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BACHELOR THESIS

The Influence of Competition on Organizational Inertia

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July 20, 2014

Abstract

Organizations must adapt continuously to their environment to survive. At the same time employees demand stability and predictability. One way of providing that stability is the leader showing commitment. The principal ensures her employees future change is unlikely and motivates them to invest in task-specific skills. The cost of commitment is organizational inertia, a limitation to adapt the organization to environmental pressures. This paper examines the ability of the principal to commit, using a principal-agent model in which both the principal and agent are risk-averse. I show that some degree of organizational inertia can be of value to the firm. In a Cournot framework, commitment limits the firm in its competitive possibilities. However, commitment is an incentive for the employee to exert more effort. Subsequently, I show that a leader does best to show commitment when uncertainty is high to prevent employees from shirking and both principals choose corresponding strategies.

Keywords: Organizational inertia, commitment, competition

Contents

1 Introduction

Leadership style has an important effect on profitability and innovation within the firm. Some leaders might aim for a dynamic organization, cutting bureaucracy to ensure speed in decision making. Others aspire control to reduce risk and guarantee stability (Rotemberg and Saloner, 1993:1299). Employees facing multiple reorganizations within a limited time horizon may become a source of internal resistance. A struggle with employees can lead to unintended consequences and a less efficient as well as less profitable business (Hannan and Freeman, 1984:152; March 1981). One way of providing stability is the leader showing commitment, for example by letting personnel know there will be no significant change in activities in the near future. This is an incentive to ensure employees their effort on task-specific productivity is well-spent. A lack of commitment can lead to sub-optimal effort as workers feel their labor is less appreciated (Delfgaauw and Swank, 2014:2).

As employees demand stability, environmental forces might push the firm in the opposite direction. For example, customers want their product to have the same technique as the product from the competing firm, or shareholders want the principal to cut costs. The leader has to tread carefully and respect this delicate balance, making a constant trade-off between exploration and exploitation (Gupta et al., 2006). By exploring new business opportunities the firm is able to innovate and adapt to demands by environmental actors. To be competitive the firm has to take risk, experiment, innovate, sell or buy assets, sack or hire employees and so on. Conversely, exploitation ensures the firm makes the most of current business practices and the skills employees already possess. Thinking about exploitation includes keywords like selection, implementation and execution. Both exploration and exploitation are crucial to ensure the existence and survival of the organization, but they compete for scarce resources (March, 1991:71).

The objective of this paper is to discuss the role of commitment within a volatile environment, and to show under which circumstances senior management does best to choose an exploitative strategy by showing commitment or an exploratory strategy by abstaining from commitment. Commitment limits the ability of the leader to make changes to organizational characteristics. Therefore, commitment is a source of organizational inertia like policy, contracts, budgets and institutionalized values. Inertia through commitment can be observed in a variety of forms and shapes. For example, as a contract with an individual employee, or a promise to an entire business unit their current tasks will continue into the future.

As each individual principal has to make this strategic choice, industrywide commitment can be a source of dynamic inefficiency. By committing to a certain task and provided that the firm does not explore new possibilities, innovation in the sector is reduced and potential larger future surplus cannot be achieved. The introduction of new processes or products is constrained, as resources for R&D are reduced by commitment (Motta, 2004:55; Delfgaauw and Swank, 2014).

Although this paper deals with commitment in a competitive framework, it is also possible to show the importance of commitment in a more general organizational context. The concept of commitment should not just be seen as a concept useful in industrial economics, but is applicable to a wide variety of situations in which rules or constraints govern and organize a group of people (Stein, 2008:204). By showing in what way commitment and organizational inertia influence the shape of the organization, this paper contributes to the theory of 'new institutionalism'. By analyzing the commitment problem as a result of organizational-environmental interactions it brings a better understanding of how firms behave, why their size and structure and what drives decision makers when they are trying to adapt to the environment (Ocasio, 1997:188; Hovenkamp, 2011:530-1).

Furthermore, Laffont and Martimort (2002) apply the concept of commitment to a wide spectrum of problems faced by senior management. Whether they are dealing with contracts, insurance and so on, the ability to make credible promises has great influence on daily operations. Like Boyer and Robert (2006) they view inertia as an endogenous rational choice, which can be manipulated by the decision maker. Delfgaauw and Swank (2014:5-6) show that by use of managerial vision, organizational task-specific investment, abstaining from exploration and incentive pay, the commitment problem can be mitigated.

As economists are trying to find causes and remedies for the problem of sub-optimal effort, I extend the model provided by Delfgaauw and Swank (2014) in which the volatility of the environment has a significant effect on the first-period output delivered by employees. In a simple principal-agent model, the addition of a competitor as environmental factor brings interesting results. Next to basic production choices, both firms have to decide on their commitment strategy and cost level. The strategic choices made by both principals affect market demand, profits and ultimately utility. The objective of this paper is to answer the following initial question:

In what way is the commitment problem, that causes organizational inertia, affected by competition?

As in Ferreira and Kittsteiner (2014) this analysis puts the firm in a competitive environment, contrary to most literature on the subject that models the firm in a monopolistic situation. Conflicting with employees demanding stability, the market system is an incentive for organizations to responds to opportunities quickly and will push the firm to explore new possibilities. Therefore, the paper should be placed in a population-ecology perspective. Thereby, acknowledging that the optimal outcome if inertial pressures are analyzed for a single firm, may not be the same if multiple firms are included in the study (Hannan and Freeman, 1977:932-4).

Ferreira and Kittsteiner (2014) find two important results when analyzing the influence of competition on commitment. First, the efficiency effect describes that commitment may be more credible under intense competition, as commitment guarantees increased efficiency. Second, the contestability effect describes tougher competition in a secondary market leads to lower profits in that market and increases the value of commitment. In the paper I am able to replicate the efficiency effect in a somewhat different form. A key result following from the model is that some degree of inertia can be useful for the principal. By committing the leader can ensure durable task-specific investment by the employee and decrease the costs of production. The principal has to weigh the benefits of certain small efficiency gains and uncertain large efficiency gains. This effect is enhanced as uncertainty is high. Commitment then creates certainty for the employee and motivates him to make task-specific investments, but limits the ability of the principal to modify the organization if a more profitable opportunity arises.

