Corporate governance and product market competition : tree essays

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Corporate Governance and Product Market Competition: three essays

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This thesis is dedicated to my lovely family.

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Abstract

My thesis entitled "Corporate Governance and Product Market Competition: Three Essays" is a theoretical research in industrial organization. The primary objective is to investigate how product market (competition or collusion) interacts with the stakeholders' relationships under perfect information and with managerial incentives (static and dynamic) under imperfect information.

The first chapter examines how social concern and product market competition (Cournot vs. Bertrand) may influence the relationships (conflicting or conciliating) between main stakeholders (shareholders, consumers and employees). We consider two identical firms, both taking care of the interests of consumers in their objective functions and allowing their employees' wages be negotiated with labor unions. We show that social concern may reverse the traditional ranking between Cournot and Bertrand equilibria and that price competition (compared to quantity competition) can to some extent attenuate the shareholders' conflicts with both consumers and employees.

The second chapter investigates how managerial incentive payment under both adverse selection and moral hazard might interact with product market competition. We consider a Cournot oligopoly market consisting of n identical managerial firms, of which the initial marginal cost is the manager's private information and his unobservable effort *indirectly* reduces the initial level of marginal cost. We show with this setting that the optimal incentive payment solving informational problems is not necessarily influenced by product market competition.

The third chapter studies how the optimal contract between shareholder and manager

(solving repeated moral hazard) may influence the stability of a cartel. We consider a cartel consisting of two identical firms, within each a risk neutral shareholder offers a menu of contracts to a risk-averse manager who may shirk in each period. The manager's unobservable effort influences the firm's marginal cost (as in chapter 2). We show in contrary with the benchmark case (under perfect information) that the degree of risk-aversion plays no longer a role upon the stability of collusion. The implementation of the optimal long-term contract solves repeated moral hazard but also constrains the manager's discretion over the decision of market conduct (collusion, deviation, or competition).

CONTENTS

General Introduction

0.1 What is corporate governance?

Corporate governance generally concerns the top-level design of an organization and influences (directly or indirectly) the interests of shareholders and other stakeholders. As Hart (1995, p.678) claimed, corporate governance issues arise when "there is an agency problem, or conflict of interest, involving members of the organisation - these might be owners, managers, workers or consumers". According to Claessens (2006, p.91), "[good corporate governance] is associated with a lower cost of capital, higher returns on equity, greater efficiency, and more favorable treatment of all stakeholders". The statement of OECD (2015, p.9) has also emphasized that "Corporate governance involves a set of relationships between a company's management, ..., its shareholders and other stakeholders".

In fact, there have been various ways to define corporate governance, since it covers a wide range of academic interests. The studies on corporate governance[1] usually depart from two divergent perspectives, leading to a general categorization[2] of either stakeholder-orientation or shareholder-orientation (see e.g., Tirole, 2001, 2006; Allen et al., 2015).

[1]The studies on corporate governance also include discussions on the corporate scandals such as Enron. These corporate scandals involve many problems that are related to corporate governance. On one hand, the problem of lacking transparency is generated from agency problems, where there is asymmetric information between the principal (e.g., shareholders, monitoring authorities) and the agent (e.g., managers, firms). On the other hand, this reveals the fact that once the company is out of run, all stakeholders are victims.

[2]In other studies, corporate governance can also be categorized in terms of external and internal governance. External governance is closely linked to corporate finance, specifically how the company is financed (investment, debt, etc.), whereas internal governance refers to the possibility of influencing decisions within a company.

Stakeholder-orientation. Represented by Germany and Japan, corporate governance in terms of stakeholder-orientation is rather popular in Europe and some Asia countries. From a stakeholder-orientation perspective, corporate governance is connected with the treatment of stakeholders and the relationships between different stakeholders, specifically when corporate social responsibility is a main subject.

It refers to a wider set of mechanisms to coordinate the relationship between a corporation and its stakeholders such as shareholders, employees, consumers, etc. The idea of defending the interests of employees and consumers in addition to just shareholders in the manner of running a business was claimed by Dodd (1932, p. 1162) in the early 1930s that

> "[business] is private property only in the qualified sense, and society may properly demand that it be carried on in such a way as to safeguard the interests of those who deal with it either as employees or consumers even if the proprietary rights of its owners are thereby curtailed".

Zingales (1998, p.499) also carried the spirit of paying attention to stakeholders and gave a broader definition of corporate governance by referring to "the complex set of constraints that shape the *ex post* bargaining over the quasi-rents generated in the course of a relationship". According to Tirole (2001, p.4), corporate governance can also be regarded as "the design of institutions that induce or force management to internalize the welfare of stakeholders". Latter on, Claessens (2012, p.94) has expanded the definition of corporate governance as "being concerned with the resolution of collective action problems among dispersed investors and the reconciliation of conflicts of interest between various corporate claim-holders".

Shareholder-orientation. In contrast with the stakeholder-orientation, shareholder-oriented corporate governance aims at protecting the interests of shareholders (normally ignoring other stakeholders' interests). This has been the mainstream in Anglo-Saxon countries, represented by the US and the UK, subsequent to the birth of capitalism. According to Tirole, the concept of shareholder-oriented corporate governance was developed from the characteristics of a separation between ownership and control and could date back from Adam Smith (1776) to Berle and Means (1932).

The nature of the agency relationship between shareholders and managers predestinated a series of agency problems that depart from imperfect information [3] even no social responsibility (in terms of treating the interests of stakeholders) is recognized such that firms solely care about profit-maximizing. In the early thirties, the same time when Dodd (1932) claimed the idea of caring the interests of stakeholders, Berle (1931, p. 1049) argued with an opposite but classical attitude that:

> "[...] all powers granted to a corporation or to the management of a corporation, or to any group within the corporation, whether derived from statute or charter or both, are necessarily and at all times exercisable only for the ratable benefit of all the shareholders as their interest appears".

Such idea is in line with a more recent and widely used definition proposed by Shleifer and Vishny (1997), that corporate governance consists of mechanisms to ensure that suppliers of finance to corporations get a return on their investment. From this perspective, shareholder-orientation is often related to agency problem, where there is asymmetric information between the shareholder and the manager. It was also marked with incentive mechanisms by which

[3] Take the downfall of energy giant Enron for example, fraudulent claims on financial statements had been made by hiding information about bad investments, poor performing assets, as well as debts (borrowing money was not shown on financial statements). Moreover, false information such as over 1 billion dollars of non-existent income had been reported.

corporations and their managers are governed (e.g., Hart, 1983; Hermalin, 1992; Schmidt, 1997).

In this thesis, we interpret corporate governance as a set of institutional arrangements and designs in connection with specifically main stakeholders' relationships and managerial incentives, under which firms operate to take the interests of different stakeholders into account and to keep the agency problems under control. In particular, our interpretation of corporate governance involves the conflict of interest between different stakeholders (stakeholder-orientation) as well as managerial incentives under imperfect information (shareholder-orientation). We'll show with more precise explanations about the problems we study and review some closely related literature in the next section.

0.2 Corporate Governance and Product Market Competition

From an industrial organization approach, this thesis explores the interaction between corporate governance (as defined above) and product market[4] competition, which is devoted to the interdependence of firms, either in a non-cooperative or a cooperative manner.

Principally, we are interested in three individual questions: 1. how might the mode of competition (Cournot vs. Bertrand) influence the relationships between different stakeholders (specifically shareholders, employees, and consumers) when firms care about the interests of stakeholders by taking the interests of consumers into account in their objective functions and negotiating employees' wages with labor unions; 2. how product market competition in a Cournot fashion might influence the design of optimal incentives contract when the manager

[4]Corporate governance is also concerned with other normative framework, such as the legal system, the judicial system, financial markets, and factor (labor) markets (e.g., Claessens, 2006). In this thesis, we focus on the product market.

observes some information that the shareholder cannot observe (adverse selection) and/or the manager has some hidden actions that are unobservable and unverifiable to the others (moral hazard); 3. how dynamic contracts under imperfect information specifically repeated moral hazard might influence the stability of a cartel whose members are run by managers at the place of shareholders.

In the following content, we present sequentially the research backgrounds and the related literature of the three individual questions.

0.2.1 Stakeholders' Interests with Social Concern and Mode of Product Market Competition

Based on the previously-mentioned categorization of corporate governance, stakeholder-orientation was developed on grounds of corporate social responsibility (CSR) in the sense that firms should not just care about their own profit but should also commit to the interests of a broader community. The point is that extraordinary attention should be paid to the interests of stakeholders, especially consumers and employees in addition to shareholders.

Consumer-oriented firms. As stated by OECD (2015, p.9) that "Corporate governance also provides the structure through which the objectives of the company are set", it is thus necessary to reconsider the objective function of a firm in the top-level design of corporate governance. Such reconsideration of objective function was recognized by Goering (2007), Kopel and Brand (2012), Kopel and Lamantia (2016) and Planer-Friedrich and Sahm (2016). They argued from a socially responsible perspective in their model, in which a socially concerned firm cares about the interests of consumers in addition to the interest of shareholders in its objective function. In this thesis, we follow their setting and emphasis the role of consumers in such alternative objective function by naming these firms as consumer-oriented (CO) firms.

Kopel and Brand (2012) showed with a duopoly consisting of a CO firm and a profit-maximizing firm that the CO firm captures a higher market share and obtains even higher profit if both firms have the same unit production cost. They also showed a non-monotonic relationship between the weight put on consumer surplus by the CO firm and its profit: an increasing weight put on consumer surplus first increases and then decreases the CO firm's profit. They argued that taking the stakeholders' interests into account can be profitable strategies but too much care put on stakeholders will turn to be harmful.

Labor union. The main activity of labor union centers on collective bargaining with firms over wages of their members (the employees). Since labor union plays an important role in defending the interests of employees, which are one of the main stakeholder groups of a business, it is thus necessary to consider the participation of labor union in the research of corporate governance in the direction of stakeholder-orientation. Earlier literature about collective wage bargaining such as Naylor (2002), Dhillon and Petrakis (2002), Lopez and Naylor (2004) studied the results of wage bargaining with profit-maximizing firms. As far as we know, the participation of labor union in a wage bargaining game is not yet studied with CO firms.

Stakeholders' relationships. Corporate governance in the sense of stakeholder-orientation strives to harmonize conflict of interests between different stakeholders, since this is critical to the success of a business in a competitive environment. However, in the existing literature that links corporate governance with product market competition (e.g., Mayer, 1997; Allen et al., 2015; Oh and Park, 2016), little attention is paid on how product market competition may influence the relationship between different stakeholders. Moreover, the definition of stakeholders' relationships in terms of conciliating or conflicting is not formally clear. In chapter

1, we'll propose a definition on conciliating interests and conflicting interests between different stakeholders and a measurement on the extent of conflict is also provided for further studies.

Cournot vs. Bertrand. The former describes the way of competition by which firms set on the quantities of the products they will produce whereas the latter describes the way of competition by which firms set on the prices of the products[5]. They are two classical modes of competitions and are often studied in pairs in industrial organization. In the first chapter, we make a static comparison between Cournot competition and Bertrand competition to investigate the effect of mode of competition upon the relationships of main stakeholders. A closely related literature is by Lopez and Naylor (2004), who showed through a decentralized wage-bargaining setting that the ranking of Cournot and Bertrand profits, but not that of total welfare, is reversed when labor unions have sufficient bargaining power and put sufficient weight on wages in their utility function. In contrast, we will show in chapter 1 that the consumer-orientation mechanism as an alternative mechanism may also reverse the equilibria and may even reverse the total welfare which is beyond the influence of wage-bargaining mechanism. We'll also the effect of the mode of competition (Cournot vs. Bertrand) upon the relationships between different stakeholders (specifically shareholders, employees, and consumers).

0.2.2 Managerial Incentives and Non-cooperative Behavior

The academic thinking on managerial incentives departs from the separation between ownership and control, where the managers who take the responsibility of a delegation may not act in the best interests of the shareholders who normally provide the funds. This may partly because the managers usually prioritize their own interests which may not necessarily be the

[5]Both modes of competition assume that firms' decisions on quantity or price are independent of one and the other and firms decide at the same time.

same as that of the shareholders (profit-maximization) and partly because the managers are normally not scrutinized too closely, leading to a number of corporate problems that are related to delegation and informational issues.

Through a history review of corporate governance in the United States, Holmström and Kaplan (2001) observed the that

> "Ever since the 1930s, management incentives had become weaker as corporations had become larger, management ownership had shrunk and shareholders had become more widely dispersed. No one watched management the way J.P. Morgan and other large investors did in the early part of the twentieth century. Boards, which were supposed to be the guardians of shareholder rights, mostly sided with management and were ineffective in carrying out their duties. "

This is a typical evidence on corporate governance from a shareholder-orientation perspective, in which the separation between ownership and control in a shareholder-manager relationship leads to managerial inefficiency, which damages the interests of shareholders. As Hart (1995, p. 681) argued

> "Because of the separation of ownership and control, and the lack of monitoring, there is a danger that the managers of a public company will pursue their own goals at the expense of those of shareholders (we suppose that the latter are interested only in profit or net market value). Among other things, managers may overpay themselves and give themselves extravagant perks; they may carry out unprofitable, but power-enhancing investments; they may seek to entrench themselves. In addition, managers may have goals that are more benign but that are still inconsistent

with value maximisation. They may be reluctant to lay off workers that are no longer productive. Or they may believe that they are the best people to run the company when in fact they are not."

Adverse selection. In contract theory, adverse selection is used to categorize principal-agent models in which an agent has some private information (only the agent can observe such information while the others cannot observe it) before the contract is written (see e.g., Laffont and Martimort, 2002). As one of the conventional informational problems, adverse selection widely exists in an agency relationship such as between shareholders and managers. Stiglitz (1977) and Baron and Myerson (1982) both considered the case of monopoly where the productivity of managerial effort can only be observed by the manager himself. They showed that for the most productive type of manager, the first best level of effort can be induced by the optimal contract whereas for all the less productive types of managers, there is a downward distortion of managerial effort. In contrast to the monopoly case, Etro and Cella (2013) showed with an oligopoly that the relationship between competition (measured by the number of firms) and induced effort of the manager is inverted U-shaped. In chapter 2, we'll show the design of optimal managerial incentive contract, which solves the problem of adverse selection. A comparison between a monopoly case and a duopoly case will also be provided to show the impact of product market competition.

Moral hazard. As another conventional informational problem, moral hazard also frequently exists in a shareholder-manager mode of agency relationship. According to Holmström (1979), moral hazard describes a situation in which unverifiable information or hidden action occurs. It widely exists in an agency relationship with all kinds of forms. As Tirole (2006, p.15) has observed:

> "... moral hazard comes in many guises, from low effort to private benefits, from inefficient investments to accounting and market value manipulation ..."

In the classical models of contract theory, the moral hazard problem arises when the unverifiable information or hidden action affects the probability distribution of the outcome. The contract is signed before the agent chooses a hidden action (e.g. an effort level) and the outcome is revealed after the agent has chosen the action. Although moral hazard is unobservable and unverifiable, it is not an unsolvable problem. Tirole (2006, p.15) found that:

> "Two broad routes can be taken to alleviate insider moral hazard. First, insiders' incentives may be partly aligned with the investors' interests through the use of performance-based incentive schemes. Second, insiders may be monitored by the current shareholders (or on their behalf by the board or a large shareholder), by potential shareholders (acquirers, raiders), or by debtholders".

In chapter 2, we consider the use of performance-based incentive schemes to alleviate moral hazard. We'll show the design of optimal managerial incentive contract at the presence of solely moral hazard and at the presence of both moral hazard and adverse selection. A study on the effect of product market competition upon managerial incentives is also presented.

Managerial slack and product market competition. Some related literature (e.g., Martin, 1993; Schmidt, 1997; Aghion et al., 2005) is interested in how efficiency in the sense of reducing managerial slack or enhancing managerial effort can be improved by the intensity of product market competition. An earlier paper of Hart (1983) showed that managerial slack could be reduced by the pressure in the competitive market and that "the market mechanism itself acts as a sort of incentive scheme ". The theoretical research on the relationship between product market competition and managerial incentive effort can date back to Leibenstein (1966, p.413), who argued that

> "[...] for variety of reasons people and organizations normally work neither as hard nor as effectively as they could. In situations where competitive pressure is light, many people will trade the disutility of greater effort, of search, and the control of other peoples' activities for the utility of feeling less pressure and of better interpersonal relations. But in situations where competitive pressure are high, and hence the costs of such traders are also high, they will exchange less of the disutility of effort for the utility of freedom from pressure, etc. "

Other literature such as Bertoletti and Poletti (1997) focused on the informational effect of competition and argued that a competitive environment provides more information to counter the moral hazard problem and makes optimal incentive contracts more feasible. The link between managerial effort and competition is also studied by focusing on the relevant information structure, in the sense that the contract between the shareholder and the manager of a firm is not observed by its rival firms before the contract is proposed (e.g., Piccolo et al., 2008).

0.2.3 Managerial Incentives and Cooperative Behavior

Collusion usually takes place within an oligopolistic market, where the behavior of a few firms can significantly influence the market as a whole. Firms interact cooperatively to maximize their collective profits by means of price-fixing, limiting supplied quantity, or other restrictive practices, and thus form a group of cartel. Theoretical insights will help us to understand why cartel activity is a matter of agency and governance issues.

Managerial incentives and collusive behavior. Derived from the separation between ownership and control, some literature such as Lambertini and Trombetta (2002) and Spagnolo (2000, 2005) highlighted the case where the market conduct decision (collude, deviate or compete) was made by the manager at the place of the shareholder. The manager-led firms maximize an alternative objective function, which is the manager's utility function at the place of strict profit-maximization. However, information was considered to be perfect in this quoted literature. Other theoretical research such as Aubert (2009) and Han and Zaldokas (2014) considered the linkage between firms' vertical managerial incentive contracts and horizontal collusive behavior when information is not perfect. Aubert (2009) argued that neglecting internal incentive issues would lead to an underestimation of the welfare losses, which are due to collusion and that the manager might substitute collusion for effort-making to achieve the same target (higher profit). Han and Zaldokas (2014) compared the consequences between a fixed compensation setting and a variable compensation setting and showed that a fixed salary short-term contract (paid at each period) works as an incentive scheme for the manager and slightly increases the cartel stability.

Repeated moral hazard. Earlier papers such as Rubinstein and Yaari (1983) and Radner (1981) showed that in the absence of discount factor, both the principal and the agent would realize payoffs in the first best level, implying no loss of efficiency that is due to repeated moral hazard. Radner (1985) showed with both principal and agent discount the future that the first best solution is approximately achievable only if the discount rate is close to one. This result is in line with Laffont and Martimort (2002). Ohlendorf and Schmitz (2012) found with a two-period moral hazard model that the incentive contract could act as carrot and stick. They showed that the manager would not make as much effort as the first-best level if the incentive compensation was not high enough.

As for the memory-exhibition characteristics, it is well known that the optimal dynamic contract exhibits memory in a repeated model: the optimal contract in any period will depend non-trivially on the entire previous history of the relationship (e.g., Lambert, 1983; Rogerson, 1985a). According to Rogerson (1985a, p72), "if an outcome plays any role in determining current wages it must necessarily also play a role in determining future wages". Technically, however, it is not easy to examine the collusive behavior following their models. Fuchs (2007) also considered an infinitely repeated model with memory but in the absence of a tractable recursive structure.

Spear and Srivastava (1987) studied dynamic contract with a recursive setting[6] and proved the existence of a simple representation of the contract that avoided the intractabilities associated with history-dependence[7]. They also showed that the optimal contracting problem of an infinitely repeated agency model could be reduced to a simple two-period constrained optimization problem. In chapter 3, our model reinterprets the recursive setting of Spear and Srivastava (1987) with a two-effort-two-outcome model. We'll show the design of dynamic contracts to solve repeated moral hazard of the manager in a long-term shareholder-manager relationship and investigate the stability of a cartel whose members are run by such managers.

0.3 Thesis Outline

Three chapters dealing with the above-mentioned subtopics of corporate governance and product market competition are presented in this thesis. Each chapter corresponds to an essay

[6] Mele (2014) provided technical support for the recursive setting in a dynamic contracting game.

[7] Fuchs (2007) also considered an infinitely repeated model with memory but in the absence of a tractable recursive structure.

and can be read independently one from another.

Chapter 1 is based on the categorization of stakeholder-orientated corporate governance. Entitled "Stakeholders' relationships influenced by Social Concern and Product Market Competition", this chapter is inspired from the Principles of Corporate Governance (OECD, 2015), where the importance of the interests of employees and other stakeholders (e.g., consumers) has been recognized in contributing to the performance and success of a company. In this chapter, we focus on the nature of relationships (conflicting or conciliating) between main stakeholders (shareholders, consumers and employees) when firms are required to take some extent of social responsibility. We examine how social concern and the mode of product market competition (Cournot vs. Bertrand) may play a role in influencing their relationships.

We consider two identical firms, both required to be socially concerned in the sense of taking care of the interests of consumers in their objective functions and allowing their employees' wages be negotiated with labor unions. We apply a two-stage game, where the employee's salary is negotiated with the labor union at the first stage and the CO firms are engaged in a Cournot or Bertrand competition at the second stage. The wage-bargaining (centralized or decentralized) mechanism and consumer-oriented mechanism work to bind together the interests of shareholders, employees, and consumers.

In the case of centralized bargaining, our model shows that social concern (in the sense of taking care of the consumer surplus when determining product market strategies) may reverse the traditional ranking between Cournot and Bertrand equilibria. Our model also shows that price competition (compared to quantity competition) can to some extent attenuate shareholders' conflicts with both consumers and employees that are provoked by social concern (the consumer-oriented mechanism).

In the case of decentralized bargaining, we introduce another measurement on conflict and affirm that product differentiation plays an important role in determining the extent of conflict between shareholders and other key stakeholders. We show that an increasing degree of product differentiation moderates the shareholder's conflict with the consumers, but at the same time exacerbates the shareholder's conflict with the employees.

Chapter 1 contributes to the existing theoretical research on stakeholder-oriented corporate governance by: i). clarifying a formal definition of conflict/conciliation of interest; ii). proposing a formal measurement on the extent of conflicting interest that is due to some external factor; iii). exploring the effect of product market competition (Cournot vs. Bertrand) on the extent of conflict between different main stakeholders.

Starting from chapter 2, we turn to study corporate governance in a shareholder-orientation perspective. Social concern in terms of stakeholder protection is temporally ignored, given that even no social responsibility is recognized in a firm's strategy (the objective function is profit-maximizing), there is still a series of problems such as informational problems that are associated with the effectiveness of corporate governance.

Chapter 2, entitled "Managerial incentives and product market competition"is built on the categorization of shareholder-orientation. This chapter is based on the existing literature such as Martin (1993), Horn et al. (1994), and Piccolo et al. (2008) which have taken both informational problems and product market competition into account. In this chapter, corporate governance is investigated through the design of the optimal managerial incentive contract, which deals with principally the agency problems between the shareholder and the manager.

We consider a Cournot oligopoly market consisting of n identical managerial firms with separated ownership and control. Each firm is concerned with cost-reducing activities and each firm's initial marginal cost is the manager's private information that cannot be observed by the shareholder (adverse selection). Different with the classical principal-agent model (e.g., Laffont and Martimort, 2002), we assume that the production level is rather a result of interaction with the rivals' behavior in the product market instead of a fixed exogenous outcome. Moreover, different with the setting of Martin (1993), Horn et al. (1994), and Piccolo et al. (2008), we let the manager's unobservable and unverifiable effort *indirectly* reduce the initial marginal cost through the likelihood of realizing a good performance. In other words, we let the extent of cost reduction replace the output to be a stochastic variable whose probability of distribution is influenced by managerial effort.

While many theoretical studies as mentioned above assess that managerial incentives are related to the product market competition, our model shows that the optimal incentive payment solving informational problems may not necessarily be influenced by product market competition. This is because the imposed incentive compatible constraint, moral hazard constraint, and participation constraint all work on the *utilities* of the manager. Dy definition as in the classical principal-agent model, the utility of the manager is strategically chosen by the shareholder and more importantly, it does not depend on product market competition.

Chapter 2 contributes to the existing theoretical research on managerial incentives (at the presence of informational problems) and product market competition from a shareholder-orientation perspective of corporate governance by: i). switching the moral hazard impact from the output level (which is a classical setting) to the marginal cost level; ii). liberating the output level as a result of competition with rival firms; iii). providing an exhaustive analysis on the characteristics of the optimal contract with the new settings.

Chapter 3 entitled "Cartel Stability and Managerial incentive contract with Repeated Moral

Hazard "is also based on the categorization of shareholder-orientation. Motivated by the fact that hidden action of the manager in a long-term manager-shareholder relationship may occur more than just once, we consider a repeated dynamic game in an infinite horizon. By considering the anticompetitive behavior of cartels driven by top managers at the place of shareholders themselves, we address the interaction between firms' horizontal collusive behavior and the vertical managerial incentive contracts. The objective of this chapter is to study how the optimal contract (solving repeated moral hazard) may influence the stability of a cartel, whose members are led by managers.

We consider a cartel consisting of two identical firms. Within each firm, a risk neutral shareholder offers a menu of contracts to a risk-averse manager. The manager practices an unobservable effort in each period of a long-term shareholder-manager relationship. Different from the standard setting, we let the managerial effort work to increase the likelihood of realizing a certain level of marginal cost at the place of a certain level of production. The shareholder can only observe the outcome, which is either a high or a low marginal cost.

Before introducing the solution of the optimal dynamic contract, we consider a benchmark case based on Spagnolo (2005) where the information is perfect. We show that the degree of risk-aversion plays an important role upon the sustainability of collusion: the more the manager is risk-averse, the more stable a cartel would be. Intuitively, this is because deviation means supporting more risk which is costly to the manager. However, when information is imperfect, specifically when repeated moral hazard is a concern, we show that the manager's preference over risk plays no longer a role upon the stability of a manager-led cartel. With the optimal contract implemented, the manager's repeated moral hazard is solved through a restriction over his actual and future utilities. This optimal design also restricts the manager's discretion of the decision on market conduct.

Chapter 3 contributes to the existing theoretical literature on repeated moral hazard with discounting and literature on cartel stability by i). linking the two branches of theoretical research; ii). investigating the stability of a manager-led cartel where the manager practice hidden action repeatedly in a long-term shareholder-manager relationship; iii). exploring the role of risk-aversion of the manager upon the stability of a manager-led cartel.

CHAPTER 1

STAKEHOLDERS' RELATIONSHIPS INFLUENCED BY SOCIAL CONCERN AND PRODUCT MARKET COMPETITION

1.1 Introduction

Consumer welfare, often measured by consumer surplus, plays an important role in firms' strategies in modern economies. The importance of consumer welfare in addition to that of shareholders has been typically emphasized through the reinforcement of corporate social responsibility and the development of consumer-oriented strategies. On one hand, the commitment to consumer surplus reflects a firm's social concern (e.g., Kopel and Brand, 2012; Kopel and Lamantia, 2016; Planer-Friedrich and Sahm, 2016); on the other hand, being altruistic to consumers helps to enhance the stability of a business (e.g., Deshpande et al., 1993).[1] As Allen et al. (2015) claimed, having an alternative objective function to profit-maximizing might increase the value of the firm in an oligopolistic industry.[2]

Consumers, employees and shareholders are the three essential groups of stakeholders for a firm's success (see e.g., Snider et al., 2003), where the two former ones are typically regarded as apt to have interests which conflict those of the latter.[3] According to McAdam and Leonard (2003), sacrificing the interests of internal stakeholders to meet social demands may lead to

[1] In their empirical work, Deshpande et al. (1993) showed that the degree of consumer consideration and business performance are positively correlated.

[2] The objective of solely maximizing profit might be too narrow in a stakeholder society.

[3] For example, when employees benefit from higher wages or when consumers benefit from lower prices, this could imply conflicts with shareholders.

undesirable consequences in labor relations. In other words, if firms care about consumers' interests, this may lead to an unpleasant relationship with employees. However, how to define a conflict of interests between different stakeholders is not unambiguously clear.

While one of the major concerns of corporate governance is about harmonizing the interests between different stakeholders[4], little theoretical work of corporate governance has been done on the issue of stakeholders' relationships (conflicting interests or conciliating interests) and its interaction with the mode of product market competition (Cournot *vs.* Bertrand).

In this chapter, we focus on consumer-oriented (denoted as CO) strategies when firms internalize consumer welfare in their objective function in addition to shareholder's profit,[5] and we consider a wage bargaining setting prior to a Cournot/Bertrand competition mode.[6] A two-stage game is developed as follows: in the first stage (bargaining stage), the CO firms bargain with a centralized labor union over wages; in the second stage (competition stage) the CO firms engage in a Cournot or a Bertrand competition. We propose a definition of conflicting/conciliating relationships between stakeholders. This definition is applied to investigate the relationship between the main stakeholders (shareholders, consumers and employees) when the firm puts different weights on consumers' interest in its objective function and when the wage-bargaining power of the firm is altered. Moreover, we propose a measurement of the intensity of the conflicts between different stakeholders and compare the extent of conflict between different modes of competition (Cournot *vs.* Bertrand) so as to examine under which mode of

[4]Tirole (2006, p. 59) also emphasized the idea of caring about stakeholders by claiming that "...a key argument for regulatory intervention in the eyes of the proponents of the stakeholder society has to do with tilting the balance of bargaining power away from investors and toward stakeholders".

[5]This broader objective function was interpreted as being socially responsible (e.g., Kopel and Brand, 2012; Lambertini and Tampieri, 2015) or being altruistic (e.g., Lakdawalla and Philipson 2006; Philipson and Posner 2009; Willner, 2013) in former literature.

[6]The Bertrand [Cournot] model is a better approximation of market competition if output and capacity can [cannot] be easily adjusted: industries like software, insurance, and banking whose capacities or output levels are adjusted more rapidly than prices are approximated with the Bertrand model, whereas industries like wheat, cement, steel, cars, and computers whose capacity is difficult to adjust are approximated with the Cournot model (Mauleon and Vannetelbosch, 2003).

competition, the main stakeholders may get along with each other harmoniously.

The well-known finding concludes that Bertrand competition leads to larger consumer surplus and larger total welfare than Cournot competition (e.g., Singh and Vives, 1984; Cheng, 1985; Vives, 1985). When goods are substitutes, the equilibrium profits will no doubt be higher in Cournot than in Bertrand competition. In this chapter, we demonstrate that taking care of consumers may reverse this hierarchy so that Cournot competition may then become more efficient (higher consumer surplus and higher total welfare) than Bertrand competition for a certain range of consumer-orientation degrees.

Moreover, our model shows that the consumer-orientation mechanism generates conflicts between shareholders and consumers. However, the conflicting relationship between shareholders and consumers may be transformed into a conciliating relationship with an increasing wage-bargaining power of the firm. We also show that the conflicting relationship of another pair, between employees and consumers, may also turn out to be conciliating when the firm is sufficiently consumer-oriented. Further, our model shows that the conflicts between both shareholders and consumers and between shareholders and employees are attenuated under Bertrand competition as compared to Cournot competition.

Related Literature. This chapter is closely related to the literature about Corporate Social Responsibility. In theoretical research, firms maximizing profit plus a certain weight of consumer surplus are often viewed as being socially concerned (e.g., Goering, 2007; Kopel and Brand, 2012; Kopel and Lamantia, 2016; Planer-Friedrich and Sahm, 2016). Stakeholders can be seen as a wide range of parties including consumers to impose different responsibilities (e.g., Papasolomou et al., 2005) on business organizations whose ability of balancing stakeholders' relationships decides the effectiveness of CSR[7] (see e.g., Uhlaner et al., 2004).

This chapter is also related to the literature about collective wage bargaining. In earlier literature, the bargaining game usually takes place in profit-maximizing firms (e.g., Naylor, 2002; Dhillon and Petrakis, 2002; Lopez and Naylor, 2004) so that the role of being altruistic towards consumers was not an issue in wage bargaining settings. Through a decentralized wage-bargaining setting, Lopez and Naylor (2004) showed that the ranking of Cournot and Bertrand profits, but not that of total welfare, is reversed when labor unions have sufficient bargaining power and put sufficient weight on wages in their utility function. In this chapter, however, we show through a centralized wage bargaining setting that the consumer-orientation mechanism instead of the wage bargaining mechanism may also reverse the equilibria and that both the equilibrium profit and total welfare are reversible.

In the existing literature on corporate governance and product market competition (e.g., Mayer, 1997; Allen et al., 2015; Oh and Park, 2016), little has considered consumer-oriented strategies and wage-bargaining mechanisms which may influence the relationship between different stakeholders and further get in touch with product market competition. Even if shareholders may have conflict with other stakeholders who have alternative objectives rather than profit-maximizing, Allen et al. (2015) show under Cournot competition that stakeholder-oriented firms which are concerned with employees can be more valuable than profit-maximizing firms. Oh and Park (2016) study the effect of the intensity of competition within the product market upon the manager's stock ownership. We depart from these approaches by considering the impact of two mechanisms (wage bargaining and consumer awareness) upon the welfare of shareholders and stakeholders. This chapter contributes to the previously mentioned literature

[7] Actually, CSR is not just about caring on consumers (see e.g., Lambertini and Tampieri, 2015, who consider the case where CSR firms internalize environmental effects in their strategies).

by proposing a measurement of the extent of the conflicts between different stakeholders as well as examining how the intensity of these conflicts interacts with different modes of competitions, specifically Cournot and Bertrand competitions.

Outline. Chapter 1 is organized as follows. Section 1.2 introduces the basic model and compares the characterization of Cournot and Bertrand equilibria. Section 1.3 proposes the definition of the relationship (conflicting and conciliating) and the measurement of conflict between the two groups of stakeholders. Section 1.4 is devoted to the influence of the competition mode on the main stakeholders' relationships. Section 1.5 studies the stakeholders' relationships under decentralized wage bargaining by emphasizing the role of product differentiation. Section 1.6 extends the model by setting the weight on consumers be endogenous and considers the delegation case with incentive schemes. Section 1.7 gives some concluding remarks of this chapter.

1.2 The Firm Influenced by Social Concern

1.2.1 A simple model of consumer-orientated firm with wage bargaining

We consider a symmetric duopolistic industry composed of two firms (i and j). Firm i produces product i with quantity x_i and firm j produces product j with quantity x_j ($i, j = 1, 2$, $i \neq j$). Both firms are either quantity setters (Cournot competition) or price setters (Bertrand competition) and there is no entry in the industry. The representative consumer's utility (see e.g., Singh and Vives, 1984) is a symmetric-quadratic function of the two products as follows

$$u\left(x_i, x_j\right) = \alpha\left(x_i + x_j\right) - \frac{1}{2}\left(x_i^2 + 2\gamma x_i x_j + x_j^2\right),$$

where $\gamma \in]0,1[$ represents the degree of substitutability between both products.[8] This utility function gives rise to the following inverse and direct demands for good i:

$$p_i = \alpha - x_i - \gamma x_j \quad \text{and} \quad x_i = \frac{\alpha}{1+\gamma} - \frac{1}{1-\gamma^2}p_i + \frac{\gamma}{1-\gamma^2}p_j.$$

Consumer surplus is thus written as

$$CS = \frac{1}{2}x_i^2 + \gamma x_i x_j + \frac{1}{2}x_j^2.$$

Following Goering (2007) and Kopel and Brand (2012), we assume that a CO firm maximizes the sum of profit and a share of the consumer surplus. This share may be interpreted as reflecting either the level of altruism towards consumers (Lakdawalla and Philipson, 2006 or Philipson and Posner, 2009) or the level of social responsibility (Kopel and Brand, 2012). The objective function of a CO firm i (V_i) is the sum of profit (π_i) and a share (θ) of the consumers surplus (CS), i.e.,

$$V_i = \pi_i + \theta CS, \tag{1.1}$$

where the parameter $\theta \in [0,1]$ is the weight the firm puts on consumer surplus in addition to profits (the degree of altruism towards consumers). To keep the profit of the firm positive at equilibrium we restrict the domain of θ between zero and $\tilde{\theta}$: $\theta < \tilde{\theta}(\gamma) = \frac{1}{1+\gamma}$.

We let the CO firms bargain with a central union. Given fixed union membership, the union is of a utilitarian type which maximizes the sum of its (risk-neutral) members' utilities (see e.g. Petrakis and Vlassis, 2004; Oswald, 1982). Supposing that the outside option (reservation wage $\bar{w}$) is the same for employees of the two firms, the utility function of the centralized labor union is written as $U = (w_i - \bar{w})\, l_i + (w_j - \bar{w})\, l_j$.

[8]We exclude the case where goods are complements, i.e., $\gamma \in]-1,0[$, so as to make our comparison with the mentioned literature clearer.

In a centralized bargaining game, $w_i = w_j \equiv w$. Assume that both CO firms adopt a constant returns-to-scale technology, thus one unit of labor l_i is turned into one unit of the output x_i. The utility function of the labor union is rewritten as

$$U = (w - \bar{w})(x_i + x_j). \tag{1.2}$$

The wage (w) is the result of bargaining, i.e., the solution of a Nash bargaining problem[9] between a central union and the sum of local firms: $w = \arg\max \left\{ B = U^{\beta} V^{1-\beta} \right\}$, where $V = V_i + V_j$ and $\beta \in [0, 1]$ represents the union's Nash bargaining power. We consider that labor costs capture all short-run marginal costs (see e.g., Lopez and Naylor, 2004) such that the profit[10] of firm i writes $\pi_i = (p_i - w) x_i$. Later on, in section 1.5, we will study the case of decentralized wage bargaining.

The timing of a two-stage game is as follows. In the first stage (bargaining stage), the industry-level wage is decided by the negotiation between CO firms and the central labor union. In the second stage, each CO firm chooses its quantity (Cournot competition) or its price (Bertrand competition) after observing the wage contract.

1.2.2 Equilibria comparison and characterization

We start by solving the last stage, first under Cournot competition, and then under Bertrand competition.

Cournot competition. Given the rival's quantity and the wage defined at the first stage, firm i chooses x_i in order to maximize V_i : $\max_{x_i} V_i(x_i, x_j, w) = (p_i - w) x_i + \theta CS$.

[9]For a wage bargaining game with an alternative nonprofit maximizing objective (public firm), see Haskel and Sanchis (1995).

[10]Of course, the condition $0 < w < \alpha$ is necessary in this model.

The resulting reaction function is

$$x_i\left(x_j\right) = \frac{1}{2-\theta}\left[\alpha - w - \gamma\left(1-\theta\right)x_j\right], \tag{1.3}$$

where the quantity also refers to the employment. The Cournot competition game (denoted with subscript "C" thereafter) is played in strategic substitutes since the reaction functions are downward-sloping ($\frac{\partial x_i}{\partial x_j} < 0$).

