profits equal revenues less expenditures in millions of dollars | ... ... | ... ... | 0.001 *(0.001)* | 0.002* *(0.001)* | 0.002* *(0.001)* |
| Industry leader equals 1 if productivity in top third of firms, 0 otherwise | ... ... | ... ... | 0.538** *(0.106)* | 0.017 *(0.076)* | 0.153 *(0.101)* |
| Sales increase in previous year equal 1 if sales growth increased in t-1, 0 otherwise | ... ... | ... ... | 0.254* *(0.108)* | -0.181* *(0.083)* | -0.029 *(0.112)* |
| Quality increase in previous year equals 1 if product quality increased in t-1, 0 otherwise | ... ... | ... ... | -0.108 *(0.138)* | 0.135 *(0.081)* | 0.263* *(0.129)* |
| Cost decrease in previous year equals 1 if unit production costs fell in t-1, 0 otherwise | ... ... | ... ... | 0.012 *(0.140)* | -0.092 *(0.093)* | 0.016 *(0.164)* |
| Industry and region fixed effects | No | Yes | Yes | Yes | Yes |
| $R^2$ | 0.03 | 0.07 | 0.12 | 0.09 | 0.11 |
| Number of observations | 4,732 | 4,732 | 4,732 | 4,541 | 2,982 |

… not applicable
* Significant at the 5% level.
** Significant at the 1% level.
1. Research and development.
Notes: Standard errors are in parentheses. Authors' calculations are based on data from the survey mentioned below.
Source: Statistics Canada, Workplace and Employee Survey.

Consider column 3 for example (our results are very robust and hold across all specifications). Substituting in the coefficients from that column into equation (19) yields

$$\frac{\partial q}{\partial c} = 0.225 + 0.023 * h \,. \qquad (20)$$

Two key empirical results can be understood from equation (20).

1) Since $h$ is always greater than or equal to zero, $\frac{\partial q}{\partial c}$ is always strictly positive. In other words, firms which operate in more competitive environments place more importance on quality

improvement than firms operating in less competitive environments. This is consistent with the second empirical prediction of our theoretical model, described in subsection 2.5.

2) The interaction coefficient, $\theta = 0.023$, is positive and significant. This suggests that the positive impact of competition on the importance a firm places on quality improvements increases with agency costs (measured by the number of employees). This result holds for all specifications in which both a direct effect of competition and the interaction between competition and agency costs are included. It is consistent with the third empirical prediction of our theoretical model. These two results are broadly consistent with Griffith's: she found that the positive effects of competition on efficiency are stronger when agency costs are present.

Note that the direct effect of firm size is positive in columns 2 and 3 of Table 1, indicating that larger firms place more importance on quality improvements than smaller firms. If we interpret firm size strictly as a measure of agency costs, then this is inconsistent with the first prediction of our model, which states that agency costs, by increasing the principal's marginal cost of inducing effort, reduces the importance firms place on quality improvements. Recall from our above discussion, however, that firm size may also capture other effects, such as scale economies, which tend to reduce the marginal cost of quality improvement, and hence to increase the importance firms place on such strategies. Such an effect, absent from our model, might dominate the negative impact of agency costs, thus explaining our positive direct coefficient. In section 5, we use a measure of agency costs (hierarchy) which is likely less correlated with economies of scale, and show that in such specifications, the direct effect of our agency costs proxy is negative, as predicted by our model.

In our theoretical model, the results are discussed largely in terms of the effect of competition on quality. However, as remarked in subsection 2.2, the results are, in fact, more general—the model predicts the same effects of competition on cost reduction as it does on quality improvement. To test the generality of our results empirically, the final two columns of Table 1 use the same set of independent variables found in column 3 to examine the effect of competition on the importance of cost reductions (column 4) and undertaking research and development (column 5). Like quality improvement, WES asked firms to rank the importance of cost reduction (reducing labour or "other" operating costs) and undertaking research and development to their general business strategy. Four thousand, five hundred and forty-one firms ranked the importance of cost reductions on a scale of 2 through 6 which 2,982 firms did the same for research and development. Consistent with the results for quality improvement, columns 4 and 5 indicate that competition significantly increases the importance firms place on both cost reduction and research and development. In addition, the effect of competition is larger for firms with more employees, or higher agency costs.

