OTHER-REGARDING PREFERENCES IN HIERARCHIES: A THEORETICAL STUDY ON COLLUSIVE BEHAVIOUR AND OPTIMAL CONTRACTS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

KEMAL SAYGILI

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
THE DEPARTMENT OF ECONOMICS

SEPTEMBER 2016

Approval of the Graduate School of Social Sciences

____

Prof. Dr. Tülin Gençöz
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

____

Prof. Dr. Nadir Öcal
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

____

Assoc. Prof. Dr. Serkan Küçükşenel
Supervisor

Examining Committee Members

Assist. Prof. Dr. Nuh Aygün Dalkıran (Bilkent Uni, ECON) ____________________

Assoc. Prof. Dr. Serkan Küçükşenel (METU, ECON) ____________________

Assist. Prof. Dr. Pınar Derin-Güre (METU, ECON) ____________________

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last Name: KEMAL SAYGILI

Signature :

ABSTRACT

OTHER-REGARDING PREFERENCES IN HIERARCHIES: A THEORETICAL STUDY ON COLLUSIVE BEHAVIOUR AND OPTIMAL CONTRACTS

Saygılı, Kemal
M.S., Department of Economics
Supervisor: Assoc. Prof. Dr. Serkan Küçükşenel

September 2016, 88 pages

This thesis aims at obtaining new theoretical insights into behavior of organizational hierarchies by combining standard principal-supervisor-agent framework with theories of social preferences. Extending Tirole's (1986) model of hierarchy with the inclusion of Fehr and Schmidt's (1999) distributional other-regarding preferences approach, the links between inequity aversion, collusive behavior throughout the levels of a hierarchy and the changes in optimal contracts are studied. It turns out that other-regarding preferences do change the collusive behaviour between the parties. Moreover, the optimal contract parameters depend on the nature of both the agents' and the supervisor's other-regarding preferences.

Keywords: Other-Regarding Preferences, Principal-Supervisor-Agent Hierarchy, Collusive Behaviour, Optimal Contract Design

ÖZ

HİYERARŞİLERDE SOSYAL TERCİHLER: GİZLİ ANLAŞMALAR VE OPTİMAL KONTRATLAR ÜZERİNE TEORİK BİR ÇALIŞMA

Saygılı, Kemal

Yüksek Lisans, İktisat Bölümü

Tez Yöneticisi: Doç. Dr. Serkan Küçükşenel

Eylül 2016 , 88 sayfa

Bu tez, standart işveren-denetçi-çalışan modelini sosyal tercih teorileriyle birleştirerek organizasyon içi hiyerarşilere yeni teorik bakış açıları sağlamayı amaçlamaktadır. Tirole'ün (1986) hiyerarşi modeli Fehr ve Schmidt'in (1999) dağılımsal sosyal tercih yaklaşımı ile genişletilerek gelir adaletsizliğinden kaçınma ve hiyerarşinin basamakları arasındaki gizli anlaşmalar ile optimal kontrat arasındaki ilişkiler incelenmiştir. Sonuçlar göstermektedir ki sosyal tercihler rüşvete yatkın davranışları ciddi anlamda etkilemekte ve optimal kontrat içeriği, çalışan ve denetçinin sosyal tercihlerinin doğasına göre değişmektedir.

Anahtar Kelimeler: Sosyal Tercihler, İşveren-Denetçi-Çalışan Hiyerarşisi, Gizli Anlaşmalar, Optimal Kontrat Dizaynı

To Essi Daven, The Blue Pearl

and

To Cirilla Fiona Elen Riannon, The Lady of Space and Time

ACKNOWLEDGMENTS

Firstly, I would like to express my sincere gratitude to my advisor Assoc. Prof. Dr. Serkan Küçükşenel for his support, patience, and guidance. It has been a great experience to work with a person who has such immense knowledge. I also thank Assist. Prof. Dr. Nuh Aygün Dalkıran and Assist. Prof. Dr. Pınar Derin-Güre for serving as my thesis committee members and for their helpful and invaluable comments.

I would also like to thank all of my collegaues and especially to Aykut Mert Yakut, Burcu Özgün, Deniz Plevneli, Fatma Taşdemir, Güney Düzçay, Hakan Genç, Özgen Öztürk, and Yetkin Uysal for their great help, companionship and motivation.