Delfgaauw and Swank (2014:16) find that organizations that develop routines have an edge in a more competitive environment. Inevitably by committing when uncertainty is high, the principal can forgo profitable business opportunities as change in a later stage is not possible. By assuming a risk-averse principal and agent I acknowledge these results. Furthermore, I show that the principal and agent shift attention to their own organization, downplaying the importance of environmental pressures, even as the other firm has a competitive advantage and puts pressure on firm profits. Both commitment and exploration show a efficiency effect, where this effect is certain when the principal has chosen commitment, the added value is uncertain if the firm has chosen exploration. The employee favors commitment, and exerts sub-optimal effort if the principal has chosen a exploratory strategy.

The paper proceeds as follows. In the next chapter I present related literature, this section places the commitment problem in a more general organizational context. In Section 3 the competitive environment and the principal-agent model is defined. In Section 4 I show under which conditions the employee exerts most effort and what the payoff for the principal and agent will be, with and without commitment. Section 5 is devoted to showing two extensions to the model. I present concluding remarks in Section 6.

2 Related Literature

Several authors have documented the phenomenon of organizational inertia and the problem a principal has when committing to an exploitative strategy. While the organization adapts to its environment, internal and external pressures are sources of structural inertia. Hannan and Freeman (1977) emphasize the limitations on changing organizational structures and argue that the reason so many variation in organizational distinctiveness exist is caused largely by a difference in internal constraint (e.g. sunk cost, political constraints) and environmental pressures (e.g. legal and fiscal barriers to entry and exit from the market, costly information about the environment and the way to adapt best, legitimacy constraints and the collective rationality problem). The collective rationality problem exist because the optimal strategy for a single firm may not be the equilibrium outcome if there is a competitive market with more than one manufacturer. In case of an exogenous shock, all firms in the same class are vulnerable, but they are all affected in a different way (Hannan and Freeman, 1977:931-4). Selection processes favor organization with high levels of inertia. Attempting to change the firm is a threat to survival because strong inertial pressures are a result of stability and accountability demanded by actors which are dependent on a steady stream of products or services and ensure the firms current and future existence.

March (1981:566) describes how the problem of inertia stems from a difference in speed between change in environmental conditions and speed of internal reorganization. A firm in a stable environment changing rapidly creates excess momentum. A business that is not able to adapt fast enough will suffer from excess inertia. Therefore, to cope with organizational inertia managers and CEO's have to balance exploration and exploitation. On the one hand the firm needs to adapt and search for new possible production techniques and routines. Alternatively, the organization can exploit existing operating procedures and knowledge (Hannan and Freeman, 1984:149-51). While some resources used by the organization are virtually limitless (e.g. information), other resources demand clear choices by the principal. Does he or she want to devote money, attention and personnel to exploitation or exploration? (Gupta et al., 2006:695-7). Delfgaauw and Swank (2014) show that there is an optimal balance between exploration and exploitation, which depends on environmental conditions. Uotila et al. (2009:222-8), in their analysis of S&P 500 corporations, show that managers have a natural tendency to support exploitation. This result suggest that managers and CEO's have a predisposition to stay with the status quo and underestimate the potential profits from finding new opportunities.

Rotemberg and Saloner (1994:1331-8) show the benefits of a narrow (exploitative) business strategy, that is committing to a certain task and preventing research to new alternative business practices, before all options are clearly defined. Their theoretical model shows that decision makers have incentives, resulting from inertia, that prevent change. If the scope of activities performed by the firm is broad, an employee has less motivation to work hard on a project he or she knows may be obsolete within a limited time horizon. In contrast, a narrow business strategy focused on current practices may motivate employees to work harder because they know they are rewarded for their effort. Therefore, a profit-maximizing organization can earn higher profits by giving up diversification, limiting innovation by carefully defining objectives and raising institutional barriers than in a situation with diversification and exploration of new markets. Furthermore, Boyer and Robert (2006:325) describe how inertia today can be a result of earlier promises. For example, a change five years ago was only possible by making promises to certain key actors. By giving in to these demands, change may be obstructed when decision makers are reminded of their previous commitment and are unable to initiate change to adapt to a new environment.

Other scholars of industrial economics recognize this commitment problem and include environmental variables to create a more general model. Van Witteloostuijn (1998:509-11) finds that, in a Cournot setting, organizational inertia can be an instrument for survival because the firm with a relatively high level of inertia may grow into a market leader or become a monopolist. In this model, the manager in such a firm (with a high level of inertia) is motivated by sales volume growth, rather than profit-maximization, because sales volume growth as exploitative strategy is a way to ensure survival. Therefore, he is willing to accept lower profits by producing more output than optimal. Within a certain time horizon there is a probability the second firm, which is a standard profit-maximizing organization, is not able to get a positive profit and decides to leave the market. The market is then free for the firm with a high level of inertia to extract producer surplus.

Ferreira and Kittsteiner (2014:17-9) include competition in their model and show that competition has a significant influence on commitment. They incorporate multiple competing firms in a Cournot, Bertrand and Hotelling setting and show how credible a CEO's commitment is, facing a choice between a focused and diversification strategy. In their analysis they find two effects which foster commitment if a firm is competing in a primary market and has the option to diversify into a second market. First, the contestability effect shows that the credibility of commitment is increasing in the strength of competition in the new market. Increasing competition reduces profits in this market and therefore makes the probability of an exploitative strategy more convincing. Second, the efficiency effect shows that the result of higher competitive pressure in the original market is ambiguous. By focusing on the initial market, there is a probability that manufacturing cost in period 2 are lower. If the market is highly competitive this cost reduction has a greater effect on profit in opposition to when competition in the market is low.

This thesis is primarily based on the work by Delfgaauw and Swank (2014). They show the manager or CEO is trying to find a balance between the search for new opportunities and exploitation of current business practices. In the principal-agent model they incorporate multiple organizational policies aimed at motivating the employee to make task-specific investments. A combination of organizational missions, incentive pay, (abstaining from) exploration and organizational task-specific investment can lead to an optimal level of inertia and creates more certainty for the employee.

This idea is consistent with the work of Rotemberg and Saloner (1993:1309-18), who demonstrate that a participatory management style, in which a manager acknowledges the value of his employees contributing to new ideas, is effective when the environment is rich in profitable investment opportunities (e.g. less competition in a new market). As heads of organizations can moderate organizational inertia, this blend of instruments (organizational missions, incentive pay, (abstaining from) exploration and organizational task-specific investment) are a solution to the commitment problem. They comfort and motivate the worker as these instrument signal future change is unlikely and effort put into the task by the employee is worthwhile. Environmental volatility can adjust the size and strength of organizational inertia because commitment is valuable to the principal, but less effective in more volatile environments. If the environment is more stable, the optimal mix of instruments is stronger than in a more volatile environment (Delfgaauw and Swank 2014:30).