Columns 3, 4, and 5 of Table 1 expand our analysis to include a number of other control variables. Several remarks can be made. First, profits have a positive impact on the importance firms place on quality improvements, cost reductions, and R&D, even though for quality improvements that effect is not significantly different from 0 at the 5% level.

Second, 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. 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.

Third, relative to weaker firms, the importance of quality improvement in a firm's business strategy is higher for approximately one-third of "Industry Leaders"—defined as firms whose self report of productivity is "better" or "much better" than their competitors. The same result holds if industry leader is measured by sales or profit performance instead of productivity. For tractability reasons, our theoretical model assumed symmetric firms with identical productivity levels. But it would easily be shown that with asymmetric firms, the productivity "leader" would place more importance on quality than its less productive competitor, a result which is confirmed here empirically.

Finally, columns 3, 4, and 5 of Table 1 also add measures of previous year quality increases and cost decreases. While it is *a priori* reasonable to suggest that a workplace's choice of quality improvements, cost reductions, and other strategic initiatives in one year will be subject to their actions in the previous year, our results show that empirically these relationships tend to be insignificant. A plausible explanation may be that competing effects cancel each other out in the aggregate. Some firms may embark on an investment or 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 enhancements made in previous year may continue to be beneficial in the current year, thereby reducing incentives for additional investments in the current year. Aggregating across firms it is not implausible for these two effects to offset one another.

***Competition and incentives***

So far, our empirical results have indicated a link between competition and the importance of quality enhancement (as well as cost reduction, and R&D) in the firm, and supported a theoretical structure which includes agency costs. To further test our theory, we now turn our attention to testing the intermediate steps through which we suggest competition influences quality: contractual incentives and agent effort. We re-estimate equation (18), replacing $q$ first with a binary variable indicating the presence or absence of incentive-based pay and then with the number of hours of unpaid overtime an employee worked. The results for contractual incentives can be found in Table 2.

We measure incentive-based contracting using four questions asking firms whether or not their compensation system includes individual incentives (such as bonuses, productivity or quality-related incentives, profit sharing, rewards for superior quality) and develop a binary dependent variable equaling 1 if the firm offers any type of incentive-based compensation and 0 otherwise. Using this measure, 38% of firms in our sample offer contractual incentives to their employees. Estimation is by probit, again adjusted for survey data.[31]

When compared with the results in Table 1, the first three columns of Table 2 are consistent in sign and significance. We confirm that competition is positively associated with firms offering incentive-based compensation and again see that this effect is larger for firms with more employees, or higher agency costs. These results are consistent with the predictions 2 and 3 described in subsection 2.5. The results also suggest that firm profits, and the productivity level of the firm relative to others, are insignificant in determining whether or not the firm offers incentive-based contracts. However, firms whose quality increased in the previous year were more likely to use incentive-based contracts than those whose quality levels either remained the same or decreased. Our results are consistent with, among others, Cunãt and Guadalupe (2003), who find that competition increases the steepness

31. See Stata Reference Manual, Release 7, Volume 4, pages 18 to 101.

of performance pay contracts, and Burgess and Metcalfe (2000) who find the likelihood of performance-related pay increases with competition. Santaló (2002), considering only managers, finds a negative correlation between the use of managerial incentives and the number of competitors in the firm's most important market.[32]