Solving the system of reaction functions (1.3), we obtain quantity as a function of the wage (denoted as w^C) which is previously negotiated:

$$x_i\left(w^C\right) = x_j\left(w^C\right) = \frac{\alpha - w^C}{1+\left(1+\gamma\right)\left(1-\theta\right)}. \tag{1.4}$$

The higher the wage is, the less a firm produces. Then, it is straightforward to derive respectively the labor union's utility and the total value of the CO firms:

$$U\left(w^C\right) = \frac{2\left(w^C - \bar{w}\right)\left(\alpha - w^C\right)}{1+\left(1+\gamma\right)\left(1-\theta\right)} \quad \text{and} \quad V\left(w^C\right) = \frac{2\left(\alpha - w^C\right)^2}{\left[1+\left(1+\gamma\right)\left(1-\theta\right)\right]^2}.$$

Bertrand competition. Given the rival's price and the wage negotiation (first stage), each firm i chooses p_i in order to maximise V_i : $\max\limits_{p_i} V_i\left(p_i, p_j, w\right) = \left(p_i - w\right)x_i + \theta CS$. The first-order condition gives the reaction function

$$p_i\left(p_j\right) = \frac{1}{2-\theta}\left[\gamma\left(1-\theta\right)p_j + w + \alpha\left(1-\gamma\right)\left(1-\theta\right)\right]. \tag{1.5}$$

The Bertrand competition game (denoted with subscript "B" thereafter) is played in strategic complements (reaction functions are upward-sloping).

Solving the system of reaction functions (1.5), we obtain the price as function of the wage (denoted as w^B for the Bertrand game):

$$p_i\left(w^B\right) = p_j\left(w^B\right) = \frac{\alpha\left(1-\gamma\right)\left(1-\theta\right) + w^B}{1+\left(1-\gamma\right)\left(1-\theta\right)}. \tag{1.6}$$

The higher the wage is, the higher the prices firms charge. It follows that the labor union's utility and the total value of the CO firms are respectively

$$U\left(w^B\right) = \frac{2\left(w^B - \bar{w}\right)\left(\alpha - w^B\right)}{(1+\gamma)\left[1 + (1-\gamma)(1-\theta)\right]} \text{ and } V\left(w^B\right) = \frac{2\left(\alpha - w^B\right)^2(\theta\gamma + 1 - \gamma)}{(1+\gamma)\left[1 + (1-\gamma)(1-\theta)\right]^2}.$$

Now, let us turn back to the first stage where the wage bargaining game takes place between CO firms and the central labor union. The Nash-bargained equilibrium wage (w) solves

$$w = \arg\max\left\{B = U^\beta V^{1-\beta}\right\}. \tag{1.7}$$

The anticipated output under Cournot competition and the anticipated price under Bertrand competition are given by (1.4) and (1.5). Solving (1.7) for each competition game yields (see appendix A.1 for detailed proof):

$$w^B = w^C = \bar{w} + \frac{\beta}{2}(\alpha - \bar{w}) \equiv w^*.$$

The equilibrium wage is the same under Cournot and Bertrand competition. This result is in line with Dhillon and Petrakis (2002), Mauleon and Vannetelbosch (2003) and Correa-López (2007). Since the wage bargaining game takes place at the industry-level, the wage spillover effects are internalized, and thus vanish. The effect of bargaining works through the overall level of industry demand. It is worth noting that the equilibrium wage is independent of θ and γ.[11]

[11]The same result is obtained by Dhillon and Petrakis (2002) for profit-maximizing firms.

The equilibrium values are reported in Table 1.

	Cournot	Bertrand
w^*	$\bar{w}+\frac{\beta}{2}(\alpha-\bar{w})$	$\bar{w}+\frac{\beta}{2}(\alpha-\bar{w})$
x^*	$\frac{\alpha-w^*}{1+(1+\gamma)(1-\theta)}$	$\frac{\alpha-w^*}{(1+\gamma)[1+(1-\gamma)(1-\theta)]}$
p^*	$\frac{\alpha[1-(1+\gamma)\theta]+(1+\gamma)w^*}{1+(1+\gamma)(1-\theta)}$	$\frac{\alpha(1-\gamma)(1-\theta)+w^*}{1+(1-\gamma)(1-\theta)}$
π^*	$\frac{[1-(1+\gamma)\theta](\alpha-w^*)^2}{[1+(1+\gamma)(1-\theta)]^2}$	$\frac{(1-\gamma)(1-\theta)(\alpha-w^*)^2}{(1+\gamma)[1+(1-\gamma)(1-\theta)]^2}$
CS^*	$\frac{(1+\gamma)(\alpha-w^*)^2}{[1+(1+\gamma)(1-\theta)]^2}$	$\frac{(\alpha-w^*)^2}{(1+\gamma)[1+(1-\gamma)(1-\theta)]^2}$
U^*	$\frac{(w^*-\bar{w})(\alpha-w^*)}{1+(1+\gamma)(1-\theta)}$	$\frac{(w^*-\bar{w})(\alpha-w^*)}{(1+\gamma)[1+(1-\gamma)(1-\theta)]}$

Table 1. Equilibrium values under Cournot and Bertrand competition

Observing the Cournot equilibrium profit, one can deduce that a necessary and sufficient condition for $\pi^{C*}>0$ is $\theta<\frac{1}{1+\gamma}=\tilde{\theta}(\gamma)\equiv\tilde{\theta}$. The hierarchy of equilibrium values according to the competition mode is given in the following proposition.

Proposition 1.2.1 *The weight that a firm assigns to the consumer surplus changes the hierarchy of equilibria between Cournot and Bertrand competition:*

i) if $\theta \in \left[0,\gamma\tilde{\theta}\right[$, $\pi^{C*}>\pi^{B*}$ *and* $CS^{C*}<CS^{B*}$;

ii) if $\theta \in \left[\gamma\tilde{\theta},\tilde{\theta}\right[$, $\pi^{C*}\leqq\pi^{B*}$ *and* $CS^{C*}\geqq CS^{B*}$.

Proof. See appendix A.2. ■

Part (i) of this proposition suggests that the hierarchy of the equilibria (profit and consumer surplus) between Cournot competition and Bertrand competition when relatively low weight is put on consumer surplus is in line with the traditional hierarchy, in which firms maximize profit: firms benefit from larger profits under Cournot competition than under Bertrand competition and the consumer surplus is larger under Bertrand competition than under Cournot competition (when goods are substitutes). Part (ii) of this proposition suggests that the traditional hierarchy of the equilibria (profit and consumer surplus) between Cournot and Bertrand competition for the equilibria is reversed, when sufficiently high weight is put on consumer surplus.

Actually, the possibility of reversing the equilibria (profit and consumer surplus) between Cournot and Bertrand competitions can also be obtained for profit-maximizing firms through a decentralized wage-bargaining mechanism when unions are sufficiently powerful and the reason of the reversed hierarchy was due to wage bargaining (Lopez and Naylor, 2004). In this chapter, we identify the CO mechanism as another cause of the reversible result. Intuitively, when a CO firm puts too much weight on consumers, it will no longer charge sufficiently low prices as a profit-maximizing firm does in a Bertrand competition, since the consumers will not be better off. With higher prices, the Bertrand profit exceeds the Cournot profit.

Since the two CO firms are perfectly symmetric, the social welfare function ($W = 2\pi + CS + U$) at equilibrium is equivalent to

$$W(x) = 2(\alpha - \bar{w})x - (1+\gamma)x^2.$$

Substituting $x = x^C$ for the Cournot case and $x = x^B$ for the Bertrand case in the above expression, one can obtain $W(x^C) - W(x^B) = \left(x^C - x^B\right)\left[2(\alpha - \bar{w}) - (1+\gamma)\left(x^C + x^B\right)\right]$. The following proposition compares social welfare according to the competition mode.

Proposition 1.2.2 *The weight that firm assigns to consumer surplus changes the hierarchy of equilibrium welfare between Cournot and Bertrand competition:*

i) for $\theta \in \left[0, \gamma\tilde{\theta}\right[$ *or* $\theta \in \left]\hat{\theta}, \tilde{\theta}\right[$, $W^{C*} < W^{B*}$;

ii) for $\theta \in \left[\gamma\tilde{\theta}, \hat{\theta}\right]$, $W^{C*} \geqq W^{B*}$, *where* $\hat{\theta} = \frac{1}{4}\left[3 + \frac{3-\gamma-\sqrt{\Delta}}{(1-\gamma^2)}\right]$, *with* $\Delta = 4 + \gamma(1-\gamma)\left[4(2\gamma+1) + \gamma(1-\gamma)\right] > 0$.

Proof. See appendix A.3. ■

When CO firms put relatively little weight or extremely high weight on the consumer surplus, the total social welfare under Bertrand competition always exceeds that under Cournot competition. One polar case of putting little weight on consumer surplus is to set CO firms as profit-maximizers where θ takes the value of zero. Then there is no reversal on the total welfare. This hierarchy with endogenous labor prices is the same as shown in standard model with exogenous labor prices.

Unlike Lopez and Naylor (2004), we show that the hierarchy of Cournot welfare and Bertrand welfare is reversed when θ belongs to the interval $\left[\gamma\tilde{\theta}, \hat{\theta}\right]$. This is partly because they considered profit-maximizers in the product market competition, leading to an unchanged hierarchy as shown in part (i) of Proposition 1.2.2 and partly because they considered a decentralized wage-bargaining setting, leading to a higher Nash equilibrium wage under Cournot than under Bertrand product market competition whereas our wage-bargaining game with a centralized labor union generates an identical Nash equilibrium wage between Cournot and Bertrand cases. For firms putting sufficient emphasis on consumer welfare, we show that the price charged turn to be higher and the quantity produced becomes lower under Bertrand competition as compared to Cournot competition. As a consequence, labor utility and consumer surplus are both lower under Bertrand competition and this effect outweighs the increase in profit (under Bertrand), leading to a global decrease of total welfare compared with Cournot competition.

1.3 Stakeholders' Relationships Influenced by Social Concern

In this section, we propose a definition and a measurement of the relationships (in terms of conciliating and conflicting) between different stakeholders, when the firms is required to be socially concerned. We then apply the definition and the measurement to analyze the effect of social concern in the sense of specifically the consumer-orientation mechanism and the wage-bargaining mechanism upon the relationships between different stakeholders.

1.3.1 How to define a conflict between stakeholders?

Here, we propose a formal definition on the relationships (in terms of conciliating and conflicting) between different stakeholders when some action takes place.

Definition 1.3.1 *Let s_1 and s_2 be two groups of stakeholders, $u^{s_1}(\epsilon, \cdot)$ [resp. $u^{s_2}(\epsilon, \cdot)$] represents the utility of s_1 (resp. s_2). Following a variation in ϵ, the relationship between s_1 and s_2 is said to be*

$$\begin{aligned} &i)\ \textit{conflicting if sign}\left[\frac{\partial u^{s_1}(\epsilon, \cdot)}{\partial \epsilon}\right] = -\textit{sign}\left[\frac{\partial u^{s_2}(\epsilon, \cdot)}{\partial \epsilon}\right]; \\ &ii)\ \textit{conciliating if sign}\left[\frac{\partial u^{s_1}(\epsilon, \cdot)}{\partial \epsilon}\right] = \textit{sign}\left[\frac{\partial u^{s_2}(\epsilon, \cdot)}{\partial \epsilon}\right]. \end{aligned}$$

When $\frac{\partial u^{s_1}(\epsilon, \cdot)}{\partial \epsilon} > 0$ and $\frac{\partial u^{s_2}(\epsilon, \cdot)}{\partial \epsilon} < 0$, an increase [decrease] in ϵ favors [damages] s_1 but damages [favors] s_2. In other words, an antagonism between s_1 and s_2 appears as soon as ϵ varies. When the two derivatives have the same sign, the antagonism between the two groups of stakeholders vanishes.

1.3.2 The role of the wage-bargaining mechanism

We consider the impact of the wage-bargaining power of the firm upon the interests of stakeholders.

Proposition 1.3.1 *In both Cournot and Bertrand competitions, a change in the wage-bargaining power of the labor union:*

i) does not lead to a conflict of interest between shareholders and consumers;

i.i) leads to a conflict of interest between shareholders and employees as well as between consumers and employees.

Proof. See appendix A.4. ■

The conciliating relationship between shareholders and consumers means that a lower bargaining power of the labor union increases both the profit and the consumer surplus. A less powerful labor union bargains for a lower wage which has a positive effect on the profit of the firm. At equilibrium, the lower wage also leads to a lower price which in turn favors the consumer surplus. As a result, the utility of shareholders and consumers are both enhanced when facing a less powerful labor union.

Shareholders and employees have conflicting interests under the effect of the wage-bargaining mechanism, since a higher bargaining power of the labor union favors union's utility but disfavors firm's profit. A more powerful labor union promotes the interests of employees and damages the interests of shareholders.

Turning to employees and consumers, we see that a more powerful labor union promotes the utility of employees and disfavors the interests of consumers. As previously shown, consumer surplus is enhanced only when facing a less powerful labor union. Hence the employees and consumers have conflicting interests under the effect of the wage-bargaining mechanism. Our result is supported by the empirical research[12] of Jung and Kim (2016), who showed a positive and significant association between CSR and organizational restructuring in terms of cost minimization, implying that firms tend to minimize labor cost (notably when the labor union is less powerful) to keep CSR activities (including insuring consumers' interests).

1.3.3 Effect of the consumer-orientation mechanism

Now, let us identify the role of the consumer-orientation mechanism (θ) on the nature of the relationships between different stakeholders.

Proposition 1.3.2 *In both Cournot and Bertrand competition, a change in the firm's weight on consumer surplus:*

i) leads to a conflict of interest between shareholders and consumers as well as between shareholders and employees;

i.i) does not lead to a conflict of interest between consumers and employees.

Proof. See appendix A.5. ■

In line with Goering (2007) and Kopel and Brand (2012), an increase in the weight put on consumer welfare promotes production for both Cournot and Bertrand cases, regardless of the degree of product differentiation and the bargaining power of the labor union. Kopel and Brand considered an asymmetric duopoly consisting of one consumer-oriented firm and one profit-maximizing firm and showed with Cournot competition that θ may increase the profit. However, this positive effect of θ upon the profit cannot happen in our symmetric setting.

[12] The research of Jung and Kim (2016) is based on a Korea database comprising 166 firms where more than half are unionized organizations.

We show that a rising θ always decreases the profit and increases the consumer surplus. This means when the firm is required to take some extent of social responsibility (such as taking care of consumers' interests), the shareholders have to surrender part of the profits to consumers. The shareholders will certainly be reluctant to accept it, implying a conflicting relationship between shareholders and consumers. Actually, in both Cournot and Bertrand competitions, the CO mechanism works for capturing a larger market share but it does not benefit the interests of shareholders, rather it is at the expense of the shareholders' interests: the more weight put on consumers, the more it decreases profit.

As for the relationship between shareholders and employees referring to social concern in the sense of caring about consumers (the CO mechanism), our model shows that a rising θ always decreases the profit and increases the utility of labor union. This means the shareholders have to surrender part of the profits to employees as well. Again, the shareholders will not be happy about this, implying a conflicting relationship between shareholders and employees. Interestingly, this reflects a free ride effect: when a firm cares about consumers' interests, it works to favor employees' interests as well.

As for the relationship between employees and consumers, the CO mechanism allows them to achieve a win-win situation in both Cournot and Bertrand competitions. This conciliatory relationship between consumers and employees is also found in a different context by Kotter and Heskett (1992) and Koys (2001), namely that a higher wage satisfies employees, who may as a result treat their consumers better, leading to a higher level of consumer satisfaction.

We can see in this section that, whatever under the effect of consumer-orientation mechanism or under the effect of wage-bargaining mechanism, the nature of relationship (conflicting or conciliating) between different stakeholders does not change according to the mode of product market competition (whatever in a price competition or in a quantity competition).

1.4 The Measurement of Conflict and Product Market Competition

1.4.1 How to measure the intensity of conflict?

Inspired by the concept of elasticity of substitution between two inputs, which was first formally introduced by Hicks (1932), we propose a measurement of the intensity of conflict, which is based on the possibilities of substitution between the welfare of two groups of stakeholders.

Definition 1.4.1 *Following a change in ϵ for any $u^{s_1}(\epsilon, \cdot)$ and $u^{s_2}(\epsilon, \cdot)$ such that sign $\left[\frac{\partial u^{s_1}(\epsilon,\cdot)}{\partial \epsilon}\right] = -$sign $\left[\frac{\partial u^{s_2}(\epsilon,\cdot)}{\partial \epsilon}\right]$, the intensity of conflict between s_1 and s_2 is measured by $\left|\eta_{s_1/s_2,\epsilon}\right|$ where*

$$\eta_{s_1/s_2,\epsilon} = \frac{\partial \left[u^{s_1}(\epsilon, \cdot) / u^{s_2}(\epsilon, \cdot)\right] / \left[u^{s_1}(\epsilon, \cdot) / u^{s_2}(\epsilon, \cdot)\right]}{\partial \epsilon / \epsilon}.$$

The elasticity $\eta_{s_1/s_2,\epsilon}$ can be viewed as a proxy for a measurement of wealth transfer between two groups of stakeholders due to the changes in ϵ. We estimate to what extent $u^{s_1}(\epsilon, \cdot)$ and $u^{s_2}(\epsilon, \cdot)$ can be substitutes for one another as ϵ varies. If $u^{s_1}(\epsilon, \cdot)$ and $u^{s_2}(\epsilon, \cdot)$ are perfect complement, no change can occur in $u^{s_1}(\epsilon, \cdot) / u^{s_2}(\epsilon, \cdot)$ when ϵ varies and $\left|\eta_{s_1/s_2,\epsilon}\right| = 0$. In the opposite case, if $u^{s_1}(\epsilon, \cdot)$ and $u^{s_2}(\epsilon, \cdot)$ are perfect substitutes, the ratio $u^{s_1}(\epsilon, \cdot) / u^{s_2}(\epsilon, \cdot)$ is very sensitive to the change of ϵ and $\left|\eta_{s_1/s_2,\epsilon}\right|$ tends to $+\infty$. The absolute value $\left|\eta_{s_1/s_2,\epsilon}\right|$ thus measures the extent of conflict between s_1 and s_2: the greater the absolute value is, the more intensive the conflict is. One can thus compare the intensities of conflict under different circumstances through the following definition.

1.4.2 Intensity of conflict: Cournot vs. Bertrand

Definition 1.4.2 *Let f and g be two modes of competition such that $f, g = \{B, C\}$. The intensity of conflicting interests between s_1 and s_2 is attenuated in mode f compared to that in mode g, if*

$$\left|\eta^{f}_{s_1/s_2,\epsilon}\right| < \left|\eta^{g}_{s_1/s_2,\epsilon}\right|.$$

Recalling that employees have conflicting interests with both shareholders and consumers when the bargaining power changes (part i.i of Proposition 1.3.1), one can thus apply the above definition to compare the extent of conflict of the two pairs between Cournot and Bertrand competitions.

Proposition 1.4.1 *The intensities of the conflict (due to a change in the wage-bargaining power) between shareholders and employees as well as between consumers and employees are both unaffected by the product market competition mode.*

Proof. See appendix A.6. ■

Under the effect of β, the substitutability between π and U as well as between U and CS remains the same in Cournot competition as in Bertrand competition. Proposition 1.4.1 implies that the mode of competition does not play a role in the extent of conflict when the conflicting interests are due to the wage-bargaining mechanism. This is because the labor union is centralized, leading to a level of wages which is identical under Cournot and Bertrand competition.

Similarly, recalling that shareholders have conflicting interests with both consumers and employees when the altruistic degree that a firm puts on consumers changes (Proposition 1.3.2), one can apply Definition 1.4.2 to compare the extent of conflict of these two pairs between

Cournot and Bertrand competitions. The following proposition summarizes the comparison.

Proposition 1.4.2 *When the firm changes the weight put on consumer welfare, the intensities of the conflict between shareholders and consumers as well as between shareholders and employees are both attenuated in Bertrand competition as compared to Cournot competition.*

Proof. See appendix A.7. ■

Under the effect of the consumer-orientation mechanism, the mode of competition (Cournot or Bertrand) plays a crucial role on the extent of conflict. When θ increases, the elasticity of substitution between profit and consumer surplus as well as between profit and union's utility are both larger under Cournot competition than under Bertrand competition. This means that caring about the interests of consumers has a stronger effect of cutting down shareholders' interests thus favoring both consumers and employees' interests in a quantity competition market as opposed to a price competition market. Consequently, for firms which address the interests of consumers in their strategies, Bertrand competition suits them better in moderating shareholder conflict with both consumers and employees.

1.5 Decentralized Wage Bargaining

In the previous section, we considered the case where the bargaining of both firms takes place with a centralized labor union. Now let us turn to the situation where both firms are unionized, implying a decentralized wage bargaining game with each of its firm specific labor union.

The objective function of a CO firm is the same as defined in the previous sections with centralized labor union, i.e., $V_i = \pi_i + \theta CS$. Since both firms are unionized, the utility function of firm i's labor union writes

$$U_i = (w_i - \bar{w})\, x_i \tag{1.8}$$

where w_i is still the wage paid by firm i and $\bar{w}$ is still the reservation level. Under a decentralized setting, the wage is the result of bargaining between each CO firm and its associated labor union:

$$w_i = \arg\max \left\{ B_i = U_i^{\beta} V_i^{1-\beta} \right\}, \tag{1.9}$$

where $\beta \in [0,1]$ remains the union's Nash bargaining power and the wage satisfies the first order condition[13], which writes

$$\beta \left(\frac{\partial U_i}{\partial w_i} \right) V_i + (1-\beta)\, U_i \left(\frac{\partial V_i}{\partial w_i} \right) = 0. \tag{1.10}$$

The timing of the two-stage game is exactly the same as in the previous centralized bargaining section. The only difference is that each CO firm endogenously decides its wage with its firm specific labor union at the place of a centralized labor union.

Cournot competition. Let us keep the same market environment as in the centralized case where the inverse demand for good i is $p_i = \alpha - x_i - \gamma x_j$. The first order condition of the maximization problem at the second stage yields

$$x_i (x_j) = \frac{1}{2-\theta} \left[\alpha - w_i - \gamma (1-\theta)\, x_j \right]. \tag{1.11}$$

Note that for all $\theta \in [0,1[$ and $\gamma \in [0,1]$, the reaction functions are downward-sloping and the product market game is played in strategic substitutes ($\frac{\partial x_i}{\partial x_j} < 0$). For $\theta = 1$, we have the quantity $x_i = \alpha - w_i$, which shows that the strategic output is independent of γ so that the effect of product differentiation vanishes in this case.

[13] The second-order condition holds, since one can justify with the equilibrium point that $\frac{\partial^2 B_i}{\partial w_i^2} \left(w_i^*, w_j^* \right) < 0$.

Given w_i and w_j, we obtain from (1.11) and its equivalent to firm j the labor demand of firm i as follows

$$x_i(w_i, w_j) = \frac{\alpha - \frac{2-\theta}{1+(1-\gamma)(1-\theta)} w_i + \gamma \frac{1-\theta}{1+(1-\gamma)(1-\theta)} w_j}{1 + (1+\gamma)(1-\theta)}. \tag{1.12}$$

It is easy to see that for all $\theta \in [0,1[$ and $\gamma \in [0,1]$, $\frac{\partial x_i}{\partial w_i} < 0$ and $\frac{\partial x_i}{\partial w_j} > 0$: since labor cost (the wage) captures all short-run marginal cost, the higher the wage is, the less a firm produces. Facing a less competitive rival (an increasing w_j), firm i will increase the production to capture the market.

The utility of labor union for firm i thus writes $U_i = (w_i - \bar{w})\, x_i(w_i, w_j)$. It is not clear at priori whether an increasing wage raises union's utility[14]. However, one can find without ambiguity that $\frac{\partial^2 U_i}{\partial w_i \partial w_j} = \frac{\partial x_i}{\partial w_j} > 0$: wages are strategic complements for the labor unions. An increasing wage in rival firm improves firm i's competitiveness in the market, hence benefices firm i's labor union to have the wage increased.

Turning back to the first stage, the optimal wage w_i satisfies the first order condition as in (1.10). Replacing $U_i = (w_i - \bar{w})\, x_i(w_i, w_j)$ in (1.10), we get an implicit reaction function $\varphi_i(w_i, w_j)$ of firm i, which satisfies

$$\varphi_i(w_i, w_j) = \beta \left[x_i + (w_i - \bar{w}) \frac{\partial x_i}{\partial w_i} \right] V_i + (1-\beta)(w_i - \bar{w})\, x_i \frac{\partial V_i}{\partial w_i} = 0$$

Substituting the objective function as shown in (1.1), the expression of quantity as shown in (1.12), and their respective derivatives with respect to w_i in the above equation $\varphi_i(w_i, w_j) = 0$ for firm i and its equivalent to firm j, we obtain a symmetric equilibrium wage[15] as follows

$$w_i^{*C} = w_j^{*C} = \bar{w} + \frac{(\alpha - \bar{w})\, \beta\, [1 + (1-\gamma)(1-\theta)]}{D} \equiv \tilde{w}^{*C},$$

[14]Since $\frac{\partial U_i}{\partial w_i} = \underbrace{x_i(w_i, w_j)}_{>0} + \underbrace{(w_i - \bar{w}) \frac{\partial x_i}{\partial w_i}}_{<0}$.

[15]Since $0 < w_i < \alpha$, the two identical roots $w_i = \alpha$ are excluded.

where we denote $D \equiv \left[\theta(2-\theta)-\gamma(1-\theta)^2\right]\beta+1+(1-\theta)(2-\theta\gamma)+(1-\theta)^2$. To differentiate with the centralized case, we denote $\tilde{w}^*$ thereafter for the decentralized case, hence obviously $\tilde{w}^{*C}$ is the equilibrium wage negociated with unionized firms, which compete in a Cournot fashion. It can be checked that for all θ, γ, $\beta \in [0,1]$, $D > 0$.

Substituting both w_i and w_j by the equilibrium wage $\tilde{w}^{*C}$ in (1.12), one can obtain the subgame perfect equilibrium output in function of $\tilde{w}^{*C}$:

$$x_i^{*C} = x_j^{*C} = \frac{\alpha - \tilde{w}^{*C}}{1+(1+\gamma)(1-\theta)} \equiv \tilde{x}^{*C}.$$

Substituting the above equilibrium output in the inverse demand function, one can obtain the subgame perfect equilibrium price in function of $\tilde{w}^{*C}$:

$$p_i^{*C} = p_j^{*C} = \frac{\alpha(1-\theta(1+\gamma)) + \tilde{w}^{*C}(1+\gamma)}{1+(1+\gamma)(1-\theta)} \equiv \tilde{p}^{*C}.$$

Then, it is straightforward to derive respectively the profit and the labor union's utility at equilibrium:

$$\pi_i^{*C} = \pi_j^{*C} = \frac{[1-\theta(1+\gamma)]\left(\alpha-\tilde{w}^{*C}\right)^2}{[1+(1+\gamma)(1-\theta)]^2} \equiv \tilde{\pi}^{*C} \quad \text{and} \quad U_i^{*C} = U_j^{*C} = \frac{\left(\tilde{w}^{*C}-\bar{w}\right)\left(\alpha-\tilde{w}^{*C}\right)}{1+(1+\gamma)(1-\theta)} \equiv \tilde{U}^{*C}.$$

Bertrand competition. Similarly, let us keep the same market environment as in the centralized case where the demand for good i is $x_i = \frac{\alpha}{1+\gamma} - \frac{1}{1-\gamma^2}p_i + \frac{\gamma}{1-\gamma^2}p_j$. The first order condition of the maximization problem at the second stage yields

$$p_i(p_j) = \frac{\gamma(1-\theta)}{2-\theta}p_j + \frac{1}{2-\theta}w_i + \frac{\alpha(1-\gamma)(1-\theta)}{2-\theta}. \tag{1.13}$$

Note that for all $\theta \in [0,1[$ and $\gamma \in [0,1]$, the reaction functions are upward-sloping and the product market game is played in strategic complements ($\frac{\partial p_i}{\partial p_j} > 0$). For $\theta = 1$, we have the price equals the marginal cost ($p_i = w_i$), which means zero profit for firm i and the effect of product differentiation vanishes because the strategic price is independent of γ.

Given w_i and w_j, we obtain from (1.13) and its equivalent to firm j the price of firm i as follows

$$\begin{aligned} p_i\left(w_i, w_j\right) &= \frac{(2-\theta)\, w_i}{\left[1+(1-\gamma)(1-\theta)\right]\left[1+(1+\gamma)(1-\theta)\right]} \\ &+ \frac{\gamma\,(1-\theta)\, w_j}{\left[1+(1-\gamma)(1-\theta)\right]\left[1+(1+\gamma)(1-\theta)\right]} + \frac{\alpha\,(1-\gamma)(1-\theta)}{1+(1-\gamma)(1-\theta)}. \end{aligned} \tag{1.14}$$

It is easy to see that for all $\theta \in [0,1[$ and $\gamma \in [0,1]$, $\frac{\partial p_i}{\partial w_i} > 0$ and $\frac{\partial p_i}{\partial w_j} > 0$: the higher the labor cost is, the higher prices a firm charges.

Substituting the above expression of price in the demand function, we obtain $x_i\left(w_i, w_j\right)$ in function of the wages. Similarly as in the Cournot case, the optimal wage satisfies the first order condition as in (1.10). One can obtain the symmetric equilibrium wage as follows

$$w_i^{*B} = w_j^{*B} = \bar{w} + \frac{(\alpha-\bar{w})\,\beta\,(1-\gamma)\left[1+(1+\gamma)(1-\theta)\right]\left[1-\gamma\,(1-\theta)\right]}{E} \equiv \tilde{w}^{*B},$$

where $E = \left\{\theta\,(2-\theta) - \gamma\,(1-\theta)\left[1-\gamma\,(1-\theta)\right]\right\}\beta + (1-\gamma)(1-\theta)^2\left(1-\gamma^2\right) + (1-\gamma)(2+\theta\gamma)(1-\theta) + (1-\gamma)\left[1-(1-\theta)^2\gamma^2\right]$. It can be checked that for all θ, γ, $\beta \in [0,1]$, $E > 0$.

Substituting both w_i and w_j by the equilibrium wage $\tilde{w}^{*B}$ in (1.14), one can obtain the subgame perfect equilibrium price in function of $\tilde{w}^{*B}$:

$$p_i^{*B} = p_j^{*B} = \frac{\tilde{w}^{*B} + \alpha\,(1-\gamma)(1-\theta)}{1+(1-\gamma)(1-\theta)} \equiv \tilde{p}^{*B}.$$

Substituting the above equilibrium price in the demand function, one can obtain the subgame perfect equilibrium output in function of $\tilde{w}^{*B}$:

$$x_i^{*B} = x_j^{*B} = \frac{\alpha - \tilde{w}^{*B}}{(1+\gamma)\left[1+(1-\gamma)(1-\theta)\right]} \equiv \tilde{x}^{*B}.$$

Then, it follows that the profit and the labor union's utility at equilibrium are respectively

$$\pi_i^{*B} = \pi_j^{*B} = \frac{(1-\theta)(1-\gamma)\left(\alpha - \tilde{w}^{*B}\right)^2}{(1+\gamma)\left[1+(1-\gamma)(1-\theta)\right]^2} \equiv \tilde{\pi}^{*B} \text{ and } U_i^{*B} = U_j^{*B} = \frac{\left(\tilde{w}^{*B} - \bar{w}\right)\left(\alpha - \tilde{w}^{*B}\right)}{1+(1+\gamma)(1-\theta)} \equiv \tilde{U}^{*B}.$$

The equilibrium values for Decentralized bargaining are reported in Table 2.

	Cournot	Bertrand
$\tilde{w}^*$	$\bar{w} + \frac{(\alpha-\bar{w})\beta[1+(1-\gamma)(1-\theta)]}{D}$	$\bar{w} + \frac{(\alpha-\bar{w})\beta(1-\gamma)[1+(1+\gamma)(1-\theta)][1-\gamma(1-\theta)]}{E}$
$\tilde{x}^*$	$\frac{\alpha-\tilde{w}^{*C}}{1+(1+\gamma)(1-\theta)}$	$\frac{\alpha-\tilde{w}^{*B}}{(1+\gamma)[1+(1-\gamma)(1-\theta)]}$
$\tilde{p}^*$	$\frac{\alpha(1-\theta(1+\gamma))+\tilde{w}^{*C}(1+\gamma)}{1+(1+\gamma)(1-\theta)}$	$\frac{\tilde{w}^{*B}+\alpha(1-\gamma)(1-\theta)}{1+(1-\gamma)(1-\theta)}$
$\tilde{\pi}^*$	$\frac{[1-\theta(1+\gamma)]}{[1+(1+\gamma)(1-\theta)]^2}\left(\alpha-\tilde{w}^{*C}\right)^2$	$\frac{(1-\theta)(1-\gamma)}{(1+\gamma)[1+(1-\gamma)(1-\theta)]^2}\left(\alpha-\tilde{w}^{*B}\right)^2$
$\tilde{CS}^*$	$(1+\gamma)\left(\frac{\alpha-\tilde{w}^{*C}}{1+(1+\gamma)(1-\theta)}\right)^2$	$(1+\gamma)\left(\frac{\alpha-\tilde{w}^{*B}}{(1+\gamma)[1+(1-\gamma)(1-\theta)]}\right)^2$
$\tilde{U}^*$	$\frac{\left(\tilde{w}^{*C}-\bar{w}\right)\left(\alpha-\tilde{w}^{*C}\right)}{1+(1+\gamma)(1-\theta)}$	$\frac{\left(\tilde{w}^{*B}-\bar{w}\right)\left(\alpha-\tilde{w}^{*B}\right)}{(1+\gamma)[1+(1-\gamma)(1-\theta)]}$

Table 2. Equilibrium values for Decentralized bargaining

under Cournot and Bertrand competition

In contrast with the centralized case where the equilibrium wage is the same between Cournot competition and Bertrand competition, with β playing a crucial role and being independent of both θ and γ, the decentralized case shows different equilibrium wage levels between Cournot competition and Bertrand competition, with both wages depending on θ and γ in addition to the influence by β.

Observing the Cournot equilibrium profit for decentralized bargaining, one can deduce that the necessary and sufficient condition for $\tilde{\pi}^{*C} > 0$ is also $\theta < \tilde{\theta}$ (recall that $\tilde{\theta} = \frac{1}{1+\gamma}$), the same as in the centralized bargaining case.

1.5.1 Consumer-orientation mechanism and wage-bargaining mechanism

Before entering to the study of stakeholders' relationships when the socially concerned CO firms are unionized, let us first take a look at how the consumer-orientation mechanism interacts with the wage bargaining mechanism. We first investigate the role of consumer-orientation mechanism (effect of θ) and that of wage bargaining mechanism (effect of β) on equilibrium wage and outputs.

Lemma 1.5.1 *(i)* $\frac{\partial \tilde{w}^{*C}}{\partial \theta} > 0$, $\forall \theta \in \left[0, \tilde{\theta}\right[$, $\gamma, \beta \in [0,1]$; *(ii)* $\frac{\partial \tilde{w}^{*B}}{\partial \theta} > 0$, *if* $\beta \in \left[0, \frac{2(1-\gamma)}{3}\right[$ *and* $\theta, \gamma \in [0,1]$; *(iii)* $\frac{\partial \tilde{w}^{*f}}{\partial \beta} > 0$, $\forall f \in \{B, C\}$ *and* $\forall \theta, \gamma, \beta \in [0,1]$.

Proof. See appendix A.8. ■

Part (i) of lemma 1.5.1 shows the role of consumer-orientation mechanism under Cournot competition: putting a certain weight on consumer surplus in a firm's objective function makes the bargaining result of the equilibrium wage more favorable for employees. Whatever the power of labor union, this result always holds true. Part (ii) of lemma 1.5.1 shows under Bertrand competition, however, that the bargaining power of the decentralized labor union alters the influence of consumer-orientation mechanism upon the equilibrium wage: only when the labor union is relatively weak can consumer-orientation mechanism have the effect of promoting equilibrium wage. Part (iii) of lemma 1.5.1 shows that for both Cournot competition and Bertrand competition, the bargaining power of the labor union always plays a positive role in promoting the equilibrium wage.

1.5.2 Stakeholders' relationships with an alternative measurement

In this section, we introduce an alternative and simple measurement on the relationships between different stakeholders.

Proposition 1.5.1 *(i).* $\frac{\partial \tilde{\pi}^{*C}}{\partial \theta} < 0$, $\forall \theta \in \left[0, \tilde{\theta}\right[$, $\gamma, \beta \in [0,1]$; *(ii).* $\frac{\partial \tilde{\pi}^{*B}}{\partial \theta} < 0$, *if* $\beta \in \left[0, \frac{2(1-\gamma)}{3}\right[$ *and* $\theta, \gamma \in [0,1]$; *(iii)* $\frac{\partial \tilde{\pi}^{*f}}{\partial \beta} < 0$, $\forall f \in \{B, C\}$ *and* $\forall \theta, \gamma, \beta \in [0,1]$.

Proof. See appendix A.9. ■

Since θ is the weight put on consumers, the size of θ indirectly represents the interests of consumers. The relationship between shareholders and consumers can be illustrated by considering the effect of θ on $\tilde{\pi}^{*f}$, with $f \in \{B, C\}$. Part (i) ad (ii) of Proposition 1.5.1 thus suggest a conflicting relationship between shareholders and consumers. Although consumers' interests are taken into account in the objective function of the firm, the nature of interests between shareholders and consumers remains conflicting, regardless of the degree of product differentiation and the degree of union's bargaining power. The explanation is based on the previous findings of lemma 1.5.1: the consumer-orientation mechanism causes lower price and increases marginal cost. The firm gets less profit despite larger output. This result is in contrast to the result of Kopel and Brand (2012) which shows that θ may increase the profit (when a consumer-oriented firm competes with a profit-maximizing firm).

Similarly, since β is the bargaining power of the labor union, its value indirectly represents the interests of employees. The relationship between shareholders and employees can be reflected through the impact of the union's bargaining power (β) upon profits. As part (iii) of Proposition 1.5.1 shows, for both Cournot competition and Bertrand competition, shareholders and employees have conflicting interests, whatever the degrees of product differentiation and the union's bargaining power. By setting $\theta = 0$, i.e., let both firms be profit maximizers (denoted therefore as PM), one can still find that a higher bargaining power decreases profit for both Cournot competition and Bertrand competition, implying a conflict of interests between shareholders and employees. Hence whether or not to consider the interests of consumers in a firm's strategy does not change the nature of conflicting interests between shareholders and employees.