3 The Model

As described in the previous section, the volatility of the environment has a major influence on organizational inertia. This chapter describes the effect of competition on commitment using game-theoretic techniques. First, the timing of events is presented (Section 3.1). In this two period game, decisions made by the principal and agent are crucial to the final outcome of competition and payoffs for people involved. Second, the organization is positioned in a simple competitive Cournot environment, where two firms compete for consumers in the market (Section 3.2). Third, the characteristics of the organization itself and its principal-agent relationship are discussed (Section 3.3). In this 'internal' organization the principal has the possibility to play a commitment strategy before the start of the game. This leads to certainty for the agent, but limits the possibility for the principal to steer the firm in a different direction.

3.1 Timing

The timing of events is as follows:

At the start of period 1 the principal chooses to commit ($X = 1$) or wants to be able to switch and maintains the status quo ($X = 0$). The agent observes this decision and chooses his level of effort.

During period 1 the agent exerts effort. A higher effort level will lower the marginal cost of production, which is crucial to the competitiveness of the firm. This level of effort will only affect costs if the principal decides to continue task A at the start of period 2.

At the start of period 2 the principal is confronted with the result of his previous choice. First, if the principal has chosen commitment ($X = 1$), he has chosen to maintain task A, and the marginal cost of production for this task are determined by first period effort. A second possible situation arises if the principal has chosen exploration ($X = 0$) (by not committing to task A). In the latter situation, at the start of period 2, she has a binary choice: maintain task A or switch to task B. The principal will switch if task B has a competitive cost advantage ($c_{i,B} < c_{i,A}$). The efficiency of task B is denoted by τ, where task B either is efficient ($\tau = 1$) or inefficient ($\tau = 0$).[1] A choice for task B means the employee effort will be redundant, while he still has to bear the cost of effort. Note that the final product of task B is the same as task A, and effort or exogenous technological improvements will only affect marginal cost of production. Therefore, when firms compete while they practice different tasks, products are still homogenous but firms can differ in marginal cost.

During period 2, firms compete in a Cournot environment by a choice of output by the principal. Both firms sell their products in the market and profits are realized. Finally, both principal and agent utility is based on these profits.

[1] The efficiency of task B will be more thoroughly discussed in paragraph 3.2.

Table 3.1 Timing and decisions

Players: P (principal) and E (Agent)

Timing:

- P takes commitment decision $X = \{0, 1\}$
- E observes X, chooses level of effort (e_i)
- E exerts effort, lowering marginal cost for task A
- Nature draws $\tau \in \{0, 1\}$ (efficiency task B)
- P observes τ
- In case $(X = 1)$, firm maintains task A

  In case $(X = 0)$, P takes decision, maintain A $(\tau = 0)$ or switch to B $(\tau = 1)$
- Firms compete and profits are realized

3.2 Competitive environment

Consider two firms, called firm I and J, in a duopoly, producing homogenous products. Firms choose quantities they want to bring to the market. For convenience, all firms have the same production technology, entry or exit is excluded and labor is the only input in production. Furthermore, costs are asymmetric and can be influenced either by a worker exerting effort, or a exogenous technological improvement. Following Ferreira and Kittsteiner (2014:36-7) marginal cost will act as a demand shifter, changing the amount of output demanded by consumers. Goods are strategic substitutes, therefore if one firm increases output the other firm will react by lowering its own output (an extension in case of Bertrand competition, in which goods are strategic complements, will be considered in Section 5).

For simplicity, both firms face a linear demand function $P = a - bQ$, with $Q = q_i + q_j$ as total industry output. To ensure a market exists because profits are positive, and firms are willing to supply goods to the market, assume $b > 0$, $a > 0$ and $a > c$. In addition, willingness to buy is large enough to cover the market.

Because effort has an effect on the cost for task A, but not on the cost for task B, the tasks differ in the way the marginal cost functions are composed. The second period cost for the firm for task A depends linearly on first period effort exerted by the employee,

$$c_{i,A} = (1 - e_i)\overline{c_{i,A}}, \tag{1}$$

where $c_{i,A}$ denotes the marginal cost for firm I for task A, $0 < c_{i,A} < 1$, and e_i denotes the effort exerted by the employee of firm I, $0 < e_i < 1$. An agent increasing his first period effort can be an additional source of profit for the firm and therefore gives the principal an incentive to motivate the worker to work hard in period 1. As in Delfgaauw and Swank (2014) effort acts as a form of task-specific investment by the employee, reducing the cost for task A and increasing the firms competitiveness in case of exploitation.

At the same time there is a possibility task B, which is not dependent on first period agent effort, will have a greater decreasing effect on cost of production. Task B can be either efficient or inefficient relatively to task A, with respective probabilities β and $(1 - \beta)$. The second period cost for the firm for task B depend on parameter τ,

$$c_{i,B} = (1 - \tau)\overline{c_{i,B}}, \tag{2}$$

where $\tau \in \{0, 1\}$ denotes the reduction in cost. With $Prob.(\tau = 1) = \beta$, task B is efficient, and marginal cost of production are $c_{i,B} = 0$. If the principal observes that task B reduces cost successfully and has not committed in the first period, she will always choose to switch to task B at the start of period 2, since if $(\tau = 1)$ task B will always have lower cost than task A if $e_i < 1$. Furthermore, with $Prob.(\tau = 0) = (1 - \beta)$, task B is inefficient and cost are $c_{i,B} = \overline{c_{i,B}}$. As a result, task B will not reduce the firms marginal cost level and the principal will always choose to maintain task A, since if $(\tau = 0)$ task A will have lower cost than task B if $e_i > 0$.

A higher effort level can be seen as an employee learning a more efficient technique, thereby improving the production process and lowering marginal cost. For example, the employee learns to write new software which significantly reduces the time involved in performing administrative tasks. Task *B* can be viewed as the software supplier releasing a new software package, making the production process more efficient independent of first period agent effort and making the task-specific investment by the employee outdated. Whether the supplier releases this package is uncertain and creates a commitment dilemma for the principal.