I am grateful to TÜBİTAK for their financial support. Thanks to them I had one less concern during my study and research.

It is a pleasure for me to thank Andrzej Sapkowski and CD Projekt Red. Thanks to their vivid imagination and story telling, writing this thesis has become more bearable.

I would like to convey special thanks to my dearest dudes Aykut Çınar, Aykut Önder, Doğukan Çetin, Enis Kayar, Metin Karyağar, Onur Akın, Onur Vardar, Safa Kumral, and Sercan Şanlıoğlu. It is always a great joy to hang with them in both real and virtual world. Especially, I will always remember the great friendship of Aykut Çınar, Aykut Önder, and Metin Karyağar through both the writing of this thesis and my entire life.

Most importantly, I deeply thank my mother, Gülşen Çalışkan, who is a constant source of love, concern, and support throughout my whole life. I do also want to thank my grandparents, uncle, aunts and cousins. Without their support, I would have not achieved any of my accomplishments in this life.

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

FIGURES

CHAPTER 1

INTRODUCTION

Many models in economics uses self-interest approach- which assumes that all people are driven by their material self well-being- for analysing real life problems. However, as Kucuksenel (2012) remarked, self-interested people assumption is problematic. Especially in recent years, countless experiments on certain topics in economics showed that self-interest approach is not sufficient in explaining all of these cases. (See Ledyard (1995), and Fehr and Schmidt (2006) for evidences on public and private good environments respectively.) Moreover, these experiments highlighted the fact that many people show other-regarding preferences while interacting with other people and concern for another's situation is a motivating factor on their decisions in different social environments. Supporting the experiments, many theoretical papers provided that these kind of behaviour can be presented in a tractable way. These papers (especially Fehr and Schmidt (1999)) in turn stirs up new developments and waves of literature trying to apply other-regarding preferences (or social preferences) to different types of problems in economics. In this thesis, we also follow this path and look for how other-regarding preferences shape principal-supervisor-agent hierarchy in an organization. We particularly investigate the impact of other-regarding preferences on the collusive behaviour in a hierarchy and optimal contract design. We show that neglecting their influence is not a wise thing to do for a principal since collusion between the levels and wage payments in an optimal contract depend on the degree of social preferences.

Sociological studies shows that collusive behaviours is not a rare event in an organization. The fact that several layer of people interacts with each other put an emphasis on group gains as well as individual gains which opens a way to forming coalitions among different parties. Thus, hierarchy design for an organization must consider the possibility of corruptive activities and aim to prevent them beforehand. To show a way to construct this kind of design, in his seminal work, Tirole (1986) puts sociological studies on corruption in hierarchies into a formal model by adding a supervisor layer between the standard principal-agent network. He views an hierarchy as a nested network of several principal-agent contracts that interacts with each other and shows that anticipating collusive behaviour between the layers before designing the whole organization does matter a lot. However, as his colleagues of the same era, he builds his model on the idea that parties in the hierarchy are driven by their self material interest only. Although he acknowledges the fact that interaction between supervisor and agent affects the shape of their relationships he does not add this fact to his theoretical framework in any formal way.

The traditional literature in standard principal-agent contract design does also use self-interested people in their models. However, several relatively recent papers on principal/agent relationships have started to consider the theories of social preferences while constructing their models. See, among others, Itoh (2004), Rey-Biel (2008), Neilson and Stowe (2010), etc. On the other hand, such models have not been widely affiliated with theoretical models used to understand the collusive behaviour and find optimal contracts in a basic three level hierarchy. However, Tirole (1986), for example, sees this type of hierarchies as a network of standard two-tier contracts. Papers such as Grund and Przemeck (2008), Giebe and Gürtler (2011) implements some type of social preferences, they focus on leniency bias of a supervisor and try to find optimal contract for supervisor in a different hierarchical framework than Tirole's (1986). Although Giebe and Gürtler (2011) comment on how a lenient supervisor in an hierarchy can change collusive action, it does not elaborate enough and does not give necessary theoretical explanation.