As for the relationship between employees and Consumers, we may have two measures to investigate their relationships. One way is to measure the the effect of altruism on consumers upon employees' wages. The other way is to measure the effect of bargaining power of the labor union upon consumer surplus.

The first measure illustrates a conciliatory relationship between consumers and employees under a Cournot competition by the fact that $\frac{\partial \tilde{w}^{*C}}{\partial \theta} > 0$ ($\forall \theta \in \left[0, \tilde{\theta}\right[$, $\gamma, \beta \in [0,1]$ as proved by part (i) of lemma 1.5.1): if a CO firm is more altruistic for the interest of consumers in its objective function, it also pays a higher equilibrium wage for employees after bargaining with the labor union[16]. The consumers and employees have similar conciliatory relationship under a Bertrand competition (i.e., $\frac{\partial \tilde{w}^{*B}}{\partial \theta} > 0$) only when the bargaining power of the labor union is not that much strong (i.e., $\beta \in \left[0, \frac{2(1-\gamma)}{3}\right[$, as proved by part (ii) of lemma 1.5.1).

The second measure, suggests however, a conflict of interests between consumers and employees. Since by examining the effect of the labor union's bargaining power upon equilibrium consumer surplus, we show that $\frac{\partial \tilde{C}S^{*f}}{\partial \beta} = 2\,(1+\gamma)\,\tilde{x}^{*f}\frac{\partial \tilde{x}^{*f}}{\partial \beta} < 0$, $\forall f \in \{B, C\}$, since $\frac{\partial \tilde{x}^{*C}}{\partial \beta} = -\frac{1}{1+(1+\gamma)(1-\theta)}\frac{\partial \tilde{w}^{*C}}{\partial \beta} < 0$, for all $\theta \in \left[0, \tilde{\theta}\right[$ and γ, $\beta \in [0,1]$ and $\frac{\partial \tilde{x}^{*B}}{\partial \beta} = -\frac{1}{(1+\gamma)[1+(1-\gamma)(1-\theta)]}\frac{\partial \tilde{w}^{*B}}{\partial \beta} <$

[16]This conciliatory relationship between consumers and employees is also found in a different context, by Kotter and Heskett (1992) or Koys (2001) they observe that a higher wage satisfies employees who may, as a result, treat their consumers better, leading to a higher level of consumer satisfaction.

0, for all θ, γ, $\beta \in [0, 1]$. This measure shows that labor union plays a role to damage the interests of consumers, regardless of the degree of altruism on consumers in the firm's objective function and regardless of the degree of product differentiation. The reason should be due to the negative impact of bargaining power upon the equilibrium output ($\frac{\partial \tilde{x}^{*f}}{\partial \beta} < 0$), which generates higher price thus decreases consumer surplus.

1.5.3 The role of product differentiation

Shareholders and Consumers. Now let us check the effect of product differentiation. We find $\frac{\partial^2 \tilde{\pi}^{*C}}{\partial \gamma \partial \theta} < 0$, $\forall\ \theta \in \left[0, \tilde{\theta}\right[$, γ, $\beta \in]0, 1[$. When γ decreases, products become more differentiated. An increase in the weighting of consumers surplus induces a smaller decrease in profit, implying less conflict between shareholders and consumers. In a Cournot market consisting of two CO firms, the consumer-orientation mechanism promotes output hence reduces price, favoring consumers. Moreover, the reduced intensity of competition (due to an increase in product differentiation) mitigates the decrease in price, which in turn favors shareholders. As for the Bertrand competition, one can find $\frac{\partial^2 \tilde{\pi}^{*B}}{\partial \gamma \partial \theta} < 0$, if $\beta \in \left[0, \frac{2(1-\gamma)}{3}\right[$, $\theta, \gamma \in [0, 1]$, which suggests the same effect of product differentiation when the labor union is not too strong. As a result, we can see that differentiated products may play a role to moderate conflict between shareholders and consumers in a CO duopoly market.

Shareholders and Employees. Now checking the effect of product differentiation, we find $\frac{\partial^2 \tilde{\pi}^{*C}}{\partial \gamma \partial \beta} > 0$, $\forall\ \theta \in \left[0, \tilde{\theta}\right[$, γ, $\beta \in [0, 1]$, which suggests that the conflict between shareholders and employees is exacerbated when products become more differentiated (γ decreases). Actually, an increase in the bargaining power of the labor union decreases the firms' profits (even in a CO duopoly market). Although less intensive competition raises prices, the effect of bargaining upon wage outweights the effect of market upon prices so that firms get further decreasing profits due to higher labor costs. As a result, differentiated products exacerbate conflict between shareholders and employees.

The above analysis suggests that product market competition plays an important role in affecting the extent of conflict between shareholders and other main stakeholders. In particular, an increasing degree of product differentiation moderates conflict between shareholders and consumers, but exacerbates conflict between shareholders and employees. This means one same competitive state cannot simultaneously satisfy everybody: the conflict between shareholders and consumers can get softened in a less competitive market whereas the conflict between shareholders and employees can only get mitigated in a more competitive market.

Employees and Consumers. With the first measurement, we show that a decreasing γ (more differentiated products) reduces the positive impact of θ on $\tilde{w}^{*f}$ (since $\frac{\partial^2 \tilde{w}^{*f}}{\partial\gamma\partial\theta} > 0$), with $f \in \{B, C\}$. This suggests that a less competitive product market inhibits the conciliatory relationship between consumers and employees.

On the other hand, when we turn to the effect of product differentiation with the second measurement, one can obtain $\frac{\partial^2 \tilde{C}S^{*f}}{\partial\gamma\partial\beta} = 2\left(\tilde{x}^{*f} + (1+\gamma)\frac{\partial \tilde{x}^{*f}}{\partial\gamma}\right)\frac{\partial \tilde{x}^{*f}}{\partial\beta} + 2(1+\gamma)\,\tilde{x}^{*f}\frac{\partial^2 \tilde{x}^{*f}}{\partial\gamma\partial\beta}$. The first part of this expression is negative and the second part is positive, hence the sign of $\frac{\partial^2 \tilde{C}S^{*f}}{\partial\gamma\partial\beta}$ is not clear a priori, implying an ambiguous effect of competition on the extent of conflict between consumers and employees.

1.6 Extension

In this section, we focus on the possibility of asymmetric duopoly consisting of a CO firm and a PM firm which was not considered in the previous sections. The possibility of delegating the output decision right to the manager is also taken into account. To simplify, we ignore the presence of labor union and let the marginal cost of each firm be a constant value c, with $c < \alpha$, given the same demand function.

1.6.1 The effect of consumer-oriented mechanism

Let us denote Ψ^i (resp. Ψ^j) a general objective function of a firm i (resp. j). Typically, if firm i is a PM firm, Ψ^i=Π^i. Later on we'll show different possibilities of Ψ^i when the objective function changes according to the delegation choice. Thereafter, we use a subscript x_i, x_j, and θ to denote a derivative with respect to these variables. In a Cournot competition, the equilibrium output couple $(x_i,\, x_j)$ is the solution of the equation system:

$$\begin{cases} \Psi^i_{x_i}\left(x_i, x_j, \theta\right) = 0, \\ \Psi^j_{x_j}\left(x_i, x_j, \theta\right) = 0. \end{cases}$$

By totally differentiating the above system of first order conditions, we get

$$\begin{bmatrix} \Psi^i_{x_i x_i} & \Psi^i_{x_i x_j} \\ \Psi^j_{x_j x_i} & \Psi^j_{x_j x_j} \end{bmatrix} \begin{bmatrix} dx_i/d\theta \\ dx_j/d\theta \end{bmatrix} = - \begin{bmatrix} \Psi^i_{x_i\theta} \\ \Psi^j_{x_j\theta} \end{bmatrix}.$$

Hence, the solution is

$$\begin{bmatrix} dx_i/d\theta \\ dx_j/d\theta \end{bmatrix} = \frac{1}{J} \begin{bmatrix} -\Psi^j_{x_j x_j} & \Psi^i_{x_i x_j} \\ \Psi^j_{x_j x_i} & -\Psi^i_{x_i x_i} \end{bmatrix} \begin{bmatrix} \Psi^i_{x_i\theta} \\ \Psi^j_{x_j\theta} \end{bmatrix},$$

which is equivalent to

$$dx_i/d\theta = \frac{-\Psi^j_{x_j x_j}\Psi^i_{x_i\theta} + \Psi^i_{x_i x_j}\Psi^j_{x_j\theta}}{J}, \tag{1.15}$$

$$dx_j/d\theta = \frac{\Psi^j_{x_j x_i}\Psi^i_{x_i\theta} - \Psi^i_{x_i x_i}\Psi^j_{x_j\theta}}{J}, \tag{1.16}$$

where

$$J = \Psi^i_{x_i x_i}\Psi^j_{x_j x_j} - \Psi^i_{x_i x_j}\Psi^j_{x_j x_i}. \tag{1.17}$$

Let firm i represent a PM firm and firm j represent a CO firm. Since a PM firm does not consider consumer's weight in its objective function, its second derivation with respect to θ is zero, i.e., $\Psi^i_{x_i\theta} = 0$. This is an important information which largely simplifies the above expressions. We can see that for an asymmetric duopoly consisting of a PM firm and a CO firm, the effect of the CO mechanism upon the output of its PM rival and its own output always satisfy the following as simplified from (1.15) and (1.16):

$$dx_i/d\theta = \frac{\Psi^i_{x_ix_j}\Psi^j_{x_j\theta}}{J}, \tag{1.18}$$

$$dx_j/d\theta = \frac{-\Psi^i_{x_ix_i}\Psi^j_{x_j\theta}}{J}. \tag{1.19}$$

If delegation is a choice of the decision makers (shareholders) within each firm: for the one who chooses not to delegate, the output is decided by the shareholders; for the one who chooses to delegate, the output is decided by a manager with an incentive scheme.

Proposition 1.6.1 *Whether delegation takes place or not, it is always true that (i).* $sign[dx_i/d\theta] = -sign[dx_j/d\theta]$*; (ii).* $sign[dp_i/d\theta] = sign[dp_j/d\theta]$*.*

Proof. See appendix A.10. ■

When competition takes place between a CO firm and a PM firm, the strategy of putting a certain weight on consumer surplus in the objective function of a CO firm has an opposite effect on the output of its rival firm whereas the effect on the price of its rival and itself is the same.

Moreover, we show that an increasing weight put on consumer surplus induces an increase of the output of the CO firm and a decrease of the output of the PM firm. Moreover, a growth of consumer's weight induces a price reduction for both firm's goods and a rise on consumer surplus.

1.6.2 The strategic value of consumer's weight

In the previous sections, the weight put on consumer surplus is exogenously given. In this section, we consider the case where the weight can be endogenously decided by the firm. We analyze specifically the case when a CO firm competes with a PM firm.

Suppose none of the firms delegate, the objective function of a PM firm is $\max \pi_i$, while the one of a CO firm is $\max V_j$. In a Cournot fashion, we obtain the quantities in terms of θ and γ, i.e.,

$$x_i(\theta, \gamma) = \frac{(2-\theta-\gamma)(\alpha-c)}{\theta\gamma^2-\gamma^2-2\theta+4}, \tag{1.20}$$

$$x_j(\theta, \gamma) = \frac{(2-\gamma+\theta\gamma)(\alpha-c)}{\theta\gamma^2-\gamma^2-2\theta+4}. \tag{1.21}$$

Substituting (1.20) and (1.21) in $\pi_j = (\alpha - x_j - \gamma x_i - c)\, x_j$, the profit of the CO firm is thus

$$\pi_j = (\alpha-c)^2 (\theta\gamma + 2 - \gamma) \frac{(\gamma^2-2)\theta + (2-\gamma)}{(2\theta+\gamma^2-\theta\gamma^2-4)^2}.$$

The shareholder of firm j chooses the optimal θ which maximizes firm's profit, i.e., $\max_\theta \pi_j$. The first order condition satisfies

$$\frac{\partial \pi_j}{\partial \theta} = 0,$$

i.e.,

$$\frac{(\alpha-c)^2(2-\gamma^2+\gamma)}{(2\theta+\gamma^2-\theta\gamma^2-4)^3}\left(4\theta-2\gamma^2+\gamma^3+2\theta\gamma-2\theta\gamma^2-\theta\gamma^3\right)=0.$$

Solving $4\theta - 2\gamma^2 + \gamma^3 + 2\theta\gamma - 2\theta\gamma^2 - \theta\gamma^3 = 0$, one obtains

$$\theta^* = \frac{\gamma^2 (2-\gamma)}{(2+\gamma)(2-\gamma^2)}. \tag{1.22}$$

One can observe that the optimal strategic weight of consumers solely depends on product differentiation. Studying the characteristics of θ^*, one can obtain

$$\frac{\partial \theta^*}{\partial \gamma} = 4\gamma \frac{(2-\gamma^2)(1-\gamma)+2}{(-\gamma^3 - 2\gamma^2 + 2\gamma + 4)^2} > 0,$$

which implies that the optimal value of θ is increasing (monotonically) with γ. The θ^* attains its maximum value when products are homogenous, i.e., $\gamma = 1$, thus $\theta^*_{\max} = \gamma^2 \frac{\gamma-2}{(\gamma+2)(\gamma^2-2)} |_{\gamma=1} = \frac{1}{3}$. The minimum value of θ^* is obviously 0 (when products are independent, i.e., $\gamma = 0$). Hence $\theta^* \in \left[0, \frac{1}{3}\right]$, this means the optimal weight put on consumers will not be too much (not exceeding $\frac{1}{3}$) whatever the degree products are differentiated.

In the following, we present an alternative method to study the effect of product differentiation upon the strategic weight on consumers.

Since the weight of consumers is strategically determined by a CO firm's shareholders who care about profit, θ^* is the solution of $\frac{\partial \pi_j}{\partial \theta} = 0$, written as $\pi^j_\theta = 0$. Considering that the output of each firm after delegation decision will be in function of θ and γ, the expression of each firm's profit will also be in function of θ and γ. For instance, the profit of a CO firm j can be written in this form: $\pi^j (x_i(\theta,\gamma), x_j(\theta,\gamma))$. One can imply that the first order derivative of $\pi^j (x_i(\theta,\gamma), x_j(\theta,\gamma))$, i.e., π^j_θ, will also be in function of θ and γ. Let us define this first order derivative π^j_θ by $g(\theta,\gamma) : (0,1) \times (0,1) \to R$. Thus θ^* is the solution of $g(\theta^*, \gamma) = 0$, with

$$g(\theta^*, \gamma) = \pi^j_\theta = \pi^j_{x_i} \frac{\partial x_i}{\partial \theta} + \pi^j_{x_j} \frac{\partial x_j}{\partial \theta}.$$

The comparative effect $d\theta^*/d\gamma$ can be obtained by totally differentiating $g(\theta^*, \gamma)$ with respect to θ and γ. One obtains thus

$$\frac{d\theta^*}{d\gamma} = -\left(\frac{\partial g\left(\theta^*, \gamma\right)}{\partial \gamma}\right) / \left(\frac{\partial g\left(\theta^*, \gamma\right)}{\partial \theta}\right).$$

One can apply this method to check our previous result about the effect of product differentiation upon the strategic weight of consumers. This method can also serve for investigations under different assumptions.

1.7 Concluding Remarks

The internalization of stakeholder welfare as part of institutional design (Tirole, 2001) may reflect a trend in a firm's strategy within a socially responsible economy. This chapter focuses on the consumer-orientation mechanism and considers its influence upon the equilibria as well as its interaction with the wage-bargaining mechanism under different modes of product market competition (Cournot *vs.* Bertrand). Firstly, we showed that the weight that a firm assigns to consumer surplus may change the traditional hierarchy between Cournot and Bertrand equilibria: Cournot competition may turn out to be more efficient than Bertrand competition (in terms of larger consumer surplus and total welfare). Secondly, under the effect of consumer-orientation mechanism, we found that the competition mode plays an important role in the intensity of conflict between different stakeholders: shareholder conflicts with both consumers and employees and the extents of both conflicts are attenuated under Bertrand competition.

In a decentralized wage bargaining setting, we find that the strategy to be CO does not change the nature of interests between shareholders and employees but plays a role to soften their conflict, notably when firms in a less competitive market are relatively more altruistic for consumers. Concerning the role of product differentiation on the range of shareholders' conflict with other main stakeholders, we show that an increasing degree of product differentiation moderates their conflict with consumers, but exacerbates their conflict with employees.

Moreover, we also considered the possibility where a CO firms competes with a traditional PM firm. We show that being altruism for consumers promotes output at the detriment of its rival which is a PM firm whereas the strategy of caring about consumers in its objective function reduces the prices of both firms, including its own good's price. Additionally, we studied the case where the weight put on consumers is strategically decided by the shareholders of the CO firm to maximize profit. We show that the magnitude of the optimal weight put on consumers depends on the degree of product differentiation: it increases (decreases) when products are less (more) differentiated. We also show that whatever the degree of product differentiation, the optimal weight is bounded within a range (from 0 to 1/3), which suggests that the shareholders of a CO firm are rational to put limited weight, which is not too much on consumer surplus.

CHAPTER 2

MANAGERIAL INCENTIVES AND PRODUCT MARKET COMPETITION

2.1 Introduction

The main purpose of Chapter 1 was to investigate how product market competition (Cournot vs. Bertrand) might influence the extent of conflict between shareholders, employees, and consumers when firms are socially concerned and bargain with labor union over the wages. Corporate governance was studied with an approach of stakeholder-orientation. Noticeably, we investigated corporate governance under an assumption of perfect information. Starting from this chapter, we turn to study corporate governance with an approach of shareholder-orientation.

In this chapter, we focus on the case where the information is imperfect and we show that even no social responsibility is recognized in a firm's strategy (the objective function is profit-maximizing), there is still a series of governance issues such as asymmetric information and agency problems that are associated with the effectiveness of corporate governance. The objective of this chapter is to investigate how the design of managerial incentives at the presence of informational problems such as adverse selection and/or moral hazard might interact with the intensity of product market competition which is measured by the number of firms.

Managerial incentive problem is one of the core issues of corporate governance in modern companies, within which there is a genuine separation between ownership and control. As a form of division of tasks, the shareholder (owner) usually delegates some control rights to the manager so that the latter can do some tasks at his place. This may proceed from the shareholder's lack of time or lack of some specific ability or skills to perform the tasks himself. However, the generating result from separation between ownership and control is the facts that (i) managers may get access to some information (referred to as private knowledge of the manager) that is not accessible to shareholders; (ii) managers may choose to perform some hidden actions that are not observable by shareholders or by some third parties such as the Court of Justice. The former fact is associated with the problem of adverse selection whereas the latter is associated with moral hazard, both implying imperfect or rather asymmetric information in a shareholder-manager relationship and leading to inefficiency in corporate governance.

In this chapter, we depart from the cost-reducing framework by allowing for adverse selection and/or moral hazard in the shareholder-manager relationship and we make an accent on the *indirect* impact of managerial effort on the *ex post* marginal cost of production. In the settings of this chapter, firms compete in a Cournot fashion and maximize profit. In other words, the output level is chosen to maximize the shareholder's interest. One can recognize the reason as that the shareholder keeps the decision right about outputs . Unlike the study of Ollier and Thomas (2013), who set the output exogenous in the absence of market competition, we focus on the role of product market competition and assume that the production level is rather a result of interaction with the rivals' behavior. Due to asymmetric information, each firm has agency problems between its shareholder and the manager. The shareholder of each firm deals with the contractual problem on the point of managerial incentives and let the manager carry out the output strategy facing rival firms in the competitive product market.

The interaction between product market competition and managerial incentive contract is studied in three cases dealing with different structure of informational problems. In each of the three cases, firms are concerned with cost-reducing activities.

In the first case (as in section 2.2), we focus solely on moral hazard. We let the stochastic variable be the level of cost reduction whose probability is influenced by managerial effort. The moral hazard setting is that the manager's effort, which is unobservable and unverifiable *indirectly* reduces the initial cost (which is common knowledge) through the likelihood of realizing a good performance (one can consider it as the probability of success). The assumption about the stochastic influence of his effort enables us to verify whether there exists a link between the optimal effort provision and the degree of market competition, as found by the literature mentioned above. Product market competition is measured by the number of firms, where a Cournot oligopoly consisting of n identical firms (run by managers) is taken into account.

We show that product market competition does not necessarily influence the managerial compensation that deals with moral hazard. The reason is that the imposed incentive compatible constraint, moral hazard constraint, and participation constraint all work on the *utilities* of the manager which do not depend on product market competition. In other words, this is because the cost of inducing the managerial effort through optimal contracts is not changed by rivals' behaviors. Although the shareholder cannot totally control the firm's performance, which to a large extent depends on the market and rival firms' behavior, he is the one to have all the bargaining power to restrain the utility of the manager.

In the second case (as in section 2.3), we focus on adverse selection when moral hazard is still present. We follow the setting of Horn et al. (1994) and Piccolo et al. (2008) by considering a situation where one component of marginal cost, specifically the initial cost is a private information of the manager and the managerial effort works to *directly* reduce the initial cost. We confirm with this setting that the optimal effort exerted by the manager is related to the degree of competition in the product market. We show that the induced managerial effort of both types decreases in a duopoly market compared to a monopoly market.

In the third case (as in section 2.4), both adverse selection and moral hazard are taken into account. We let the initial cost be the private information of the manager and we assume that his effort *indirectly* reduces the initial cost by influencing the likelihood of realizing a good performance (a large amount of cost reduction). These assumptions provide a reason of granting a two-part payment to the manager: one part is fixed and intended to embody the ability of the manager in the project whereas the other part is a variable bonus, which depends on the actual performance of the manager (the same as in practice). In this event, we wonder if it is necessary to set the managerial incentive payment in a two-part form. Actually, although it appears to be good news for the manager to get a combination of both fixed salary and performance-based bonus, the optimal contract shows that the manager does not earn more through the performance-based bonus even he obtains a good performance in a good product market background (for instance a less competitive market which favors the firm to gain more profit). This is because the aggregate sum of the fixed salary and the performance-based bonus is blocked by the shareholder in an optimal way which favors his own interest.

This chapter contributes to the branch of the literature that considers product market competition in the contractual design with adverse selection and/or moral hazard by switching the moral hazard impact to the marginal cost from the output level (which is a classical setting) and liberating the output level as a result of competition with rival firms. It also provides an exhaustive analysis on the characteristics of the optimal contract with the new settings.

Related Literature. Some related literature has taken the informational problems such as adverse selection and moral hazard into account when studying the relationship between managerial incentive contracts and product market competition. However, the results about how managerial effort is influenced by product market competition is mixed.

An empirical estimation of Aghion *et al.* (2005) detected a reversed U-shape relationship between the firm's propensity to innovate (in the sense of making more effort in cost-reducing activities) and the product market competition. As for the theoretical research, Hart (1983) considered the case where managerial effort reduces total costs and proved with a general model that managerial slack is lower under competition. Since prices are reduced due to the expansion of rivals, the manager has to make more effort to maintain profit. Martin (1993) considered a specific model where managerial effort reduces marginal cost and there is additionally a component of the marginal cost, which can only be observed by the manager. Using a cost-target contractual mechanism, he showed that product market competition measured by the number of firms increases cost-target, implying less managerial effort under a more intensive competition.

The cost-target contractual mechanism as in Martin (1993) is frequently used in the studies of managerial incentive contracts under product market competition (see also Horn et al., 1994; Piccolo et al., 2008). The setting is to let the unobservable effort of the manager play a role to *directly* reduce the marginal cost. Horn et al. (1994) considered three different modes of interaction in the product competition - Bertrand competition, Cournot competition, and output Cartel (seen as successively less competitive) - and found a negative relationship between the competitiveness and the effort incentives (the induced effort). Piccolo et al. (2008) compared two contractual regimes: cost-target regime and profit-target regime, and argued that the inverted-U shaped relationship is more likely to be found in industries where managerial incentives are based on profit rather than on cost. It is worth noting that this setting requires the manager to practice the "right" level of effort, which is induced from the cost-target. In this way, the manager is passive to practice the required level of effort and more importantly, the moral hazard problem will transform into a pure adverse selection problem.

In the above-mentioned literature, Piccolo et al. (2008) considered a timing structure where the managerial efforts and outputs are simultaneously determined (without a second-stage sub-game). Such timing is also taken into account by Bertoletti and Poletti (1997), who focused on the informational role of the market by considering the correlation of different firms' marginal cost.

Moreover, Etro and Cella (2013) also studied the effect of product market competition upon managerial effort in a shareholder-manager relationship. They found that a more intensive competition (a rising number of the firms) increases the managerial incentives in the sense of a larger differential between the effort provided by a more efficient manager and the effort provided by a less efficient manager. However, the effort is assumed to be observable, hence not moral hazard incentive constraint is needed.

Chapter 2 is organized as follows. Section 2.2 introduces the basic model at the presence of solely moral hazard and clarifies the shareholders' contractual design in the underlying product market competition. Section 2.3 studies the adverse selection case when the manager has private information about the initial marginal cost and investigates the effect of product market competition. Section 2.4 examine the interaction between product market competition and the agency problem at the presence of both moral hazard and adverse selection. Section 2.5 extends the contractual design on the base of Fershtman and Judd (1987), where the performance-based compensation works on the sales revenue. The role of manager's limited liability is also taken into account in the product market competition. Section 2.6 concludes. All proofs are settled in Appendix.

2.2 The Basic Model with Moral Hazard

Product market competition. Consider n identical firms competing in a Cournot market with homogenous goods. Since they are identical, let us focus on firm i, one of the n firms and we denote the other $n-1$ firms with superscript $-i$. The output levels of firm i and the other $n-1$ firms are respectively q^i and q^{-i}. Firm i's revenue thus writes $R_i\left(q^i,\, q^{-i}\right)$.

Technology. Each firm has a risk neutral shareholder and a risk neutral manager and each firm is running with a cost-reduction project, the stochastic nature of which is modeled in a two-effort-two-outcome setting. Let θ be each firm's initial marginal cost and r_k be the extent of cost reduction. The *ex post* marginal cost thus writes $c_k = \theta - r_k$. Let the outcome $k \in \{G, B\}$, with G referring to "Good" performance (i.e., a high level of cost reduction) and B referring to "Bad" performance (i.e., a low level of cost reduction). Of course, $r_G > r_B$. Here we do not restrict r_B so that the value of a bad result can be positive, null or even negative.

Since the outcome of the project cannot be predicted with certainty, the numerical measure of the performance r_k is a random variable. The distribution of r_k depends on how much effort the manager exerts in executing the project. To simplify, let the manager choose between making effort and not making effort $e \in \{0, 1\}$. His personal cost of making effort $\psi\left(e\right)$ is normalized with $\psi\left(0\right) = 0$ and $\psi\left(1\right) = \psi$. The effort is unobservable and unverifiable and influences the conditional probability of success. If the manager does not make effort, the probability of highly reducing the cost (Good performance) is $\Pr\left(r_k = r_G | e = 0\right) \equiv \pi_0$, thus the probability of weakly reducing the cost (Bad performance) is $\Pr\left(r_k = r_B | e = 0\right) = 1 - \pi_0$. If the manager exerts effort, the probability of significantly reducing the cost (Good performance) is $\Pr(r_k = r_G|e = 1) \equiv \pi_1$, thus the probability of slightly reducing the cost (Bad performance) is $\Pr(r_k = r_B|e = 1) = 1 - \pi_1$. Making effort implies a higher probability of achieving a significant level of cost reduction: $\pi_1 > \pi_0 \geq 0$. Denote $\pi_1 - \pi_0 \equiv \Delta\pi$.

Utilities. The managers usually have the rights to use corporate assets for any expense of a company such as for production. In this model, we let the manager receive a transfer t_k from the shareholder and uses part of the transfer to finance production costs. Once the outcome k is revealed, the manager of firm i realizes his utility, which is in function of the rest of the transfer after paying for production: $u_k = I(t_k - c_k q_k^i)$, given the production level q_k^i. To simplify, we consider a linear case where

$$u_k = t_k - c_k q_k^i. \tag{2.2}$$

Constraints. Since the manager does not know the result k of his performance when he makes the effort decision, his utility before knowing the result k is in expected term. To induce effort of the manager, the shareholder should respect the the moral hazard constraint, in which the expected utility of the manager when making effort $\mathbb{E}_{k|1}[u_k] - \psi$ should exceed the expected utility when not making effort $\mathbb{E}_{k|0}[u_k]$. The moral hazard incentive constraint (MH-2.2) writes

$$\mathbb{E}_{k|1}[u_k] - \psi \geqq \mathbb{E}_{k|0}[u_k], \tag{MH-2.2}$$

i.e., $\pi_1 (t_G - c_G q_G^i) + (1 - \pi_1)(t_B - c_B q_B^i) - \psi \geqq \pi_0 (t_G - c_G q_G^i) + (1 - \pi_0)(t_B - c_B q_B^i)$, which by simplification is equivalent to

$$\left(t_G - c_G q_G^i\right) - \left(t_B - c_B q_B^i\right) \geq \frac{\psi}{\Delta\pi}. \tag{MH-2.2-1}$$

The above expression shows that both the output level and the marginal cost influence the manager's choice of making effort or not. Since by assumption, the manager uses part of the transfer to finance the costs of production. Writing in form of the utilities, the moral hazard incentive constraint (MH-2.2-1) is also equivalent to

$$u_G - u_B \geq \frac{\psi}{\Delta\pi}. \tag{MH-2.2-2}$$

To induce an effort-making manager to participate, his expected utility must cover his reservation utility, which is still normalized at zero. The participation constraint (PC-2.2) thus writes

$$\mathbb{E}_{k|1}\left[u_k\right] - \psi \geqq 0. \tag{PC-2.2}$$

Program. We ignore momently the limited liability constraints. Since the performance of the manager is known *ex post*, shareholder designs contracts to maximize his expected payoff. The shareholder's program (P-2.2) is as follows.

$$\begin{cases} \max\limits_{\left\{\left(t_k; q_k^i\right)\right\}, k\in\{G,B\}} \left\{\mathbb{E}_{k|e}\left[R_i\left(q_k^i\right) - t_k\right]\right\} \\ \text{subject to (MH-2.2) and (PC-2.2)} \end{cases} \tag{P-2.2}$$

The shareholder of firm i receives a revenue $R_i\left(q_k^i\right)$, which depends on the output level in reaction of the rivals' behavior in the product market and gives his manager a transfer t_k according to the result of the performance. The contractual allocation[1] is $\left\{\left(t_k; q_k^i\right)\right\}$, with $k \in \{G, B\}$. As usual, the Revelation Principle applies so that the contractual menu offered by the shareholder is incentive compatible.

Timing. At the beginning of the game, the shareholder proposes a menu of contractual allocations with an anticipation of product market competition. The manager chooses the effort e and is responsible for production. Then, the result of k is realized and publicly observed. The

[1] In the settings of Martin (1993), Horn et al. (1994), Etro and Cella (2013), the contract does not contain the size of production whereas in Bertoletti and Poletti (1997) and Piccolo et al. (2008), the output is part of the contract designed by the shareholder.

manager receives the payments and implements the output level in the competitive product market. The timing is graphically presented as follows.

$t=0$	$t=1$	$t=2$	$t=3$	$t=4$
S offers a contract: $\{(t_k; q_k^i)\}$, $k \in \{G, B\}$	M accepts or refuses the contract	M exerts an effort or not	The outcome k is realized and revealed	M receives the payment and implements the output

Figure 2.1: Timing of contracting under Moral Hazard.

2.2.1 Contractual design

Suppose it is in the best interests of the shareholder to induce effort of the manager ($e = 1$). From (2.2), one can obtain $t_k = u_k + c_k q_k^i$. Substituting this expression in the program of the shareholder (P-2.2), one can rewrite the program as follows, named as program (P'-2.2).

$$\begin{cases} \max\limits_{\left\{\left(t_k; q_k^i\right)\right\}, k\in\{G,B\}} \left\{\mathbb{E}_{k|1}\left[R_i\left(q_k^i\right) - u_k - c_k q_k^i\right]\right\} \\ \text{subject to (MH-2.2) and (PC-2.2)} \end{cases} \tag{P'-2.2}$$

The program (P'-2.2) shows that $\mathbb{E}_{k|1}\left[u_k\right]$ is costly to the shareholder. It is thus optimal for the shareholder to minimize the expected utility of the manager.

Proposition 2.2.1 *With solely moral hazard, (i). the optimal contract requires*

$$\begin{aligned} u_B &= -\frac{\pi_0 \psi}{\Delta\pi}, \\ u_G &= \frac{(1-\pi_0)\,\psi}{\Delta\pi}; \end{aligned}$$

(ii). the optimal payments satisfies

$$
\begin{aligned}
t_G &= c_G q_G^i + \frac{(1-\pi_0)\,\psi}{\Delta\pi}, \\
t_B &= c_B q_B^i - \frac{\pi_0 \psi}{\Delta\pi}.
\end{aligned}
$$

Proof. See appendix B.1. ∎

This proposition suggests that the moral hazard problem is solved by punishing (through the utility) the manager who realizes a bad result and compensating the manager who realizes a good result. Later on, we will also consider the case where it is necessary to have $u_B \geq 0$, which means that the manager is protected by limited liability even when the performance is bad.

Observing the optimal transfers for good and bad results, we can see that both depend on the conditional probabilities of performance, the disutility of effort as well as the total costs of production. One can observe that whatever the result of the performance, the transfer to the manager increases with the quantity of the product. In other words, the manager would get higher (lower) compensation when the firm captures a larger (smaller) part of the market. This is because more (less) finance is needed to realize a larger (smaller) production.

2.2.2 The role of product market competition

Substituting the binding constraint in the objective function, we obtain the simplified program of the shareholder as follows

$$
\max_{\left\{q_k^i\right\}, k\in\{G,B\}} \left\{\mathbb{E}_{k|1}\left[R_i\left(q_k^i\right) - c_k q_k^i\right] - \psi\right\}, \qquad \text{(P"-2.2)}
$$

where q_k^i shows that the shareholder will propose two levels of production according to the result of the project. Observing this objective function, one can confirm that the shareholder does not need to provide extra rent for inducing effort of the manager. Actually, the rent transferred to the manager is extracted from the net present value of the project by the shareholder in order to induce the manager to participate as well as exert effort.

Let us denote $\mathbb{E}_{k|1}\left[R_i\left(q_k^i\right) - c_k q_k^i\right] - \psi \equiv V_1^i$ as the value of firm i's shareholder when inducing the manager to make effort ($e = 1$). Expanding this expression, we have

$$V_1^i = \pi_1\left[R_i\left(q_G^i\right) - c_G q_G^i\right] + (1-\pi_1)\left[R_i\left(q_B^i\right) - c_B q_B^i\right] - \psi.$$

The program of the shareholder (P') is to choose the optimal level of production so as to maximize the value of firm i. Denote $\frac{\partial R_i\left(q_k^i;q\right)}{\partial q_k^i} = R_i'\left(q_k^i\right)$.

Proposition 2.2.2 *With solely moral hazard, the first best output level can be implemented such that*

$$R_i'\left(q_k^{i*}\right) = c_k,\ \forall k \in \{G, B\}.$$

Proof. See appendix B.2. ■

When the (solely) moral hazard problem is solved, marginal revenues are equal to marginal costs so that the first best level (superscript with star) can be implemented.

Applying the first order conditions with a linear demand function $p = a - Q = a - q_k^i - \sum^{n-1} q^{-i}$, we have $R_i'\left(q_k^{i*}\right) = a - q_k^i - Q$ for firm i. In equilibrium, the output level is $q_k^{i*} = \frac{a+\sum_{i=1}^n c^i}{n+1} - c_k, \forall k \in \{G, B\}$. Without knowing the *ex post* cost of each firm, it is hard to tell how the number of firms influences the equilibrium output. In the following, we consider two polar cases: when the outcome of cost-reduction performance of each firm is independent one from another; when the outcome of cost-reduction performance of each firm is perfectly correlated one to another.

Independent performance. For the first case where the cost-reduction performance of each firm is independent one from another, the performance on the marginal cost of one firm has no impact on that of another firm. Let us suppose x (the number of firms) firms among the total n firms have realized performance k (hence the marginal cost is c_k), then considering the binomial setting of the performance, we have all the rest $n-x$ firms to realize the opposite performance $-k$ (hence the marginal cost is c_{-k}). The output level of firm i is thus $q_k^{i*} = \frac{a+xc_k+(n-x)c_{-k}}{n+1} - c_k = \frac{a+(n-x)(c_{-k}-c_k)-c_k}{n+1}, \forall k \in \{G, B\}$. One can imply that $\frac{\partial q_k^{i*}}{\partial n} = \frac{(n+1)(c_{-k}-c_k)-[a+(n-x)(c_{-k}-c_k)-c_k]}{(n+1)^2} = \frac{(1+x)(c_{-k}-c_k)-a-c_k}{(n+1)^2}$. Hence, if $(1+x)(c_{-k}-c_k)-a-c_k \geq 0$, i.e., $c_{-k}-c_k \geq \frac{a+c_k}{1+x}$ (one necessary condition is $c_{-k}-c_k \geq 0$, which implies $-k = B$ and $k = G$ since only $c_B - c_G > 0$ is true), then $\frac{\partial q_k^{i*}}{\partial n} \geq 0$. If most of the n firms realize a good performance (i.e., a lower marginal cost) as firm i does, one can see that it is easier to have $c_B - c_G \geq \frac{a+c_G}{1+x}$ satisfied when $x \to +\infty$.

Perfectly correlated performance. For the second case where the cost-reduction performance of each firm is perfectly correlated, if firm i realizes performance k then all the other firms all realize the same performance. Since $c^i = c_k$, $\forall i = 1, 2, 3, ..., n$, the equilibrium output of firm i is $q_k^{i*} = \frac{a+nc_k}{n+1} - c_k = \frac{a-c_k}{n+1}$, $\forall k \in \{G, B\}$. Obviously, $\frac{\partial q_k^{i*}}{\partial n} < 0$. In this case, whether the manager makes effort or not, competition always decreases output. On the other hand, one can also obtain $\frac{\partial t_k}{\partial n} = \frac{\partial t_k}{\partial q_k}\frac{\partial q_k^{i*}}{\partial n} = c_k \frac{\partial q_k^{i*}}{\partial n} < 0$. Hence more intensive product market competition also implies lower transfer to the manager.

2.3 False Moral Hazard and Adverse Selection

In this section, we focus on adverse selection and study its interaction with product market competition. To simplify, we consider a two-type discrete model which is based on the setting[2]

[2]In the model of Horn et al. (1994), the manager's type is continuous.

of Horn et al. (1994). We also let the manager's effort work to decrease *directly* a firm's initial marginal cost θ_j, the marginal cost writes: $c_j = \theta_j - e$.