Before the start of period 2 the principal observes the exact level of effort exerted by the employee in period 1 and is able to make an accurate prediction of the cost level at which the firm has to produce in period 2. Furthermore, the principal is able to observe and verify the cost level of the competing firm and knows whether this firm has committed to task *A*, is choosing to maintain task *A* in period 2 or is going to switch to task *B*. Solving the system we find firm *I*'s reaction function (3) and complete information efficient production level (4) (or Nash equilibrium output):

$$q_i = \frac{a - c_{i,T}}{2b} - \frac{q_j}{2}, \tag{3}$$

and

$$q_i^* = \frac{a - 2c_{i,T} + c_{j,T}}{3b}. \tag{4}$$

Subscript $T \epsilon \{A, B\}$ shows that marginal cost of production depend on the choice of the principal for task *A* or *B*. Inserting the firms reaction functions into the demand curve leads to

$$P^* = \frac{a + c_{i,T} + c_{j,T}}{3}, \tag{5}$$

and

$$\pi_{i,T}^* = \frac{\left(a - 2c_{i,T} + c_{j,T}\right)^2}{9b}, \tag{6}$$

and illustrate in what way industry price (5) and profits (6) for firm *I* depend on the marginal cost level of both firms.

3.3 The organization

The goal of this paper is to show the effect of commitment by connecting the competitive environment described above, and the internal organization structure where each firm consists of a principal and employee. The initial goal is to show that both the effort choice by the employee and the principal choice concerning commitment affect the more general competitive environment and therefore influence payoffs (and effort and commitment choices) in the other organization.

A crucial assumption in this simple principal-agent model is that the principal is risk-averse. The principal is said to be risk-averse if the utility function is concave, caused by the law of diminishing marginal utility (Wilkinson and Klaes, 2012). Several authors describe the features of a risk-averse principal, and stress the relevance of corporate law and jurisprudence that ensure a board member or CEO has responsibilities to act prudent with regard to taking risk and have a liability in protecting their business (Sinclair-Desgangé and Spaeter, 2011). Furthermore, McAnally et al. (2011) have found empirical evidence that executives are cautious in taking risk to ensure firm survival. Other studies describe that there is robust evidence supporting loss-aversion in both experimental and field studies, especially that utility is concave for gains (Wilkinson and Klaes, 2012:170; Abdellaoui et al., 2007:28-31). This assumptions has great impact on the final result and the (limited) effect of competition on commitment (an extension in case of risk-neutral principal and agent will be considered in Section 5).

Consequently, task A or B yields a benefit to the principal in period 2 equal to

$$U_2(T) = \sqrt{\pi_T}\,, \tag{7}$$

where subscript T denotes the choice between task A or B and π_T is the profit resulting from the chosen task in period 2.

The agent's utility equals the utility of the principal. Therefore the agent will not receive a variable or fixed salary and his payoff is solely dependent on the profitability of the organization. The difference between agent and principal utility is that the agent has to bear the complete cost of effort. The cost of first period effort is equal to $C(e_i) = \frac{1}{2}\theta(e_i)^2$, where

$0 < e_i < 1$ and cost of effort is convex: $C^{'}(e_i) > 0$, $C^{''}(e_i) > 0$. Because of the cost of effort, the utility of principal and agent are not the identical. The agent has a tendency to exert minimal effort to produce the optimal level of output and necessary competitive cost level. The principal would prefer the agent exerts maximum effort. If the principal chooses to switch to task *B*, the agent has exerted avoidable effort in the first period and would rather have exerted no effort at all.

Like the principal, the agent is risk-averse. Although an individual level of risk-aversion is still hard to estimate and depends strongly on the chosen methodology, several authors describe the effects of incentives on risk-averse agents (e.g. Jouini and Napp, 2008; Laffont and Martimort, 2002:59-63).

Summarizing, task *A* or *B* yields a benefit to the agent equal to that of the principal minus cost of first period effort

$$U_2(T) = \sqrt{\pi_T} - C(e_i). \tag{8}$$

4 Analysis

In this section I will combine the 'internal' principal-agent organization and the 'external' competitive environment. Doing so it is possible to analyze the effects of commitment by the principal on effort exerted by the agent (Section 4.1). Following this effort choice we can see under which circumstances the principal does best to show commitment or when an exploratory (non-commitment) strategy will be optimal (Section 4.2).

In this non-cooperative game, at the start of period 1 both principals have to make a choice whether they want to commit to task *A*, or postpone their choice and explore whether task *B* results in a successful cost reduction. By committing to task *A* the principal will no longer be able to switch to task *B* at the start of period 2. This will limit the firms possibilities, but can also be an incentive for the employee to make task-specific investments in task *A*, and be more productive in adjusting the cost level, increasing profits and utility for agent and principal. The effort put in by the agent in period 1 is the sole variable affecting cost level in period 2 for task *A*, while profit (and utility) also depends on the exploitation or exploration choice made by the principal of the rival firm. This results in a total of four possible combinations of cost and commitment (Table 4.1) between firms to be discussed in the following subsections.

Table 4.1 Principal Commitment Strategy

		Firm J	
		Commitment	Exploration
Firm I	Commitment	Industrywide commitment (4.1)	Rival exploration (4.2)
	Exploration	Rival commitment (4.3)	Industrywide exploration (4.4)

4.1 Industrywide commitment

The optimal effort level for the agent is calculated by backward induction. If both firms in the industry commit to task A, their employees will exert the same amount of effort and their marginal cost of production will be the same. By committing to task A, the possible cost advantage of task B is irrelevant and agent and principal utility is solely dependent on agent's first period effort. First, I give the agent utility function

$$U_{2,i}(A) = \sqrt{\pi_A} - C(e_i) = \sqrt{\frac{\left(a - 2\left((1-e_i)\overline{c_{i,A}}\right) + \left((1-e_j)\overline{c_{j,A}}\right)\right)^2}{9b}} - \frac{1}{2}\theta(e_i)^2. \tag{9}$$

$\partial U_{2,i}(A)/\partial e_i$, leads to

$$e_i^* = e_j^* = \frac{2\overline{c_{i,A}}}{3\theta\sqrt{b}}. \tag{10}$$

This effort level has some interesting properties. First, effort decreases in θ, denoting disutility of effort. If the cost of an additional unit of effort are rising, the agent will be tempted to decrease his effort level as an increase in profits will not compensate the cost of exerted effort. Second, effort increases in $\overline{c_{i,A}}$, denoting the size of marginal cost, which the agent is able to lower by exerting effort. If this production cost level is high, a small increase in effort will lead to a relatively large cost reduction, increasing the competitiveness of the firm and possibly increasing the utility of the agent (and principal). Contrary, if the cost level is already low, an additional level of effort will have a negligible effect on profits and will not offset the increase in effort.