We think that social preferences for the parties in hierarchies are not getting the attention it deserves through a formal theoretical framework. There should be a detailed theoretical study on how social preferences in an hierarchy influence collusive tendency and behaviour of the parties in it and- consequently- optimal contract design. Several empirical studies (Agell and Ludborg (1995), Bewley (1999), Blinder and Choi (1990), Campbell and Kamplani (1997)) report that employees in an organization not only care about their own well-being but also take the well-being of their co-workers into consideration and managers designs contracts that avoids too much internal inequality. Moreover, Gore and Pepper (2012) argues that an employee of an organization may take the compensation (rewards) of her peers, immediate subordinates or immediate superiors as a reference for her own rewards and compensation. Thus, it appears essential to apply other regarding preferences into hierarchical models. It is also important to gain further and more realistic insight into collusive behaviour between parties and designing optimal contracts in such environments. In addition to reasons we have mentioned above, I have also a personal driving force to investigate social preferences in organizational hierarchies coming from a real life conversation with one of my friends. His fierce words implying that his supervisor earns tons of money by doing almost nothing but raving about productivity make me curious. How in the world a person this spiteful against his superior can form a coalition with him?

The first objective of this thesis is to introduce other-regarding preferences for the utilities of supervisor and agent in the hierarchy and investigate its effect on the collusive behaviour between these two party. Second one is to explore the changes in the optimal contract parameters- namely efforts exerted by agent, supervisor's and agent's wage structure at different states. We chose to use Fehr and Schmidt (1999) type of other-regarding utility function, since it is simple, powerful and can easily be applied to three layer principal-supervisor-agent hierarchy. We investigate two different cases. In the first case only supervisor has other-regarding preferences. For the second one, we analyze the case where only agent has other-regarding preferences. We separate them since we want to look for individual impacts of these two different cases. Experimental results in Eisenkopf and Teyssier (2016) suggest that agents either focus on vertical social preferences and do care about the payoff his superior or focus on horizontal social preferences and look at the payoff of his co-worker at same level. Thus, for the case with multiple agents in an hierarchy, we take that agents only do care about the well-being of the other agent. They don't show other-regarding preferences against their supervisor.

Introduction of other-regarding preferences changes the amount how much the briber has to pay in order to persuade the bribed party and how much she can pay at most if she wants to form a coalition. Moreover, the impact of changing supervisor's and agent's wages at different states on preventing collusive behaviour differs from the case where parties are completely self-interested. The components of contracts (especially efforts exerted) also change with the introduction of other-regarding preferences. Though the ranking of agent's and supervisor's utilities does not differ from Tirole's (1986) model, wages and dispersion between them at different states may vary due to changes in collusion constraints coming from social preferences. Furthermore, we have found that inequity aversion results in wage contraction between layers of the hierarchy. Lastly, at certain situations the principal may escape from the burden of preventing collusive behaviour, since it is automatically diminishes. We provide intuition and explanation for these results in more details throughout the thesis.

The rest of this thesis is organized as follows. Chapter 2 reviews the literature on contract theory in hierarchical environments. Moreover, other-regarding (social) preferences and its relation with contract theory framework are investigated throughout the literature up to current date. It shows that our approach to the principal-supervisor-agent hierarchy in the light of social preferences is unique and a candidate to contribute current literature on organizational hierarchies. Chapter 3 constructs and explains the key points of the main model, which is basically Tirole's (1986) model with Fehr and Schmidt (1999) type other-regarding utility functions. Chapter 4 analyses the principal's problem for different situations. We investigate the structure of optimal contracts with collusion when supervisor "or" the agent has other regarding preferences and provide the results respectively. The reason why we use "or" but not "and" is that we want to show distinct effects of these preferences for different players on principal's problems. Moreover, we investigate vertical and horizontal social preferences individually due to empirical results provided by Eisenkopf and Teyssier (2016). Chapter 5 concludes by summarizing main points and results of this thesis, and states the remaining open questions for future research. Proofs of the main results are relegated to the Appendix.