**Table 2 Incentive-based compensation**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Level of competition equals intensity of competition (scale of 1 to 6) | 0.204** *(0.044)* | 0.145** *(0.045)* | 0.158** *(0.051)* | 0.163** *(0.052)* |
| Firm size equals ln (total employees) | ... ... | 0.231** *(0.037)* | 0.229** *(0.046)* | 0.259** *(0.053)* |
| Competition* size equals level of competition* firm size | ... ... | ... ... | 0.002* *(0.001)* | 0.002* *(0.001)* |
| Profits equal revenues less expenditures in millions of dollars | ... ... | ... ... | ... ... | 0.001 *(0.001)* |
| Industry leader equals 1 if productivity in top third of firms, 0 otherwise | ... ... | ... ... | ... ... | 0.219 *(0.120)* |
| Sales increase in previous year equal = 1 if sales growth increased in t-1, 0 otherwise | ... ... | ... ... | ... ... | -0.072 *(0.123)* |
| Quality increase in previous year equals 1 if product quality increased in t-1, 0 otherwise | ... ... | ... ... | ... ... | 0.452** *(0.129)* |
| Cost decrease in previous year equals 1 if unit production costs fell in t-1, 0 otherwise | ... ... | ... ... | ... ... | -0.121 *(0.149)* |
| Industry and region fixed effects | No | Yes | Yes | Yes |
| Number of observations | 5,657 | 5,657 | 5,657 | 5,657 |

… not applicable
* Significant at the 5% level.
** Significant at the 1% level.
Notes: Standard errors are in parentheses. Authors' calculations are based on data from the survey mentioned below.
Source: Statistics Canada, Workplace and Employee Survey.

### *Competition and managerial effort*

Moving from incentives to effort, the 4,732 firms analyzed in the first three columns of Table 1 were matched with the 19,147 of their employees surveyed in the employee portion of the WES and reporting values for our independent variables of interest. 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

32. Santaló also uses the WES data set. However, he uses only the first year of the WES data set, data we do not use as our dependent variables are lagged; and Santaló considers only managers where we use all employees.

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 jobs. 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 those employees reporting unpaid overtime, the mean amount of unpaid overtime usually worked in a week was just over 5 hours.

The results for the amount of unpaid overtime can be found in Table 3. Estimation is survey weighted GLS, with standard errors robust clustered at the firm level. The first two columns of Table 3 use the same firm-level variables found in Tables 1 and 2, while columns 3 and 4 add employee-specific control variables. In all four columns, consistent with our results for quality and incentives, increased competition is associated with an increase in the number of hours of unpaid overtime an employee usually works in a week. Further supporting our model with agency costs, this increase is greater for the larger firms we expect to experience higher agency costs. In columns 2 and 3, the interaction between competition and size is significant at the 5% level, while in column 4, the interaction term is significant at 10%.

The addition of employee-specific control variables greatly increases the explanatory power of the regression. We find that the amount of unpaid overtime significantly increases with age and education, and is also higher for employees that supervise others. Unpaid overtime significantly decreases if the employee is a member of a collective bargaining agreement and if the employee is female. Interestingly, employees who were married or living in common-law relationships worked significantly more unpaid overtime than their single counterparts, though only at the 10% level.

**Table 3 Hours of unpaid overtime**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Level of competition equals<br>intensity of competition (scale of 1 to 6) | *0.042**<br>*(0.021)* | *0.074**<br>*(0.031)* | *0.068**<br>*(0.028)* | *0.080**<br>*(0.029)* |
| Firm size equals<br>ln (total employees) | ...<br>... | *0.116**<br>*(0.054)* | *0.088**<br>*(0.041)* | *0.080**<br>*(0.039)* |
| Competition* size equals<br>level of competition* firm size | ...<br>... | *0.013**<br>*(0.006)* | *0.012**<br>*(0.006)* | *0.012^*<br>*(0.007)* |
| Profits equal<br>revenues less expenditures in millions of dollars | ...<br>... | *0.001*<br>*(0.001)* | *0.001*<br>*(0.001)* | *0.001*<br>*(0.001)* |
| Industry leader equals<br>1 if productivity in top third of firms, 0 otherwise | ...<br>... | 0.137<br>(0.165) | *0.136*<br>*(0.156)* | *0.152*<br>*(0.158)* |
| Supervisor equals<br>1 if supervises other employees, 0 otherwise | ...<br>... | ...<br>... | *1.880***<br>*(0.189)* | *1.758***<br>*(0.183)* |
| Education equals<br>employees highest educational attainment | ...<br>... | ...<br>... | *0.403***<br>*(0.047)* | *0.409***<br>*(0.049)* |
| Unionized equals<br>1 if employee is a member of a collective bargaining agreement | ...<br>... | ...<br>... | *-0.618***<br>*(0.157)* | *-0.748***<br>*(0.154)* |
| Age equals<br>age of employee in years | ...<br>... | ...<br>... | ...<br>... | 0.015**<br>(0.006) |
| Gender equals<br>1 if employee is female, 0 otherwise | ...<br>... | ...<br>... | ...<br>... | -0.543**<br>(0.140) |
| Marital status equals<br>1 if employee is married or living common-law, 0 otherwise | ...<br>... | ...<br>... | ...<br>... | 0.239<br>(0.140) |
| Dependent children equal<br>1 if employee has dependent children, 0 otherwise | ...<br>... | ...<br>... | ...<br>... | -0.051<br>(0.150) |
| Industry and region fixed effects | No | Yes | Yes | Yes |
| $R^2$ | 0.03 | 0.03 | 0.07 | 0.16 |
| Number of observations | 19,147 | 19,147 | 19,147 | 19,147 |