The two-type discrete model requires firm's initial marginal cost $\theta_j \in \{\theta_L, \theta_H\}$ be a private information of the manager, with $\theta_H > \theta_L > 0$. The variable θ_j may represent the ability of the manager: the θ_L-type manager is efficient whereas the θ_H-type manager is inefficient. We denote $\theta_H - \theta_L \equiv \Delta\theta$, the spread of the manager's types, which can also represent the difference of the ability between the two managers. Without observing θ_j, the shareholder only knows the corresponding probability that $\Pr(\theta_j = \theta_L) = \alpha > 0$ and $\Pr(\theta_j = \theta_H) = 1 - \alpha > 0$. As in Laffont and Martimort (2002), the relationships between cost-target and effort of the inefficient and efficient manager are respectively $c_H = \theta_H - e_H$ and $c_L = \theta_L - e_L$, where e_H and e_L are the corresponding "right"levels of effort of the type H manager and the type L manager. Although the effort of the manager is not directly observed by the shareholder, the level of effort can be induced from these relationships, given the cost-target and the initial cost (type) value. This setting is named false moral hazard, since the manager does not have freedom to choose his level of effort once the contract is implemented according to his type. The model will turn out to be a pure adverse selection problem in the end.

The shareholder makes a transfer t_j to the manager and pays for the costs of production. The contractual allocation is $\{(t_H, c_H); (t_L, c_L)\}$. The utility of the manager writes

$$u_j = t_j - \varphi(e). \tag{2.3}$$

The incentive compatible constraint $t_L - \varphi(\theta_L - c_L) \geqq t_H - \varphi(\theta_L - c_H)$ is equivalent to

$$u_L \geqq u_H + \varphi(\theta_H - c_H) - \varphi(\theta_L - c_H). \tag{IC-2.3}$$

The participation constraint is thus

$$u_H \geqq 0. \tag{PC-2.3}$$

2.3.1 Contract design for monopoly

Consider a Monopoly firm with production $q^*(c_j)$, for $j \in \{H, L\}$. The shareholder's program is

$$\left\{ \begin{array}{c} \max\limits_{\{(t_H,c_H);(t_L,c_L)\}} \left\{ \begin{array}{c} \alpha \left[R\left(q^*\left(c_L\right)\right) - c_L q^*\left(c_L\right) - t_L\right] \\ +\left(1-\alpha\right)\left[R\left(q^*\left(c_H\right)\right) - c_H q^*\left(c_H\right) - t_H\right] \end{array} \right\} \\ \text{subject to (IC-2.3) and (PC-2.3).} \end{array} \right.$$

Substituting the transfers to the manager, the shareholder's program rewrites

$$\left\{ \begin{array}{c} \max\limits_{\{(u_H,c_H);(u_L,c_L)\}} \left\{ \begin{array}{c} \alpha \left[R\left(q^*\left(c_L\right)\right) - c_L q^*\left(c_L\right) - u_L - \varphi\left(\theta_L - c_L\right)\right] \\ +\left(1-\alpha\right)\left[R\left(q^*\left(c_H\right)\right) - c_H q^*\left(c_H\right) - u_H - \varphi\left(\theta_H - c_H\right)\right] \end{array} \right\} \\ \text{subject to (IC-2.3) and (PC-2.3).} \end{array} \right.$$

One can see that both u_L and u_H are costly for the shareholder. Consequently, it is in the best interest of the shareholder to minimize u_L and u_H. Hence both (IC-2.3) and (PC-2.3) are binding: at optimum, $u_L = \varphi\left(\theta_H - c_H\right) - \varphi\left(\theta_L - c_H\right)$ and $u_H = 0$. Substituting u_L and u_H in the above objective function, one can rewrite the shareholder's program as follows

$$\max_{\{c_H;c_L\}} \left\{ \begin{array}{c} \alpha\left[R\left(q^*\left(c_L\right)\right) - c_L q^*\left(c_L\right) - \varphi\left(\theta_H - c_H\right) + \varphi\left(\theta_L - c_H\right) - \varphi\left(\theta_L - c_L\right)\right] \\ +\left(1-\alpha\right)\left[R\left(q^*\left(c_H\right)\right) - c_H q^*\left(c_H\right) - \varphi\left(\theta_H - c_H\right)\right] \end{array} \right\}$$

The first order condition (FOC) with respect to c_H and c_L yields

$$\left\{ \begin{array}{l} \varphi'\left(\theta_H - c_H\right) = \alpha\varphi'\left(\theta_L - c_H\right) + \left(1-\alpha\right) q^*\left(c_H\right), \\ \varphi'\left(\theta_L - c_L\right) = q^*\left(c_L\right). \end{array} \right.$$

To take a further look at the result, let us apply with a simple linear inverse demand function $p = a - q$ and a quadratic disutility of effort $\varphi(e) = \frac{e^2}{2}$. One can easily obtain the equilibrium output $q^*(c_j) = \frac{a-c_j}{2}$, $\forall j \in \{H, L\}$, which is in function of the marginal cost. Applying these in the FOCs of the optimal contract, one can obtain

$$\begin{cases} \theta_H - c_H = \alpha(\theta_L - c_H) + (1-\alpha)\frac{a-c_H}{2}, \\ \theta_L - c_L = \frac{a-c_L}{2}. \end{cases}$$

Solving each FOC, one gets

$$\begin{cases} c_H^* = \theta_H - (a - \theta_H) + \frac{\alpha}{1-\alpha}\Delta\theta, \\ c_L^* = \theta_L - (a - \theta_L). \end{cases}$$

One can induce that the inefficient manager has to make effort e_H, which equals $a - \theta_H - 2\frac{\alpha}{1-\alpha}\Delta\theta$ to achieve the cost-target c_H^* whereas the efficient manager has to make effort e_L which equals $a - \theta_L$ to achieve the cost-target c_L^*. Since $2\frac{\alpha}{1-\alpha}\Delta\theta > 0$, the contract works as a cost-plus incentive scheme for the inefficient manager (type H). This is in line with the contract theory literature such as in Laffont and Martimort (2002).

2.3.2 Contract design for duopoly

Now consider a duopoly market. The equilibrium level of production does not solely depend on its own marginal cost. It also depends on the cost level of the rival firm. Let the two firms be firm 1 and firm 2, their equilibrium output thus writes $q_1(c_{1j}, c_{2j})$ and $q_2(c_{1j}, c_{2j})$, with $c_{1j} \in \{c_{1H}, c_{1L}\}$ and $c_{2j} \in \{c_{2H}, c_{2L}\}$.

The program of firm 1's shareholder thus writes

$$\max_{\{c_{1H};c_{1L}\}} \left\{ \begin{array}{c} \alpha \left[\begin{array}{c} R_1\left(q_1\left(c_{1L},c_{2j}\right),q_2\left(c_{1L},c_{2j}\right)\right) - c_{1L}q_1\left(c_{1L},c_{2j}\right) \\ -\varphi\left(\theta_H - c_{1H}\right) + \varphi\left(\theta_L - c_{1H}\right) - \varphi\left(\theta_L - c_{1L}\right) \end{array} \right] \\ +\left(1-\alpha\right) \left[\begin{array}{c} R_1\left(q_1\left(c_{1H},c_{2j}\right),q_2\left(c_{1H},c_{2j}\right)\right) \\ -c_{1H}q_1\left(c_{1H},c_{2j}\right) - \varphi\left(\theta_H - c_{1H}\right) \end{array} \right] \end{array} \right\}$$

The FOC with respect to c_{1H} and c_{1L} yields

$$\begin{cases} \alpha\left[\varphi'\left(\theta_L - c_{1H}\right) - \varphi'\left(\theta_L - c_{1H}\right)\right] + \left(1-\alpha\right) \left[\begin{array}{c} \frac{\partial R_1}{\partial q_1}\frac{\partial q_1}{\partial c_{1H}} + \frac{\partial R_1}{\partial q_2}\frac{\partial q_2}{\partial c_{1H}} - q_1\left(c_{1H},c_{2j}\right) \\ -c_{1H}\frac{\partial q_1}{\partial c_{1H}} + \varphi'\left(\theta_H - c_{1H}\right) \end{array} \right] = 0, \\ \alpha\left[\frac{\partial R_1}{\partial q_1}\frac{\partial q_1}{\partial c_{1L}} + \frac{\partial R_1}{\partial q_2}\frac{\partial q_2}{\partial c_{1L}} - q_1\left(c_{1L},c_{2j}\right) - c_{1L}\frac{\partial q_1}{\partial c_{1L}} + \varphi'\left(\theta_L - c_{1L}\right)\right] = 0. \end{cases}$$

After simplification, one can obtain the FOCs as follows

$$\begin{cases} \varphi'\left(\theta_H - c_{1H}\right) = \alpha\varphi'\left(\theta_L - c_{1H}\right) - \left(1-\alpha\right)\left[\frac{\partial R_1}{\partial q_2}\frac{\partial q_2}{\partial c_{1H}} - q_1\left(c_{1H},c_{2j}\right)\right], \\ \varphi'\left(\theta_L - c_{1L}\right) = q_1\left(c_{1L},c_{2j}\right) - \frac{\partial R_1}{\partial q_2}\frac{\partial q_2}{\partial c_{1L}}. \end{cases}$$

To further analyze the result and compare with the previous monopoly case, let us still apply the quadratic disutility of effort $\varphi\left(e\right) = \frac{e^2}{2}$. In a duopoly market with firms producing homogenous products, the linear inverse demand function writes $p = a - q_1 - q_2$. Then the revenue of firm 1 is $R_1 = \left(a - q_1 - q_2\right)q_1$, hence $\frac{\partial R_1}{\partial q_2} = -q_1$. With the first order condition, one can obtain the equilibrium outputs

$$\begin{cases} q_1^*\left(c_{1j},c_{2j}\right) = \frac{a+c_{2j}-2c_{1j}}{3}, \forall j \in \left\{H,L\right\}, \\ q_2^*\left(c_{1j},c_{2j}\right) = \frac{a+c_{1j}-2c_{2j}}{3}, \forall j \in \left\{H,L\right\}. \end{cases}$$

Clearly, the cost-targets of firm 1 and firm 2 are strategic substitutes. If both firms realize the same marginal cost (with $c_{2j} = c_{1j}$, $\forall j \in \{H,L\}$), then $q_1^*\left(c_{1j}\right) = q_2^*\left(c_{1j}\right) = \frac{a-c_{1j}}{3}$, which is obviously less compared to the monopoly case. Applying these in the FOCs of the optimal contract, one can obtain

$$\begin{cases} \theta_H - c_{1H} = \alpha\left(\theta_L - c_{1H}\right) + (1-\alpha)\,\frac{a-c_{1H}}{9}, \\ \theta_L - c_{1L} = \frac{4}{9}(a - c_{1L}). \end{cases}$$

Solving each FOC, one gets

$$\begin{cases} c^*_{1H} = \theta_H - \frac{1}{8}\left(a - \theta_H\right) + \frac{9}{8}\frac{\alpha}{1-\alpha}\Delta\theta, \\ c^*_{1L} = \theta_L - \frac{4}{5}\left(a - \theta_L\right). \end{cases}$$

Similarly as in the monopoly case, one can induce that the inefficient manager has to make effort e_{1H} which equals $\frac{1}{8}\left(a - \theta_H\right) - \frac{9}{8}\frac{\alpha}{1-\alpha}\Delta\theta$ to achieve the cost-target c^*_{1H} whereas the efficient manager has to make effort e_{1L} which equals $\frac{4}{5}\left(a - \theta_L\right)$ to achieve the cost-target c^*_{1L}.

Proposition 2.3.1 *(Horn et al., 1994) With type and effort dependent marginal cost of production, i.e., $c_j = \theta_j - e$, the optimal effort exerted by the manager is related to the degree of competition in the product market such that the induced managerial effort of both types decreases in a duopoly market compared to a monopoly market.*

Proof. See appendix B.3. ■

This proposition based on the setting of Horn et al. (1994) reexamines the effect of product market competition upon managerial effort by comparing a duopoly case with a monopoly case. It suggests that the manager is to make less effort under a comparative more intensive competition compared to the no competition case. This result is in line with Martin (1997) who showed with another false moral hazard setting that competition increases marginal cost, the cost-target. In reality, this may due to the lack of an efficient monitoring mechanism whereas in this model, the optimal contract works to replace the costly monitoring system by leaving no freedom for the manager on the choice of his effort: once the target is set, he has to make the required effort to achieve it. This proposition is just in contrast with the widely agreed observation in reality that people in monopoly industry works less while people in competitive industry works more.

Whatever the type of the manager, one can see that how much effort the manager has to make depends on the shareholder's setting upon cost-targets. In the duopoly case, the shareholder chooses the cost-targets in reaction of both market demand and the rival firm's choice of cost-targets, which work as strategic substitutes. In the monopoly case, the shareholder chooses the cost-targets in reaction of solely market demand, since he has no competitor in the market hence no cost-target of rivals that may hinder his objective. Intuitively, the shareholder of a monopoly will set the cost-target as hard as possible (to have minimal marginal cost) without being affected by the others whereas the shareholder of a duopoly will set easier cost-targets (in reaction of the rival's behavior) in order to maximize his own objective.

2.4 Adverse Selection followed by Moral Hazard

In this section, we consider the case where adverse selection and moral hazard both exist in a shareholder-manager relationship. We assume now that the probability distribution of the cost depends on both type j and effort e. In other words, ability and effort are complementary for the success of a firm (e.g., Ollier and Thomas, 2013). Following the previous sections, we still have two types of the manager, with $j \in \{H, L\}$, two outcomes of the performance, with $k \in \{G, B\}$, and two levels of managerial effort, with $e \in \{0, 1\}$. The marginal cost in this section thus writes $c_{jk} = \theta_j - r_k$. Given the inputs (e, j), we denote $\Pr(k = G|e, j) \equiv \pi_e(j)$, the likelihood of realizing a good performance. Hence, the likelihood of realizing a bad performance is $\Pr(k = B|e, j) = 1 - \pi_e(j)$. Given type j, it is assumed that making effort increases the likelihood of realizing a good performance, hence the probability of success (realizing a good performance) when making effort ($e = 1$) exceeds that when not making effort ($e = 0$), i.e., $\pi_1(j) > \pi_0(j)$. We denote $\pi_1(j) - \pi_0(j) = \Delta\pi(j)$. Hence $\Delta\pi(j) > 0$. Moreover, given effort e, an efficient manager with low initial marginal cost (type L) is more likely to succeed than an inefficient manager with high initial marginal cost (type H), i.e., $\pi_e(L) > \pi_e(H)$. Since the contractual design is the same for all firms, we *remove* thereafter the superscripts i of each firm.

To take into account that the performance of the manager depends on both his ability and the effort he exerts in the cost-reducing activity, the payment t_{jk} includes two components. Formally, $t_{jk} = w_j + v_{j,k}$, where w_j is the fixed wage of the manager, related exclusively to his type j, and $v_{j,k}$ is the bonus provided depending on his type as well as his performance. Before the manager decides on effort, the performance is not realized yet, thus the manager of type j's expected utility is

$$U_j(e) = w_j + \mathbb{E}_{k|e,j}[v_{jk}] - \psi(e), \tag{2.4}$$

where the expected value $\mathbb{E}_{k|e,j}[v_{jk}]$ depends on effort e and type j.

Timing. At the beginning of the game, nature draws type θ_j for each manager and each manager privately observes his type. The shareholder of each firm i proposes a menu of contractual allocations $\{(t_{jk}; q_{jk})\}$, where $j \in \{L, H\}, k \in \{G, B\}$. This menu will be chosen according to whether the shareholder wants to induce effort (satisfy the moral hazard incentive constraint). The manager chooses the report of his type j between H and L and obtains a corresponding fixed payment w_H or w_L. Later, the manager decides whether or not to make effort. Then the performance about r_k is realized and is publicly observed and the manager obtains a corresponding bonus v_{jk}. In the end, firms engage in competition in the product market, in which the manager implements the quantity q_{jk} as contractually agreed upon and realizes his *ex post* utility. The timing of the game is as follows.

$t=0$	$t=1$	$t=2$	$t=3$	$t=4$	$t=5$	$t=6$
Only M observes θ_j	S offers a contract: $\left\{\left(t^i_{jk}; q^i_{jk}\right)\right\}$, $j \in \{L, H\}$, $k \in \{G, B\}$.	M accepts or refuses the contract	M reports j and receives w_j	M exerts an effort or not	The outcome k is realized and revealed	M receives v^i_{jk} and implements the output

Figure 2.2: Timing of the contractual game with Adverse Selection followed by Moral Hazard.

Notice that we consider a full commitment framework. This means by the time when the type j is reported and the performance k is revealed and publicly observed, the shareholder can no longer change the contractual conditions agreed upon and the manager cannot decide to produce an alternative quantity other than q_{jk}, given j and k.

Constraints. To induce the manager to tell the truth about his type such that an efficient manager takes the payment designed for an efficient type and an inefficient manager takes the payment designed for an inefficient type, the adverse selection constraints must be satisfied.

Adverse selection constraints. Since the contract is designed before knowing the result of the performance k, the adverse selection constraints (AS-2.4-1) and (AS-2.4-2) for type L and type H are respectively:

$$w_L + \mathbb{E}_{k|e,L}\left[v_{Lk}\right] \quad \geq \quad w_H + \mathbb{E}_{k|e,L}\left[v_{Hk}\right], \tag{AS-2.4-1}$$

$$w_H + \mathbb{E}_{k|e,H}\left[v_{Hk}\right] \quad \geq \quad w_L + \mathbb{E}_{k|e,H}\left[v_{Lk}\right]. \tag{AS-2.4-2}$$

Giving (2.4), one can rewrite the two constraints (AS-2.4-1) and (AS-2.4-2) as follows

$$U_L(e) \geq U_H(e) + \mathbb{E}_{k|e,L}[v_{Hk}] - \mathbb{E}_{k|e,H}[v_{Hk}], \tag{AS-2.4-3}$$

$$U_H(e) \geq U_L(e) + \mathbb{E}_{k|e,H}[v_{Lk}] - \mathbb{E}_{k|e,L}[v_{Lk}]. \tag{AS-2.4-4}$$

Developing the last two terms on the right side of (AS-2.4-3), we have $\mathbb{E}_{k|e,L}[v_{Hk}] - \mathbb{E}_{k|e,H}[v_{Hk}] = [\pi_e(L) - \pi_e(H)](v_{HG} - v_{HB})$. Since $v_{jG} - v_{jB} > 0$, $\forall j \in \{L, H\}$, and $\pi_e(L) - \pi_e(H) > 0$, $\forall e \in \{0, 1\}$, one can tell that the last two terms on the right side of (AS-2.4-3) is positive. Similarly for (AS-2.4-4), one can tell that the last two terms on the right side $\mathbb{E}_{k|e,H}[v_{Lk}] - \mathbb{E}_{k|e,L}[v_{Lk}] = -[\pi_e(L) - \pi_e(H)](v_{LG} - v_{LB})$ is negative. Substituting these developments in (AS-2.4-3) and (AS-2.4-4), the two adverse selection constraints rewrites

$$U_L(e) \geq U_H(e) + [\pi_e(L) - \pi_e(H)](v_{HG} - v_{HB}), \tag{AS-2.4-5}$$

$$U_H(e) \geq U_L(e) - [\pi_e(L) - \pi_e(H)](v_{LG} - v_{LB}). \tag{AS-2.4-6}$$

Noticeably, if there was no complementarity between type and effort, i.e., $\pi_e(L) = \pi_e(H)$, then the shareholder would assign the same utility to the manager, regardless of his specific ability. In this case, the shareholder would be unable to distinguish between the two types. Consequently, it is necessary to have the assumption that type and effort are complements.

Further more, from (AS-2.4-5) and (AS-2.4-6), one can obtain

$$U_H(e) + [\pi_e(L) - \pi_e(H)](v_{LG} - v_{LB}) \geq U_L(e) \geq U_H(e) + [\pi_e(L) - \pi_e(H)](v_{HG} - v_{HB}),$$

which implies that the following monotonicity condition (MC-2.4) needs to be hold for the satisfaction of both constraints:

$$(v_{LG} - v_{LB}) \geq (v_{HG} - v_{HB}). \tag{MC-2.4}$$

This constraint requires a larger spread of bonus for the efficient type ($j = L$) compared to the inefficient type ($j = H$).

Moral hazard incentive constraints. To induce the manager to choose effort ($e = 1$) rather than no effort ($e = 0$), the moral hazard incentive constraints (MH-2.4) must be satisfied for each type j (after having truthfully reported his type):

$$\mathbb{E}_{k|e=1,j}\left[v_{jk}\right] - \psi \geq \mathbb{E}_{k|e=0,j}\left[v_{jk}\right], \forall j \in \{L, H\}. \tag{MH-2.4}$$

Developing (MH-2.4), on can obtain $\pi_1(j)\, v_{jG} + [1 - \pi_1(j)]\, v_{jB} - \psi \geqq \pi_0(j)\, v_{jG} + [1 - \pi_0(j)]\, v_{jB}$, which is equivalent to:

$$v_{jG} - v_{jB} \geq \frac{\psi}{\Delta\pi(j)}, \forall j \in \{L, H\}. \tag{MH-2.4-1}$$

Participation constraints. To ensure the participation of the manager before knowing his type, the total utility of each type needs to be no less than its reservation utility level (which is normalized to zero). The participation constraints are:

$$U_L(e) \geq 0, \tag{PC-2.4-1}$$

$$U_H(e) \geq 0. \tag{PC-2.4-2}$$

Working on the constraints (PC-2.4-1) and (AS-2.4-5), we see that (PC-2.4-1) is automatically slack if (AS-2.4-5) is satisfied. Together with monotonicity condition (MC-2.4), it follows that (AS-2.4-6) is also slack. Hence only three of the above-mentioned constraints are key to be satisfied, they are: (MH-2.4-1), (AS-2.4-5), and (PC-2.4-2).

Program. Suppose it is in the best interests of the shareholder to induce effort ($e = 1$), then program of the shareholder is to choose the optimal contract $\{U_j; q_{jk}\}$, for $j \in \{H, L\}$ and $k \in \{G, B\}$ to maximize the expected payoff of the shareholder, subject to the the four closely related constraints. Since (2.4) implies $\mathbb{E}_j[w_j] + \mathbb{E}_{j,k|1}[v_{jk}] = \mathbb{E}_j[U_j(1)] + \psi$, for $e = 1$, the program of the shareholder writes

$$\begin{cases} \max\limits_{\{(U_j;q_{jk})\}} \mathbb{E}_{j,k|1}\left[R(q_{jk}) - (\theta_j - r_k)q_{jk}\right] - \mathbb{E}_j[U_j(1)] - \psi \\ \text{subject to (MH-2.4-1), (AS-2.4-5), and (PC-2.4-2)} \end{cases} \tag{P-2.4}$$

One can observe that the expected utility of the manager is costly to the shareholder, hence maximizing the expected payoff of the shareholder is equivalent to minimizing the expected utility of the manager, i.e., $\mathbb{E}_j[U_j(1)]$.

2.4.1 The optimal contracts

Proposition 2.4.1 *With both adverse selection and moral hazard, (i). the optimal contract fixes the total managerial payment, which is composed of a fixed salary and a bonus as follows*

$$\begin{aligned} w_H + v_{HB} &= -\frac{\psi}{\Delta\pi(H)}\pi_0(H), \\ w_L + v_{LB} &= -\frac{\psi}{\Delta\pi(L)}\pi_0(L) + [\pi_1(L) - \pi_1(H)]\frac{\psi}{\Delta\pi(H)}; \end{aligned}$$

(ii). the shareholder has to give up an information rent which equals

$$\mathbb{E}_j[U_j(1)] = \alpha\frac{[\pi_1(L) - \pi_1(H)]\psi}{\Delta\pi(H)}.$$

Proof. See appendix B.4. ■

The optimal payment scheme in part (i) of Proposition 2.4.1 shows that many combinations of fixed wages and bonuses are possible. It is obvious that the first equation refers to a negative transfer[3] ($w_H + v_{HB} < 0$), which means the moral hazard problem is solved by punishing the inefficient manager who realizes a bad result.

[3]Later on, we will also consider the case where it is necessary to have $t_{HB} \geq 0$.

The information rent is generated from the manager's informational advantage, which allows the efficient manager to mimic the inefficient manager. This is the case when the probabilities of success between the two types are different, as previously assumed in our model that $\pi_1(L) > \pi_1(H)$. Interestingly, as in most literature where the probabilities of success between different types are not differentiated, if we set $\pi_1(L) = \pi_1(H)$, then the information rent will turn out to be zero. Proposition 2.4.1 underlines the importance of this differentiation (it is not surprising that the efficient one is more likely to success than the inefficient one) and shows that there is still an amount of information rent charged by the shareholder as long as this assumption holds.

Through the expression of the total managerial payment where the result of the project is revealed to be bad for the efficient manager (as shown in the second equation of part (i) of Proposition 2.4.1), it is not clear at priori whether or not the compensation concerns a punishment. The question follows is under what condition is an identified efficient manager punished when he realizes a bad result.

Corollary 2.4.1 *The efficient manager realizing a bad result is to be punished (i.e.,* $w_L + v_{LB} < 0$*), iff*

$$\frac{[\pi_1(L) - \pi_1(H)]}{\Delta\pi(H)} < \frac{\pi_0(L)}{\Delta\pi(L)}.$$

Proof. See appendix B.5. ■

In spite of the fact that the manager's optimal payment is in function of his cost of effort (as shown in part (i) of Proposition 2.4.1), the condition shown in Corollary 2.4.1 suggests that the manager's disutility of effort does not play a role on the decision of punishment. This is because the incentive contracts are designed and offered by the shareholder in defending the very best interest of his own. To decide whether or not the incentive payment is about a punishment, the shareholder does not care how much it costs the manager to make effort. What matters to him is the likelihoods of success for different types when making and not making effort. In other words, the probability of success is the crucial factor to determine the nature of compensation.

Interestingly, if $\pi_1(L) = \pi_1(H)$, then the efficient manager realizing a bad result is surely be punished, since $0 < \frac{\pi_0(L)}{\Delta\pi(L)}$ is always true. In this case, what determines the nature of the compensation (punishment or not) is rather the result of the project: a bad result corresponds to a punishment even the manager is identified to be efficient. The optimal contract design thus requires a punishment for the bad result of the project for both types of the manager. This result is also in line with most literature where the probabilities of success between different types are not differentiated.

2.4.2 Shareholder's choice of managerial effort

Let $V(e)$ denote the expected payoff of the shareholder with managerial effort $e \in \{0, 1\}$, then it is written as

$$V(e) = \mathbb{E}_{j,k|e}\left[R(q_{jk}) - (\theta_j - r_k)\, q_{jk}\right] - \mathbb{E}_j\left[U_j(e)\right] - \psi(e), \tag{V-2.4}$$

where $R(q_{jk})$ is the market revenue obtained by the shareholder of firm i when selling a quantity q_{jk}.

If the manager chooses not to make effort ($e = 0$), the shareholder does not need to propose different levels of bonus to induce effort. Hence the moral hazard constraint can be ignored: whatever the result of the performance, the bonus is always the same, i.e., $v_{HG} = v_{HB}$. Then the relevant constraints become solely (AS-2.4-5) and (PC-2.4-2). With both of these constraints binding, the optimal utilities satisfy $U_H(e) = U_L(e) = 0$, which shows neither types of the manager can gain by cheating on the information. The optimized value of the shareholder is

$$V(0) = \mathbb{E}_{j,k|e=0}\left[R\left(q_{jk}^{*}\right) - \left(\theta_j - r_k\right) q_{jk}^{*}\right].$$

Effort inducing condition. It is in the shareholder's interest to induce effort of the manager, when their payoffs in case of effort exceed that in case of no effort, i.e., $V(1) - V(0) \geq 0$, which is equivalent to

$$\psi \leq \digamma \left\{\mathbb{E}_{j,k|e=1}\left[R\left(q_{jk}^{*}\right) - \left(\theta_j - r_k\right) q_{jk}^{*}\right] - \mathbb{E}_{j,k|e=0}\left[R\left(q_{jk}^{*}\right) - \left(\theta_j - r_k\right) q_{jk}^{*}\right]\right\},$$

where

$$\digamma = \frac{\Delta\pi(H)}{\alpha\left[\pi_1(L) - \pi_1(H)\right] + \Delta\pi(H)}.$$

One can see that a larger $\pi_1(L) - \pi_1(H)$ decreases $\digamma$, hence decreases the whole value of the right side. This means the above condition is less often to be satisfied with a larger gap between the likelihoods of an efficient manager and an inefficient manager. In other words, this implies that the shareholder is less willing to induce the manager to exert effort. This result induced from the likelihoods is based on the assumption of complementarity between type and effort.

Without complementarity on the contrary, i.e., $\pi_1(L) = \pi_1(H)$, no type has incentive to cheat so that the moral hazard problem is the only remaining issue. The above expression would then be reduced to

$$\digamma = 1.$$

Proposition 2.4.2 *The shareholder's choice of inducing managerial effort is independent of the number of firms, i.e., $d\left[V(1) - V(0)\right]/dn = 0$.*

Proof. See appendix B.6. ■

This proposition shows that there is no necessary link between product market competition which is measured by the number of firms and the shareholder's choice of whether to induce managerial effort. This result also reflects a no necessary link between the decisions taken on the competitive market and the incentive contract offered to the manager to solve informational problems. This finding may generate from the fact that the performance of the manager is observed before the production takes place. Noticeably, this is also the case in Horn et al. with a similar timing. However, they proved a link between product market competition and the managerial incentives. The reason why our result differs with theirs is actually determined by the setting that the managerial effort stochastically affects the cost of production, rather than being a shock on the production. Moreover, the moral hazard problem is solved within the design of contract while in Horn et al. and some previously mentioned literature (e.g., Martin, 1993; Piccolo et al., 2008), managerial effort is induced from the cost-target and moral hazard is no longer an issue.

2.5 Extension

2.5.1 A Fershtman-Judd style contract

In this section, we extend the previously studied contractual design on the base of Fershtman and Judd (1987), where the manager's performance-based compensation is in function of the sales revenue. We consider the transfer to the manager t_{jk} is composed of two parts such that $t_{jk} = w_j + \sigma_{jk} R(\cdot)$, where w_j is the fixed wage of the manager based solely on his ability (type), and σ_{jk} is the bonus ratio that works on the sales revenue $R(\cdot)$.

Following the previous sections with a two-type-two-effort model, the conditional probabilities of realizing different outputs, given inputs (e, j) are $\Pr(k = G|e = 1, j) = \beta_1(j)$ and $\Pr(k = B|e = 0, j) = \beta_0(j)$, with $\beta_1(j) > \beta_0(j)$. Thus $\Pr(k = G|e = 1, j) = 1 - \beta_1(j)$ and $\Pr(k = B|e = 0, j) = 1 - \beta_0(j)$. As usual, we denote $\beta_1(j) - \beta_0(j) = \Delta\beta(j)$. Hence $\Delta\beta(j) > 0$, $\forall j \in \{L, H\}$.

The contractual allocation offered to the manager of any firm i is given by $\{(w_j; \sigma_{jk}; q_{jk})\}$ with $j \in \{L, H\}$ and $k \in \{G, B\}$. Noticeably, all managers have types drawn from the same distribution and the shareholders of all firms observe the distribution prior to offering a contract. Hence, it is without loss of generality to assume that firms and managers are matched randomly. Once each firm is matched with one manager, the shareholder offers identical incentive contract to each firm's manager. The Revelation Principle applies so that the contractual menu of each firm is incentive compatible.

Utilities. Before the manager decides on effort, the performance is not realized yet. The manager j's expected utility is

$$U_j(e) = w_j + \mathbb{E}_{k|e,j}\left[\sigma_{jk} R\left(q_{jk}, \cdot\right)\right] - \psi(e). \tag{2.5}$$

Constraints. To induce the manager to tell the truth, to induce the manager to make effort and to let the manager participate, the following constraints need to be satisfied.

Adverse selection constraints. Since the contract is designed before knowing the result of the project, the adverse selection constraints, for any given effort $e \in \{0, 1\}$, are written as:

$$w_L + \mathbb{E}_{k|e,L}\left[\sigma_{Lk} R\left(q_{Lk}, \cdot\right)\right] \geq w_H + \mathbb{E}_{k|e,L}\left[\sigma_{Hk} R\left(q_{Hk}, \cdot\right)\right], \tag{AS-2.5-1}$$

$$w_H + \mathbb{E}_{k|e,H}\left[\sigma_{Hk} R\left(q_{Hk}, \cdot\right)\right] \geq w_L + \mathbb{E}_{k|e,H}\left[\sigma_{Lk} R\left(q_{Lk}, \cdot\right)\right]. \tag{AS-2.5-2}$$

Rewriting the two constraints with utilities, we have

$$U_L(e) \geq U_H(e) + \mathbb{E}_{k|e,L}\left[\sigma_{Hk} R(q_{Hk}, \cdot)\right] - \mathbb{E}_{k|e,H}\left[\sigma_{Hk} R(q_{Hk}, \cdot)\right], \quad \text{(AS-2.5-3)}$$

$$U_H(e) \geq U_L(e) + \mathbb{E}_{k|e,H}\left[\sigma_{Lk} R(q_{Lk}, \cdot)\right] - \mathbb{E}_{k|e,L}\left[\sigma_{Lk} R(q_{Lk}, \cdot)\right]. \quad \text{(AS-2.5-4)}$$

Developing the last two terms on the right side of each inequality, one can rewrite the two adverse selection constraints as follows

$$U_L(e) \geq U_H(e) + \left[\beta_e(L) - \beta_e(H)\right]\left[\sigma_{HG} R(q_{HG}, \cdot) - \sigma_{HB} R(q_{HB}, \cdot)\right], \quad \text{(AS-2.5-5)}$$

$$U_H(e) \geq U_L(e) - \left[\beta_e(L) - \beta_e(H)\right]\left[\sigma_{LG} R(q_{LG}, \cdot) - \sigma_{LB} R(q_{LB}, \cdot)\right]. \quad \text{(AS-2.5-6)}$$

Clearly, $\beta_e(L) - \beta_e(H) > 0$, since an efficient manager with lower cost is closer to success than the inefficient one with higher cost, and $\sigma_{jG} R(q_{jG}, \cdot) - \sigma_{jB} R(q_{jB}, \cdot) > 0$, since having a good result deserves higher bonus than having a bad result, whatever the type of the manager is. Then both incentive constraints imply that $U_L(e) > U_H(e)$. Noticeably, if there was no complementarity between type and effort, such that $\beta_e(L) = \beta_e(H)$, the shareholder would assign the same utility to the manager, regardless of his specific ability. In this case, the shareholder would be unable to distinguish between different types. Or else, the following monotonicity condition:

$$\sigma_{LG} R(q_{LG}, \cdot) - \sigma_{LB} R(q_{LB}, \cdot) \geq \sigma_{HG} R(q_{HG}, \cdot) - \sigma_{HB} R(q_{HB}, \cdot) \quad \text{(MC-2.5)}$$

needs to be hold for the satisfaction of both constraints. The (MC-2.5) constraint requires a larger spread of premiums for the efficient manager than for the inefficient manager between good and bad result.

Moral hazard constraints. Given a certain type j, the moral hazard incentive constraint, which induces each type j to exert effort (after having truthfully reported his type) writes

$$\mathbb{E}_{k|e=1,j}\left[\sigma_{jk}R\left(q_{jk},\cdot\right)\right]-\psi\geq\mathbb{E}_{k|e=0,j}\left[\sigma_{jk}R\left(q_{jk},\cdot\right)\right],\ \forall j\in\left\{L,H\right\}. \tag{MH-2.5}$$

This constraint can be further developed as

$$\begin{aligned}&\beta_{1}\left(j\right)\sigma_{jG}R\left(q_{jG},\cdot\right)+\left[1-\beta_{1}\left(j\right)\right]\sigma_{jB}R\left(q_{jB},\cdot\right)-\psi\\ \geqq\ &\beta_{0}\left(j\right)\sigma_{jG}R\left(q_{jG},\cdot\right)+\left[1-\beta_{0}\left(j\right)\right]\sigma_{jB}R\left(q_{jB},\cdot\right),\ \forall j\in\left\{L,H\right\},\end{aligned} \tag{MH-2.5-1}$$

which is equivalent to

$$\sigma_{jG}R\left(q_{jG},\cdot\right)-\sigma_{jB}R\left(q_{jB},\cdot\right)\geq\frac{\psi}{\Delta\beta\left(j\right)},\ \forall j\in\left\{L,H\right\}. \tag{MH-2.5-2}$$

Participation constraints. To ensure the participation of the manager, the total utility of each type needs to be no less than its alternative payoff, which is normalized to zero. The participation constraints for the two types are:

$$U_{L}\left(e\right)\geq 0, \tag{PC-2.5-1}$$

$$U_{H}\left(e\right)\geq 0. \tag{PC-2.5-2}$$

Working on the constraints (PC-2.5-1) and (AS-2.5-1), we see that (PC-2.5-1) is slack. Hence (AS-2.5-1) is binding. Together with monotonicity condition (MC-2.5), it follows that (AS-2.5-2) is slack. Hence the related constraints remain with the adverse selection constraint for the efficient manager (AS-2.5-1), the participation constraint for the inefficient manager (PC-2.5-2) and the moral hazard constraint for both managers (MH-2.5).

Observing the constraints shown above, one can see that the firm's sales revenue plays an important role upon the payoff of the manager. Moreover, it is worth noting that our model with performance-based setting is in contrast with earlier related literature such as Martin (1993), Stenbacka (1993), Horn et al. (1994) and Panunzi (1994), in which the incentive constraints are independent of product market.