CHAPTER 2

LITERATURE REVIEW

This thesis is related to the two strands of the economics literature. The first one is contract theory (especially for principal-supervisor-agent hierarchies) and second one is social (other-regarding) preferences. The formal models analysing the principal-supervisor-agent environment dates back to seminal paper of Tirole (1986). The paper takes standard moral hazard (hidden action) problem in contract theory and combines it with hidden information problem. The information Tirole (1986) writes about is the knowledge of productivity level in an agent's working environment. To observe it, the principal hires a supervisor who reports her findings to the principal in a verifiable way and thus, a principal-supervisor-agent hierarchy is born. Adding supervisor to an organization also comes with a prospect of collusion between informed parties-between supervisor and agent. The fact that manipulation of supervisor's report can result in Pareto-optimal payoffs for both agent and supervisor, the principal should consider such cases in the design of contracts. There exists an optimal contract which is collusion proof and the properties of this contract are different from the case the principal faces only with moral hazard problem of the agent.

Building on the findings of Tirole (1986), many more papers is written to analyse the function of supervision in organizational hierarchies. Bac (1996), for example, extends this analysis by trying to find a hierarchical structure and an incentive system which minimize the cost of supervision for a target level of corruption. Moreover, he takes external bribe into account as well as internal collusion in an hierarchy. His finding for a group of identical agents who constructs supervision chain among themselves is that upper part of a supervision chain is in a higher risk of collusion than the lower part. Moreover, he argues that economies of scale in monitoring results in a decrease in supervision costs, yet can cause higher risk of collusive behaviour in relatively flat hierarchies.

Baliga (1999) extends Tirole's model by analysing how monitoring and collusive behaviour is affected when information reported to the principal is soft. In the original three level hierarchy model, Tirole (1986) argues that hiring a supervisor beneficial if the content of supervisor's report on productivity level of agent's working environment relies on hard (verifiable) information. However, Baliga (1999) shows that even though there exist a possibility of a coalition between supervisor and agent soft information becomes not useless, and it is beneficial to hire a supervisor presenting reports based on soft (unverifiable) information.

Bac and Kucuksenel (2006) introduces supervision cost to the Tirole's (1986) principal-supervisor-hierarchy model. Relaxing costless supervision technology assumption and making monitoring costly creates a new opportunity for an agent to collude with supervisor in a different way than before. The agent can offer a bribe to the supervisor so that she does not monitor the former at all. They call this type of collusion as ex-ante collusion. After exploring the links between monitoring cost, ex-ante collusion and ex-post collusion, Bac and Kucuksenel (2006) reports that the principal can ignore the possibility of an ex-ante collusion and supervisor's incentive constraint if cost of supervision is small and the probability of observing productivity level is large. Moreover, in case of preventing ex-ante collusion becomes a necessity, principal makes the gap between the wages when the report of supervisor is empty and shows the level of productivity wider.

The literature we mentioned above and many more on collusive behaviour in organizational hierarchies and how optimal contract schemes changes accordingly contributes to increasing the scope of hierarchy models for real life problems greatly. However, as we have noted before, self-interest approach which assumes that all people are driven by their material self well-being is dominant in constructing the models and explaining the results of these papers. On the other hand, several papers considers social preferences in the models of organizational hierarchies. Grund and Przemeck (2008) investigates the case where the supervisor shows leniency and centrality bias to her subordinates, agents, who are inequality averse towards each other. They use different kind of model (use no principal) than standard three level hierarchy models and look for the factors determining the size of these biases. They do not deal with the principal's problem directly. Therefore, their results include only the changes coming from supervisor's biases and inequality aversion between agents in efforts exerted by the agents. They do not investigate collusion at all. Giebe and Gürtler (2011) also focus on leniency bias of a supervisor in a three level hierarchy and try to find an optimal contract for supervisor. They compare a neutral type supervisor with a lenient one and shows that optimal contract for supervisor is simply giving her a flat wage independent of her type. Although the paper has some comments on how a lenient supervisor in an hierarchy can change collusive action, a full analysis of collusion is beyond its scope and necessary theoretical explanation is not given. To sum up, we believe that there is not enough study on other-regarding preferences' impact on collusive behaviour and all of the components of optimal contracts offered to both agent and supervisor. Thus, we want to extend the literature by using social preferences and by giving more realistic insight into organizational hierarchies.