… not applicable
* Significant at the 5% level.
** Significant at the 1% level.
Notes: Standard errors are in parentheses. Authors' calculations are based on data from the survey mentioned below.
Source: Statistics Canada, Workplace and Employee Survey.

All of the specifications in Table 3 were re-estimated using only the subset of employees who were managers, replacing the existing dependent variable with a dummy variable equaling 1 if the employee reported any unpaid overtime and 0 otherwise (estimation by probit), and using the *total* number of hours an employee worked as the dependent variable. In all three of these cases, the results for competition, firm size and the interaction between competition and firm size, were of larger sign and stronger significance than those reported in Table 3.

### *4.3 Sequentiality results*

Tables 1, 2 and 3 have investigated the direct link between competition and the importance firms place on quality improvements, incentives, and effort. Consistent with predictions 2 and 3 of our model, our results demonstrate a positive association between competition and these variables, and indicate that this effect is amplified in those larger firms more subject to agency costs.

However, the fourth prediction of our model suggests that these are not independent results, but part of a series of events. Specifically, an increase in competition, by lowering agency costs, reduces the cost to the principal of inducing effort from her agent and accordingly increases her interest in providing a better quality product. In order to facilitate higher quality, the principal offers higher powered incentives to her agent who in turn works harder. To more directly test this sequence, we first estimate the effect of competition on the importance firms place on quality as in Table 1, and then use the importance firms place on quality as an explanatory variable in determining incentives, and finally use the presence or absence of incentives to determine hours worked.

The results can be found in Table 4. Column 1 is the same as column 2 of Table 1, where we find a positive effect of competition on the importance firms place on quality improvements. In column 2, our binary variable for the presence or absence of incentive-based contracts is regressed on the importance firms place on quality, the firm's number of employees and the interaction between employees and the importance of quality. We find that presence of incentives in an employee's contract is positively related to higher rankings of the importance of quality improvements, and that this effect is larger when agency costs are present. This confirms the second step in our sequence. Finally, in column 3, the number of hours of unpaid overtime an employee works is regressed on the presence incentive-based compensation, the number of employees and the interactions between size and incentives. We find that the presence of incentive-based compensation is positively associated with the number of hours of unpaid overtime that firm's employees work. This effect is larger in the presence of agency costs. In sum, all results presented in Table 4 offer further confirmation of our theoretical structure.