The most important observation (also derived in the following subsections) is that the optimal effort level is not affected by any variable relating to the rival firm. One of the consequences of the assumption that the agent is risk-averse is that any effect of competition is mitigated by manipulation of the utility function. The effort decision made by the agent is exclusively determined by variables that belong to the own firm. Essentially, we see the attention of the agent and principal focuses on the own organization, even if the other firm has a competitive advantage and puts pressure on the firm's profits.

4.2 Rival exploration

A second possible situation arises when firm I chooses to commit on task A, while firm J wants to be able to choose task B at the start of period 2. This will not affect the effort level of the employee in firm I, but will influence the effort exerted by the employee in firm J (as shown in Section 4.3). While firm I's cost level is exclusively determined by first period agent effort, firm J chooses task B if this task is more efficient than task A (with probability β). The exploration decision by the principal of firm J creates uncertainty about profits for both firms, which is reflected in the agents utility function

$$U_{2,i}(A) = \sqrt{\pi_A} - C(e_i) \tag{11}$$

$$= \beta\sqrt{\frac{\left(a - 2\left((1 - e_i)\overline{c_{i,A}}\right)\right)^2}{9b}} + (1-\beta)\sqrt{\frac{\left(a - 2\left((1 - e_i)\overline{c_{i,A}}\right) + \left((1 - e_j)\overline{c_{j,A}}\right)\right)^2}{9b}} - \frac{1}{2}\theta(e_i)^2,$$

and will lead to an optimal effort level for the agent of firm I equal in case both principals commit to task A, decreasing in θ, increasing in $\overline{c_{i,A}}$:

$$e_i^* = \frac{2\overline{c_{i,A}}}{3\theta\sqrt{b}}. \tag{12}$$

4.3 Rival commitment

A third possible combination of cost and commitment exists if the principal of firm I chooses an exploratory strategy and wants to be able to switch to task B at the start of period 2. Now uncertainty following the exploration decision will affect the effort level of the agent in firm I. While the principal of firm J can ensure the employee first period effort will not be useless in the second period, the principal of firm I will prefer to switch to task B if this task is more efficient than task A. In equation (14) we see the agent in firm I will adjust his effort level as uncertainty about the durability of his first period effort will have a negative effect on effort. The agent utility function is

$$\begin{aligned} U_{2,i}(T) &= \sqrt{\pi_T} - C(e_i) \\ &= \beta\sqrt{\frac{\left(a + \left((1 - e_j)\overline{c_{j,A}}\right)\right)^2}{9b}} \\ &\quad + (1-\beta)\sqrt{\frac{\left(a - 2\left((1 - e_i)\overline{c_{i,A}}\right) + \left((1 - e_j)\overline{c_{j,A}}\right)\right)^2}{9b}} - \frac{1}{2}\theta(e_i)^2. \end{aligned} \tag{13}$$

Differentiation of (13) with respect to e_i gives

$$e_i^* = (1-\beta)\frac{2\overline{c_{i,A}}}{3\theta\sqrt{b}}. \tag{14}$$

Note that this optimal effort level will at all times be lower than in case the principal has chosen to commit. The parameters have the same aspects as the effort level calculated above in the commitment cases. Optimal effort level is decreasing in cost of effort (θ) and increasing in cost level ($\overline{c_{i,A}}$).

The difference between the commitment and non-commitment case lies in the possibility that task B is more efficient than task A (denoted by β). An increasing probability that task B will be more efficient will lower optimal first period effort and cause the agent to shirk. This shows that the agent, not knowing the effectiveness of task B when choosing his effort level, favors commitment. These results indicate we can replicate the findings in Delfgaauw and Swank (2014) that the principal does best to cultivate some degree of organizational inertia. Investment in task-specific capital by the agent will then be higher, which results in increased profits in case task B is inefficient. In accordance with Rotemberg and Saloner (1994:1332-8) this shows senior management may have a difficulty motivating employees as the scope of activities is broad and can earn higher profits by focusing on a single task. Commitment ensures the agent knows his pains will have an effect on the profitability of the firm. In case the principal refuses to commit there is a possibility all effort was superfluous and task-specific investment was unnecessary.

This illustrates the dilemma the principal has when deciding on a level of inertia in the organization. For example, a principal getting a signal from his software supplier that new updated software is imminent ($\beta \approx 1$), will not commit to the current task but has to accept a low first period effort from his agent. In case the supplier is unable to deliver the software (a small chance but still possible) the firm has to compete with high marginal cost and face the consequences in profit and payoffs.

4.4 Industrywide exploration

If both firms choose exploration, they refuse to commit to task A. Again, uncertainty will trigger the agent to shirk and exert an optimal effort level lower than in the commitment situation. Agent utility is

$$U_{2,i}(T) = \sqrt{\pi_{2,T}} - C(e_i) \tag{15}$$

$$= \beta^2 \sqrt{\frac{(a)^2}{9b}} + \beta(1-\beta)\sqrt{\frac{\left(a - 2\left((1-e_i)\overline{c_{i,A}}\right)\right)^2}{9b}}$$

$$+ \beta(1-\beta)\sqrt{\frac{\left(a + \left((1-e_j)\overline{c_{j,A}}\right)\right)^2}{9b}}$$

$$+ (1-\beta)^2 \sqrt{\frac{\left(a - 2\left((1-e_i)\overline{c_{i,A}}\right) + \left((1-e_j)\overline{c_{j,A}}\right)\right)^2}{9b}} - \frac{1}{2}(\theta e_i)^2.$$

By rearranging the FOC the optimal effort level is obtained:

$$e_i^* = (1-\beta)\frac{2\overline{c_{i,A}}}{3\theta\sqrt{b}}. \tag{16}$$

Again, we can replicate the above findings and see the influence of a possible switch of tasks on first period effort. Commitment by the principal of the rival firm and effort exerted by her employee are not relevant in the effort choice of the agent. In case the agent exerts effort the principal can control the level of his marginal cost in period 2 and is in direct command of his utility. Conversely, the principal cannot be sure task B will reduce costs and deliver a gain (the principal values possible gains less than potential losses). With these findings we are able to replicate the findings by Delfgaauw and Swank (2014:16) that the value of commitment is smaller in more volatile environments (larger values of β). Furthermore, the decision maker can decide to commit, making inertia a strategic variable which can be manipulated by the use of the right instruments (Van Witteloostuijn, 1998:516-7). In case the principal has committed and task B turns out to be efficient we can say there is excess inertia.