The second strand of this thesis is related to other-regarding preferences. There are two main pillars for other-regarding preferences in the literature: Rabin's (1993) paper which uses intention based approach and Fehr and Schmidt's (1999) paper which adopts distributional approach. Itoh (2004) summarizes other-regarding preferences in the economics literature as follows:

$$u_i(x_1, x_2) = x_i + g_i(x_j - x_i)x_j$$

where $i = 1, 2$ and $j = i$. x_1 and x_2 shows the material preferences of each person i. The utility function of these people represented by $u_i(x_1, x_2)$. Note that utility function of each person depends on the material payoff of other person. As Itoh (2004) mentioned these types of social preference functions are additively separable in the person's own material well-being and her concern for the material payoff of the other. Moreover, the second part is multiplicatively separable in the person's relative payoff to the other person and material well being of the other person. A person is purely altruistic towards his peer if $g_i(.)$ is positive and constant. On the other hand, if $g_i(.)$ is negative and constant we can say that she shows purely spiteful feelings toward other person.

Fehr and Schmidt (1999) uses the following piecewise linear utility function to show other-regarding preferences for the two player case:

$$u_i(x_1, x_2) = x_i - \alpha_i max\{x_j - x_i, 0\} - \beta_i max\{x_i - x_j, 0\}, \quad i \neq j$$

which can be represented as

$$u_i(x_1, x_2) = x_i - \alpha_i(x_j - x_i) \quad for\ x_j \geq x_i$$

$$u_i(x_1, x_2) = x_i - \beta_i(x_j - x_i) \quad for\ x_i \geq x_j$$

$\alpha_i > 0$ is the inequity aversion parameter and shows the sensitivity of a person's to inequality between payoffs when she is behind in payoffs. Fehr and Schmidt (1999) choose $0 < \beta_i \leq 1$ and implies that the person is also inequity averse when he is ahead in payoffs. Note that although β_i is positive, it is smaller than 1. Because $\beta_i \geq 1$ means that when a person's payoff increases a unit she completely gives this unit increase to other person to reduce his advantage over her. This seems not realistic. Moreover, they assume $\alpha_i \geq \beta_i$ which can be called as behindness aversion: A person suffers more from inequality when he is behind.

Neilson and Stowe (2004) relaxes the assumption on β_i. They think that there are also some people who enjoys being ahead in payoffs which means $\beta_i < 0$ is also a possibility. These people can be categorized as status-seeker or competitive.

Rabin (1993) takes game theoretical approach to other-regarding preferences. His model is based on the intentions of the players. According to Rabin (1993), beliefs affects a player's preference and it includes the strategies of the players, same player's beliefs about other player's strategy and the other player's beliefs about his strategy. Itoh (2004) summarizes it as follows:

$$u_i(\sigma_i, \sigma_j, \sigma_i^{'}) = v_i(\sigma_i, \sigma_j) + g_i(\sigma_i^{'}, \sigma_j) v_j(\sigma_i, \sigma_j)$$

where σ_i represents the strategy of player i, σ_j represents the belief of player i about why player j choose his strategy, and $\sigma_i^{'}$ represents the belief of player i about the belief of player j what the latter thinks about the former's strategy choice.

In this thesis, we use Fehr and Schmidt's (1999) inequity aversion model with the extension of Neilson and Stowe's (2003) on β_i. First of all, it is simple and tractable. On the other hand, Rabin's (1993) model is complicated and difficult to implement in most of the contract theory models as we are concerned. In addition, Fehr and Schmidt (1999) type other-regarding preference model's intuition is psychologically plausible and it answers to several types of empirical results with just one function. Moreover, due to its simplicity and power to explain experimental results, Fehr and Schmidt's (1999) model is well studied in most of the economics literature and widely used for behavioural contract theory.

One of the papers who implements Fehr and Schmidt's (1999) model to contract theory is Itoh (2004). He investigates the impact of social preferences on a standard moral hazard principal-agent framework. His first main model consists one principal with one agent and agent cares about the well-being of her principal. The second one investigates the multiple agent case in which two agents care about not only their own payoffs but also the payoff of her colleague. Itoh (2004) proposes that hiring an inequity averse agent who cares about the well-being of her principal generally makes the principal worse off. Moreover, multiple agents who have other-regarding preferences give an opportunity to principal in which she exploits the nature of her employees by designing an interdependent contract. Rey-Biel (2008) has also written a paper similar to Itoh (2004). Rey-Biel's (2008) model uses a selfish principal with two other-regarding agents who care about the payoff of his co-worker in their own utility functions. Similar to Itoh (2004), he also founds that the principal can design an exploitative contract which creates inequity between agents, and benefit from it.