Program. Suppose it is in the shareholder's interest to induce effort. The shareholder's program is

$$\begin{cases} \max\limits_{\left\{U_j; q_{jk}\right\}, j\in\{H,L\}, k\in\{G,B\}} \mathbb{E}_{j,k|1}\left[R\left(q_{jk},\cdot\right) - \left(\theta_j - r_k\right) q_{jk} - t_{jk}\right] \\ \text{subject to (MH-2.5), (AS-2.5-1), and (PC-2.5-2)} \end{cases} \tag{P-2.5}$$

Rewriting the expected transfer of the effort-making manager in terms of expected utility $\mathbb{E}_{jk}\left[t_{jk}\right] = \mathbb{E}_j\left[w_j\right] + \mathbb{E}_{jk|1}\left[\sigma_{jk} R\left(q_{jk},\cdot\right)\right] = \mathbb{E}_j\left[U_j\left(1\right)\right] + \psi$, one can simplify the shareholder's program as

$$\begin{cases} \max\limits_{\left\{U_j; q_{jk}\right\}, j\in\{H,L\}, k\in\{G,B\}} \mathbb{E}_{j,k|1}\left[R\left(q_{jk},\cdot\right) - \left(\theta_j - r_k\right) q_{jk}\right] - \mathbb{E}_j\left[U_j\left(1\right)\right] - \psi \\ \text{subject to (MH-2.5), (AS-2.5-1), and (PC-2.5-2)} \end{cases} \tag{P'-2.5}$$

2.5.2 Limited liability

Now let us consider the case when the manager is protected by limited liability. In this case, the manager's compensation is supposed to be no smaller than some certain level (let us normalize this level as null for simplicity). Then whatever the type and the performance result are, the limited liability constraints need to be satisfied

$$w_j + \sigma_{jk} R\left(q_{jk},\cdot\right) \geq 0, \forall j \in \{L, H\}, k \in \{G, B\}. \tag{LL-2.5}$$

If (LL-2.5) holds for $\sigma_{jB} R\left(q_{jB},\cdot\right)$ it holds for $\sigma_{jG} R\left(q_{jG},\cdot\right)$ as well, provided that (MH-2.5-2) implies that $\sigma_{jG} R\left(q_{jG},\cdot\right) \geq \sigma_{jB} R\left(q_{jB},\cdot\right)$. Then the shareholder only needs to consider the constraint (LL-2.5) for the manager realizing a bad performance ($k = B$). Moreover, (LL-2.5) be binding implies that (PC-2.5-2) is automatically binding. Hence only three of the above mentioned constraints are closely related to the program, they are (MH-2.5), (AS-2.5-1), and (LL-2.5).

Denote thereafter the utility of the manager under limited liability as $\check{U}_j(1)$, the shareholder's program thus writes:

$$\begin{cases} \max_{\{\check{U}_j;q_{jk}\},j\in\{H,L\},k\in\{G,B\}} \mathbb{E}_{j,k|1}\left[R(q_{jk},\cdot)-(\theta_j-r_k)\,q_{jk}\right]-\mathbb{E}_j\left[\check{U}_j(1)\right]-\psi \\ \text{subject to (MH-2.5), (AS-2.5-1), and (LL-2.5)} \end{cases} \tag{P'-2.5-LL}$$

Since the shareholder's value decreases with $\mathbb{E}_j\left[\check{U}_j(1)\right]$, it is in the best interest of the shareholder to have a minimum value of the expected utility $\mathbb{E}_j\left[\check{U}_j(1)\right]$, which means to have the minimum value of both $\check{U}_H(1)$ and $\check{U}_L(1)$.

Proposition 2.5.1 *With limited liability, (i). the optimal contract fixes the total managerial payment, which is composed of a fixed salary and a bonus as follows*

$$\begin{aligned} w_H+\sigma_{HB}R(q_{HB},\cdot) &= 0, \\ w_L+\sigma_{LB}R(q_{LB},\cdot) &= -\beta_0(L)\frac{\psi}{\Delta\beta(L)}+\beta_1(L)\frac{\psi}{\Delta\beta(H)}-\psi; \end{aligned}$$

(ii). the shareholder has to give up an information rent which equals

$$\begin{aligned} \mathbb{E}_j\left[\check{U}_j(1)\right] &= \check{U}_H(1)+\mathbb{E}_j\left[U_j(1)\right] \\ &= \frac{\beta_0(H)+\alpha\left[\beta_1(L)-\beta_1(H)\right]}{\Delta\beta(H)}\psi. \end{aligned}$$

Proof. See appendix B.7. ■

One can see that instead of receiving a negative payment (punishment), the manager receives the reservation utility level (which was normalized to zero) thanks to limited liability. Comparing with Lemma 3, one can see that limited liability leads to higher payment for the efficient manager realizing a bad result and that limited liability raises the information rent. The added amount $\check{U}_H(1)$ is the rent due to limited liability, called limited liability rent. This means the shareholder needs to pay higher information rent to the manager when the latter is protected by limited liability. It is worth noting that the information rent does not depend on the output of the firm hence does not depend on the competitiveness of the market.

Corollary 2.5.1 *With limited liability, the efficient manager realizing a bad result is to be punished iff*

$$\Delta\beta(H) > \Delta\beta(L).$$

Proof. See appendix B.8. ■

Now that we have identified the optimal payments, let us turn back to the shareholder's program, where the remaining objective is to choose the optimal level of production that maximizes $V(1)$, when the manager is required to make effort. The simplified program (P') rewrites

$$\max_{\{q_{jk}\}} \mathbb{E}_{j,k|1}\left[R(q_{jk},\cdot) - (\theta_j - r_k)\, q_{jk}\right] - \alpha \frac{\left[\beta_1(L) - \beta_1(H)\right]\psi}{\Delta\beta(H)} - \psi. \tag{P"-2.5}$$

Considering the combination of the type of the manager (j) and the result of the project (k), we can see that q_{jk} implies four levels of outputs. Observing this objective function, one can confirm that the shareholder does not need to give up extra rent that is due to imperfect information. The rent transferred to the manager is extracted from the net present value of the project by the shareholder in order to induce the manager to participate and to exert effort.

The manager is required to take care of the production by implementing the level of output in the market. The optimal outputs according to the manager's type and the performance satisfy the following condition:

$$R'(q_{jk},\cdot) = (\theta_j - r_k),\ \forall j \in \{L, H\},\ k \in \{G, B\}. \tag{2.5-6}$$

This time, the production cost is not financed with the transfer the manager receives. However, the result is the same as in the previous case where the production cost is financed with the manager's transfer. We see that marginal revenue equals marginal cost when adverse selection and moral hazard are both solved, thus the first best level of production can still be implemented. Similar as in section 2.2, one can imply that more intensive competition, measured by the number of firms, still leads to lower production.

2.5.3 Shareholder's choice of managerial effort

Let us denote $\check{V}(e)$ as the equilibrium payoff of the shareholder with effort $e \in \{0, 1\}$. Given optimal level of outputs q_{jk}^{i*}, the shareholder's expected value

$$\check{V}(e) = \mathbb{E}_{j,k|e}\left[R\left(q_{jk}, \cdot\right) - \left(\theta_j - r_k\right) q_{jk}\right] - \mathbb{E}_j\left[\check{U}_j\left(1\right)\right] - \psi\left(e\right).$$

Consider now that if the manager chooses not to make effort, then $e = 0$. In this situation, the shareholder does not need to propose different levels of performance-based compensation to induce effort. Whatever the result of the project, the manager always get the same level of bonus ratio, i.e., $\sigma_{jG} = \sigma_{jB}$, $\forall j \in \{L, H\}$, hence no moral hazard constraint is needed in this case. Then only two relevant constraints (when not making effort) are left: the adverse selection constraint for the efficient manager

$$\check{U}_L\left(0\right) \geq \check{U}_H\left(0\right),$$

and the participation constraint for the inefficient manager

$$\check{U}_H\left(0\right) \geq 0.$$

Hence, the optimal utilities satisfy $\check{U}_H\left(0\right) = \check{U}_L\left(0\right) = 0$, which implies that neither the efficient manager nor the inefficient manager gains although they have private information on their types. Given the optimal output level q_{jk}^* anticipated, the payoff of the shareholder in terms of expectation is

$$\check{V}(0) = \mathbb{E}_{j,k|e=0}\left[R\left(q_{jk}^*, \cdot\right) - (\theta_j - r_k)\, q_{jk}^*\right].$$

It is in the shareholder's interest to induce effort of the manager, when $\check{V}(1) - \check{V}(0) \geq 0$, which rewrites

$$\psi \leq \check{F}\left\{\mathbb{E}_{j,k|e=1}\left[R\left(q_{jk}^*, \cdot\right) - (\theta_j - r_k)\, q_{jk}^*\right] - \mathbb{E}_{j,k|e=0}\left[R\left(q_{jk}^*, \cdot\right) - (\theta_j - r_k)\, q_{jk}^*\right]\right\}, \qquad (2.5\text{-}7)$$

where

$$\check{F} = \frac{\Delta\beta(H)}{\alpha\left[\beta_1(L) - \beta_1(H)\right] + \beta_1(H)}.$$

Clearly, the right-hand side of (2.5-7) captures the gain of inducing effort from $e = 0$ to $e = 1$, while the left-hand side of (2.5-7) is the first-best cost of inducing the manager to exert effort. When the benefit of inducing effort is greater than the cost, it is in shareholder's interest to induce effort when designing the contracts.

Moreover, one can observe that $\check{F}$ which depends on the probability of success also plays an important role on the decision of effort inducing. The larger $[\beta_1(L) - \beta_1(H)]$ the less the shareholder is willing to induce the manager to exert effort so that effort is induced less often. Without complementarity, no type has incentive to cheat so that the moral hazard problem is the only remaining issue. The above expression would then be reduced to

$$\check{F} = \frac{\Delta\beta(H)}{\beta_1(H)} = 1 - \frac{\beta_0(H)}{\beta_1(H)}.$$

Comparing with the previous case where $F = 1 > \check{F}$, one can imply that the shareholder is less willing to induce effort from the manager when the manager is protected by limited liability.

Proposition 2.5.2 *With a bonus ratio setting based on Fershtman and Judd (1987), the shareholder's choice of inducing managerial effort is still independent of the product market competition as measured by the number of firms.*

Proof. See appendix B.9. ■

This finding is partly in line with Piccolo et al. (2008) who showed that if the contracts takes the form of cost-target mechanisms, the incentive constraints are not affected by product market competition, which is measured by the degree of products' substitutability. Our setting with a Fershtman and Judd (1987) style, where the bonus of the manager is the bonus ratio (as designed by the optimal contract) times the sales revenue, which depends on the intensity of product market competition, shows however that there is no necessary link between the decisions taken on the product market competition and the managerial payment which solves the incentive problems. This result may follow from the fact that the performance of the manager is observed before production taking place. However, this was also the case in Horn et al. (1994) with a similar timing but a result of a negative relation between the competitiveness and the effort incentives. The reason of the independence between competition and managerial incentives may be due to the fact that the effort plays a role to affect stochastically the cost of production, rather than being a shock on production.

Our result is neither the same as Etro and Cella (2013) who find an inverted-U shaped relationship between competition and managerial incentive for the most productive manager. This is because the effort level in our model influences the probabilities of the level of cost reduction and the moral hazard problem is solved within the design of contract while in models of the previously mentioned literature, where effort can be induced from the cost-target and the type or is supposed to be observable, moral hazard is not an issue.

2.6 Concluding Remarks

In this chapter, we have studied the interaction between product market competition and the contractual screening at the presence of adverse selection and/or moral hazard in a shareholder-manager relationship. We have considered performance-based bonus to induce managerial effort, fixed salary to ensure truth-telling of the manager, and a combination of fixed salary and performance-based bonus when both moral hazard and adverse selection exist.

Different with the existing literature such as Hart (1983), Horn et al. (1994), and Etro and Cella (2013), we show that managerial incentives do not necessarily depend on product market competition. Note that the shareholders have all the bargaining power upon the incentive contracts when offering a take-it-or-leave-it contract, the optimal solution of the contract which minimizes the costs of the shareholders is designed in a manner to restrict the manager's utilities by the shareholder. We show that the managers' utilities are optimally fixed with given values, which do not necessarily depend on competition. This manner consequently allows the shareholder to prevent the managerial incentives from being influenced by product market competition.

CHAPTER 3

CARTEL STABILITY AND MANAGERIAL INCENTIVE CONTRACT WITH REPEATED MORAL HAZARD

3.1 Introduction

Informational problems (such as moral hazard) between a shareholder and a manager often arise in oligopolistic firms where there is a genuine separation between ownership and control. In the previous chapter, we have studied the interaction between product market competition and managerial incentive contract (including solution of moral hazard) in a static setting with a one-shot shareholder-manager relationship. In this chapter, we are interested in the dynamic managerial incentives (solving repeated moral hazard) where the contractual relationship between a shareholder and a manager is repeated over time.

In an infinitely repeated horizon, classical wisdom argues that forming or sustaining a cartel allows them to obtain supra-normal profits although this risks of being detected by the antitrust authorities. However, this argument is based on the assumption that firms are profit-maximizers, i.e., firms are led by shareholders/entrepreneurs. When firms are run by managers instead, given that the relationship between a shareholder and a manager can last for a long time, the incentive of sustaining a cartel might not always be guaranteed. Two reasons are provided as in the following.

On one hand, managers may not necessarily maximize profit, since their interests generally differ from that of the shareholders. In view of the fact that the managers would naturally prioritize their own interests, the decisions made by the manager may be based on their own utility in place of profit-maximization (see e.g., Sun, 2014; Piccolo and Spagnolo, 2015; Oh and Park, 2016). This is specifically the case for cartel members, which are often large oligopolists that are run by managers and would probably bring in a distortion of the collusive outcome.

On the other hand, managers may exert some hidden actions that are unobservable to the shareholder and may do so repeatedly in each period (repeated moral hazard) of a long-term relationship. Since the separation between ownership and control often leaves the managers unwatched, moral hazard of the manager plays a crucial role in an oligopolistic market, where manager-led firms may confront significant informational problems. The manager's hidden action such as unobservable effort normally influences some important components of a firm, for instance, a firm's production costs. Considering a repeated moral hazard possibility of the manager, one might conjecture that a cartel run by managers instead of the shareholder himself is inherently unstable.

Evidence shows that managerial incentives are indeed linked with the stability of collusion. For instance, Joh (1999) investigated 796 Japanese firms during the period 1968 to 1992 and found that when shareholders evaluate the manager by overall industry performance, it is easier to evaluate the effort of the manager while this may hinder the collusive stability; when the managerial compensation is positively related to industry performance, the credibility of the manager's commitment to collusion increases. In theoretical research, however, collusive behavior and repeated moral hazard as two important issues in industrial organization are often studied separately. The issue of how repeated moral hazard in the design of dynamic contract may affect firms' abilities to sustain collusive outcomes thus remains a subject to be formally[1] explored.

Moreover, existing evidence suggests that managerial incentives aiming at solving moral hazard firms would bring firms more profits. Using longitudinal data on returns to firms and managerial compensation, Margiotta and Miller (2000) found that the costs of paying compensation to the manager are much less than the benefits from the resulting managerial performance. This also implies that it pays off to pay more attention to the effect of hidden action within managerial incentive problems in the top-level design of corporate governance.

Motivated by the above-mentioning reasons, this chapter is concerned with the interaction between firms' vertical managerial incentive contract in a long-term shareholder-manager relationship and firms' horizontal collusive behavior in an infinitely repeated relationship with other firms. In particular, we are interested in investigating the following questions: i) how is the optimal incentive contract designed to solve the repeated moral hazard problem in a long-term shareholder-manager relationship; ii) how might the existence of collusive equilibria change when the firm is run by the manager taking the optimal contract; iii) how might the sustainability of a cartel be influenced when each member's manager have the optimal contract implemented; iv) does the manager's attitude of facing risk (risk-aversion) matter in the stability of collusive outcome.

We start our analysis by focusing on oligopolistic markets where firms wish to collude with each other to form a cartel (maximizing joint profit) and by letting the collusive firms run by risk-averse managers, who are always pursuing their own interests at the place of profit-

[1] Although some researches in law and business (e.g., Thépot, 2011; Kirstein and Kirstein, 2009) have attempted to figure out the interaction between firms' vertical governance structure and horizontal possibility of collusion, the existing literature in economics contains virtually no theoretical interpretations to clarify how repeated moral hazard may influence the stability of cartels.

maximization. Formally, we consider a cartel consisting of two identical firms, interacting over an infinitely repeated horizon in a dynamic Bertrand setting and we consider a two-effort-two-outcome setting on the repeated moral hazard model.

Vertically, an incentive dynamic contract designed by each firm's shareholder is offered to the manager so as to deter the sacrifice of the firm's interests. Hidden action refers to the manager's effort, which cannot be observed or verified and this happens in each period and repeats infinitely in a long-term shareholder-manager relationship. With the presence of moral hazard, each firm's marginal cost is random, either be high or low. Manager's effort works to increase the likelihood of having a low or high marginal cost[2]. Suppose the shareholder commits not to renegotiate, he only needs to offer *once* a menu of contracts to the manager at the very first beginning of the game.

Horizontally, when firms interact repeatedly in the product market, they may be able to maintain higher collusive prices, which enables them to obtain supra-normal profits and trigger some retaliation to any firms that deviate from the collusive path. Since each member of the cartel is run by the manager, the condition of cartel sustainability would depend on the manager's utility. Given a certain market conduct (collude, deviate or compete), each firm would realize a gross profit. The shareholder's payoff (the gross profit net of the manager's compensation) thus depends on the realized marginal cost, the optimal design of the contract, and the behavior of the other firm. This setting links the vertical moral hazard problem with the horizontal interaction of tacit collusion.

Additionally, since it is mostly impossible to observe the effort of the manager prior to the outcome, shareholders may plausibly refer the performance realized by the manager in the past

[2]In the standard model of moral hazard, hidden action influences the likelihood of realizing a certain outcome, which is normally a firm's output.

as an indicator of present or future performance. We also consider the model in a recursive setting and we confirm that the optimal dynamic contract exhibits memory (e.g., Lambert, 1983; Rogerson, 1985a). To simplify, we let the effort of each period be independent[3] over time. The cases where firms realize symmetric and asymmetric costs at each period are also discussed.

This chapter contributes to the existing literature on repeated moral hazard and the existing literature on cartel stability by linking the two branches. It also provides to antitrust authority some new breakthroughs with related theoretical support, specifically on managerial incentive contract (for repeated moral hazard problem) in the top level design of corporate governance and its interaction with cartel stability.

In a perfect information benchmark case, which is built on Spagnolo (2005), we prove that the degree of risk-aversion by the manager alters the sustainability of collusion: the more the manager dislikes risk, the more stable a cartel would be. Intuitively, this is because deviation means supporting more risk which is costly to the manager.

In an imperfect information case, however, where the manager may shirk in each period of a long-term shareholder-manager relationship, we show that the degree of risk-aversion by the manager plays no role upon the sustainability of collusion. With the presence of an efficient contractual mechanism, the repeated moral hazard problem is solved by constraining the manager's actual and future utilities. We show that the manager taking the optimal dynamic contract is indifferent between deviation and collusion. Intuitively, this is because the optimal contact solving repeated moral hazard also constrains the discretion of manager over the decision choice of market conduct.

[3]In Mason and Välimäki (2008), they considered a payment schedule that changes over time in order to counteract the agent's effort smoothing incentive to push effort into the future.

This chapter also sheds some light on this possibility where costs of firms may be asymmetric. One may refer to the well-known finding which concludes that it would be more difficult to maintain collusion if costs are asymmetric.

Related Literature. This chapter is closely related in spirit with Aubert (2009) and Han and Zaldokas (2014), which are both theoretical work that gave rise to the linkage between firms' vertical managerial incentive contracts[4] and horizontal collusive behavior. Aubert (2009)[5] argued that the manager might substitute collusion for effort-making to achieve a higher profit when both the market conduct and the effort are the manager's hidden actions. In our model, we focus on the case where solely managerial effort is unobservable to the shareholder and we are specifically interested in the design of optimal contract with a recursive setting. Han and Zaldokas (2014) compared the consequences between a fixed compensation regime and a variable compensation regime and showed that a fixed salary short-term contract (paid at each period) works as an incentive scheme for the manager and slightly increases the cartel stability. However, an effective contractual mechanism in solving the moral hazard problem was not a focus in their paper.

Our study on the stability of tacit collusion between managerial-led firms is inspired from the literature about strategic delegation such as Lambertini and Trombetta (2002) and Spagnolo (2000, 2005). Derived from the separation between ownership and control, these literatures highlighted the case where the market conduct decision (collude, deviate or compete) was made by the manager instead of the shareholder. Lambertini and Trombetta (2002) addressed the sustainability of collusion conducted by delegated managers whose objective functions are required

[4]Incentive contract in a shareholder-manager relationship with the presence of product market competition is also studied by Martin (1993), Horn et al. (1994), Bertoletti and Poletti (1997).

[5]Aubert (2009) also argued that neglecting internal incentive issues would lead to an underestimation of the welfare losses that are due to tacit collusion.

by the shareholder in an incentive way. Spagnolo (2000, 2005)[6] focus on the collusive behavior of manager-led firms, maximizing an alternative objective function (manager's utility) at the place of strict profit-maximization, which is basically true in reality. However, information between the shareholders and managers is supposed to be perfect, thus informational problem such as moral hazard was not an issue in these papers.

Our model on the contractual design is in reference to the literature on repeated agency[7]. which concerns the role of discount factor and the memory-exhibition characteristics. In the absence of discount factor, earlier papers such as Rubinstein and Yaari (1983) and Radner (1981) showed that both the principal and the agent would realize payoffs in the first best level, implying no loss of efficiency that is due to moral hazard. Ohlendorf and Schmitz (2012) found with a two-period moral hazard model that the incentive contract could act as carrot and stick. They showed that the manager would not make as much effort as the first-best level if the incentive compensation was not high enough. When both principal and agent discount the future, Radner (1985) showed that the first best solution is approximately achievable only if the discount rate is close to one. This result is in line with Laffont and Martimort (2002).

As for the memory-exhibition characteristics, it is well known that the optimal dynamic contract exhibits memory in a repeated model: the optimal contract in any period will depend non-trivially on the entire previous history of the relationship (e.g., Lambert, 1983; Rogerson, 1985a). According to Rogerson (1985a, p72), "if an outcome plays any role in determining current wages it must necessarily also play a role in determining future wages". Technically, however, it is not easy to examine the collusive behavior following their models. Fuchs (2007)

[6]In these two papers of Spagnolo, he studied separately the role of stock-related compensation and income smoothing.

[7]Repeated moral hazard models have also received great interests in studying long-term lender-borrower relationships (e.g., Clementi and Hopenhayn, 2006; De Marzo and Fishman, 2007a, 2007b; Biais et al., 2010).

also considered an infinitely repeated model with memory but in the absence of a tractable recursive structure, which is one of the main features of our model.

The recursive setting[8] of our dynamic contract is rather based on Spear and Srivastava (1987), who proved the existence of a simple representation of the contract that avoided the intractabilities associated with history-dependence and showed that the optimal contracting problem of an infinitely repeated agency model could be reduced to a simple two-period constrained optimization problem. In this chapter, we reinterpret their recursive setting (continuous variables) with a two-effort-two-outcome model.

Outline. This chapter is organized as follows. Section 3.2 introduces a benchmark which is based on Spagnolo (2005) and studies the manager-led cartel stability under perfection information. Section 3.3 presents the model of repeated moral hazard. Section 3.4 studies the characteristics of the optimal contract. Section 3.5 examines the stability of a manager-led cartel when the managerial compensation is profit-independent, given that the optimal contract is implemented. Section 3.6 gives some concluding remarks of this chapter.

3.2 Manager-led Cartel Stability under Perfect Information

The stability of cartel is studied in a context where there is separation between ownership and control, whatever the information is perfect or imperfect. Before addressing the discussion on firms' horizontal collusive behavior with imperfect information between shareholder and the manager, let us first take a look at the benchmark case with perfect information.

This section is a benchmark built on Spagnolo (2005). Since each member of the cartel is run by the manager, firms' collusive behavior is based on the utility of the manager in place

[8]Mele (2014) provided technical support for the recursive setting in a dynamic contracting game.

of profit-maximization. Under perfect information, no mechanism design is needed hence no transfer from the shareholder is given to the manager. The manager's utility simply depends on the realized gross profit π. Let $U_m(\pi)$ be the manager m's utility.

Definition 3.2.1 *Given* $A_m(\pi) = -\frac{U''_m(\pi)}{U'_m(\pi)}$, *with* $m \in \{1, 2\}$. *Manager 1 is more risk-averse than manager 2 in the sense of Arrow-Pratt, iff* $A_1(\pi) \geq A_2(\pi)$, *for the same* $\pi \in R$.

Under risk-aversion, $U'_m(\pi) > 0$ and $U''_m(\pi) < 0$, hence $A_m(\pi)$ is clearly positive. From an Arrow-Pratt approximation, $A_m(\pi)$ measures the degree of concavity of the utility function and is referred to as the degree of absolute risk aversion of the manager. Manager 1 is more risk-averse than manager 2 means U_1 is more concave than U_2. This implies that the risk premium of any risk is larger for manager 1 than for manager 2. In other words, if any risk is undesirable for manager 2, it is even more undesirable for manager 1.

Assumption 3.2.1 *The utility function of a risk-averse manager* m *is given as* $U_m(\pi) = \lambda\pi - \frac{\mu_m}{2}\pi^2$, *with* $\lambda, \mu_m \in R^+$.

This assumption is based on a frequently used utility function with the characteristics of risk-aversion.

Lemma 3.2.1 *Given assumption 3.2.1, manager 1 is more risk-averse than manager 2 in the sense of Arrow-Pratt (i.e.,* $A_1(\pi) \geq A_2(\pi)$ *by definition 3.2.1) iff*

$$\mu_1 \geq \mu_{2.}$$

Proof. See appendix C.1. ■

In an ideal collusive scheme, where firms have incentives to communicate truthfully market-share, firms would communicate truthfully about their respective costs, so that, at each point in time, they could both maintain high prices and assign all production to the firms with the lowest production cost. In this chapter, we assume that both firms insist on equal market shares, namely $Q/2$. For being sustainable, retaliation must be sufficiently costly to outweigh the short-term benefits from deviating on the collusive path. The collusive outcome maintains by the threat of infinite reversion (Nash equilibrium[9]) that yields approximately zero payoff. Given the collusive price r, a cartel member can deviate by pricing at $r-\varepsilon$, where ε is small enough (almost equals zero). The manager's payoff from cheating is approximately $U\left[\pi^D(c_i)\right] = U\left[(r-c_i)Q\right]$ and his payoff $U\left[\pi^C(c_i)\right]$ by applying a trigger strategy is $U[0]$ which equals zero.

If both firms have the same marginal cost, namely $c_i = c_j = c$, firm i conducted by its manager will sustain the collusion as long as

$$\frac{1}{1-\delta}U\left[\pi^M(c)\right] \geq U\left[\pi^D(c)\right] + \frac{\delta}{1-\delta}U[0],$$

which can be simplified to

$$\delta \geq \frac{U\left[\pi^D(c)\right] - U\left[\pi^M(c)\right]}{U\left[\pi^D(c)\right]} \equiv \delta^*.$$

In the setting of this chapter, $\pi^M(c) = (r-c)Q/2$ and $\pi^D(c) = (r-c)Q$, hence $\pi^D(c) = 2\pi^M(c)$. Similar as in Spagnolo (2005), the manager's objective function is strictly concave in profit, with $U'(\pi_t) > 0$ and $U''(\pi_t) < 0$. Spagnolo (2005) compared his model with the classical cartel literature, which shows the existence of collusive equilibria in infinitely repeated games when firms (profit-maximizing) are sufficiently patient, i.e., the discount factor is sufficiently large.

One can also consider the case where firm i has cost advantage compared to firm j, namely $c_i < c_j$. If its rival deviates, firm i playing trigger strategy will punish it by charging the price

[9] The trigger strategy applies so that none of the firms earns profit if one of them deviates.

at its rival's marginal cost level and obtain $U\left[\pi^{C}\left(c_i\right)\right] = U\left[(c_j - c_i)Q\right]$. Its rival, firm j will lose the whole market from that period on, the condition of collusion as in the previous case with symmetric cost still holds for firm j. What changes is firm i's condition of sustaining the collusion. Since even deviating, the cost advantage still allows him to capture the whole market. When firms' costs become asymmetric, this may imply a less stable collusive outcome.

Proposition 3.2.1 *Given assumption 3.2.1 and* $\delta_m^* = 1 - \frac{U_m\left[\pi^M(c)\right]}{U_m\left[2\pi^M(c)\right]}$, *with* $m \in \{1, 2\}$, *the necessary and sufficient condition for* $\delta_1^* \leq \delta_2^*$ *is* $\mu_1 \geq \mu_2$.

Proof. See appendix C.2. ■

This proposition suggests that the preference of risk of the manager plays a crucial role on the stability of collusion when firms are led by managers at the place of shareholders. Since the utility of the manager is a concave function which depends on profit, an increasing profit which is due to deviation leads to a relatively lower marginal utility of the manager. The more concave the manager's utility function is (i.e., the more risk-averse the manager is), the lower marginal utility the manager obtains. Consequently, a more risk-averse manager has less incentive to deviate from the collusive strategies.

It is worth noting that this is the case under the assumption of perfect information. We show in the next section the case under imperfect information, specifically when the manager exerts hidden actions (moral hazard) that cannot be observed or verified by the shareholder in each period of a long-term shareholder-manager relationship.

3.3 The Basic Model of Repeated Moral Hazard

Consider two identical firms engaging in a Bertrand product market with homogeneous goods. Both firms interact in an infinitely repeated game with $t \in \{1, 2, ..., T\}$, where $T \to \infty$.

The demand is inelastic[10] in each period t. This means firms can sell a total quantity D as long as the price does not exceed the customers' fixed reservation price r, which covers the marginal cost.

Each firm is conducted by a risk-averse manager. The market conduct at each period t, i.e., K_t, is practiced by the manager by charging a Monopolistic strategy (collusion), a Deviating strategy (deviation), or a Competing strategy (trigger strategy), denoted as $K_t \in \{M, D, C\}$. In period t, the manager receives a transfer I_t from his shareholder. The marginal cost $\tilde{c}_t$ of each firm is random at each period and can only take two values such that $\tilde{c}_t \in \{c_L, c_H\}$, with $c_L < c_H < r$. The probability of realizing a certain marginal cost is conditional on the manager's effort, which is discrete and has two possibilities: either no effort or effort, i.e., $e_t \in \{0, 1\}$. The conditional probabilities of realizing different outcomes are given as $\Pr(\tilde{c}_t = c_L | e = 1) = \beta_1$ and $\Pr(\tilde{c}_t = c_L | e = 0) = \beta_0$, with $\beta_1 > \beta_0$. Thus $\Pr(\tilde{c}_t = c_H | e = 1) = 1 - \beta_1$ and $\Pr(\tilde{c}_t = c_H | e = 0) = 1 - \beta_0$. As usual, we denote $\beta_1 - \beta_0 = \Delta\beta$. The disutility of effort is $\varphi(e_t)$ with the normalizations $\varphi(0) = 0$ and $\varphi(1) = \varphi$. To simplify, let the stochastic outcomes be independently distributed over time so that the past history of realizations does not yield any information on the current likelihood of realizing a high or low marginal cost.

Let the risk-averse manager's preference be separable (e.g., Spear and Srivastava, 1987), his instantaneous utility function by the end of period t thus writes:

$$U_t(I_t, e_t) = \Phi(I_t) - \varphi(e_t).$$

It is worth noting that $\Phi'(I_t) > 0$ and $\Phi''(I_t) < 0$. At the beginning of the game, each firm's shareholder offers a menu of contract aimed at solving the repeated moral hazard problem. The instantaneous payoff of each firm's shareholder by the end of period t is thus gross profit net of

[10] Similar settings see e.g. Athey and Bagwell (2008).

the transfer:

$$S_t = \pi^{K_t}(\tilde{c}_t) - I_t.$$

By the end of period t, the history of outcome (marginal cost) is $h_t^{\tilde{c}} = \{\tilde{c}_1, \tilde{c}_2, ..., \tilde{c}_t\}$ whereas the history of market conduct is $h_t^K = \{K_1, K_2, ..., K_t\}$. Shareholder's strategic contract concerns the transfer to the manager I_t by the end of period t and a promised utility for the future $\hat{U}_{t+1}$, both depending on the history of marginal cost as well as the history of market conduct. Denote shareholder's strategy as σ^s, then $\sigma^s = \left\{I_t\left(h_t^{\tilde{c}}, h_t^K\right), \hat{U}_{t+1}\left(h_t^{\tilde{c}}, h_t^K\right)\right\}$. Interestingly, if the market conduct at t is M, then the market conduct at $t+1$ can be either M or D; if the market conduct at t is D already, then the market conduct at $t+1$ can only be C. As mentioned before, e_t is independent over the whole history so that the outcome realized in the last period does not influence the manager's effort in the current period. In addition to his effort e_t, the manager's strategy also concerns his choice of market conduct K_t, which is based on the history of previous decisions. The manager's strategy thus writes $\sigma^m = \left\{e_t, K_t\left(h_{t-1}^K\right)\right\}$.

The timing is as follows.

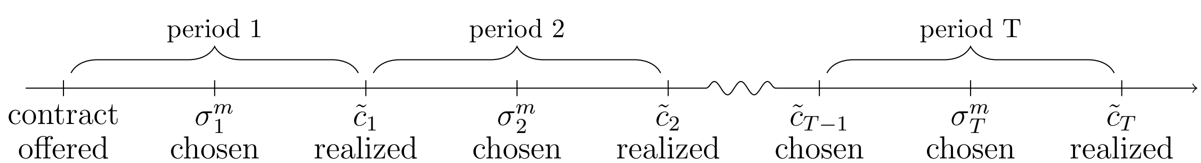


Figure 3.1: Timing of the dynamic game.

At time zero, the contract established by the shareholder is offered to the manager. Then comes the repeated period: the manager chooses his level of effort and decides on the market conduct (collude, deviate, or compete) before the outcome about the marginal cost is realized. It is supposed that the realized marginal cost is publicly observed. The corresponding contract is thus implemented and the gross profit following each period's market conduct is publicly revealed. By the end of each repeated period, the enforceable wages are paid and the manager realizes his *ex post* utility.

In period 1, given market conduct K_1, let $I_{1H}^{K_1}$ (resp. $I_{1L}^{K_1}$) denote the the transfer by the shareholder if the outcome $\tilde{c}_1$ is revealed to be c_H (resp. c_L). In period 2, given the history of market conduct $h_2^K = \{K_1, K_2\}$, let $U_{2HH}^{h_2^K}$ (resp. $U_{2HL}^{h_2^K}$) denote the the utility of the manager if the previous outcome $\tilde{c}_1$ is revealed to be c_H (resp. c_H) and the current outcome $\tilde{c}_2$ is also revealed to be c_H (resp. c_L). Similarly, let $U_{2LH}^{h_2^K}$ (resp. $U_{2LL}^{h_2^K}$) denote the the utility of the manager if the previous outcome $\tilde{c}_1$ is revealed to be c_L (resp. c_L) and the current outcome $\tilde{c}_2$ is revealed to be c_H (resp. c_L).

Here we give a simple example to better understand the implementation of the contract. Suppose a high cost is realized by the end of period 1, the manager thus receives a transfer $I_{1H}^{K_1}$ for the current period and a promised expected utility $\hat{U}_{2H}^{h_T^K}$ for the future, with $h_T^K = \{K_1, K_2, ..., K_T\}$, where $T \to \infty$. It is worth noting that the subscript H in both $I_{1H}^{K_1}$ and $\hat{U}_{2H}^{h_T^K}$ refers to the realized cost at the current period 1. Since the future is uncertain, the promise is motivated by what happens today: based on the outcome that is currently revealed. Furthermore, it is important to learn that the promise $\hat{U}_{2H}^{h_T^K}$ for the future is the net present value (NPV) which discounts the expected utilities of all the subsequent periods by the end of period 1, i.e., $\hat{U}_{2H}^{h_T^K} = \mathbb{E}\left[U_{2H}^{h_2^K}\right] + \delta\mathbb{E}\left[U_3^{h_3^K}\right] + \delta^2\mathbb{E}\left[U_4^{h_4^K}\right] + \ldots$, where $\mathbb{E}\left[U_{2H}^{h_2^K}\right]$ is the instantaneous expected utility before $\tilde{c}_2$ is realized, thus $\mathbb{E}\left[U_{2H}^{h_2^K}\right] = \beta_1 U_{2HL}^{h_2^K} + (1-\beta_1)\, U_{2HH}^{h_2^K}$. By the end of period 2, if a low cost is realized (i.e., $\tilde{c}_2 = c_L$), then the manager earns his *ex post* utility $U_{2HL}^{h_2^K}$ and obtains a promise $\hat{U}_{3HL}^{h_T^K}$ for the future[11] (the whole subsequent periods). One can observe

[11]One can induce that the expected NPV of $\hat{U}_{3HL}^{h_T^K}$ satisfies $\hat{U}_{3HL}^{h_T^K} = \mathbb{E}\left[U_{3HL}^{h_3^K}\right] + \delta\mathbb{E}\left[U_4^{h_4^K}\right] + \delta^2 E\left[U_5^{h_5^K}\right] + \ldots,$

from the subscripts that the dynamic contract exhibits memory.

Following the standard setting on repeated moral hazard model, where the shareholder is risk-neutral and the manager is risk-averse, we assume that the discount factor δ is the same for both shareholders and managers. The contractual allocation is a menu $\left\{ \binom{I_{1L}^{K_1}}{I_{1H}^{K_1}}; \binom{\hat{U}_{2L}^{h_T^K}}{\hat{U}_{2H}^{h_T^K}} \right\}$, where $\binom{I_{1L}^{K_1}}{I_{1H}^{K_1}}$ concerns the actual transfer for the period 1 and $\binom{\hat{U}_{2L}^{h_T^K}}{\hat{U}_{2H}^{h_T^K}}$ concerns the promised utility for the future. This setting implicitly assumes that both parties commit to the contract[12].

3.4 Characterization of the Optimal Contract

Let us focus on the expected discounted values that are written with a hat accent. In period 1 before the outcome $\tilde{c}_1$ is realized, the manager's expected NPV writes $\hat{U}_1 = \sum_{t=1}^{T} \delta^{t-1}\mathbb{E}\left[U_t\right]$. Similarly, the manager's expected NPV in period 2 before c_2 is realized can be developed as $\hat{U}_2 = \mathbb{E}\left[U_2\right] + \delta E\left[U_3\right] + \delta^2\mathbb{E}\left[U_4\right] + \ldots$ Comparing the two expressions, one can easily obtain the recursive relationship between $\hat{U}_1$ and $\hat{U}_2$ as follows:

$$\hat{U}_1 = \mathbb{E}\left[U_1\right] + \delta\hat{U}_2. \tag{3.4-a}$$

The general expression of $\hat{U}_t$ thus writes

$$\hat{U}_t = \mathbb{E}\left[U_t\right] + \delta\hat{U}_{t+1},\ \forall t \in 1, 2, ..., T, \text{ where } T \to \infty.$$

Correspondingly, the shareholder's expected NPV in period 1 before the outcome is realized writes $\hat{S}_1 = \sum_{t=1}^{T} \delta^{t-1}\mathbb{E}\left[S_t\right]$. Hence, one can induce the recursive relationship between $\hat{S}_1$ and $\hat{S}_2$ as follows:

$$\hat{S}_1 = \mathbb{E}\left[S_1\right] + \delta\hat{S}_2. \tag{3.4-b}$$

where $\mathbb{E}\left[U_{3HL}^{h_3^K}\right] = \beta_1 U_{3HLL}^{h_3^K} + (1-\beta_1)\, U_{3HLH}^{h_3^K}$.