4.5 Principal payoff and the commitment decision

Table 4.2 summarizes the above findings about combinations of commitment and optimal effort levels. By exploitation the agent exerts more effort and shirking is less likely. However, to analyze the choice made by the principal, the firms profit function has to be taken into account. If the principal whishes to explore task B and this task turns out to be efficient, the lower effort level by the agents is irrelevant and the principal can increase her utility in case marginal cost for this task are lower.

Table 4.2 Effort under exploitation and exploration

		Firm J	
		Commitment	Exploration
Firm I	Commitment	$e_i^* = \frac{2\overline{c_{i,A}}}{3\theta\sqrt{b}}$ $e_j^* = \frac{2\overline{c_{j,A}}}{3\theta\sqrt{b}}$	$e_i^* = \frac{2\overline{c_{i,A}}}{3\theta\sqrt{b}}$ $e_j^* = (1-\beta)\frac{2\overline{c_{j,A}}}{3\theta\sqrt{b}}$
	Exploration	$e_i^* = (1-\beta)\frac{2\overline{c_{i,A}}}{3\theta\sqrt{b}}$ $e_j^* = \frac{2\overline{c_{j,A}}}{3\theta\sqrt{b}}$	$e_i^* = (1-\beta)\frac{2\overline{c_{i,A}}}{3\theta\sqrt{b}}$ $e_j^* = (1-\beta)\frac{2\overline{c_{j,A}}}{3\theta\sqrt{b}}$

We can insert these optimal effort levels into the principal utility function, and see under which circumstances commitment is optimal (under what β the principal chooses exploitation). The principal utility function is the same as the agent utility function without the cost of effort function, $C(e_i)$. For convenience we denote effort level under commitment as $e_{i,com} = e_i^* = \frac{2\overline{c_{i,A}}}{3\theta\sqrt{b}}$, and effort level without commitment as $e_{i,expl} = (1-\beta)e_i^*$.

If both firms commit to task *A*, the resulting utility for the principal is

$$U_{2,i}(A) = \frac{a - c_{i,A}(1 - e_{i,com})}{3\sqrt{b}}. \quad (17)$$

Note that the cost part of the equation will always be negative. As in a normal Cournot duopoly setting a rising cost level decreases output and profits. By exerting effort the employee can reduce the cost level and increase profitability for the firm and payoff for the principal.

If one of the firms wants to postpone his decision until the efficiency of task *B* is known, parameter β, the probability that task *B* is more efficient, shows up in principal utility function. If firm *I* commits, while firm *J* chooses exploration the utility is

$$U_{2,i}(A) = \frac{a - 2c_{i,A}\left(1 - e_{i,com}\right) + c_{j,T}\left(1 - e_{j,expl}\right) - \beta c_{j,T}(1 - e_{j,expl})}{3\sqrt{b}}. \quad (18)$$

In case the principal of firm *I* decides to delay her decision this results in the following utility

$$U_{2,i}(T) = \frac{a - 2c_{i,T}(1 - e_{i,expl}) + c_{j,A}(1 - e_{j,com}) + 2\beta c_{i,T}(1 - e_{i,expl})}{3\sqrt{b}}. \quad (19)$$

Both utilities show the same effect as in equation (17). A higher effort level by the employee reduces marginal cost of production and increases competitiveness for the firm. This increases payoff to the principal and the willingness to commit to task *A*. Furthermore, we can now analyze the effect of a possible efficiency effect of task *B*. In equation (18) the part of the equation containing β will always be negative. Therefore, if the chance firm *J* successfully explores task *B* increases, this will reduce the expected profits for the principal of firm *I*. The reverse is true for equation (19) in which firm *I* explores task *B* and firm *J* commits to task *A*. An increasing chance that task *B* will be efficient will then lead to higher expected profits for the principal.

If both firms choose to wait and see how efficient task B is, the principal utility function is

$$U_{2,i}(T) = \frac{a - c_{i,T}(1 - e_{i,expl}) + \beta c_{i,T}(1 - e_{i,expl})}{3\sqrt{b}}. \quad (20)$$

Where the first cost term is always negative and the second term is always positive (denoting an increase in utility in case task B is efficient).

Table 4.3 summarizes the findings and shows the payoffs for the principals with commitment and without commitment.

Table 4.3 Principal payoff under exploitation and exploration

		Firm J	
		Commitment	Exploration
Firm I	Commitment	$U_{2,i}(A) = \frac{a-c_{i,A}(1-e_{i,com})}{3\sqrt{b}}$ $U_{2,j}(A) = \frac{a-c_{j,A}(1-e_{j,com})}{3\sqrt{b}}$	$U_{2,i}(A) = \frac{a-2c_{i,A}(1-e_{i,com})+c_{j,T}(1-e_{j,expl})-\beta c_{j,T}(1-e_{j,expl})}{3\sqrt{b}}$ $U_{2,j}(T) = \frac{a-2c_{j,T}(1-e_{j,expl})+c_{i,A}(1-e_{i,com})+2\beta c_{j,T}(1-e_{j,expl})}{3\sqrt{b}}$
	Exploration	$U_{2,i}(T) = \frac{a-2c_{i,T}(1-e_{i,expl})+c_{j,A}(1-e_{j,com})+2\beta c_{i,T}(1-e_{i,expl})}{3\sqrt{b}}$ $U_{2,j}(A) = \frac{a-2c_{j,A}(1-e_{j,com})+c_{i,T}(1-e_{i,expl})-\beta c_{i,T}(1-e_{i,expl})}{3\sqrt{b}}$	$U_{2,i}(T) = \frac{a-c_{i,T}(1-e_{i,expl})+\beta c_{i,T}(1-e_{i,expl})}{3\sqrt{b}}$ $U_{2,j}(T) = \frac{a-c_{j,T}(1-e_{j,expl})+\beta c_{j,T}(1-e_{j,expl})}{3\sqrt{b}}$

With these results it is possible to find a pure strategy Nash equilibrium. This equilibrium describes a pair of strategies that forms an equilibrium if it maximizes the expected payoff of the principal, given that the other principal also plays her optimal strategy (Milgrom and Roberts, 1982:446). As this is a pure strategy, there is no randomization and the principal will always make the same decision in the same circumstances (or same value of parameters). By assigning parameter q to the probability the principal of firm J will play a commitment strategy, we can get information on the tendency for commitment[2]. Noticeable is that the strategy of the principal is independent of the probability the other firm will play a commitment strategy as q is removed from the equation. As both principals are fully rational, utility maximizing and firms are symmetric there is no credible threat to play a strategy that does not maximize expected payoff. Both principals know what the value of the parameters will be, so they also know whether the other firm will commit to task A, or will choose an exploratory strategy.