He also shows conditions where inequity aversion becomes a reason behind forming work teams even when the individual efforts of the agents are contractible.

Neilson and Stowe (2010) also use Fehr and Schmidt's (1999) distributional other-regarding preferences approach for their models. They work on piece rate contracts for workers, and derive the conditions where inequity between workers make them exert higher effort than traditional case. Moreover, they investigate the circumstances where the employers reduces piece rates due to inequality attitudes of the workers.

Although the papers we mentioned above has provided great insights for behavioural contract theory, they do not deal with the concerns of hierarchical models in any way. Their approach to standard contract models using other-regarding preferences opens a path for us to follow in this thesis. Moreover, we benefit from their mentality at great amounts since three level hierarchy can be seen as network of two-tier hierarchies.

Lastly, Eisenkopf and Teyssier (2016) is another important paper we reviewed and benefited from. They design an experiment in which a principal implements a tournament and two agents compete for its prize. Their experiment's results suggest that while other-regarding players take a reference point for their other-regarding utilities they either show horizontal social preferences (an agent care about the payoff of other agent) or vertical preferences (an agent cares about the payoff of the principal). They do not focus on both the other player's and principal's payoff at the same time. In our models we use this important result in a great extent. We analyze vertical and horizontal social preferences individually.

CHAPTER 3

THE MODEL

The models in this thesis are built upon Tirole's (1986) three level (principal-supervisor-agent) hierarchy model. In order to show the effects of inequity aversion between supervisors and agents on the collusive behaviour and optimal contracts in this type of hierarchy, we use Fehr and Schmidt's (1999) theory of inequity aversion approach in the definition of supervisor's and agents' utilities.

We first define the standard principal-supervisor-agent hierarchy:

The Parties: The only productive unit in this hierarchy is the *agent*. Principal earns profit (or output) from the agent's productive effort $e > 0$ and the productivity parameter θ in the environment according to the technology below:

$$x = \theta + e$$

Agent faces disutility coming from the exerted effort, and it is shown as $g(e)$ in monetary terms where g is strictly convex, increasing in effort, and $g(0) = g'(0) = 0$. Principal pays a wage W to the agent from her profit x.

Supervisor's main and the most important role in this hierarchy is to monitor agent and his environment, and then report the result of her inspection about productivity θ to the principal. The details about supervisor's duty is explained later with hidden action and hidden information problem existing in the hierarchical model. The assumption about the supervision technology is the fact that supervisor exerts no effort while monitoring the agent and thus, there is no monitoring cost for the supervisor. Same with the agent's case, principal pays a wage S to the supervisor from her profit x.

The utility functions in our models is different from Tirole's (1986) case. Inequity aversion approach tells us that interacting participants in this kind of environments do care about not only their own payoffs but also the payoff of the interacted party. Moreover, other-regarding preferences occur between peoples with similar social circles according to experiments. Hence, we assume that other-regarding behaviour appears throughout supervisor and agents in the principal-supervisor-agent hierarchy. Although supervisor and agent in this hierarchical set-up are in different levels of hierarchy it is safe to assume that they see each other as co-workers. Since principal is in the owner role of the whole game her total gain is not considered in the utilities of supervisor and agents, or the payoffs of the supervisor and agents does not have any effect on the utility of principal.

Agent's utility in this setup has two components, W and $g(e)$. Thus, one should has to decide on whether comparison between payoffs of interacting parties includes both pay and effort cost of agent or only the wage paid W. Neilson and Stowe (2004) argues that interacting parties can only observe the wages of his co-workers (when wages are observable) and they probably tend to not consider the effort differences, which also generates payoff differences, among themselves. Moreover, since a principal can not observe the effort levels of their agents perfectly (hidden action problem) it is reasonable to think that workers can most probably not observe their co-workers' effort levels perfectly. As a result, to include disutility coming from efforts in the comparisons between payoffs is a difficult action. Similar assumption has been made in one of the models of Itoh (2004), where the agent and principal cares about the other party's payoff as well as their own. Thus, we assume that supervisor and agents only consider the wage paid and ignore the cost of efforts in the comparison between their utilities.