**Table 4 Three stage estimation**

| Dependent variable | 1<br>Quality enhancement | 2<br>Incentives | 3<br>Hours worked |
|---|---|---|---|
| Level of competition equals<br>intensity of competition (scale of 2 to 6) | 0.223**<br>(0.068) | ...<br>... | ...<br>... |
| Firm size equals<br>ln (total employees) | 0.376**<br>(0.063) | 0.315**<br>(0.024) | 1.678**<br>(0.465) |
| Competition* size equals<br>level of competition* firm size | 0.029*<br>(0.011) | ...<br>... | ...<br>... |
| Importance of quality enhancement equals<br>self report on a scale of 2 to 6 | ...<br>... | 0.101*<br>(0.049) | ...<br>... |
| Importance of quality* size equals<br>importance of quality enhancement* size | ...<br>... | 0.052*<br>(0.025) | ...<br>... |
| Incentives equal<br>1 if firms offer performance based incentives | ...<br>... | ...<br>... | 5.509**<br>(2.000) |
| Incentives* size equal<br>incentives (0-1 dummy)* size | ...<br>... | ...<br>... | 1.398*<br>(0.617) |
| Industry and region fixed effects | Yes | Yes | Yes |
| Number of observations | 4,732 | 5,657 | 19,147 |

… not applicable
* Significant at the 5% level.
** Significant at the 1% level.
Notes: Standard errors are in parentheses. Authors' calculations are based on data from the survey mentioned below.
Source: Statistics Canada, Workplace and Employee Survey.

## *5. Extensions and robustness*

All of the results reported above are consistent with a number of permutations and combinations of independent variables, different subsamples and estimation methods. In this section, we mention some of our more interesting robustness checks and extensions.

*Measures of agency cost*

In the body of the paper, the firm's number of employees has been used to measure agency costs. While it is reasonable to expect that larger firms are generally more afflicted with agency costs than their smaller counterparts, firm size is also a somewhat clouded measure of agency costs in that it may be capturing more than just agency effects. To clarify our measure, the specifications in Tables 1 to 4 above were re-estimated adding a measure of decision hierarchy, and its interaction with competition, as explanatory variables. Decision hierarchy is measured using a dummy variable equaling 1 if decisions regarding follow-up results 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

assumes that the "higher up," or further away from the individual employee, decisions are made or results are supervised, the larger the agency cost. The results of estimation using the decision hierarchy variable for the importance of quality improvements (column 1 of Table 5), the presence or absence of incentives (column 2) and hours of unpaid overtime (column 3) can be found in Table 5.

The results again suggest that the importance firms place on quality, their use of incentive-based compensation, and the effort exerted by their employees all increase with both competition and firm size. Firms with higher agency costs, as measured by their decision hierarchy, place less importance on quality improvements, are less likely to use incentive-based compensation and have employees who work fewer hours of unpaid overtime. This is consistent with prediction 1 of our model. The interaction between competition and decision hierarchy is positive, significant at the 10% level in the first two columns of Table 5, and at the 5% level in the third column of Table 5. This suggests that firms more subject to agency costs see a larger increase in the importance they place on quality, the probability that they will use incentive-based contracts, and the effort exerted by their employees, as a result of increasing competition when compared with firms less affected by agency costs. While we do not obtain results as strong as those found earlier in the paper, the general consistency of this measure of agency costs with our previous results offers some corroboration of our findings.

*Measures of competition*

In addition to examining the implications of changing dependent variables, we also used a number of different measures of competition. In our base specifications, competition was defined as the maximum level of competition a firm faced. 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 firm's and the median level of competition, as well as the number of firms competing in the firm's most important market. In all cases, the results were consistent with those in Tables 1 to 4. Within WES, all of the competition measures rely of the self reports of firms. To provide a more objective measure of competition, we used another Statistics Canada data source, the T2-LEAP (Longitudinal Employment Analyses Program) file, to construct a CR4 (top four enterprise concentration ratio) for each of the 14 industries in WES, both for Canada as a whole and for each of the 6 regions identified in WES. Again, our results were consistent with those described above.

**Table 5 Alternate measure of agency costs**

| Dependent variable | 1<br>Quality | 2<br>Incentives | 3<br>Unpaid hours |
|---|---|---|---|
| Level of competition equals intensity of competition (scale of 1 to 6) | 0.334**<br>(0.105) | 0.184*<br>(0.075) | 0.071**<br>(0.024) |
| Firm size equals ln (total employees) | 0.269**<br>(0.044) | 0.291**<br>(0.045) | 0.046*<br>(0.022) |
| Decision hierarchy equals 1 if results supervised by manager-owner or outside workplace, 0 if supervision at lower level | -1.111*<br>(0.561) | -0.331**<br>(0.106) | -0.192*<br>(0.075) |
| Competition* hierarchy equals level of competition* decision hierarchy | 0.197<br>(0.116) | 0.066<br>(0.35) | 0.022*<br>(0.009) |
| Industry and region fixed effects | Yes | Yes | Yes |
| Number of observations | 4,732 | 5,657 | 19,147 |