[12]Operatively, the contract must also specify provisions if a party fails to offer the expected compensation or fails to finish the expected work. Here, we do not assume that the parties respond by breaking off trade, since these events lead to the worst outcome and never occur in equilibrium (Abreu, 1988).

The general expression of $\hat{S}_t$ thus writes

$$\hat{S}_t = \mathbb{E}\left[S_t\right] + \delta \hat{S}_{t+1}, \; \forall t \in 1, 2, ..., T, \text{ where } T \to \infty.$$

Observing (3.4-a) and (3.4-b), one can remark that the utility of the manager as well as the payoff of the shareholder are both recursive functions that can be reduced to a two-period formality. Let us denote $\hat{S}\left(\cdot\right)$ the value function of the shareholder's payoff, then (3.4-b) is equivalent to the following expression:

$$\hat{S}\left(\hat{U}_1\right) = \mathbb{E}\left[S_1\left(U_1\right)\right] + \delta \hat{S}\left(\hat{U}_2\right). \tag{3.4-c}$$

This relationship clarifies the recursive characteristics of the shareholder's value in an infinitely repeated game and shows that the shareholder's expected NPV of payoff depends on the manager's expected NPV of utility.

The objective of the shareholder is to maximize the expected discounted payoff at the beginning of the game subject to the constraints to induce the participation of the manager and effort-making in each period. Suppose an expected amount of rent U has been promised to the manager over the whole duration of the game so that the manager has incentive to participate as long as his expected utility is no less than this level. The Participation Constraint (PC-3.4) thus writes:

$$\beta_1 \Phi\left(I_{1L}^{K_1}\right) + \left(1 - \beta_1\right)\Phi\left(I_{1H}^{K_1}\right) - \varphi + \delta\left[\beta_1 \hat{U}_{2L}^{h_T^K} + \left(1 - \beta_1\right)\hat{U}_{2H}^{h_T^K}\right] \geq U. \tag{PC-3.4}$$

Suppose it is in the best interest for the shareholder to induce effort at each period[13] so that the manager's discounted expected utility with effort is no less than that without effort.

[13]For repeated moral hazard with discrete effort levels, it is usually assumed that it is in owner's interest to induce a high effort in each period if it is also optimal to do so in a one-shot relationship (e.g., Laffont and Martimort, 2002).

The Moral Hazard incentive constraint (MH-3.4) thus writes:

$$\begin{aligned}
&\beta_1 \Phi\left(I_{1L}^{K_1}\right) + (1-\beta_1)\,\Phi\left(I_{1H}^{K_1}\right) - \varphi + \delta\left[\beta_1 \hat{U}_{2L}^{h_T^K} + (1-\beta_1)\,\hat{U}_{2H}^{h_T^K}\right] \\
\geqq\ &\beta_0 \Phi\left(I_{1L}^{K_1}\right) + (1-\beta_0)\,\Phi\left(I_{1H}^{K_1}\right) + \delta\left[\beta_0 \hat{U}_{2L}^{h_T^K} + (1-\beta_0)\,\hat{U}_{2H}^{h_T^K}\right],
\end{aligned}$$

which is equivalent to:

$$\Phi\left(I_{1L}^{K_1}\right) - \Phi\left(I_{1H}^{K_1}\right) + \delta\left(\hat{U}_{2L}^{h_T^K} - \hat{U}_{2H}^{h_T^K}\right) \geqq \frac{\varphi}{\Delta\beta}. \tag{MH-3.4}$$

Assume that the shareholder wants to induce a high effort in each period, the problem of the shareholder can formally be stated as follows:

$$\max_{\left\{\binom{I_{1L}^{K_1}}{I_{1H}^{K_1}};\binom{\hat{U}_{2L}^{h_T^K}}{\hat{U}_{2H}^{h_T^K}}\right\}} \hat{S}(U) = \left\{\begin{array}{c} \beta_1\left[\pi^{K_1}(c_L) - I_{1L}^{K_1}\right] + (1-\beta_1)\left[\pi^{K_1}(c_H) - I_{1H}^{K_1}\right] \\ +\delta\left[\beta_1 \hat{S}\left(\hat{U}_{2L}^{h_T^K}\right) + (1-\beta_1)\,\hat{S}\left(\hat{U}_{2H}^{h_T^K}\right)\right] \end{array}\right\}$$

subject to (PC-3.4) and (MH-3.4).

To simplify the calculation, let us first denote $\Phi\left(I_{1L}^{K_1}\right) = u_{1L}^{K_1}$ and $\Phi\left(I_{1H}^{K_1}\right) = u_{1H}^{K_1}$. Let $h(\cdot)$ be the inverse function of $\Phi(\cdot)$, then one can substitute $I_{1L}^{K_1}$ by $h\left(u_{1L}^{K_1}\right)$ and substitute $I_{1H}^{K_1}$ by $h\left(u_{1H}^{K_1}\right)$. Solving the optimal variables $\left\{I_{1L}^{*K_1}, I_{1H}^{*K_1}; \hat{U}_{2L}^{*h_T^K}, \hat{U}_{2H}^{*h_T^K}\right\}$ in the maximizing problem becomes finding out the optimal variables $\left\{u_{1L}^{*K_1}, u_{1H}^{*K_1}; \hat{U}_{2L}^{*h_T^K}, \hat{U}_{2H}^{*h_T^K}\right\}$ instead.

Let λ_1 and λ_2 be respectively the Lagrange multipliers of the constraints (PC-3.4) and (MH-3.4). The optimizations with respect to $u_{1L}^{K_1}$ and $u_{1H}^{K_1}$ yield respectively

$$-\beta_1 h'\left(u_{1L}^{K_1}\right) + \lambda_1\beta_1 + \lambda_2 = 0, \tag{3.4-1}$$

$$-(1-\beta_1)\,h'\left(u_{1H}^{K_1}\right) + \lambda_1(1-\beta_1) - \lambda_2 = 0. \tag{3.4-2}$$

Summing (3.4-1) and (3.4-2), one can obtain

$$\lambda_1 = \mathbb{E}\left[h'\left(u_1^{K_1}\right)\right],$$

where $\mathbb{E}(\cdot)$ is the expectation operator with respect to the distribution of the current outcome (the marginal cost) induced by a high effort ($e = 1$).

Similarly, the optimizations with respect to $\hat{U}_{2L}^{h_T^K}$ and $\hat{U}_{2H}^{h_T^K}$ yield respectively

$$\beta_1 \hat{S}'\left(\hat{U}_{2L}^{h_T^K}\right) + \lambda_1\beta_1 + \lambda_2 = 0, \tag{3.4-3}$$

$$(1-\beta_1)\hat{S}'\left(\hat{U}_{2H}^{h_T^K}\right) + \lambda_1(1-\beta_1) - \lambda_2 = 0. \tag{3.4-4}$$

Summing (3.4-3) and (3.4-4), one can obtain

$$\lambda_1 = -\mathbb{E}\left[\hat{S}'\left(\hat{U}_2^{h_T^K}\right)\right].$$

Relating the previously found two equations $\lambda_1 = \mathbb{E}\left[h'\left(u_1^{K_1}\right)\right]$ and $\lambda_1 = -\mathbb{E}\left[\hat{S}'\left(\hat{U}_2^{h_T^K}\right)\right]$, one can easily obtain part (i) of the following remark (see appendix C.3. for more details and the demonstrations of part (ii) and (iii) of the remark 3.4.1).

Remark 3.4.1 *(i).* $\mathbb{E}\left[h'\left(u_1^{K_1}\right)\right] = -\mathbb{E}\left[\hat{S}'\left(\hat{U}_2^{h_T^K}\right)\right]$*; (ii).* $h'\left(u_{1L}^{K_1}\right) = -\hat{S}'\left(\hat{U}_{2L}^{h_T^K}\right)$*; (iii).* $h'\left(u_{1H}^{K_1}\right) = -\hat{S}'\left(\hat{U}_{2H}^{h_T^K}\right)$.

This remark confirms the finding in Spear and Srivastava (1987) and shows substitution between the manager's expected marginal utility and the shareholder's expected marginal payoff that works on the manager's present and future utilities.

Applying the Envelope Theorem, one can obtain $\hat{S}'(U) = -\lambda_1$. Relating this result with the previous $\lambda_1 = -\mathbb{E}\left[\hat{S}'\left(\hat{U}_2^{h_T^K}\right)\right]$, one can obtain another characteristic of the optimal contract as in the following remark.

Remark 3.4.2 $\hat{S}'(U) = \mathbb{E}\left[\hat{S}'\left(\hat{U}_2^{h_T^K}\right)\right]$.

The marginal value function satisfies the martingale property which links the current utility with the promised utility in the future. It shows that the marginal cost of paying some rent to the manager in the current period must be even with the marginal cost of paying rent in the following periods. Comparing with the case of static moral hazard, which shows that the optimal contract requires the risk-averse manager to bear some risk, we can see that the case of repeated moral hazard allows the shareholder to benefit from the repetition of the game, since the reward and punishment of the manager are dispersed to the whole time, leaving the manager supporting only a fraction of the risk at each period.

3.5 Profit-Independent Compensation

Similar as in the benchmark, the sustainability of collusion depends on the utility of the manager who's running the firm. The difference is that the manager's utility when sticking to the monopolistic cartel price, his short-term benefits from "cheating" (in period 1), as well as the magnitude of being retaliated by the rivals (in period 2), are decided and fixed by the incentive (dynamic) contract.

The serious consequence of utility loss compared with the utility that the manager would have obtained by sticking to the collusive path is partly due to the retaliation from the rivals after observing a deviation and partly due to the dynamic incentive contract design. To avoid being effectively retaliated, the incentive contracts must imply a negligible utility loss for the deviating manager. However, the optimal incentive contract is designed to solve the repeated moral hazard, according to which the utility of the manager is fixed. When the managerial compensation (the transfer) is profit-independent, the manager will sustain the collusion as long as

$$\begin{aligned} & \beta_1 \Phi\left(I_{1L}^{*M}\right) + (1-\beta_1)\Phi\left(I_{1H}^{*M}\right) + \delta\left[\beta_1 \hat{U}_{2L}^{*h_T^K(M)} + (1-\beta_1)\hat{U}_{2H}^{*h_T^K(M)}\right] \\ \geq \ & \beta_1 \Phi\left(I_{1L}^{*D}\right) + (1-\beta_1)\Phi\left(I_{1H}^{*D}\right) + \delta\left[\beta_1 \hat{U}_{2L}^{*h_T^K(C)} + (1-\beta_1)\hat{U}_{2H}^{*h_T^K(C)}\right], \end{aligned}$$

which is equivalent to

$$\begin{aligned} & \beta_1 u_{1L}^{*M} + (1-\beta_1) u_{1H}^{*M} + \delta\left[\beta_1 \hat{U}_{2L}^{*h_T^K(M)} + (1-\beta_1)\hat{U}_{2H}^{*h_T^K(M)}\right] \\ \geq \ & \beta_1 u_{1L}^{*D} + (1-\beta_1) u_{1H}^{*D} + \delta\left[\beta_1 \hat{U}_{2L}^{*h_T^K(C)} + (1-\beta_1)\hat{U}_{2H}^{*h_T^K(C)}\right], \end{aligned}$$

where $h_T^K(M)$ means the market conduct of each period (except period 1) is M and $h_T^K(C)$ means the market conduct of each period (except period 1) is C.

Proposition 3.5.1 *When the managerial compensation is independent of gross profit, the implementation of the optimal contract leads to an indifference between deviation and collusion for the manager.*

Proof. See appendix C.4. ■

Whatever the choice of market conduct, this does not alter the allocation of the optimal contract which constrains the manager's payoff. In this circumstance, the manager has no incentive to deviate. The optimal contract which solves the repeated moral hazard problem within each member of the cartel may make the collusion in a stable state.

To further show the characteristics of the optimal contract, we follow the setting of Laffont and Martimort (2002) by considering the inverse function as $h(u) = u + \frac{d}{2}u^2$, which is increasing and convex, with $d > 0$; and the expected payoff value of the shareholder as $\hat{S}(U) = \alpha_0 - \alpha_1 U - \frac{\alpha_2}{2}U^2$, for all $U \in R$, with some parameters α_0, α_1, and α_2. Using the constraints (PC-3.4) and

(MH-3.4), as well as the two previous remarks, one can obtain (see demonstration in appendix C.5):

$$\begin{aligned}
u_{1H}^{*K_1}(U) &= (1-\delta)U + \frac{\varphi}{\Delta\beta}\left(\beta_1 \frac{\delta d}{\alpha_2+\delta d} - \beta_0\right), \\
u_{1L}^{*K_1}(U) &= u_{1H}^{*K_1}(U) + \frac{\varphi}{\Delta\beta}\left(\frac{\alpha_2}{\alpha_2+\delta d}\right), \\
\hat{U}_{2H}^{*h_T^K}(U) &= U - \frac{\varphi}{\Delta\beta}\left(\beta_1 \frac{d}{\alpha_2+\delta d}\right), \\
\hat{U}_{2L}^{*h_T^K}(U) &= \hat{U}_{2H}^{*h_T^K}(U) + \frac{\varphi}{\Delta\beta}\left(\frac{d}{\alpha_2+\delta d}\right).
\end{aligned}$$

This example confirms the fact that each optimal level is in function of the expected utility U which is promised over the whole duration of the game. One can check the result in remark 3.4.2 with the application of Envelope Theorem. Observing the expressions of the optimal contract, one may tell that the discount factor δ as well as the parameter d which decides both the convexity and the concavity of the inverse function $h(\cdot)$ and the original function $\Phi(\cdot)$ also play a crucial role in the optimal contract. Further, it is worth noting that each component of the four expressions of the contract is independent of gross profit, which is the exceptional variable that is influenced by the market conduct decision. Alternatively, the utility of the manager as constrained by the contract maintains a level, which is independent of the choice of market conduct.

Different with the benchmark, the manager's preference over risk (i.e., the degree of risk-aversion) no longer plays a role on the stability of a manager-led cartel. With the implementation of the optimal, the manager's preference over risk does not alter the utility of manager, which is crucial in influencing the stability of a manager-led cartel.

One can still consider the case where one of the firms realizes a lower marginal cost whereas the other realizes a higher marginal cost. It is worth noting that once the optimal dynamic contract is implemented, the manager's utilities both in the current and promised levels are settled by the contract, depending no longer on the firm's gross profit. Consequently, the same condition of collusion holds whatever the rivals have cost advantage or not.

3.6 Concluding Remarks

The traces of proof of collusive behavior that antitrust authorities have been looking for are usually based on the prices, but rarely based on managerial incentive compensation. This chapter links the design of managerial incentive contracts with firms' collusive behavior and may help to provide insights and theoretical support for the antitrust authorities pertaining corporate governance.

We have studied the role of risk-aversion of the manager upon the stability of a cartel in a benchmark case, which is built on the base of Spagnolo (2005) where information is perfect. We've proved that a cartel becomes more sustainable by recruiting a more risk-averse manager, when the manager's compensation increases with gross profit. In other words, the more the manager dislikes risk, the more stable a manager-led cartel would be.

Moreover, relaxing the assumption that shareholders and managers have perfect information between them, we have examined how managerial compensation schemes in a repeated moral hazard model may influence the sustainability of a manager-led cartel. Using recursive formulations in a two-effort-two-outcome model, we have confirmed some characteristics of the optimal dynamic contract as in Spear and Srivastava (1987). Specifically, we've verified that the infinitely repeated moral hazard model can be reduced to a two period maximization problem. Different with the benchmark, we have shown that the preference of risk of the manager plays no more role upon the stability of a cartel: when the manager's compensation is independent of gross profit, a cartel may remain sustainable since the manager taking the optimal dynamic contract is indifferent between collusion and deviation. This is because the shareholder has all the bargaining power to offer the contract, which is designed in a manner to restrict the utility of the manager for his very best interests. The shareholder's design of optimal dynamic contract solves the repeated the moral hazard and at the same time, the optimal design constrains the manager's discretion over the decision of market conduct as well.

General Conclusion

This thesis contributes to the existing theoretical literature on the theme of corporate governance and product market competition by demonstrating the necessary influence of product market competition upon main stakeholders' relationships (chapter 1) and the unnecessary influence of product market competition upon managerial incentive contract (chapter 2 and 3).

In chapter 1, we have shown that Cournot competition may turn out to be more efficient (in terms of larger consumer surplus and total welfare) than Bertrand competition if sufficiently high weight is put on consumer surplus when firms integrate the interests of consumers in their objective function. Moreover, we have found that the competition mode plays an important role in the intensity of conflict between different stakeholders. Specifically, we have proved that the shareholders' conflicts (provoked by the consumer-orientation mechanism) with both consumers and employees are attenuated under Bertrand competition compared to Cournot competition, although the latter is more efficient.

In further studies, it would be interesting to extend the duopoly model to an oligopolistic industry containing several consumer-oriented firms competing with several profit-maximizing firms. Such extension would allow to investigate whether there is an optimal allocation of firms of each type.

In chapter 2, we have studied corporate governance from a shareholder-orientation perspective by focusing on the contractual design of managerial incentives, which can be greatly complicated because of asymmetric information between shareholders and managers. Informational problems such as moral hazard and/or adverse selection in an agency relationship between a shareholder and a manager were specifically studied through the optimal incentive contracts. We have shown that managerial incentives solving moral hazard and/or adverse selection are not necessarily influenced by product market competition. Since the shareholder has all the bargaining power when offering a take-it-or-leave-it contract, he restricts the manager's utilities to maximize his own interests. We have shown that the optimal contracts fixed the managers' utilities with given values, which do not necessarily depend on competition.

We have considered a simple model where one shareholder versus one manager in the principal-agent relationship. Without competitors, the manager cannot free-ride another manager when taking a collective decision and the shareholder can neither benefit from the competition between the managers to better reduce the information rents. In further studies, it would be interesting to consider a multi-manager organization, in which the shareholder must also concern the group incentives in addition to individual managerial incentives.

In chapter 3, we have also studied corporate governance through the design of managerial incentive contracts from a shareholder-orientation perspective. One difference with chapter 2 is that we considered a long-term shareholder-manager relationship, in which the informational problem (specifically moral hazard) is repeated over time. Another difference is that we focus on firms' cooperative behavior in the sense of collusion rather than non-cooperative behavior (although competition is applied with trigger strategy when a deviation is detected) in an infinitely repeated horizon. We have shown different with the benchmark that the preference of risk of the manager plays no more role upon the stability of a manager-led cartel. Specifically, when the manager's compensation is independent of gross profit, a cartel may remain sustainable since the manager taking the optimal dynamic contract is indifferent between collusion and deviation.

It is worth noting that we have solely considered the case when the managerial compensation is profit-independent. In further research, it is necessary to investigate how the optimal dynamic contract might influence the stability of a manager-led cartel when the manager's compensation depends on profit (for instance, be proportional to the gross profit). It would be very interesting to compare the corresponding result with our previous findings.

As for the whole thesis, the scope of the studies on corporate governance can be far more larger than dealing with different stakeholders to ensure and balance their interests (chapter 1) and treating informational problems that are due to separation between ownership and control (chapter 2 and 3). It is necessary to complete the investigations on the interaction between product market competition and corporate governance by exploring other governance issues that are related to, such as, concentrated or dispersed ownership, mergers and acquisitions, residual rights of control, the free-ride problem, etc. The effect of antitrust policy upon the top-level design of corporate governance is also a very interesting topic that needs further research.

Appendices

APPENDIX A

FOR CHAPTER 1

A.1 Equilibrium wage

Proof. At the first stage of the game, the first-order condition requires $\frac{\partial B}{\partial w} = 0$, i.e.,

$$[U(w)]^{\beta-1}[V(w)]^{-\beta}\left[\beta\frac{\partial U(w)}{\partial w}V(w) + (1-\beta)U(w)\frac{\partial V(w)}{\partial w}\right] = 0.$$

Or equivalently

$$\beta\frac{\partial U(w)}{\partial w}V(w) + (1-\beta)U(w)\frac{\partial V(w)}{\partial w} = 0. \tag{A1.1}$$

At the second stage of the game, under Cournot competition, we have: $\frac{\partial U^C}{\partial w^C} = \frac{2\left(\alpha-2w^C+\bar{w}\right)}{1+(1+\gamma)(1-\theta)}$ and $\frac{\partial V^C}{\partial w^C} = -\frac{4\left(\alpha-w^C\right)}{[1+(1+\gamma)(1-\theta)]^2}$. Substituting these expressions in (A1.1), one can obtain the wage equilibrium (w^C) as follows

$$4\left(\alpha-w^C\right)^2\frac{\left[2w^C-2\bar{w}-\beta(\alpha-\bar{w})\right]}{[1+(1+\gamma)(1-\theta)]^3} = 0.$$

Or equivalently (since $\alpha > w^C$)

$$2w^C-2\bar{w}-\beta(\alpha-\bar{w}) = 0. \tag{A1.2}$$

At the second stage of the game, under Cournot competition, we have: $\frac{\partial U^B}{\partial w^B} = \frac{2\left(\alpha-2w^B+\bar{w}\right)}{(1+\gamma)[1+(1-\gamma)(1-\theta)]}$ and $\frac{\partial V^B}{\partial w^B} = -\frac{4\left(\alpha-w^B\right)(\theta\gamma+1-\gamma)}{(1+\gamma)[1+(1-\gamma)(1-\theta)]^2}$. Substituting these expressions in (A1.1), one can obtain the wage equilibrium (w^B) as follows

$$4\left(\alpha-w^B\right)^2\frac{[1-\gamma(1-\theta)]\left[2w^B-2\bar{w}-\beta(\alpha-\bar{w})\right]}{(1+\gamma)^2[1+(1-\gamma)(1-\theta)]^3} = 0.$$

Or (since $\alpha > w^B$)

$$2w^B - 2\bar{w} - \beta\left(\alpha - \bar{w}\right) = 0. \tag{A1.3}$$

Then $w^B = w^C = \bar{w} + \frac{\beta}{2}\left(\alpha - \bar{w}\right) \equiv w^*$. ■

A.2 Proof of Proposition 1.2.1

Proof. From the equilibrium levels of production under Cournot and Bertrand games, we derive

$$x^{C*} - x^{B*} = \frac{\left(\alpha - w^*\right)\gamma\left[\left(1+\gamma\right)\theta - \gamma\right]}{\left(1+\gamma\right)\left[1 + \left(1+\gamma\right)\left(1-\theta\right)\right]\left[1 + \left(1-\gamma\right)\left(1-\theta\right)\right]},$$

whose denominator is positive. Since $\alpha - w^* > 0$ for $\gamma > 0$: $sign\left(x^{C*} - x^{B*}\right) = sign\left[\left(1+\gamma\right)\theta - \gamma\right]$.

From the equilibrium levels of price under Cournot and Bertrand games, we derive

$$p^{C*} - p^{B*} = \frac{-\left(\alpha - w^*\right)\gamma\left[\left(1+\gamma\right)\theta - \gamma\right]}{\left[1 + \left(1-\gamma\right)\left(1-\theta\right)\right]\left[1 + \left(1+\gamma\right)\left(1-\theta\right)\right]},$$

whose denominator is positive. Then $sign\left(p^{C*} - p^{B*}\right) = -sign\left[\left(1+\gamma\right)\theta - \gamma\right] = -sign\left(x^{C*} - x^{B*}\right)$.

The difference of the equilibrium profits under Cournot and Bertrand gives

$$\pi^{C*} - \pi^{B*} = \frac{-\left(\alpha - w^*\right)^2\gamma\left\{\gamma + \theta + \left(1-\theta\right)\left[\gamma + \theta\left(1-\gamma^2\right)\right]\right\}\left[\left(1+\gamma\right)\theta - \gamma\right]}{\left(1+\gamma\right)\left[1 + \left(1+\gamma\right)\left(1-\theta\right)\right]^2\left[1 + \left(1-\gamma\right)\left(1-\theta\right)\right]^2},$$

where the denominator is positive. Hence $sign\left(\pi^{C*} - \pi^{B*}\right) = -sign\left[\left(1+\gamma\right)\theta - \gamma\right] = sign\left(p^{C*} - p^{B*}\right)$.

Concerning the consumer surplus ($CS^{f*} = \left(1+\gamma\right)\left(x^{f*}\right)^2$ where $f \in \{B, C\}$ is the mode of competition) and the utility of labor union ($U^{f*} = 2\left(w^* - \bar{w}\right)x^{f*}$) at equilibrium, we have

$$CS^{C*} - CS^{B*} = \left(1+\gamma\right)\left(x^{C*} + x^{B*}\right)\left(x^{C*} - x^{B*}\right)$$

and

$$U^{C*} - U^{B*} = 2\left(w^* - \bar{w}\right)\left(x^{C*} - x^{B*}\right)$$

Then $sign\left(CS^{C*}-CS^{B*}\right)=sign\left(U^{C*}-U^{B*}\right)=sign\left(x^{C*}-x^{B*}\right)$.

Since $sign\left(x^{C*}-x^{B*}\right)=sign\left[(1+\gamma)\,\theta-\gamma\right]=sign\left(\frac{\theta}{\tilde{\theta}}-\gamma\right)$, when $\theta\in\left[0,\gamma\tilde{\theta}\right[$, we have $x^{C*}<x^{B*}$, $p^{C*}>p^{B*}$, $\pi^{C*}>\pi^{B*}$, $CS^{C*}<CS^{B*}$, $U^{C*}<U^{B*}$; when $\theta\in\left[\gamma\tilde{\theta},\tilde{\theta}\right[$, we have $x^{C*}\geqq x^{B*}$, $p^{C*}\leqq p^{B*}$, $\pi^{C*}\leqq\pi^{B*}$, $CS^{C*}\geqq CS^{B*}$, $U^{C*}\geqq U^{B*}$. ■

A.3 Proof of Proposition 1.2.2

Proof. The gap in social welfare between the two modes of competition is given by

$$W^{C*}-W^{B*}=\left(x^{C*}-x^{B*}\right)\left[2\left(\alpha-\bar{w}\right)-\left(1+\gamma\right)\left(x^{C*}+x^{B*}\right)\right].$$

Denote $2\left(\alpha-\bar{w}\right)-\left(1+\gamma\right)\left(x^{C}+x^{B}\right)\equiv Z$. Substituting x^{C*} and x^{B*} in Z, one can obtain

$$\begin{aligned} Z &= \left(\alpha-\bar{w}\right)\left[2-\left(\frac{1}{1+\left(1-\gamma\right)\left(1-\theta\right)}+\frac{1+\gamma}{1+\left(1+\gamma\right)\left(1-\theta\right)}\right)\right] \\ &= \frac{\left(\alpha-\bar{w}\right)}{\left[1+\left(1-\gamma\right)\left(1-\theta\right)\right]\left[1+\left(1+\gamma\right)\left(1-\theta\right)\right]}\left(\theta-\hat{\theta}\right)\left(\theta-\hat{\hat{\theta}}\right), \end{aligned}$$

with $\hat{\theta}=\frac{1}{4}\left[3+\frac{3-\gamma-\sqrt{\Delta}}{(1-\gamma^{2})}\right]$, $\hat{\hat{\theta}}=\frac{1}{4}\left[3+\frac{3-\gamma+\sqrt{\Delta}}{(1-\gamma^{2})}\right]$ and $\Delta=4+\gamma\left(1-\gamma\right)\left[4\left(2\gamma+1\right)+\gamma\left(1-\gamma\right)\right]>0$. Since $\gamma\in\left]0,1\right[$, one can easily check that $\gamma\tilde{\theta}<\hat{\theta}<\tilde{\theta}<\hat{\hat{\theta}}$.

-When $0\leqq\theta<\gamma\tilde{\theta}$, then $Z>0$ and

$$sign\left(W^{C*}-W^{B*}\right)=sign\left(x^{C*}-x^{B*}\right).$$

Since $x^{C*}<x^{B*}$, we have $W^{C*}<W^{B*}$.

-When $\gamma\tilde{\theta}<\theta<\hat{\theta}$, then $Z>0$, but since $x^{C*}>x^{B*}$, hence $W^{C*}>W^{B*}$.

-When $\hat{\theta}<\theta<\tilde{\theta}$, then $Z<0$, and

$$sign\left(W^{C*}-W^{B*}\right)=-sign\left(x^{C*}-x^{B*}\right).$$

Since $x^{C*}>x^{B*}$, one can obtain thus $W^{C*}<W^{B*}$. ■

A.4 Proof of Proposition 1.3.1

Proof. Part i) Since $\frac{\partial w^*}{\partial \beta} = \frac{\alpha-\bar{w}}{2} > 0$, then $\frac{\partial x^{C*}}{\partial \beta} = -\frac{1}{1+(1+\gamma)(1-\theta)}\frac{\partial w^*}{\partial \beta} < 0$ and $\frac{\partial x^{B*}}{\partial \beta} = -\frac{1}{(1+\gamma)[1+(1-\gamma)(1-\theta)]}\frac{\partial w^*}{\partial \beta} < 0$. These two inequalities mean that, in both Cournot and Bertrand competitions, an increase of the bargaining power of the labor union lowers output regardless of the degree of product differentiation and the degree of being consumer-oriented. From the equilibrium expressions, one can obtain for $0 \leqq \theta < \tilde{\theta}$ that $\frac{\partial \pi^{C*}}{\partial \beta} = -2\frac{[1-\theta(1+\gamma)](\alpha-w^*)}{(\theta-\gamma+\theta\gamma-2)^2}\frac{\partial w^*}{\partial \beta}$ and $\frac{\partial CS^{C*}}{\partial \beta} = 2(1+\gamma)\, x^{C*}\frac{\partial x^{C*}}{\partial \beta}$. Similarly for the Bertrand case, one can obtain $\frac{\partial \pi^{B*}}{\partial \beta} = -2\frac{(1-\theta)(1-\gamma)(\alpha-w^*)}{(1+\gamma)(-\theta-\gamma+\theta\gamma+2)^2}\frac{\partial w^*}{\partial \beta}$ and $\frac{\partial CS^{B*}}{\partial \beta} = 2(1+\gamma)\, x^{B*}\frac{\partial x^{B*}}{\partial \beta}$. As previously shown, an increasing bargaining power of the labor union increases wage (i.e., $\frac{\partial w^*}{\partial \beta} > 0$) and decreases output (i.e., $\frac{\partial x^{C*}}{\partial \beta} < 0$), and it is easy to see $\frac{\partial \pi^{C*}}{\partial \beta} < 0$, $\frac{\partial CS^{C*}}{\partial \beta} < 0$ and $\frac{\partial \pi^{B*}}{\partial \beta} < 0$, $\frac{\partial CS^{B*}}{\partial \beta} < 0$. Consequently, $sign\left[\frac{\partial \pi^*}{\partial \beta}\right] = sign\left[\frac{\partial CS^*}{\partial \beta}\right]$ for both Cournot and Bertrand cases.

Part i.i) Given that $U^{f*}(\beta,\cdot) = 2[w^*(\beta,\cdot) - \bar{w}]\, x^{f*}(\beta,\cdot)$, with $f = \{B, C\}$, one can obtain

$$\frac{\partial U^{f*}(\beta,\cdot)}{\partial \beta} = 2\frac{\partial w^*(\beta,\cdot)}{\partial \beta}x^{f*}(\beta,\cdot) + 2[w^*(\beta,\cdot) - \bar{w}]\frac{\partial x^{f*}(\beta,\cdot)}{\partial \beta},$$

From the equilibrium expressions of the labor union's utility we derive $\frac{\partial U^{C*}}{\partial \beta} = \frac{(1-\beta)(\alpha-\bar{w})^2}{2[(1-\theta)(1+\gamma)+1]} > 0$ and $\frac{\partial U^{B*}}{\partial \beta} = \frac{(1-\beta)(\alpha-\bar{w})^2}{2(1+\gamma)[1+(1-\gamma)(1-\theta)]} > 0$. From part i), one can obtain $sign\left[\frac{\partial \pi^*}{\partial \beta}\right] = -sign\left[\frac{\partial U^*}{\partial \beta}\right]$ for both Cournot and Bertrand cases.

From part i) and part i.i), it is obvious that $sign\left[\frac{\partial U^*}{\partial \beta}\right] = -sign\left[\frac{\partial CS^*}{\partial \beta}\right]$ for both Cournot and Bertrand cases. ■

A.5 Proof of Proposition 1.3.2

Proof. Part i) For the Cournot case, the derivation gives $\frac{\partial \pi^{C*}}{\partial \theta} = -\frac{(1+\gamma)[(1+\gamma)\theta+\gamma](\alpha-w^*)^2}{[1+(1+\gamma)(1-\theta)]^3} < 0$ and $\frac{\partial CS^{C*}}{\partial \theta} = 2(1+\gamma)\, x^{C*}\frac{\partial x^{C*}}{\partial \theta} > 0$. Similarly for the Bertrand case, the derivation gives $\frac{\partial \pi^{B*}}{\partial \theta}$

$= -\frac{(1-\gamma)[(1-\gamma)\theta+\gamma](\alpha-w^*)^2}{(1+\gamma)[1+(1-\gamma)(1-\theta)]^3} < 0$ and $\frac{\partial CS^{B*}}{\partial\theta} = 2(1+\gamma)\, x^{B*} \frac{\partial x^{B*}}{\partial\theta} > 0$. Hence, for both modes of competition, i.e., $f = \{B, C\}$, we have $sign\left[\frac{\partial \pi^{f*}}{\partial\theta}\right] = -sign\left[\frac{\partial CS^{f*}}{\partial\theta}\right]$. Consequently, shareholders and consumers have conflicting interests under the effect of θ for both Cournot and Bertrand competition modes.

Observing that $w^* = \bar{w} + \frac{\beta}{2}(\alpha - \bar{w})$ is independent of θ, the utility of the labor union rewrites $U^{f*}(\theta, \cdot) = 2[w^* - \bar{w}]\, x^{f*}(\theta, \cdot)$. Hence, the derivation with respect to θ is

$$\frac{\partial U^{f*}(\theta, \cdot)}{\partial\theta} = 2(w^* - \bar{w}) \frac{\partial x^{f*}(\theta, \cdot)}{\partial\theta}.$$

Since being consumer-oriented promotes production for both Cournot and Bertrand cases (i.e., $\frac{\partial x^{f*}(\theta,\cdot)}{\partial\theta} > 0$), one can easily obtain a positive effect of θ upon the utility of the labor union (i.e., $\frac{\partial U^{f*}(\theta,\cdot)}{\partial\theta} > 0$ with $f = \{B, C\}$). Hence, $sign\left[\frac{\partial \pi^{f*}}{\partial\theta}\right] = -sign\left[\frac{\partial U^{f*}}{\partial\theta}\right]$, with $f = \{B, C\}$.

Part i.i) From the results above, one can obtain $sign\left[\frac{\partial CS^{f*}}{\partial\theta}\right] = sign\left[\frac{\partial U^{f*}}{\partial\theta}\right]$ for both Cournot and Bertrand cases (with $f = \{B, C\}$). ■

A.6 Proof of Proposition 1.4.1

Proof. a) The conflict between shareholders and employees is reflected by $sign\left[\frac{\partial \pi^*}{\partial\beta}\right] = -sign\left[\frac{\partial U^*}{\partial\beta}\right]$ (see part i. of Proposition 1.3.1). We consider: $\left|\eta_{\pi/U,\beta}\right| = \left|\frac{d(\pi^*/U^*)/(\pi^*/U^*)}{d\beta/\beta}\right|$

In Cournot competition, $\frac{\pi^{C*}}{U^{C*}}(\beta, \cdot) = \frac{1}{\beta}(2-\beta)\frac{[1-\theta(1+\gamma)]}{[1+(1+\gamma)(1-\theta)]}$, then

$$\begin{aligned} \left|\eta^C_{U/\pi,\beta}\right| &= \left|-\frac{2}{\beta^2}\frac{[1-\theta(1+\gamma)]}{[1+(1+\gamma)(1-\theta)]}\frac{\beta}{\frac{1}{\beta}(2-\beta)\frac{[1-\theta(1+\gamma)]}{[1+(1+\gamma)(1-\theta)]}}\right| \\ &= \frac{2}{2-\beta}. \end{aligned}$$

In Bertrand competition, $\frac{\pi^{B*}}{U^{B*}}(\beta,\cdot)=\frac{1}{\beta}(2-\beta)\frac{(1-\theta)(1-\gamma)}{[1+(1-\gamma)(1-\theta)]}$, then

$$\begin{aligned}\left|\eta^{B}_{\pi/U,\beta}\right| &= \left|-\frac{2}{\beta^2}\frac{(1-\theta)(1-\gamma)}{[1+(1-\gamma)(1-\theta)]}\frac{\beta}{\frac{1}{\beta}(2-\beta)\frac{(1-\theta)(1-\gamma)}{[1+(1-\gamma)(1-\theta)]}}\right| \\ &= \frac{2}{2-\beta}.\end{aligned}$$

Clearly, $\left|\eta^{C}_{U/\pi,\beta}\right|=\left|\eta^{B}_{\pi/U,\beta}\right|$.

b) The conflict between employees and consumers is reflected by $sign\left[\frac{\partial U^*}{\partial\beta}\right]=-sign\left[\frac{\partial CS^*}{\partial\beta}\right]$(see part i.i. of Proposition 1.3.1). We consider: $\left|\eta_{CS/U,\beta}\right|=\left|\frac{d(CS^*/U^*)/(CS^*/U^*)}{d\beta/\beta}\right|$

In Cournot competition, $\frac{CS^{C*}}{U^{C*}}(\beta,\cdot)=\frac{1}{\beta}(2-\beta)\frac{(1+\gamma)}{[1+(1+\gamma)(1-\theta)]}$, then

$$\begin{aligned}\left|\eta^{C}_{CS/U,\beta}\right| &= \left|-\frac{2}{\beta^2}\frac{(1+\gamma)}{[1+(1+\gamma)(1-\theta)]}\frac{\beta}{\frac{1}{\beta}(2-\beta)\frac{(1+\gamma)}{[1+(1+\gamma)(1-\theta)]}}\right| \\ &= \frac{2}{2-\beta}.\end{aligned}$$

In Bertrand competition, $\frac{CS^{B*}}{U^{B*}}(\beta,\cdot)=\frac{1}{\beta}(2-\beta)\frac{1}{[1+(1-\gamma)(1-\theta)]}$, then

$$\begin{aligned}\left|\eta^{B}_{CS/U,\beta}\right| &= \left|-\frac{2}{\beta^2}\frac{1}{[1+(1-\gamma)(1-\theta)]}\frac{\beta}{\frac{1}{\beta}(2-\beta)\frac{1}{[1+(1-\gamma)(1-\theta)]}}\right| \\ &= \frac{2}{2-\beta}.\end{aligned}$$

Clearly, $\left|\eta^{C}_{CS/U,\beta}\right|=\left|\eta^{B}_{CS/U,\beta}\right|$. ■

A.7 Proof of Proposition 1.4.2

Proof. a) The conflict between shareholders and consumers: $sign\left[\frac{\partial\pi(\theta,\cdot)}{\partial\theta}\right]=-sign\left[\frac{\partial CS(\theta,\cdot)}{\partial\theta}\right]$ (see A.5). We consider: $\left|\eta_{\pi/CS,\theta}\right|=\left|\frac{d(\pi^*/CS^*)/(\pi^*/CS^*)}{d\theta/\theta}\right|$

In Cournot competition, $\frac{\pi^{C*}}{CS^{C*}}(\theta,\cdot)=\frac{1}{1+\gamma}-\theta$, then

$$\left|\eta^{C}_{\pi/CS,\theta}\right|=\frac{\theta(1+\gamma)}{1-\theta(1+\gamma)},$$

which is indeed positive since $0<\theta<\tilde{\theta}=\frac{1}{1+\gamma}$.