In the specifications of the utilities of the supervisor and the agent, we also assume that the party at the supervisor level earns a higher wage in every state of information, i.e, $S_i > W_i$. (Hidden information problem is defined extensively at later parts.) This assumption corresponds to most of the wage settings in the real world hierarchies, and it also simplifies the construction and solution of our models greatly without weakening their applicability. Thus, it can be considered as a natural specification in a hierarchical inequity aversion setting.

By using Fehr and Schmidt's (1999) two player utility function with inequity aversion, we define the utility of the agent as:

$$U(W - g(e) - \lambda_A(S - W))$$

and supervisor's utility:

$$V(S - \lambda_S(S - W))$$

where λ_A and λ_S represents inequity aversion parameters of the agent and the supervisor respectively. Since $S > W$ in all states, $\lambda_A > 0$ (agent is inequity averse and dislikes being behind) and $\lambda_S < 1$ (either supervisor is inequity averse as well as behindness averse, the case where $0 < \lambda_S < 1$, or supervisor loves being ahead and she is status-seeker (competitive), the case where $\lambda_S < 0$) As λ_A increases the agent becomes more inequity averse, i.e, becomes more sensitive to being behind. For $0 < \lambda_S < 1$, increase in λ_S makes the supervisor more inequity averse and more sensitive to being behind. On the other hand, for $\lambda_S < 0$, as λ_S decreases the supervisor becomes more status-seeker and thrives more from being ahead. The case where $\lambda_A = 0$ and $\lambda_S = 0$ represents our benchmark case, the model in Tirole (1986).

Both U and V are differentiable, strictly concave and increasing Von Neumann Morgenstern utility functions with $U'(0) = \infty$ and $V'(0) = \infty$.

Due to hidden information problem (which is described later in detail), expected utility approach for both the supervisor and the agent is used in the solution of the model. The expected utility of the agent is $EU(W - g(e) - \lambda_A(S - W))$ and the expected utility of the supervisor is $EV(S - \lambda_S(S - W))$.

The supply of supervisors and agents has competitive nature, and agents have reservation wages W_0 with reservation utility $\overline{U} \equiv U(W_0)$ while supervisors have reservation wages S_0 with reservation utility $\overline{V} \equiv V(S_0)$. Then, the participation (individual rationality) constraints can be written as:

$$EU(W - g(e) - \lambda_A(S - W)) \geq \overline{U} \quad for\ agent$$

$$EV(S - \lambda_S(S - W)) \geq \overline{V} \quad for\ supervisor$$

The last party of this hierarchy is the principal. She assigns the agent to the work project, and designs and offers contracts to both the supervisor and the agent. The assumption about the principal is that she is risk-neutral. Hence, her expected utility is defined as:

$$E(x - S - W) = E(\theta + e - S - W)$$

Hidden Information Problem: There are two level of productivities in the working environment, low state of productivity $\underline{\theta}$ and high state of productivity $\overline{\theta}$, where $0 < \underline{\theta} < \overline{\theta}$, and $\Delta\theta = \overline{\theta} - \underline{\theta}$

The agent is always aware of the productivity level in the environment, and determines her effort level after she realizes this productivity level. However, the supervisor sometimes fails in observing productivity level in the environment. Thus, when supervisor monitors the agent one of the four following states of nature (which is indexed by i) can arise:

State 1: Both agent and supervisor observe low level of productivity $\underline{\theta}$.

State 2: Agent observes $\underline{\theta}$. However, supervisor fails in observing current productivity level.

State 3: Agent observes high level of productivity $\overline{\theta}$. However, supervisor fails in observing current productivity level.

State 4: Both agent and supervisor observe $\theta = \overline{\theta}$.

Each state of nature has probabilities of occurring p_i where $\sum_{i=1}^{i=4} p_i = 1$.

Lastly, it is assumed that the agent has information on whether the supervisor observed the productivity level successfully or not. The information structure becomes poorer as we go through the upper levels in the hierarchy. Moreover, supervisor, as well as the principal, can not observe the level of effort exerted by the agent.