… not applicable
* Significant at the 5% level.
** Significant at the 1% level.
Notes: Standard errors are in parentheses. Authors' calculations are based on data from the survey mentioned below.
Source: Statistics Canada, Workplace and Employee Survey.

*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. While our results are robust to a number of different measures of competition, this does not alleviate the question of causality. In addition to using control variables, we have compensated for this issue in several ways. First, 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.

Second, 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. Accordingly, it is less likely for the actions of small 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 endogeniety. 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.

## *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, and yields two main empirical predictions. First, product market competition, by *"directly"* reducing marginal agency costs, *unambiguously* increases the importance firms place on quality improvements. This leads to an increase in the propensity to use incentive-based contracts, and in turn to increased managerial effort. Second, these positive effects are increasing in the severity of agency problems inside the firm.

Using a unique set of Canadian data which allows us to simultaneously observe the characteristics of firms as well as their employees, we are able to test the predictions of our model in great detail. Our empirical analysis confirms our theoretical results. Our data show that an increase in the degree of competition generates the following series of events: 1) firms place a greater emphasis on pursuing quality, 2) as a consequence, they offer incentive-based compensation to their employees, 3) in turn, those employees work more hours of unpaid overtime. Moreover, we find that these effects are stronger for large, hierarchical corporations—which are particularly vulnerable to agency problems—than in small, entrepreneurial firms where agency cost is less of an issue.

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.

***Data appendix***

What follows are the specific wordings of the questions in the Workplace and Employee Survey (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 four 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

The number of firms competing in the firm's most important market was measured using the following question:

*Please indicate how many firms (whether or not based in Canada) offer products/services directly competing with yours in your most important market (most important market is indicated as the market— local, Canadian, American, or rest of world—in which the firm had its highest percentage of sales):*

1. 0 firm
2. 1 to 5 firms
3. 6 to 20 firms
4. over 20 firms

**Table 1A Percentage of firms in each category**

| | Not applicable | Not important | Slightly important | Important | Very important | Crucial |
|---|---|---|---|---|---|---|
| Competition equals highest rank from any source | 9.3% | 2.2% | 4.2% | 15.9% | 33.3% | 35.1% |
| Quality enhancement equals Strategy question no. 6 | 10.9% | 1.0% | 3.9% | 31.9% | 36.9% | 15.4% |
| Reduce labour costs equal Strategy question no. 7 | 14.2% | 6.7% | 14.6% | 33.9% | 22.3% | 8.3% |
| Reduce other costs equal Strategy question no. 9 | 10.8% | 3.2% | 9.6% | 39.6% | 27.7% | 9.1% |
| Importance of R&D[1] equals Strategy question no. 1 | 45.7% | 7.0% | 12.9% | 19.3% | 9.8% | 5.3% |

1. Research and development.
Source: Statistics Canada, Workplace and Employee Survey.

Firm size 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 by asking:

*How has your workplace's performance in each of the following areas changed? (Areas are: unit production costs, product quality, sales growth.)* Each area was noted as either:

1. Increased
2. Remained the same
3. Decreased

The existence of incentive-based compensation was measured using the following four 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 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 high school?*

8. *In your current job, are you a member of a union or covered by a collective bargaining agreement?*
9. *Have you received any other education?*
   *What was that education?*

    1. Trade or vocational diploma or certificate
    2. Some college, CEGEP, Institute or technology 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:

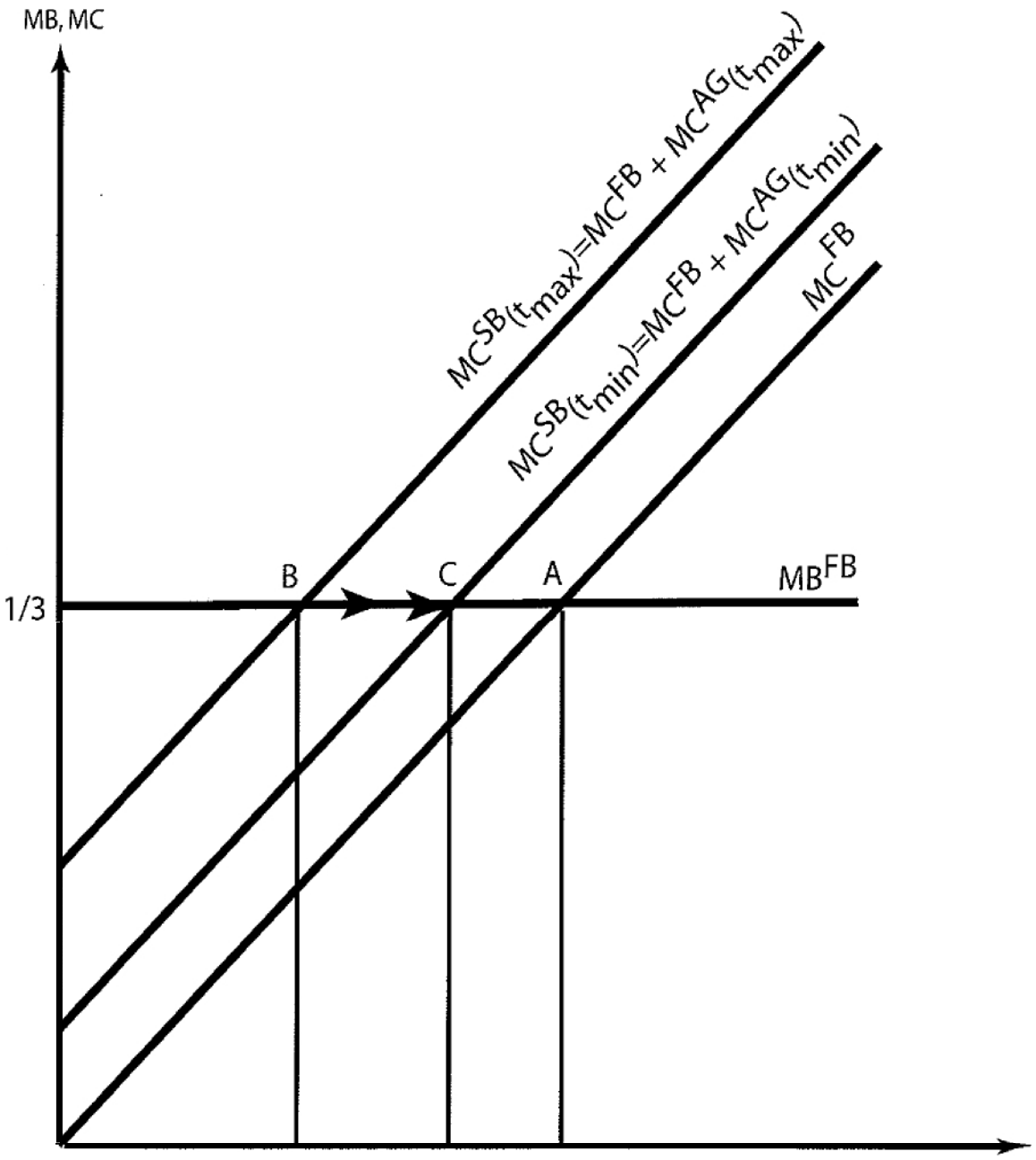
*Who normally makes decisions with respect to the following activities?:*

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

**Figure 1 Equilibrium effort levels**




Notes: MB= Marginal benefit
MC= Marginal cost
$MC^{AG}$= Marginal agency cost
$MB^{FB}$= Marginal benefit first-best
$MC^{SB}$= Marginal cost second-best
$MC^{FB}$= Marginal cost first-best
Source: Authors' calculations based on data from the Workplace and Employee Survey.

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