In Bertrand competition, $\frac{\pi^{B*}}{CS^{B*}}(\theta,\cdot) = (1-\theta)(1-\gamma)$, then

$$\left|\eta^{B}_{\pi/CS,\theta}\right| = \frac{\theta}{1-\theta}.$$

We have $\left|\eta^{C}_{\pi/CS,\theta}\right| - \left|\eta^{B}_{\pi/CS,\theta}\right| = \frac{\theta(1+\gamma)}{1-\theta(1+\gamma)} - \frac{\theta}{1-\theta} = \theta\frac{\gamma}{(1-\theta)[1-\theta(1+\gamma)]}$. Then $\left|\eta^{C}_{\pi/CS,\theta}\right| > \left|\eta^{B}_{\pi/CS,\theta}\right|$, since $0<\theta<\tilde{\theta}=\frac{1}{1+\gamma}$.

b) The conflict between shareholders and employees. We consider $\left|\eta_{\pi/U,\theta}\right| = \left|\frac{d(\pi/U)/(\pi/U)}{d\theta/\theta}\right|$.

In Cournot competition, $\frac{\pi^{C*}}{U^{C*}}(\theta,\cdot) = \frac{[\alpha-w^*(\beta)]}{[w^*(\beta)-\bar{w}]}\frac{[1-\theta(1+\gamma)]}{[1+(1+\gamma)(1-\theta)]}$, where $w^*(\beta) = \bar{w} + \frac{\beta}{2}(\alpha-\bar{w})$, then

$$\left|\eta^{C}_{\pi/U,\theta}\right| = \frac{\theta(1+\gamma)^2}{[1+(1+\gamma)(1-\theta)][1-\theta(1+\gamma)]}.$$

In Bertrand competition, $\frac{\pi^{B*}}{U^{B*}}(\theta,\cdot) = \frac{[\alpha-w^*(\beta)]}{[w^*(\beta)-\bar{w}]}\frac{(1-\theta)(1-\gamma)}{[1+(1-\gamma)(1-\theta)]}$, then

$$\left|\eta^{B}_{\pi/U,\theta}\right| = \frac{\theta}{(1-\theta)[1+(1-\gamma)(1-\theta)]}.$$

So we have

$$\left|\eta^{C}_{\pi/U,\theta}\right| - \left|\eta^{B}_{\pi/U,\theta}\right| = \theta\gamma\frac{1+(1+\gamma)(1-\theta)[\theta(1+\gamma)+1-\gamma]}{(1-\theta)[1+(1-\gamma)(1-\theta)][1-\theta(1+\gamma)][1+(1+\gamma)(1-\theta)]},$$

implying that $\left|\eta^{C}_{\pi/U,\theta}\right| > \left|\eta^{B}_{\pi/U,\theta}\right|$. ∎

A.8 Proof of Lemma 1.5.1

Proof. Lemma 1.5.1 (i). Recall that $\tilde{w}^{*C} = \bar{w} + \frac{(\alpha-\bar{w})\beta[1+(1-\gamma)(1-\theta)]}{D}$, with $D = \left[\theta(2-\theta)-\gamma(1-\theta)^2\right]\beta + 1 + (1-\theta)(2-\theta\gamma) + (1-\theta)^2 > 0$, $\forall\ \theta \in \left[0,\tilde{\theta}\right[$ and $\gamma,\beta\in[0,1]$. One can obtain

$$\frac{\partial\tilde{w}^{*C}}{\partial\theta} = \frac{(\alpha-\bar{w})\beta}{D^2}D^{C\theta},$$

where $D^{C\theta} = (1-\gamma^2)(1-\beta)\theta^2 - 2(1+\gamma)(2-\gamma)(1-\beta)\theta + \gamma(2-\gamma) + 4(1-\beta) - \beta\gamma(1-\gamma)$.

Since $\frac{(\alpha-\bar{w})\beta}{D^2}$ is positive, one can have $sign\left[\frac{\partial\tilde{w}^{*C}}{\partial\theta}\right] = sign\left[D^{C\theta}\right]$. Observing the expression of $D^{C\theta}$, one can tell that $D^{C\theta}$ is a parabola function of θ. The coefficient of θ^2 is positive (since $(1-\gamma^2)(1-\beta) > 0$), hence the U-shaped parabola curve is opening to the top. Studying the symmetric axis, one can obtain $\frac{2(1+\gamma)(2-\gamma)(1-\beta)}{2(1-\gamma^2)(1-\beta)} = \frac{1}{1-\gamma}(2-\gamma) = 1 + \frac{\gamma}{1-\gamma} > 1 > \frac{1}{1+\gamma} = \tilde{\theta}$. This implies that the parabola curve is decreasing for $\theta \in \left[0, \tilde{\theta}\right[$. Hence when $\theta = \tilde{\theta}$, i.e., $\theta = \frac{1}{1+\gamma}$, $D^{C\theta}$ attains its minimum value. Substituting $\theta = \frac{1}{1+\gamma}$ in the expression of $D^{C\theta}$, one obtains $D^{C\theta} = \gamma + \left(2\gamma + \frac{1-\gamma^3}{1+\gamma}\right)(1-\beta)$, which is obviously positive for all $\gamma, \beta \in [0,1]$. Even the minimum value of $D^{C\theta}$ is positive, the decreasing $D^{C\theta}$ must be positive for all $\theta \in \left[0, \tilde{\theta}\right[$. Hence, $\frac{\partial\tilde{w}^{*C}}{\partial\theta}$ is also positive.

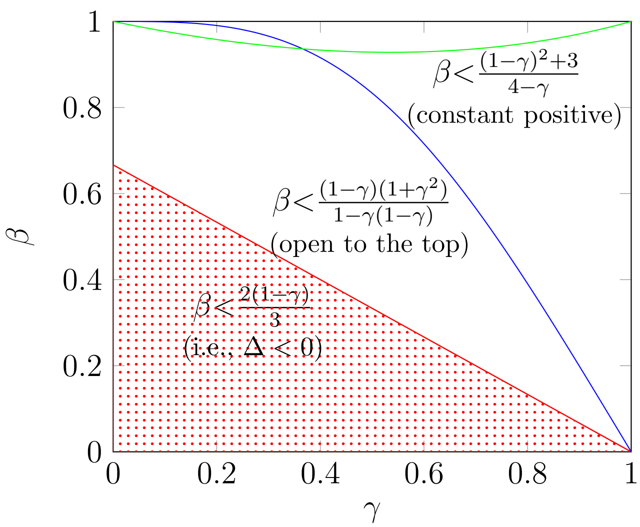
Idem, recall $\tilde{w}^{*B} = \bar{w} + \frac{(\alpha-\bar{w})\beta(1-\gamma)[1+(1+\gamma)(1-\theta)][1-\gamma(1-\theta)]}{E}$, with $E = (1-\gamma)(1-\theta)^2(1-\gamma^2) + (1-\gamma)(2+\theta\gamma)(1-\theta) + (1-\gamma)\left[1-(1-\theta)^2\gamma^2\right] + \{\theta(2-\theta) - \gamma(1-\theta)[1-\gamma(1-\theta)]\}\beta > 0$, $\forall\ \theta, \gamma, \beta \in [0,1]$, thus one can obtain

$$\frac{\partial\tilde{w}^{*B}}{\partial\theta} = \frac{(\alpha-\bar{w})\beta(1-\gamma^2)}{E^2}E^{B\theta},$$

where $E^{B\theta} = \{(1-\gamma)(1+\gamma^2) - [1-\gamma(1-\gamma)]\beta\}\theta^2 + 2(1-\gamma)[\beta(2-\gamma)+\gamma-\gamma^2-2]\theta + (1-\gamma)\left[(1-\gamma)^2 - (4-\gamma)\beta + 3\right]$.

Since $\frac{(\alpha-\bar{w})\beta\left(1-\gamma^2\right)}{E^2}$ is positive, one can have $sign\left[\frac{\partial\tilde{w}^{*B}}{\partial\theta}\right] = sign\left[E^{B\theta}\right]$. Observing the expression of $E^{B\theta}$, one can tell that $E^{B\theta}$ is also a parabola function of θ, with the form of $a\theta^2 + b\theta + c$. The parabola curve is opening to the top if and only if a the coefficient of θ^2 is strictly positive, i.e., $\{(1-\gamma)(1+\gamma^2) - [1-\gamma(1-\gamma)]\beta\} > 0$, which is equivalent to $\beta < \frac{(1-\gamma)\left(1+\gamma^2\right)}{1-\gamma(1-\gamma)}$ (the zone below the blue curve as shown in the following figure). The intersection with the $E^{B\theta}$-axe is positive if and only if the constant value c of $E^{B\theta}$ is strictly positive, i.e., $(1-\gamma)\left[(1-\gamma)^2 - (4-\gamma)\beta + 3\right] > 0$, which is equivalent to $(1-\gamma)^2 - (4-\gamma)\beta + 3 > 0$, i.e.,

$\beta < \frac{(1-\gamma)^2+3}{4-\gamma}$ (the zone below the green curve as shown in the following figure). The parabola curve has no intersection to the θ-axe if and only if $\Delta < 0$, i.e., $b^2 - 4ac < 0$, which writes $4\gamma(1-\gamma)(1-\beta)(3\beta+2\gamma-2) < 0$, which is equivalent to $3\beta + 2\gamma - 2 < 0$, i.e., $\beta < \frac{2(1-\gamma)}{3}$ (the zone below the red curve as shown in the following figure).



One can induce that if $\beta < \frac{2(1-\gamma)}{3}$ is satisfied, $\beta < \frac{(1-\gamma)^2+3}{4-\gamma}$ and $\beta < \frac{(1-\gamma)(1+\gamma^2)}{1-\gamma(1-\gamma)}$ are both satisfied. This means the value of $E^{B\theta}$ is always true for $\beta \in \left[0, \frac{2(1-\gamma)}{3}\right[$, which corresponds to the red zone in the figure, since it refers to a U-shaped parabola opening to the top with a positive constant and no intersection to the θ-axe. One can see that for any β in the zone between the red curve and the blue curve or between the blue curve and the green curve, the value of $E^{B\theta}$ is not guaranteed to be positive. Consequently, $\frac{\partial \tilde{w}^{*B}}{\partial \theta} > 0$, only if $\beta \in \left[0, \frac{2(1-\gamma)}{3}\right[$.

Lemma 1.5.1 (ii). We turn to study the effect of β. One can obtain for the Cournot case

$$\frac{\partial \tilde{w}^{*C}}{\partial \beta} = \frac{(\alpha - \bar{w})}{D^2} D^{C\beta},$$

where $D^{C\beta} = \theta(1-\theta)^2\gamma^2 + (2-\theta)\left[(1-\theta)^2 + 2(1-\theta)(1-\gamma) + 1\right]$. Obviously $D^{C\beta}$ is positive, thus $\frac{\partial \tilde{w}^{*C}}{\partial \beta} > 0$.

Idem, for the Bertrand case, one can obtain

$$\frac{\partial \tilde{w}^{*B}}{\partial \beta} = \frac{(\alpha - \bar{w})(\theta\gamma + 1 - \gamma)(1-\gamma)^2}{E^2} E^{B\beta},$$

where $E^{B\beta} = 1 + (1-\theta)^2 + 2(1-\theta)(1-\gamma^2) + \theta(1-\theta)\gamma$. Obviously $E^{B\beta}$ is positive, thus $\frac{\partial \tilde{w}^{*B}}{\partial \beta} > 0$. ■

A.9 Proof of Proposition 1.5.1

Proof. (i). Recall that $\tilde{\pi}^{*C} = \frac{[1-\theta(1+\gamma)]}{[1+(1+\gamma)(1-\theta)]^2}\left(\alpha - \tilde{w}^{*C}\right)^2$. Let us denote $\chi_1 = \frac{[1-\theta(1+\gamma)]}{[1+(1+\gamma)(1-\theta)]^2}$. Obviously $\chi_1 > 0$. One can thus obtain

$$\begin{aligned} \frac{\partial \tilde{\pi}^{*C}}{\partial \theta} &= \frac{\partial \chi_1}{\partial \theta}\left(\alpha - \tilde{w}^{*C}\right)^2 + \chi_1 2\left(\alpha - \tilde{w}^{*C}\right)\left(-\frac{\partial \tilde{w}^{*C}}{\partial \theta}\right) \\ &= -\left(\alpha - \tilde{w}^{*C}\right)\left\{-\frac{\partial \chi_1}{\partial \theta}\left(\alpha - \tilde{w}^{*C}\right) + 2\chi_1 \frac{\partial \tilde{w}^{*C}}{\partial \theta}\right\}. \end{aligned}$$

Since $\left(\alpha - \tilde{w}^{*C}\right) > 0$, let us focus on the value of $-\frac{\partial \chi_1}{\partial \theta}$. One can obtain

$$\begin{aligned} -\frac{\partial \chi_1}{\partial \theta} &= -\left\{\frac{\begin{array}{c} -(1+\gamma)[1+(1+\gamma)(1-\theta)]^2 \\ -2[1-\theta(1+\gamma)][1+(1+\gamma)(1-\theta)][-(1+\gamma)] \end{array}}{[1+(1+\gamma)(1-\theta)]^4}\right\} \\ &= \frac{(1+\gamma)[1+(1+\gamma)(1-\theta)] - 2[1-\theta(1+\gamma)](1+\gamma)}{[1+(1+\gamma)(1-\theta)]^3} \\ &= \frac{(1+\gamma)}{[1+(1+\gamma)(1-\theta)]^3}\{1+(1+\gamma)(1-\theta) - 2[1-\theta(1+\gamma)]\} \\ &= \frac{(1+\gamma)}{[1+(1+\gamma)(1-\theta)]^3}(\gamma + \theta + \gamma\theta), \end{aligned}$$

which is positive for all θ, $\gamma, \beta \in [0,1]$.

According to part (i) of lemma 1.5.1, $\frac{\partial \tilde{w}^{*C}}{\partial \theta} > 0, \forall \theta \in \left[0, \tilde{\theta}\right[$, $\gamma, \beta \in [0,1]$, hence the second term in the bid brackets is certainly positive. Hence the value inside the bid brackets is positive. One can obtain $\frac{\partial \tilde{\pi}^{*C}}{\partial \theta} < 0, \forall \theta \in \left[0, \tilde{\theta}\right[, \gamma, \beta \in [0,1]$.

(ii). Recall that $\tilde{\pi}^{*B} = \frac{(1-\theta)(1-\gamma)}{(1+\gamma)[1+(1-\gamma)(1-\theta)]^2}\left(\alpha - \tilde{w}^{*B}\right)^2$. Similarly, let us denote $\chi_2 = \frac{(1-\theta)(1-\gamma)}{(1+\gamma)[1+(1-\gamma)(1-\theta)]^2}$. Obviously $\chi_2 > 0$. One can thus obtain

$$\begin{aligned}
\frac{\partial \tilde{\pi}^{*B}}{\partial \theta} &= \frac{\partial \chi_2}{\partial \theta}\left(\alpha - \tilde{w}^{*B}\right)^2 + \chi_2 2\left(\alpha - \tilde{w}^{*B}\right)\left(-\frac{\partial \tilde{w}^{*B}}{\partial \theta}\right) \\
&= -\left(\alpha - \tilde{w}^{*B}\right)\left\{-\frac{\partial \chi_2}{\partial \theta}\left(\alpha - \tilde{w}^{*B}\right) + 2\chi_2 \frac{\partial \tilde{w}^{*B}}{\partial \theta}\right\}.
\end{aligned}$$

Since $\left(\alpha - \tilde{w}^{*B}\right) > 0$, let us focus on the value of $-\frac{\partial \chi_2}{\partial \theta}$. One can obtain

$$\begin{aligned}
-\frac{\partial \chi_2}{\partial \theta} &= -\left\{\frac{\begin{array}{c} -(1-\gamma)(1+\gamma)[1+(1-\gamma)(1-\theta)]^2 \\ -2(1-\theta)(1-\gamma)(1+\gamma)[1+(1-\gamma)(1-\theta)][-(1-\gamma)] \end{array}}{(1+\gamma)^2[1+(1-\gamma)(1-\theta)]^4}\right\} \\
&= -\left\{\frac{-(1-\gamma)[1+(1-\gamma)(1-\theta)] - 2(1-\theta)(1-\gamma)[-(1-\gamma)]}{(1+\gamma)[1+(1-\gamma)(1-\theta)]^3}\right\} \\
&= \frac{(1-\gamma)[1+(1-\gamma)(1-\theta)] - 2(1-\theta)(1-\gamma)^2}{(1+\gamma)[1+(1-\gamma)(1-\theta)]^3} \\
&= \frac{(1-\gamma)[1-(1-\gamma)(1-\theta)]}{(1+\gamma)[1+(1-\gamma)(1-\theta)]^3} \\
&= \frac{(1-\gamma)[\theta(1-\gamma)+\gamma]}{(1+\gamma)[1+(1-\gamma)(1-\theta)]^3},
\end{aligned}$$

which is obviously positive for all $\theta, \gamma, \beta \in [0,1]$.

According to part (ii) of lemma 1.5.1, $\frac{\partial \tilde{w}^{*B}}{\partial \theta} > 0$, if $\beta \in \left[0, \frac{2(1-\gamma)}{3}\right[$ and $\theta, \gamma \in [0,1]$, hence the second term in the bid brackets is surely positive. Hence the value inside the bid brackets is positive. One can obtain $\frac{\partial \tilde{\pi}^{*B}}{\partial \theta} < 0$, if $\beta \in \left[0, \frac{2(1-\gamma)}{3}\right[$ and $\theta, \gamma \in [0,1]$.

(iii). According to part (iii) of lemma 1.5.1, it is easy to obtain

$$\frac{\partial \tilde{\pi}^{*C}}{\partial \beta} = \frac{2[1-\theta(1+\gamma)]}{[1+(1+\gamma)(1-\theta)]^2}\left(\alpha - \tilde{w}^{*C}\right)\left(-\frac{\partial \tilde{w}^{*C}}{\partial \beta}\right) < 0,$$

$\forall\ \theta \in \left[0, \tilde{\theta}\right[$, γ, $\beta \in [0,1]$, and

$$\frac{\partial \tilde{\pi}^{*B}}{\partial \beta} = \frac{(1-\theta)(1-\gamma)}{(1+\gamma)\left[1+(1-\gamma)(1-\theta)\right]^2}\left(\alpha - \tilde{w}^{*B}\right)\left(-\frac{\partial \tilde{w}^{*B}}{\partial \beta}\right) < 0,$$

$\forall\ \theta$, γ, $\beta \in [0,1]$. ■

A.10 Proof of Proposition 1.6.1

Without delegation. If the shareholder of firm i chooses not to delegate the production decision to a manager, the first order condition to maximize the objective function of a PM firm i is $\pi^i_{x_i} = p^i_{x_i} x_i + p_i - c = 0$. Clearly, $\pi^i_{x_i\theta} = 0$. One can also find that the second order condition of π^i with respect to x_i is

$$\pi^i_{x_i x_i} = p^i_{x_i x_i} x_i + 2p^i_{x_i} = -2 < 0. \tag{A.10-1}$$

Hence the second order condition which guarantees the uniqueness of the Cournot equilibrium is satisfied. In a simultaneous-move game, the first order condition makes the Cournot equilibrium a Nash equilibrium in outputs and it is clear that the resulting implicit function is the reaction function of a firm i.

We show that another regularity condition, called the Gale-Nikaido condition, which ensures that various comparative static properties of the model are "well-behaved"(see Dixit, 1986) is also satisfied. Since

$$\pi^i_{x_i x_j} = p^i_{x_i x_j} x_i + p^i_{x_j} = -\gamma < 0. \tag{A.10-2}$$

Similarly, if the shareholder of firm j chooses not to delegate the production decision to a manager, the first order condition to maximize the objective function of a CO firm j is $V^j_{x_j} = \pi^j_{x_j} + \theta CS_{x_j} = 0$. Hence, $V^j_{x_j\theta} = CS_{x_j} = \gamma x_i + x_j$. One can also find the second order condition

$$V^j_{x_jx_j} = p^j_{x_jx_j}x_j + 2p^j_{x_j} + \theta CS_{x_jx_j} = -2\gamma + \theta. \tag{A.10-3}$$

Hence the condition to guarantee the uniqueness of the Cournot equilibrium is

$$\theta < 2\gamma. \tag{A.10-4}$$

The Gale-Nikaido condition writes

$$V^j_{x_jx_i} = p^j_{x_jx_i}x_j + p^j_{x_i} + \theta CS_{x_jx_i} = \theta\gamma - 1. \tag{A.10-5}$$

This condition is satisfied, since $\theta, \gamma \in [0,1]$, which implies $\theta\gamma \in [0,1]$, thus $\theta\gamma - 1 \leq 0$.

Substituting (A.10-1), (A.10-2), (A.10-3), and (A.10-5) in (1.17), one obtains

$$J = 3\gamma - \theta(2 - \gamma^2).$$

Similar substitution for (1.18) and (1.19), one obtains $dx_i/d\theta = -\gamma V^j_{x_j\theta}/J$ and $dx_j/d\theta = 2V^j_{x_j\theta}/J$. As previously found $V^j_{x_j\theta} = CS_{x_j} = \gamma x_i + x_j > 0$, one can obtain $sign[dx_i/d\theta] = -sign[J]$ and $sign[dx_j/d\theta] = sign[J]$. Consequently,

$$sign[dx_i/d\theta] = -sign[dx_j/d\theta].$$

As for the good's price of a PM firm, we have $dp_i\left(x_i\left(\theta\right), x_j\left(\theta\right)\right)/d\theta = p^i_{x_i}dx_i/d\theta + p^i_{x_j}dx_j/d\theta$, hence

$$dp_i\left(x_i\left(\theta\right), x_j\left(\theta\right)\right)/d\theta = -dx_i/d\theta - \gamma dx_j/d\theta = \frac{-\gamma V^j_{x_j\theta}}{J},$$

similarly for the good's price of a CO firm, we have

$$dp_j\left(x_i\left(\theta\right), x_j\left(\theta\right)\right)/d\theta = -\gamma dx_i/d\theta - dx_j/d\theta = \frac{-(2-\gamma^2)V^j_{x_j\theta}}{J}.$$

Hence $sign[dp_i/d\theta] = -sign[J]$ and $sign[dp_j/d\theta] = -sign[J]$. Consequently, one obtains

$$sign[dp_i/d\theta] = sign[dp_j/d\theta].$$

With delegation. If the shareholder of firm i chooses to delegate the production decision to a manager and sign an incentive contract with him, we assume in line with the strategic incentives literature (e.g., Fershtman and Judd, 1987) that the compensation contract of a profit-maximizing firm's manager is based on a weighted average of profits π_i and sales revenue $R_i = p_i x_i$. Hence the objective function is

$$\begin{aligned} \max F^i &= (1-\delta_i)\,\pi^i + \delta_i R_i \\ &= (p_i - c\,(1-\delta_i))\,x_i, \end{aligned}$$

where the parameter $\delta_i \in (0,1)$ represents the incentive level of a PM firm i. We can see that the incentive scheme works as an discount effect on the marginal cost. The first order condition to maximize the objective function of a PM firm i which chooses to delegate is $F^i_{x_i} = p^i_{x_i} x_i + p_i - c\,(1-\delta_i) = 0$. Clearly, $F^i_{x_i\theta} = 0$. One can also find for the second order condition that

$$F^i_{x_i x_i} = p^i_{x_i x_i} x_i + 2p^i_{x_i} = -2 < 0, \tag{A.10-6}$$

hence the second order condition is satisfied and the Gale-Nikaido condition is also satisfied, since

$$F^i_{x_i x_j} = p^i_{x_i x_j} x_i + p^i_{x_j} = -\gamma < 0. \tag{A.10-7}$$

Similarly, if the shareholder of firm j chooses to delegate the production decision to a manager and sign a compensation contract with him. On the base of the strategic incentives literature as for the PM case, we assume that the compensation contract of a CO firm's manager is based on a weighted average of the firm's objective and his manager's objective. Under the impact of Confucian ethics, manager's objective is supposed to be the sum of sales revenue and a certain weight of consumer surplus, i.e., $R_i + \theta CS$. To show sincerity and loyalty, the manager takes the same weight of consumer surplus as the CO firm does. The compensation contract of a CO firm's manager corresponds with the following objective function, i.e.,

$$\begin{aligned} \max \Omega^i &= (1-\delta_i) V^i + \delta_i (R_i + \theta CS) \\ &= (p_i - c(1-\delta_i)) x_i + \theta CS \end{aligned}$$

where the incentive level $\delta_i \in (0,1)$ of a CO firm i also works as an discount effect on the marginal cost.

The first order condition to maximize the objective function of a CO firm j which chooses to delegate is $\Omega^j_{x_j} = F^j_{x_j} + \theta CS_{x_j} = 0$. Hence, $\Omega^j_{x_j\theta} = CS_{x_j} = \gamma x_i + x_j$. One can also find the second order condition

$$\Omega^j_{x_jx_j} = p^j_{x_jx_j} x_j + 2p^j_{x_j} + \theta CS_{x_jx_j} = -2\gamma + \theta. \tag{A.10-8}$$

Hence, the same as the no-delegation case for CO firms, the condition which guarantees the uniqueness of the Cournot equilibrium is also $\theta < 2\gamma$. Moreover, the Gale-Nikaido condition is satisfied, since

$$\Omega^j_{x_jx_i} = p^j_{x_jx_i} x_j + 2p^j_{x_i} + \theta CS_{x_jx_i} = -\gamma (1-\theta) < 0. \tag{A.10-9}$$

Substituting (A.10-6), (A.10-7), (A.10-8), and (A.10-9) in (1.17), one obtains the expression of J, denoted as J' for the delegation case:

$$J' = 4\gamma - \gamma^2 - \theta(2-\gamma^2).$$

Similar substitution for (1.18) and (1.19), one obtains $dx_i/d\theta = -\gamma V^j_{x_j\theta}/J'$ and $dx_j/d\theta = 2V^j_{x_j\theta}/J'$. Hence $sign[dx_i/d\theta] = -sign[J']$ and $sign[dx_j/d\theta] = sign[J']$. Consequently,

$$sign[dx_i/d\theta] = -sign[dx_j/d\theta].$$

As for the good's price of a PM firm with delegation, we have

$$dp_i\left(x_i\left(\theta\right), x_j\left(\theta\right)\right)/d\theta = -dx_i/d\theta - \gamma dx_j/d\theta = \frac{-\gamma V^j_{x_j\theta}}{J'},$$

and for the good's price of a CO firm, we have

$$dp_j\left(x_i\left(\theta\right), x_j\left(\theta\right)\right)/d\theta = -\gamma dx_i/d\theta - dx_j/d\theta = \frac{-(2-\gamma^2)V^j_{x_j\theta}}{J'}.$$

Hence $sign[dp_i/d\theta] = -sign[J']$ and $sign[dp_j/d\theta] = -sign[J']$. Consequently, one still obtains

$$sign[dp_i/d\theta] = sign[dp_j/d\theta],$$

which is the same as the no-delegation case.

APPENDIX B

FOR CHAPTER 2

B.1 Proof of Proposition 2.2.1

Proof. At optimum, both constraints (MH-2.2) and (PC-2.2) are binding, i.e.,

$$u_G - u_B = \frac{\psi}{\Delta\pi}, \tag{B.1-1}$$

$$\mathbb{E}_{k|1}[u_k] - \psi = 0. \tag{B.1-2}$$

Developing (B.1-2), one can obtain $\pi_1 (u_G - u_B) + u_B = \psi$, which is equivalent to

$$u_B = \psi - \pi_1 (u_G - u_B). \tag{B.1-3}$$

Substituting (B.1-1) in (B.1-3), one obtains

$$u_B = \psi - \pi_1 \frac{\psi}{\Delta\pi} = -\frac{\pi_0 \psi}{\Delta\pi}.$$

Now substituting the above expression in (B.1-1), one can thus obtain

$$u_G = \frac{\psi}{\Delta\pi} - \frac{\pi_0 \psi}{\Delta\pi} = \frac{(1-\pi_0)\psi}{\Delta\pi}.$$

■

B.2 Proof of Proposition 2.2.2

Proof. Given the expected payoff of the shareholder

$$V_1^i = \pi_1 \left[R_i\left(q_G^i\right) - c_G q_G^i\right] + (1-\pi_1)\left[R_i\left(q_B^i\right) - c_B q_B^i\right] - \psi,$$

one can obtain the first order condition by deriving the value function V_1^i with respect to q_G^i and q_B^i, as follows

$$\begin{aligned} R_i'\left(q_G^{i*}\right) &= c_G, \\ R_i'\left(q_B^{i*}\right) &= c_B, \end{aligned}$$

which is equivalent to $R_i'\left(q_k^{i*}\right) = c_k$, $\forall k \in \{G, B\}$. ■

B.3 Proof of Proposition 2.3.1

Proof. The effect of product market competition upon managerial incentive effort is reflected through a comparison between the monopoly case (i.e., e_H and e_L) and the effort of the duopoly case (i.e., e_{1H} and e_{1L}). Given $e_H = a - \theta_H - 2\frac{\alpha}{1-\alpha}\Delta\theta$ and $e_{1H} = \frac{1}{8}\left(a - \theta_H\right) - \frac{9}{8}\frac{\alpha}{1-\alpha}\Delta\theta$, one can obtain

$$e_H - e_{1H} = \frac{7}{8}\left(a - \theta_H - \frac{\alpha}{1-\alpha}\Delta\theta\right).$$

Since $e_H > 0$, i.e., $a - \theta_H - 2\frac{\alpha}{1-\alpha}\Delta\theta > 0$, we have $a - \theta_H > 2\frac{\alpha}{1-\alpha}\Delta\theta > \frac{\alpha}{1-\alpha}\Delta\theta$, hence $a - \theta_H > \frac{\alpha}{1-\alpha}\Delta\theta$, which implies $e_H - e_{1H} > 0$.

Idem, given $e_L = a - \theta_L$ and $e_{1L} = \frac{4}{5}\left(a - \theta_L\right)$, one obtains

$$e_L - e_{1L} = \frac{1}{5}\left(a - \theta_L\right),$$

which is obvisouly positive. Consequently, both types imply less managerial effort induced in a duopoly market. ■

B.4 Proof of Proposition 2.4.1

Proof. (i). At optimum, the minimization of $\mathbb{E}_j\left[U_j\left(1\right)\right]$ requires a minimization of the expected bonus $\mathbb{E}_{k|1,j}\left[v_{jk}\right]$, which is part of the expected utility of the manager. Consequently, the (MH-2.4-1) which constraints on the bonus must be binding, i.e., $v_{HG} - v_{HB} = \frac{\psi}{\Delta\pi(H)}$. Substituting in the following expression, the inefficient manager's expected bonus thus writes

$$\begin{aligned}
\mathbb{E}_{k|1,H}\left[v_{Hk}\right] &= v_{HB} + \pi_1\left(H\right)\left(v_{HG} - v_{HB}\right) \\
&= v_{HB} + \frac{\psi}{\Delta\pi\left(H\right)}\pi_1\left(H\right).
\end{aligned}$$

Replacing the above expression in $U_H\left(1\right) = w_H + \mathbb{E}_{k|1,H}\left[v_{Hk}\right] - \psi$, one can obtain

$$U_H\left(1\right) = w_H + v_{HB} + \frac{\psi}{\Delta\pi\left(H\right)}\pi_1\left(H\right) - \psi.$$

Since a minimal expected utility of the manager requires (PC-2.4-2) be binding, i.e.,

$$U_H\left(1\right) = 0, \tag{B.4-0}$$

this implies that

$$\begin{aligned}
w_H + v_{HB} &= -\left(\frac{\psi}{\Delta\pi\left(H\right)}\pi_1\left(H\right) - \psi\right) \\
&= -\frac{\psi}{\Delta\pi\left(H\right)}\pi_0\left(H\right).
\end{aligned}$$

Idem, the optimal contract also requires (AS-2.4-1) be binding, hence

$$U_L\left(1\right) = U_H\left(1\right) + \left[\pi_1\left(L\right) - \pi_1\left(H\right)\right]\left(v_{HG} - v_{HB}\right).$$

Given that $v_{HG} - v_{HB} = \frac{\psi}{\Delta\pi(H)}$, since the constraint (MH-2.4-1) must be binding, one can obtain

$$\begin{aligned}
U_L\left(1\right) &= U_H\left(1\right) + \left[\pi_1\left(L\right) - \pi_1\left(H\right)\right]\frac{\psi}{\Delta\pi\left(H\right)} \\
&= \left[\pi_1\left(L\right) - \pi_1\left(H\right)\right]\frac{\psi}{\Delta\pi\left(H\right)}.
\end{aligned} \tag{B.4-1}$$

Recall (2.4),

$$\begin{aligned}
U_L\left(1\right) &= w_L + \pi_1\left(L\right)v_{LG} + \left[1 - \pi_1\left(L\right)\right]v_{LB} - \psi \\
&= w_L + v_{LB} + \pi_1\left(L\right)\left(v_{LG} - v_{LB}\right) - \psi.
\end{aligned} \tag{B.4-2}$$

From the equivalence between (B.4-1) and (B.4-2), one can obtain

$$w_L + v_{LB} = [\pi_1 (L) - \pi_1 (H)] \frac{\psi}{\Delta\pi (H)} + \psi - \pi_1 (L) (v_{LG} - v_{LB}) . \tag{B.4-3}$$

Substituting $v_{LG} - v_{LB} = \frac{\psi}{\Delta\pi(L)}$ (since the moral hazard incentive constraint is binding) in (B.4-3), one obtains

$$\begin{aligned} w_L + v_{LB} &= [\pi_1 (L) - \pi_1 (H)] \frac{\psi}{\Delta\pi (H)} + \psi - \pi_1 (L) \frac{\psi}{\Delta\pi (L)} \\ &= [\pi_1 (L) - \pi_1 (H)] \frac{\psi}{\Delta\pi (H)} - \frac{\psi}{\Delta\pi (L)} \pi_0 (L) \\ &= -\frac{\psi}{\Delta\pi (L)} \pi_0 (L) + [\pi_1 (L) - \pi_1 (H)] \frac{\psi}{\Delta\pi (H)} . \end{aligned}$$

(ii). The information rent $\mathbb{E}_j [U_j (1)] = \alpha U_L (1) + (1 - \alpha) U_H (1)$. Substituting (B.4-0) and (B.4-1) in this expression, one obtains

$$\mathbb{E}_j [U_j (1)] = \alpha U_L (1) = \alpha \frac{[\pi_1 (L) - \pi_1 (H)] \psi}{\Delta\pi (H)} .$$

■

B.5 Proof of Corollary 2.4.1

Proof. Sufficient condition: if $w_L + v_{LB} < 0$, given that $w_L + v_{LB} = -\frac{\psi}{\Delta\pi(L)}\pi_0 (L) + [\pi_1 (L) - \pi_1 (H)] \frac{\psi}{\Delta\pi(H)}$, then $-\frac{\psi}{\Delta\pi(L)}\pi_0 (L) + [\pi_1 (L) - \pi_1 (H)] \frac{\psi}{\Delta\pi(H)} < 0$, i.e., $\frac{[\pi_1(L)-\pi_1(H)]}{\Delta\pi(H)} < \frac{\pi_0(L)}{\Delta\pi(L)}$ is true. Necessary condition: if $\frac{[\pi_1(L)-\pi_1(H)]}{\Delta\pi(H)} < \frac{\pi_0(L)}{\Delta\pi(L)}$, then $\frac{[\pi_1(L)-\pi_1(H)]}{\Delta\pi(H)} - \frac{\pi_0(L)}{\Delta\pi(L)} < 0$, hence $-\frac{\psi}{\Delta\pi(L)}\pi_0 (L) + [\pi_1 (L) - \pi_1 (H)] \frac{\psi}{\Delta\pi(H)} < 0$. Given that $-\frac{\psi}{\Delta\pi(L)}\pi_0 (L) + [\pi_1 (L) - \pi_1 (H)] \frac{\psi}{\Delta\pi(H)} = w_L + v_{LB}$, hence $w_L + v_{LB} < 0$. ■

B.6 Proof of Proposition 2.4.2

Proof. The shareholder's choice of effort provision depends on the following difference:

$$\begin{aligned} V(1) - V(0) &= \mathbb{E}_{j,k|1}\left[R\left(q_{jk}^*\right) - (\theta_j - r_k)\, q_{jk}^*\right] - \mathbb{E}_{j,k|e=0}\left[R\left(q_{jk}^*\right) - (\theta_j - r_k)\, q_{jk}^*\right] \\ &\quad -\alpha\frac{\left[\pi_1(L) - \pi_1(H)\right]\psi}{\Delta\pi(H)} - \psi, \end{aligned}$$

where the first line of the right-hand side of the equality represents the efficiency gain and the second line of the right-hand side of the equality represents the cost of inducing effort. Note that the cost of inducing effort is independent of the number of firms, one obtains

$$\begin{aligned} \frac{d}{dn}\left[V(1) - V(0)\right] &= \frac{\partial \mathbb{E}_{j,k|1}\left[R\left(q_{jk}^*\right) - (\theta_j - r_k)\, q_{jk}^*\right]}{\partial n} \\ &\quad - \frac{\partial \mathbb{E}_{j,k|e=0}\left[R\left(q_{jk}^*\right) - (\theta_j - r_k)\, q_{jk}^*\right]}{\partial n}. \end{aligned}$$

As for the term $\mathbb{E}_{j,k|e}\left[R\left(q_{jk}^*\right) - (\theta_j - r_k)\, q_{jk}^*\right]$, $e \in \{0,1\}$, one can obtain by applying the optimal condition $R'\left(q_{jk}^*\right) = (\theta_j - r_k)$, that the value does not change when the number of firms n changes. Since whatever the value of e, one can always obtain the following result

$$\begin{aligned} &\frac{d}{dn}\left\{\mathbb{E}_{j,k|e}\left[R\left(q_{jk}^*\right) - (\theta_j - r_k)\, q_{jk}^*\right]\right\} \\ = \;& \mathbb{E}_{j,k|e}\left\{\left[R'\left(q_{jk}^*\right) - (\theta_j - r_k)\right]\frac{dq_{jk}^*}{dn}\right\} = 0, \forall e, j, k. \end{aligned}$$

Hence $\frac{d}{dn}\left[V(1) - V(0)\right] = 0$. ■

B.7 Proof of Proposition 2.5.1

Proof. (i). Considering the fact that $\mathbb{E}_j\left[\check{U}_j(1)\right]$ is costly for the shareholder, the optimal contract requires a minimization of both $\check{U}_H(1)$ and $\check{U}_L(1)$. Let us first focus on $\check{U}_H(1)$. Given the expected utility (2.5), the inefficient $(j = H)$ manager's expected utility under limited liability when making effort writes

$$\begin{aligned}\check{U}_H(1) &= w_H + \mathbb{E}_{k|1,H}\left[\sigma_{Hk}R(q_{Hk},\cdot)\right] - \psi \\ &= w_H + \beta_1(H)\,\sigma_{HG}R(q_{HG},\cdot) + \left[1-\beta_1(H)\right]\sigma_{HB}R(q_{HB},\cdot) - \psi \\ &= w_H + \sigma_{HB}R(q_{HB},\cdot) + \beta_1(H)\left[\sigma_{HG}R(q_{HG},\cdot) - \sigma_{HB}R(q_{HB},\cdot)\right] - \psi \quad \text{(B.7-1)}\end{aligned}$$

At optimum, the limited liability constraint (LL-2.5) for the inefficient manager ($j = H$) realizing a bad performance ($k = B$) is binding, i.e.,

$$w_H + \sigma_{HB}R(q_{HB},\cdot) = 0. \quad \text{(B.7-2)}$$

Substituing (B.7-2) in (B.7-1), one obtains

$$\check{U}_H(1) = \beta_1(H)\left[\sigma_{HG}R(q_{HG},\cdot) - \sigma_{HB}R(q_{HB},\cdot)\right] - \psi. \quad \text{(B.7-3)}$$

Since the probability of an inefficient manager when making effort as well as the cost of effort are rather fixed, the question of having a minimum value of $\check{U}_H(1)$ turns out to have a minimum value of $\left[\sigma_{HG}R(q_{HG},\cdot) - \sigma_{HB}R(q_{HB},\cdot)\right]$. Note that the constraint (MH-2.5) is binding, one can obtain

$$\sigma_{jG}R(q_{jG},\cdot) - \sigma_{jB}R(q_{jB},\cdot) = \frac{\psi}{\Delta\beta(j)},\ \forall j \in \{L, H\}, \quad \text{(B.7-4)}$$

which implies for the inefficient manager ($j = H$) the following condition

$$\sigma_{HG}R(q_{HG},\cdot) - \sigma_{HB}R(q_{HB},\cdot) = \frac{\psi}{\Delta\beta(H)}. \quad \text{(B.7-5)}$$

Substituting (B.7-5) in (B.7-3), one obtains thus

$$\begin{aligned}\check{U}_H(1) &= \beta_1(H)\frac{\psi}{\Delta\beta(H)} - \psi \\ &= \beta_0(H)\frac{\psi}{\Delta\beta(H)} > 0. \quad \text{(B.7-6)}\end{aligned}$$

The positive value of $\check{U}_H(1)$ ensures the participation of the inefficient manager which confirms the satisfaction of the constraint (PC-2.5-2).