By combining the above stated utility functions, we find that it is optimal for the principal to commit to task A at the start of period 1 iff

$$\beta < 2 - \frac{3\theta\sqrt{b}}{2\overline{c_{i,T}}}. \tag{21}$$

and play exploration otherwise. A value of β smaller than the right-hand side of the equation will trigger the principal into commitment. This is a pure strategy equilibrium as the principal will always play the same strategy under identical conditions. Furthermore, both firms maximize expected utility by choosing corresponding strategies. If the probability task B is efficient is small, there will be industrywide commitment. In case β is large, both principals will decide to wait and the result is industrywide exploration.

The right-hand side of the equation is increasing in $\overline{c_{i,T}}$. As the level of marginal cost of production is increasing, commitment is more likely. Increasing uncertainty about marginal cost makes the principal want to commit early, in order to guarantee a higher effort level by the agent. This assures the principal some of these costs will be cut by effort, although he no longer has the freedom to switch to task B in the second period. The principal therefore has willingly created organizational inertia because of uncertainty, which can result in excess inertia in case task B turns out to be efficient. This corresponds to the findings in Delfgaauw and Swank (2014) and Rotemberg and Saloner (1994), where abstaining from exploration or choosing a focused strategy can be beneficial to the principal. Furthermore, increasing disutility of effort for the agent has a reverse effect on commitment. As disutility of effort increases, the optimal effort level for the agent is lower, reducing the value of commitment. In a case of high disutility of effort, the principal is more likely to wait and see whether task B is efficient in decreasing marginal

[2] Calculations can be found in the Appendix.

cost of production, as the difference between a shirking employee and an employee exerting optimal effort is not that big.

Again effort by the agent in the rival firm or a signal of competition influencing the principals commitment decision is absent in the equation due to the assumption of a risk-averse agent and principal and symmetry between firms. Therefore, with these results it is not possible to replicate the findings by Delfgaauw and Swank (2014) that the value of commitment is smaller in more volatile (or competitive) environments. What is certain is that committing to task A will provide a certain efficiency gain, increasing the competitiveness of the firm as marginal costs will decrease. The effect of not committing is uncertain and can lead to increased competitiveness if task B is efficient. However, in case task B turns out to be inefficient the firm will have a problem in competing with the rival firm and there is a significant probability profits will decline. So, not only outside forces tend to enlarge organizational inertia. The employee and principal have a tendency towards commitment to limit risk and ensure a steady stream of income.

5 Extensions

Now that the commitment problem has been analyzed it is necessary to discuss two extensions to make the model more widely applicable and discuss some of the earlier comments on crucial assumptions. First, I discuss the effects of the assumption that principals and agents are risk-averse, and discuss what the effects of a different assumption would be. Second, a few notes on Bertrand competition in which goods are strategic complements will be discussed. This would overturn the competition setting and have drastically different consequences.

5.1 Risk neutral principal and employee

The assumption that agent and principal are risk-averse removes the effect of effort by the agent in the competing firm. Furthermore, assuming a risk-averse agent can be a realistic assumption but, although some empirical research has been found that a principal can be risk-averse, most literature assigns properties of risk-neutral or risk-seeking entrepreneurs.

Fully resolving the debate about the influence of risk-neutral or risk-seeking actors is beyond the scope of this paper. By assuming a risk-neutral agent the utility function of the agent changes and the optimal first-period effort is influenced by the effort put in by the employee of the other firm. When the principal of firm *I* shows commitment for task *A*, the optimal effort of the agent of firm *I* is clearly negatively impacted by effort of the agent of the other firm. The explanation for this is that effort by the agent of the rival firm will increase the competitiveness of this firm and when the principal of this firm chooses task *A* the marginal cost of production for this task will be lower. As goods are strategic substitutes and reaction functions are negatively sloped, this will decrease profit and optimal effort for the agent of firm *I*. The effect of the marginal cost level is ambiguous.

5.2 Bertrand competition

A further extension of the model concerns the case in which the industry is characterized by Bertrand characteristics and firms set prices instead of quantities. If we assume collusion between firms is not possible and the environment consist of more than one firm, Bertrand competition implies that eventually the price of the finished product will be lowered until price approaches marginal cost because each firm can capture the entire market by slightly undercutting the price set by the rival. The impact of such a price has two significant effects on the analysis of Section 4.

First, if price is lowered to approach marginal cost, both firms will eventually not be able to make a positive profit. With the given agent utility function, in which the utility of the agent depends solely on the profit made by the firm and no fixed or variable salary is given, the agent will never be able to get a positive utility and therefore minimizes utility loss by exerting no effort at all. Second, the price of the product will be lowered till it reaches the minimal marginal cost over both firms, $P = \min(c_{i,T}, c_{j,T})$. If task *B* is inefficient relative to task *A*, agent effort will determine marginal cost of production and sets price for consumers. If firms are asymmetric and for example firm *I* is able to reduce cost by switching to task *B*, and firm *J* has to maintain task *A*, this will cause firm *J* to have negative profits and will eventually force the firm to leave the market. The only possibility in which both firms survive is if their cost are symmetric (e.g. both successfully explore task *B*, or both commit to task *A* and their agents exert the same amount of effort). Again, this will create a paradox in which profits are reduced to marginal cost, agents will exert no effort and the supply side of the market disappears.

To create a workable model it is recommended to change the utility function of the agent. For example, by making agent utility dependent on a variable salary (which depends on effort and cost for task A) the agent will exert effort to earn a salary although the firm is not able to make a significant profit. As the agent is no longer reliant on firm profits we now look at the principal decision and when it is optimal for her to commit.

6 Concluding remarks

This paper has developed a model to test the effect of competition on commitment and organizational inertia within organizations. I have shown that some degree of inertia can be of service to the principal. As in Delfgaauw and Swank (2014) commitment in a firm is valuable to the principal as it can ensure durable task-specific investment by the agent. A straightforward result is that it is optimal for the principal to commit if uncertainty is high. Commitment then motivates the employee into making task-specific investments and guarantees a certain level of profit. Committing in such a situation can be disadvantageous as the principal has no possibility to change the organization when a profitable business opportunity comes along, and these opportunities arise more often when uncertainty is high. The principal has to weigh certain small efficiency gains and uncertain large efficiency gains. Therefore, the cost of inertia is that the organization cannot adapt optimal to the environment if necessary (Delfgaauw and Swank, 2014:4; Boyer and Robert, 2006:343).