Now let us consider the minimization of $\check{U}_L(1)$. At optimum, the limited liability case of (AS-2.5-5) which is equivalent to (AS-2.5-1) is binding, i.e.,

$$\check{U}_L(1) = \check{U}_H(1) + [\beta_1(L) - \beta_1(H)][\sigma_{HG} R(q_{HG}\cdot) - \sigma_{HB} R(q_{HB}, \cdot)]. \tag{B.7-7}$$

To obtain a minimum value of (B.7-7), one needs to have a minimum value of both $\check{U}_H(1)$ and $[\sigma_{HG} R(q_{HG}\cdot) - \sigma_{HB} R(q_{HB}, \cdot)]$. Substituting (B.7-6) and (B.7-5) in (B.7-7), one obtains

$$\begin{aligned} \check{U}_L(1) &= \beta_0(H)\frac{\psi}{\Delta\beta(H)} + [\beta_1(L) - \beta_1(H)]\frac{\psi}{\Delta\beta(H)} \\ &= \beta_1(L)\frac{\psi}{\Delta\beta(H)} - \psi. \end{aligned} \tag{B.7-8}$$

Recall by (2.5) that

$$\begin{aligned} \check{U}_L(1) &= w_L + \mathbb{E}_{k|1,L}[\sigma_{Lk} R(q_{Lk}, \cdot)] - \psi \qquad \text{(B.7-9)} \\ &= w_L + \sigma_{LB} R(q_{LB}, \cdot) + \beta_1(L)[\sigma_{LG} R(q_{LG}, \cdot) - \sigma_{LB} R(q_{LB}, \cdot)] - \psi, \end{aligned}$$

which equals

$$\begin{aligned} \check{U}_L(1) &= w_L + \sigma_{LB} R(q_{LB}, \cdot) + \beta_1(L)\frac{\psi}{\Delta\beta(L)} - \psi \\ &= w_L + \sigma_{LB} R(q_{LB}, \cdot) + \beta_0(L)\frac{\psi}{\Delta\beta(L)}. \end{aligned} \tag{B.7-10}$$

after substituting $[\sigma_{LG} R(q_{LG}, \cdot) - \sigma_{LB} R(q_{LB}, \cdot)]$ by the moral hazard constraint (B.7-4) for the efficient manager. Relating (B.7-8) and (B.7-10), one obtains

$$w_L + \sigma_{LB} R(q_{LB}, \cdot) = -\beta_0(L)\frac{\psi}{\Delta\beta(L)} + \beta_1(L)\frac{\psi}{\Delta\beta(H)} - \psi.$$

(ii). In the case of unlimited liability, the optimal contract requires (PC-2.5-2) binding, i.e.,

$$U_H(1) = 0. \tag{B.7-11}$$

Hence the binding (AS-2.5-1) implies

$$\begin{aligned}U_L(1) &= U_H(1) + [\beta_1(L) - \beta_1(H)][\sigma_{HG} R(q_{HG}\cdot) - \sigma_{HB} R(q_{HB}, \cdot)] \\ &= [\beta_1(L) - \beta_1(H)][\sigma_{HG} R(q_{HG}\cdot) - \sigma_{HB} R(q_{HB}, \cdot)]. \qquad \text{(B.7-12)}\end{aligned}$$

Linking the unlimited liability with the limited liability case, one obtains from (B.7-12) and (B.7-7) that

$$\check{U}_L(1) = \check{U}_H(1) + U_L(1). \qquad \text{(B.7-13)}$$

Substituting (B.7-13) in the manager's expected utility (information rent) under limited liability, one obtains

$$\begin{aligned}\mathbb{E}_j\left[\check{U}_j(1)\right] &= \alpha \check{U}_L(1) + (1-\alpha)\check{U}_H(1) \\ &= \alpha\left[\check{U}_H(1) + U_L(1)\right] + (1-\alpha)\check{U}_H(1) \\ &= \check{U}_H(1) + \alpha U_L(1) \qquad \text{(B.7-14)}\end{aligned}$$

Hence, substituting (B.7-6) and (B.7-12) in (B.7-14), one can obtain the information rent under limited liability as the following

$$\begin{aligned}\mathbb{E}_j\left[\check{U}_j(1)\right] &= \beta_0(H)\frac{\psi}{\Delta\beta(H)} + \alpha[\beta_1(L) - \beta_1(H)][\sigma_{HG} R(q_{HG}\cdot) - \sigma_{HB} R(q_{HB}, \cdot)] \\ &= \beta_0(H)\frac{\psi}{\Delta\beta(H)} + \alpha[\beta_1(L) - \beta_1(H)]\frac{\psi}{\Delta\beta(H)} \\ &= \frac{\beta_0(H) + \alpha[\beta_1(L) - \beta_1(H)]}{\Delta\beta(H)}\psi,\end{aligned}$$

since the moral hazard incentive constraint (B.7-5) is binding. ■

B.8 Proof of Corollary 2.5.1

Proof. Recall first that by definition 3.2.1 both $\Delta\beta(H)$ and $\Delta\beta(L)$ are strictly positive. Proof of the necessary condition. If $\Delta\beta(H) > \Delta\beta(L)$ (i.e., $\beta_1(H) - \beta_0(H) > \beta_1(L) - \beta_0(L)$)

holds true, then $\frac{1}{\Delta\beta(H)} < \frac{1}{\Delta\beta(L)}$ is true, which implies

$$\frac{\beta_1(L)}{\Delta\beta(H)} < \frac{\beta_1(L)}{\Delta\beta(L)} \tag{B.8-1}$$

is true. Since $\frac{\beta_1(L)}{\Delta\beta(L)} = \frac{\beta_0(L)+\beta_1(L)-\beta_0(L)}{\Delta\beta(L)} = \frac{\beta_0(L)+\Delta\beta(L)}{\Delta\beta(L)} = \frac{\beta_0(L)}{\Delta\beta(L)} + 1$, (B.8-1) is thus equivalent to

$$\frac{\beta_1(L)}{\Delta\beta(H)} < \frac{\beta_0(L)}{\Delta\beta(L)} + 1$$

Hence

$$\frac{\beta_1(L)}{\Delta\beta(H)} - \frac{\beta_0(L)}{\Delta\beta(L)} - 1 < 0.$$

Recall that $\left[\frac{\beta_1(L)}{\Delta\beta(H)} - \frac{\beta_0(L)}{\Delta\beta(L)} - 1\right]\psi = w_L + \sigma^i_{LB}R^i(q^i_{LB}, \cdot)$, one can include that

$$w_L + \sigma^i_{LB}R^i\left(q^i_{LB}, \cdot\right) < 0.$$

Proof of the sufficient condition. If $w_L + \sigma^i_{LB}R^i(q^i_{LB}, \cdot) < 0$ holds true, which means $\left[\frac{\beta_1(L)}{\Delta\beta(H)} - \frac{\beta_0(L)}{\Delta\beta(L)} - 1\right]\psi < 0$, hence $\frac{\beta_1(L)}{\Delta\beta(H)} - \frac{\beta_0(L)}{\Delta\beta(L)} - 1 < 0$ holds true. Moving the last two terms on the right side, one obtains

$$\frac{\beta_1(L)}{\Delta\beta(H)} < \frac{\beta_0(L)}{\Delta\beta(L)} + 1 = \frac{\beta_0(L)+\beta_1(L)-\beta_0(L)}{\Delta\beta(L)} = \frac{\beta_1(L)}{\Delta\beta(L)}$$

Consequently, one obtains

$$\frac{1}{\Delta\beta(H)} < \frac{1}{\Delta\beta(L)},$$

which implies

$$\Delta\beta(H) > \Delta\beta(L)$$

holds true. ∎

B.9 Proof of Proposition 2.5.2

Proof. Similar as the proof of proposition 2.4.2, we have

$$\begin{aligned}\check{V}(1)-\check{V}(0) &= \mathbb{E}_{j,k|1}\left[R\left(q_{jk}^{*},\cdot\right)-\left(\theta_j-r_k\right)q_{jk}^{*}\right]-\mathbb{E}_{j,k|e=0}\left[R\left(q_{jk}^{*},\cdot\right)-\left(\theta_j-r_k\right)q_{jk}^{*}\right]\\ &\quad -\frac{\beta_0\left(H\right)+\alpha\left[\beta_1\left(L\right)-\beta_1\left(H\right)\right]}{\Delta\beta\left(H\right)}\psi-\psi,\end{aligned}$$

where the first line of the right-hand side of the equality represents the efficiency gain and the second line of the right-hand side of the equality represents the cost of inducing effort. Note that the cost of inducing effort is independent of the number of firms, one obtains

$$\begin{aligned}\frac{d}{dn}\left[\check{V}(1)-\check{V}(0)\right] &= \frac{\partial\mathbb{E}_{j,k|1}\left[R\left(q_{jk}^{*},\cdot\right)-\left(\theta_j-r_k\right)q_{jk}^{*}\right]}{\partial n}\\ &\quad -\frac{\partial\mathbb{E}_{j,k|e=0}\left[R\left(q_{jk}^{*},\cdot\right)-\left(\theta_j-r_k\right)q_{jk}^{*}\right]}{\partial n}.\end{aligned}$$

Applying the optimal condition $R'\left(q_{jk}^{*},\cdot\right)=\left(\theta_j-r_k\right)$, one can always obtain the following result

$$\begin{aligned}&\frac{d}{dn}\left\{\mathbb{E}_{j,k|e}\left[R\left(q_{jk}^{*},\cdot\right)-\left(\theta_j-r_k\right)q_{jk}^{*}\right]\right\}\\ =\;&\mathbb{E}_{j,k|e}\left\{\left[R'\left(q_{jk}^{*},\cdot\right)-\left(\theta_j-r_k\right)\right]\frac{dq_{jk}^{*}}{dn}\right\}=0,\forall e,j,k.\end{aligned}$$

Hence $\frac{d}{dn}\left[\check{V}(1)-\check{V}(0)\right]=0$. ■

APPENDIX C

FOR CHAPTER 3

C.1 Proof of Lemma 3.2.1

Proof. If assumption 3.2.1 holds true, i.e., $U_m(\pi) = \lambda\pi - \frac{\mu_m}{2}\pi^2$, it is easy to find $U_m'(\pi) = \lambda - \mu_m\pi$ and $U_m''(\pi) = -\mu_m$. Since $A_m(\pi) = -\frac{U_m''(\pi)}{U_m'(\pi)}$ by definition, one can obtain

$$A_m(\pi) = \frac{\mu_m}{\lambda - \mu_m\pi}$$

According to Definition 3.2.1, manager 1 is more risk-averse than manager 2 in the sense of Arrow-Pratt, iff $A_1(\pi) \geq A_2(\pi)$, i.e.,

$$\frac{\mu_1}{\lambda - \mu_1\pi} \geq \frac{\mu_2}{\lambda - \mu_2\pi}.$$

Since the characteristic of a risk-averse manager ensures $\lambda - \mu_m\pi > 0$ (since $U_m'(\pi) = \lambda - \mu_m\pi > 0$) and $\mu_m > 0$ (since $U_m''(\pi) = -\mu_m < 0$), the values of both sides are positive. One can thus obtain the equivalence as the following

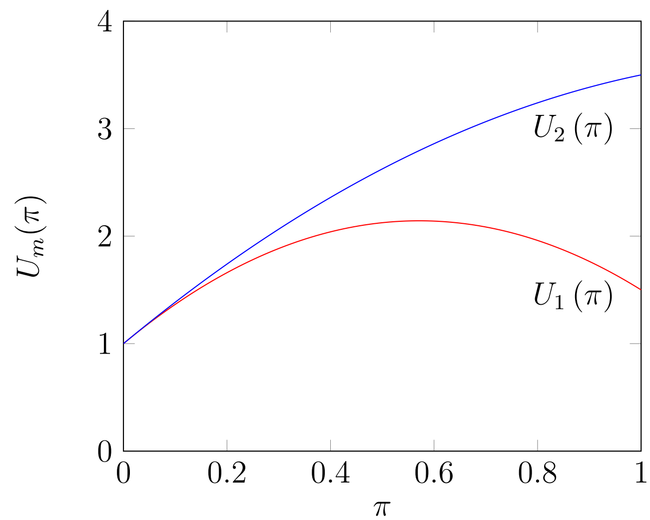
$$\mu_1(\lambda - \mu_2\pi) \geq \mu_2(\lambda - \mu_1\pi)$$

$$\Leftrightarrow \mu_1\lambda - \mu_1\mu_2\pi \geq \mu_2\lambda - \mu_1\mu_2\pi$$

$$\Leftrightarrow \mu_1\lambda \geq \mu_2\lambda$$

$$\Leftrightarrow \mu_1 \geq \mu_2.$$

As shown in the graphic below, the red curve is more concave than the blue curve. ■



C.2 Proof of Proposition 3.2.1

Proof. Consider two managers whose utility function are given as $U_m(\pi) = \lambda\pi - \frac{\mu_m}{2}\pi^2$, for $m \in \{1, 2\}$. They have different preferences on risk: manager 1 is more risk averse than manager 2, i.e., $\mu_1 \geq \mu_2$.

According to the setting of this chapter, $\pi^D(c) = 2\pi^M(c)$. Recall from (1), hence a firm conducted by its manager will sustain the collusion as long as

$$\delta \geq \frac{U_m\left[2\pi^M(c)\right] - U_m\left[\pi^M(c)\right]}{U_m\left[2\pi^M(c)\right]} = 1 - \frac{U_m\left[\pi^M(c)\right]}{U_m\left[2\pi^M(c)\right]} \equiv \delta_m^*.$$

Denote $\pi^M(c) = \pi$ for simplicity, we have $\delta_m^* = 1 - \frac{U_m(\pi)}{U_m(2\pi)}$. If the collusion is more sustainable when the firm is conducted by manager 1 than by manager 2, this means $\delta_1^* \leq \delta_2^*$, i.e.,

$$1 - \frac{U_1(\pi)}{U_1(2\pi)} \leq 1 - \frac{U_2(\pi)}{U_2(2\pi)}$$
$$\Leftrightarrow \frac{U_1(\pi)}{U_1(2\pi)} \geq \frac{U_2(\pi)}{U_2(2\pi)}$$
$$\Leftrightarrow U_1(\pi)\, U_2(2\pi) \geq U_1(2\pi)\, U_2(\pi)$$
$$\Leftrightarrow \left(\lambda\pi - \frac{\mu_1}{2}\pi^2\right)\left(2\lambda\pi - \frac{\mu_2}{2}4\pi^2\right) \geq \left(2\lambda\pi - \frac{\mu_1}{2}4\pi^2\right)\left(\lambda\pi - \frac{\mu_2}{2}\pi^2\right)$$
$$\Leftrightarrow \left(\lambda - \frac{\mu_1}{2}\pi\right)(2\lambda - 2\mu_2\pi) \geq (2\lambda - 2\mu_1\pi)\left(\lambda - \frac{\mu_2}{2}\pi\right)$$
$$\Leftrightarrow -2\lambda\mu_2\pi - \lambda\mu_1\pi \geq -\lambda\mu_2\pi - 2\lambda\mu_1\pi$$
$$\Leftrightarrow -2\mu_2 - \mu_1 \geq -\mu_2 - 2\mu_1$$
$$\Leftrightarrow \mu_1 \geq \mu_2.$$

Hence $\delta_1^* \leq \delta_2^*$ if and only if $\mu_1 \geq \mu_2$. ∎

C.3 Characteristics of the optimal contract

Proof. Let λ_1 and λ_2 be respectively the Lagrange multipliers of the constraints (PC-3.4) and (MH-3.4). Given that $I_{1L}^{K_1} = h\left(u_{1L}^{K_1}\right)$, $I_{1H}^{K_1} = h\left(u_{1H}^{K_1}\right)$, $\Phi\left(I_{1L}^{K_1}\right) = u_{1L}^{K_1}$, and $\Phi\left(I_{1H}^{K_1}\right) = u_{1H}^{K_1}$, the Lagrange function writes

$$\begin{aligned}
& L\left(u_{1L}^{K_1}, u_{1H}^{K_1}, \hat{U}_{2L}^{h_T^K}, \hat{U}_{2H}^{h_T^K}, \lambda_1, \lambda_2\right) \\
= \; & \beta_1\left[\pi^{K_1}(c_L) - h\left(u_{1L}^{K_1}\right)\right] + (1-\beta_1)\left[\pi^{K_1}(c_H) - h\left(u_{1H}^{K_1}\right)\right] \\
& +\delta\left[\beta_1 \hat{S}\left(\hat{U}_{2L}^{h_T^K}\right) + (1-\beta_1)\,\hat{S}\left(\hat{U}_{2H}^{h_T^K}\right)\right] \\
& +\lambda_1\left\{\beta_1 u_{1L}^{K_1} + (1-\beta_1)\,u_{1H}^{K_1} - \varphi + \delta\left[\beta_1 \hat{U}_{2L}^{h_T^K} + (1-\beta_1)\,\hat{U}_{2H}^{h_T^K}\right] - U\right\} \\
& +\lambda_2\left[u_{1L}^{K_1} - u_{1H}^{K_1} + \delta\left(\hat{U}_{2L}^{h_T^K} - \hat{U}_{2H}^{h_T^K}\right) - \frac{\varphi}{\Delta\beta}\right].
\end{aligned}$$

Following the classical method with the first order derivations with $L_{u_{1L}^{K_1}} = 0$, $L_{u_{1H}^{K_1}} = 0$, $L_{\hat{U}_{2L}^{h_T^K}} = 0$, and $L_{\hat{U}_{2H}^{h_T^K}} = 0$, one obtains successively

$$\begin{aligned} -\beta_1 h^{'}\left(u_{1L}^{K_1}\right) + \lambda_1\beta_1 + \lambda_2 &= 0, \\ -\left(1-\beta_1\right) h^{'}\left(u_{1H}^{K_1}\right) + \lambda_1\left(1-\beta_1\right) - \lambda_2 &= 0, \\ \delta\beta_1 \hat{S}^{'}\left(\hat{U}_{2L}^{h_T^K}\right) + \lambda_1\delta\beta_1 + \delta\lambda_2 &= 0, \\ \delta\left(1-\beta_1\right)\hat{S}^{'}\left(\hat{U}_{2H}^{h_T^K}\right) + \lambda_1\delta\left(1-\beta_1\right) - \delta\lambda_2 &= 0, \end{aligned}$$

which are equivalent to the equations below:

$$\lambda_2 = \beta_1 h^{'}\left(u_{1L}^{K_1}\right) - \lambda_1\beta_1, \tag{C.3-1}$$

$$\lambda_2 = -\left(1-\beta_1\right) h^{'}\left(u_{1H}^{K_1}\right) + \lambda_1\left(1-\beta_1\right), \tag{C.3-2}$$

$$\lambda_2 = -\beta_1\hat{S}^{'}\left(\hat{U}_{2L}^{h_T^K}\right) - \lambda_1\beta_1, \tag{C.3-3}$$

$$\lambda_2 = \left(1-\beta_1\right)\hat{S}^{'}\left(\hat{U}_{2H}^{h_T^K}\right) + \lambda_1\left(1-\beta_1\right). \tag{C.3-4}$$

Relating (C.3-1) and (C.3-2), one can obtain

$$\beta_1 h^{'}\left(u_{1L}^{K_1}\right) - \lambda_1\beta_1 = -\left(1-\beta_1\right) h^{'}\left(u_{1H}^{K_1}\right) + \lambda_1\left(1-\beta_1\right),$$

hence

$$\begin{aligned} \lambda_1 &= \beta_1 h^{'}\left(u_{1L}^{K_1}\right) + \left(1-\beta_1\right) h^{'}\left(u_{1H}^{K_1}\right) \\ &= \mathbb{E}\left[h^{'}\left(u_1^{K_1}\right)\right]. \end{aligned} \tag{C.3-5}$$

Relating (C.3-3) and (C.3-4), one can obtain

$$-\beta_1\hat{S}^{'}\left(\hat{U}_{2L}^{h_T^K}\right) - \lambda_1\beta_1 = \left(1-\beta_1\right)\hat{S}^{'}\left(\hat{U}_{2H}^{h_T^K}\right) + \lambda_1\left(1-\beta_1\right),$$

hence

$$\begin{aligned}\lambda_1 &= -\beta_1 \hat{S}'\left(\hat{U}_{2L}^{h_T^K}\right) - (1-\beta_1)\,\hat{S}'\left(\hat{U}_{2H}^{h_T^K}\right) \\ &= -\mathbb{E}\left[\hat{S}'\left(\hat{U}_{2}^{h_T^K}\right)\right]. \qquad \text{(C.3-6)}\end{aligned}$$

Relating (C.3-5) and (C.3-6), one obtains part (i) of remark 3.4.1. Further, from (C.3-1) and (C.3-3), one can obtain

$$h'\left(u_{1L}^{K_1}\right) = -\hat{S}'\left(\hat{U}_{2L}^{h_T^K}\right).$$

Similarly, from (C.3-2) and (C.3-4), one obtains

$$h'\left(u_{1H}^{K_1}\right) = -\hat{S}'\left(\hat{U}_{2H}^{h_T^K}\right).$$

Hence, one also obtains part (ii) and part (iii) of remark 3.4.1. ∎

C.4 Proof of Proposition 3.5.1

Proof. The optimal contract $\left\{u_{1L}^{*K_1}, u_{1H}^{*K_1}; \hat{U}_{2L}^{*h_T^K}, \hat{U}_{2H}^{*h_T^K}\right\}$ is the solution of the system consisting of part (ii) and (iii) of remark 3.4.1, remark 3.4.2, the binding constraints (MH-3.4), and (PC-3.4), i.e.,

$$h'\left(u_{1L}^{K_1}\right) = -\hat{S}'\left(\hat{U}_{2L}^{h_T^K}\right),$$

$$h'\left(u_{1H}^{K_1}\right) = -\hat{S}'\left(\hat{U}_{2H}^{h_T^K}\right),$$

$$\hat{S}'(U) = \mathbb{E}\left[\hat{S}'\left(\hat{U}_{2}^{h_T^K}\right)\right],$$

$$u_{1L}^{K_1} - u_{1H}^{K_1} + \delta\left(\hat{U}_{2L}^{h_T^K} - \hat{U}_{2H}^{h_T^K}\right) = \frac{\varphi}{\Delta\beta},$$

$$\beta_1 u_{1L}^{K_1} + (1-\beta_1)\,u_{1H}^{K_1} - \varphi + \delta\left[\beta_1 \hat{U}_{2L}^{h_T^K} + (1-\beta_1)\,\hat{U}_{2H}^{h_T^K}\right] = U.$$

However, none of the above equation changes according to K_1 and h_T^K. Consequently, the value of each component of the solution $\left\{u_{1L}^{*K_1}, u_{1H}^{*K_1}; \hat{U}_{2L}^{*h_T^K}, \hat{U}_{2H}^{*h_T^K}\right\}$ is not changing with K_1 or

h_T^K. In other words, the value of each component of the solution is fixed regardless of K_1 or h_T^K. For instance, the value of $u_{1L}^{*K_1}$ is fixed whatever the market conduct K_1. One can induce that $u_{1L}^{*K_1} = u_{1L}^{*M} = u_{1L}^{*D} = u_{1L}^{*C}$. Similarly for the other component of the solution. Then the condition of maintaining the collusion

$$\begin{aligned} & \beta_1 u_{1L}^{*M} + (1-\beta_1) u_{1H}^{*M} + \delta \left[\beta_1 \hat{U}_{2L}^{*h_T^K(M)} + (1-\beta_1) \hat{U}_{2H}^{*h_T^K(M)} \right] \\ \geq \; & \beta_1 u_{1L}^{*D} + (1-\beta_1) u_{1H}^{*D} + \delta \left[\beta_1 \hat{U}_{2L}^{*h_T^K(C)} + (1-\beta_1) \hat{U}_{2H}^{*h_T^K(C)} \right], \end{aligned}$$

is everlastingly true, which means the manager is indifferent between deviation and collusion.

■

C.5 Demonstration of the optimal contract

Proof. Given $\hat{S}(U) = \alpha_0 - \alpha_1 U - \frac{\alpha_2}{2} U^2$, one obtains $\hat{S}'(U) = -\alpha_1 - \alpha_2 U$. The martingale property (as in remark 3.4.2) $\hat{S}'(U) = \mathbb{E}\left[\hat{S}'\left(\hat{U}_2^{h_T^K}\right)\right]$ is thus equivalent to

$$\begin{aligned} -\alpha_1 - \alpha_2 U &= \beta_1 \hat{S}'\left(\hat{U}_{2L}^{h_T^K}\right) + (1-\beta_1) \hat{S}'\left(\hat{U}_{2H}^{h_T^K}\right) \\ \Leftrightarrow -\alpha_1 - \alpha_2 U &= \beta_1 \left(-\alpha_1 - \alpha_2 \hat{U}_{2L}^{h_T^K}\right) + (1-\beta_1)\left(-\alpha_1 - \alpha_2 \hat{U}_{2H}^{h_T^K}\right) \\ \Leftrightarrow -\alpha_2 U &= \beta_1 \left(-\alpha_2 \hat{U}_{2L}^{h_T^K}\right) + (1-\beta_1)\left(-\alpha_2 \hat{U}_{2H}^{h_T^K}\right) \\ \Leftrightarrow U &= \beta_1 \hat{U}_{2L}^{h_T^K} + (1-\beta_1) \hat{U}_{2H}^{h_T^K} \end{aligned} \tag{C.5-1}$$

Given $h(u) = u + \frac{d}{2} u^2$, the part (ii) and part (iii) of remark 3.4.1, i.e., $h'\left(u_{1L}^{K_1}\right) = -\hat{S}'\left(\hat{U}_{2L}^{h_T^K}\right)$ and $h'\left(u_{1H}^{K_1}\right) = -\hat{S}'\left(\hat{U}_{2H}^{h_T^K}\right)$, are respectively equivalent to

$$1 + u_{1L}^{K_1} d = \alpha_1 + \alpha_2 \hat{U}_{2L}^{h_T^K}, \tag{C.5-2}$$

$$1 + u_{1H}^{K_1} d = \alpha_1 + \alpha_2 \hat{U}_{2H}^{h_T^K}. \tag{C.5-3}$$

Moreover, with the constraint (PC-3.4) binding, one obtains

$$\beta_1 u_{1L}^{K_1} + (1-\beta_1)\, u_{1H}^{K_1} - \varphi + \delta \left[\beta_1 \hat{U}_{2L}^{h_T^K} + (1-\beta_1)\, \hat{U}_{2H}^{h_T^K}\right] = U. \tag{C.5-4}$$

Similarly, with the constraint (MH-3.4) binding, one obtains

$$u_{1L}^{K_1} - u_{1H}^{K_1} + \delta \left(\hat{U}_{2L}^{h_T^K} - \hat{U}_{2H}^{h_T^K}\right) = \frac{\varphi}{\Delta\beta}. \tag{C.5-5}$$

Let (C.5-2) minus (C.5-3), one obtains

$$\begin{aligned} \left(u_{1L}^{K_1} - u_{1H}^{K_1}\right) d &= \alpha_2 \left(\hat{U}_{2L}^{h_T^K} - \hat{U}_{2H}^{h_T^K}\right) \\ \Leftrightarrow u_{1L}^{K_1} - u_{1H}^{K_1} &= \frac{\alpha_2}{d} \left(\hat{U}_{2L}^{h_T^K} - \hat{U}_{2H}^{h_T^K}\right). \end{aligned} \tag{C.5-6}$$

Substituting (C.5-6) in (C.5-5), one obtains

$$\begin{aligned} \left(\frac{\alpha_2}{d} + \delta\right) \left(\hat{U}_{2L}^{h_T^K} - \hat{U}_{2H}^{h_T^K}\right) &= \frac{\varphi}{\Delta\beta} \\ \Leftrightarrow \hat{U}_{2L}^{h_T^K} - \hat{U}_{2H}^{h_T^K} &= \frac{\varphi}{\Delta\beta} \left(\frac{d}{\alpha_2 + \delta d}\right). \end{aligned} \tag{C.5-7}$$

Substituting (C.5-7) in (C.5-1), rewritten as $U = \hat{U}_{2H}^{h_T^K} + \beta_1 \left(\hat{U}_{2L}^{h_T^K} - \hat{U}_{2H}^{h_T^K}\right)$, one thus obtains

$$\begin{aligned} U &= \hat{U}_{2H}^{h_T^K} + \beta_1 \frac{\varphi}{\Delta\beta} \left(\frac{d}{\alpha_2 + \delta d}\right) \\ \Leftrightarrow \hat{U}_{2H}^{h_T^K} &= U - \beta_1 \frac{\varphi}{\Delta\beta} \left(\frac{d}{\alpha_2 + \delta d}\right). \end{aligned}$$

Now that we've found the solution of $\hat{U}_{2H}^{h_T^K}$ in the above expression, a substitution of this expression in (C.5-7) induces the solution of $\hat{U}_{2L}^{h_T^K}$, i.e.,

$$\hat{U}_{2L}^{h_T^K} = \hat{U}_{2H}^{h_T^K} + \frac{\varphi}{\Delta\beta} \left(\frac{d}{\alpha_2 + \delta d}\right).$$

Since the participation constraint (PC-3.4), i.e., (C.5-4) can be rewritten as

$$\begin{aligned} u_{1H}^{K_1} + \beta_1 \left(u_{1L}^{K_1} - u_{1H}^{K_1}\right) - \varphi + \delta \hat{U}_{2H}^{h_T^K} + \delta\beta_1 \left(\hat{U}_{2L}^{h_T^K} - \hat{U}_{2H}^{h_T^K}\right) &= U \\ \Leftrightarrow u_{1H}^{K_1} - \varphi + \delta \hat{U}_{2H}^{h_T^K} + \beta_1 \left[u_{1L}^{K_1} - u_{1H}^{K_1} + \delta \left(\hat{U}_{2L}^{h_T^K} - \hat{U}_{2H}^{h_T^K}\right)\right] &= U, \end{aligned} \tag{C.5-8}$$

substituting the binding (MH-3.4) constraint, i.e., (C.5-5) in (C.5-8), one obtains

$$
\begin{aligned}
& u_{1H}^{K_1} - \varphi + \delta \hat{U}_{2H}^{h_T^K} + \beta_1 \frac{\varphi}{\Delta\beta} = U \\
\Leftrightarrow\ & u_{1H}^{K_1} = U + \varphi - \delta \hat{U}_{2H}^{h_T^K} - \beta_1 \frac{\varphi}{\Delta\beta} \\
\Leftrightarrow\ & u_{1H}^{K_1} = U - \delta \hat{U}_{2H}^{h_T^K} - \beta_0 \frac{\varphi}{\Delta\beta}.
\end{aligned} \tag{C.5-9}
$$

Hence, substituting the solution of $\hat{U}_{2H}^{h_T^K}$ in (C.5-9), one obtains the solution of $u_{1H}^{K_1}$, i.e.,

$$
\begin{aligned}
u_{1H}^{K_1} &= U - \delta \left[U - \beta_1 \frac{\varphi}{\Delta\beta} \left(\frac{d}{\alpha_2 + \delta d} \right) \right] - \beta_0 \frac{\varphi}{\Delta\beta} \\
&= (1-\delta) U + \frac{\varphi}{\Delta\beta} \left(\beta_1 \frac{\delta d}{\alpha_2 + \delta d} - \beta_0 \right).
\end{aligned}
$$

As for the solutions of $u_{1L}^{K_1}$, a substitution of (C.5-7) in (C.5-6) gives

$$
u_{1L}^{K_1} - u_{1H}^{K_1} = \frac{\varphi}{\Delta\beta} \left(\frac{\alpha_2}{\alpha_2 + \delta d} \right).
$$

Hence $u_{1L}^{K_1} = u_{1H}^{K_1} + \frac{\varphi}{\Delta\beta} \left(\frac{\alpha_2}{\alpha_2 + \delta d} \right)$. ■

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Résumé

Ma thèse intitulée “Gouvernance d'entreprise et concurrence sur le marché des produits” est composée de trois chapitres théoriques relevant essentiellement de l'Économie Industrielle. L'objectif principal est d'étudier comment le marché des produits interagit à la fois avec l'intérêt des parties prenantes lorsque l'information est parfaite et avec les incitations managériales (statiques et dynamiques) lorsque l'information est imparfaite.

Le premier chapitre porte sur les interactions entre le mode de concurrence sur le marché des produits (Cournot vs. Bertrand) et les relations (conflictuelles ou conciliantes) entre les principaux acteurs (actionnaires, consommateurs et employés) lorsque l'intérêt des consommateurs est pris en compte dans la fonction objectif de la firme. Nous considérons un duopole symétrique où les firmes négocient préalablement avec les syndicats sur le salaire versé aux employés et puis se concurrencent entre elles sur le marché des biens. Nous montrons que l'orientation client (mesurée par le degré de prise en compte du surplus des consommateurs) peut inverser la hiérarchie traditionnelle entre les équilibres de Cournot et les équilibres de Bertrand. Une concurrence en prix (par rapport à une concurrence en quantité) est à même d'atténuer les conflits entre les actionnaires et les consommateurs et entre les actionnaires et les employés.

Le deuxième chapitre examine comment les incitations managériales pourraient interagir avec la concurrence sur le marché des produits dans un contexte de sélection adverse et d'aléa moral. Nous considérons un oligopole de Cournot composé de n firmes identiques dont le coût marginal initial est une information privée du manager. L'effort du manager, qui est non observable, réduit *indirectement* le coût marginal initial. Dans un tel contexte, nous montrons qu'à l'optimum les paiements incitatifs versés aux managers ne sont pas nécessairement influencés par la concurrence sur le marché des produits.

Le troisième chapitre étudie comment le contrat optimal entre l'actionnaire et le manager (résolution d'aléa moral répété) peut influencer la stabilité d'un cartel. Nous considérons un cartel composé de deux firmes identiques et dans chaque firme un actionnaire neutre à l'égard du risque offre un menu de contrats à un manager averse au risque. L'effort du manager influence le coût marginal de la firme (comme au chapitre 2) à chaque période. Nous montrons que, contrairement au cas où l'information est parfaite, le degré d'aversion au risque du manager n'impacte pas la stabilité du cartel lorsque le contrat optimal à long terme est mis en place. Le contrat optimal résout le problème d'aléa moral répété et limite également le pouvoir discrétionnaire du manager sur la décision de conduite du marché (collusion, déviation, ou compétition).