I have tried to assess the effect of competition on inertia. Thereby, trying to validate the findings by Delfgaauw and Swank (2014), whether volatility has a positive or negative effect on commitment, and Ferreira and Kittsteiner (2014), that a commitment strategy becomes relatively more attractive if competition intensifies. As we have seen the attention of the agent and principal focuses on the own organization, even if the other firm has a competitive advantage and puts pressure on the firm's profits. During decision making, senior management takes interest in variables relating to the own organization and the environment becomes relatively uninteresting. The manipulation of the principal and agent utility function leads to limitations in assessing the effects of competition on inertia. By assuming risk-averse agents and principals the rival firm has limited influence on decision making and the pressure of competition is restricted. Two effects of competition stand out. First, if the principal chooses commitment he is sure of the level of effort exerted by the agent and knows how competitive he is in the Cournot environment. Second, by not committing the principal creates uncertainty and cannot be sure about the competitiveness of the firm. If task B is efficient he is very competitive, but in case task B is inefficient this will significantly impact the position of the firm in the environment. By combining these findings we are able to define a pure strategy Nash equilibrium, that maximizes the expected payoff for the principal. The principals choose corresponding strategies, which will result in either industrywide commitment (in case β is small enough) or industrywide exploration.

This paper does reinforce the idea that employees have a role in deciding the level of inertia in the organization. When a principal decides to change the organization she should act careful in deciding when and how change is most effective and should not ruthlessly make adjustments to adapt to environmental forces. A lack of commitment can lead to shirking by employees and sub-optimal effort may reduce future profitability.

Although the results in this paper do not give a direct answer, it does provide a starting-point for further research. As noted, the results change when the risk-aversion assumption is dropped. This should make the influence of competition on commitment more clear. Moreover, extending the model to a larger number of firms can bring more volatility into the model and provide a more thorough analysis of the commitment problem. Finally, this thesis and previous theoretical literature require empirical research to test statements about competition and commitment and supply a scientific foundation of organizational inertia.

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A Appendix

Here I show the underlying calculations of the analysis of the pure strategy Nash equilibrium problem in Section 4.

Principal payoff and commitment decision

To calculate when commitment by the principal is optimal we insert first period agent effort into the principal utility function. This results in four possible combinations of commitment for both firms (equation (17) to (20)). Consider the principal of firm *I*:

If she plays Commitment she'll receive payoff of

$$U_{2,i}(A) = \frac{a - c_{i,A}(1 - e_{i,com})}{3\sqrt{b}}, \tag{22}$$

with probability q, and

$$U_{2,i}(A) = \frac{a - 2c_{i,A}\left(1 - e_{i,com}\right) + c_{j,T}\left(1 - e_{j,expl}\right) - \beta c_{j,T}(1 - e_{j,expl})}{3\sqrt{b}}, \tag{23}$$

with probability $(1 - q)$. If she plays exploration, she receives a payoff of

$$U_{2,i}(T) = \frac{a - 2c_{i,T}(1 - e_{i,expl}) + c_{j,A}(1 - e_{j,com}) + 2\beta c_{i,T}(1 - e_{i,expl})}{3\sqrt{b}}, \tag{24}$$

with probability q, and

$$U_{2,i}(T) = \frac{a - c_{i,T}(1 - e_{i,expl}) + \beta c_{i,T}\left(1 - e_{i,expl}\right)}{3\sqrt{b}}, \tag{25}$$

with probability $(1 - q)$.

The principal will choose commitment if the expected payoff of the first two strategies is higher than the expected payoff of the exploration strategy. So if

$$q\left(\frac{a-c_{i,A}(1-e_{i,com})}{3\sqrt{b}}\right)+(1-q)\left(\frac{a-2c_{i,A}(1-e_{i,com})+c_{j,T}(1-e_{j,expl})-\beta c_{j,T}(1-e_{j,expl})}{3\sqrt{b}}\right)> \tag{26}$$
$$q\left(\frac{a-2c_{i,T}(1-e_{i,expl})+c_{j,A}(1-e_{j,com})+2\beta c_{i,T}(1-e_{i,expl})}{3\sqrt{b}}\right)+$$
$$(1-q)\left(\frac{a-c_{i,T}(1-e_{i,expl})+\beta c_{i,T}(1-e_{i,expl})}{3\sqrt{b}}\right).$$

Which can be rewritten as:

$$\begin{aligned}qa-qc_{i,A}(1-e_{i,com})+a-2c_{i,A}(1-e_{i,com})+c_{j,T}(1-e_{j,expl})\\ -\beta c_{j,T}(1-e_{j,expl})-qa+2qc_{i,A}(1-e_{i,com})-qc_{j,T}(1-e_{j,expl})\\ +q\beta c_{j,T}(1-e_{j,expl})\\ >qa-2qc_{i,T}(1-e_{i,expl})+qc_{j,A}(1-e_{j,com})\\ +2q\beta c_{i,T}(1-e_{i,expl})+a-c_{i,T}(1-e_{i,expl})+\beta c_{i,T}(1-e_{i,expl})\\ -qa+qc_{i,T}(1-e_{i,expl})-q\beta c_{i,T}(1-e_{i,expl}).\end{aligned} \tag{27}$$

I have show that $e_{i,com}=e_{j,com}$, and $e_{i,expl}=e_{j,expl}$. Furthermore, the initial cost levels (before effort is exerted) are equal, so this can be rewritten as

$$\begin{aligned}2c_{i,T}(1-e_{i,expl})-2\beta c_{j,T}(1-e_{i,expl})-2c_{i,A}(1-e_{i,com})\\ >2qc_{i,T}(1-e_{i,expl})-2qc_{i,T}(1-e_{i,expl}).\end{aligned} \tag{28}$$

Where q, the possibility the rival firm chooses commitment is eliminated from the equation. Resulting in

$$2c_{i,T}(e_{i,com}-e_{i,expl})+2\beta c_{i,T}(e_{i,expl}-1)>0. \tag{29}$$

And as $e^*_{i,com}=\frac{2\overline{c_{i,T}}}{3\theta\sqrt{b}}$, and $e_{i,expl}=(1-\beta)e^*_{i,com}$, we find the pure strategy and equilibrium that shows when the principal is indifferent between exploration and exploitation: $\beta = 2 - \frac{3\theta\sqrt{b}}{2\overline{c_{i,T}}}$,, and can say that it is optimal for the principal to play a commitment strategy if

$$\beta < 2 - \frac{3\theta\sqrt{b}}{2\overline{c_{i,T}}}, \tag{30}$$

and play exploration otherwise.