Timing: First, the principal offers contracts to both parties. S and W are specified in this contract as functions of observable contractible variables which are the profit (output) x and the report of the supervisor on the current productivity level r, and the supervisor's and the agent's inequity aversion parameters λ_S and λ_A which are assumed to be common knowledge for all parties in the hierarchy. At the same time, both supervisor's and agent's wages become common knowledge to all parties during the discussion on the context of contracts.

After the contracts, offered by the principal, are accepted, the agent learns productivity level in the environment. On the other hand supervisor may or may not learn at which level θ is.

In the next step, the supervisor and the agent move to collusion stage and try to decide on the side transfers between both parties. Similar to the main contract offered by the principal, a side transfer is a also a function of profit (output) x, supervisor's report on productivity level r, and inequity aversion parameters of the colluding parties λ_A, λ_S. Side transfers are not observable by the principal. If a side contract satisfies following assumptions, made by Tirole (1986), a coalition is formed between the supervisor and the agent, and collusion occurs between both parties.

1) A side transfer is Pareto-optimal for both supervisor and agent.

2) No-side-contract outcome should be guaranteed for each of the colluding parties.

After collusion stage, agent chooses his effort level. It means that the profit (output) is realized accordingly. Around the same time, supervisor prepares her report and presents it to the principal.

As we have already mentioned, the supervisor may or may not observe the true productivity level in the environment. If she fails to observe it, her report is considered empty, that is, $r = \phi$. In the case where the supervisor observes the productivity level successfully, she has the option to report his monitoring in a truthful manner or to hide the true information and give empty report, i.e. the supervisor's report is $r \in \{\theta, \phi\}$ if she does not fail to monitor agent's environment. Throughout the discussion on the context of supervisor's report, we assumed that when the supervisor observes the level of productivity in the environment her reports are considered as credible by the principal. On the other hand, we also assume that the agent can not make verifiable and credible announcements about productivity level on her own.

The final step is the execution of contracts. In other words, the principal pays S and W to the supervisor and the agent respectively after she has seen the output (profit) and report of the supervisor. Moreover, if supervisor and agent decides to form a coalition at the collusion stage, side transfers are allocated. See Figure 3.1 for more on the timing of our problem.

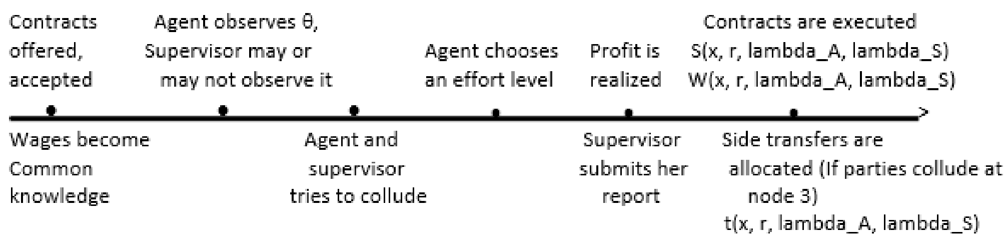

Figure 3.1: The Sequence of Events

First Best Solution (No Hidden Action, No Hidden Information, Self-Interested Parties): In order to use the results in the comparison later, consider the case when principal can observe productivity levels in the environment perfectly (no hidden information problem), and the effort level exerted by the agent (no hidden action problem). Moreover, all of the parties in the hierarchy is self interested ($\lambda_A = 0$, $\lambda_S = 0$).

In this case, principal does not need a supervisory duty. Thus, in every state realized, the supervisor gets her reservation wage S_0. Then we can find optimal effort level of the agent that maximizes:

$$\max_{e}\{\theta + e - g(e)\}$$

which results in $g'(e^*) = 1$ for both $\underline{\theta}$ and $\overline{\theta}$.

The wage of the agent is $W = W_0 + g(e^*)$ in every state of nature.

Before moving to next chapter and analysing principal's problem for different cases, for further discussion and justification of the main theoretical backgrounds and their assumptions that we used in this thesis, we refer the reader to Tirole's (1986) and Fehr and Schmidt's (1999) papers.

CHAPTER 4

ANALYSIS OF THE PRINCIPAL'S PROBLEM

The problems analysed in this thesis follows the methodology below in general:

1) All of the constraints that post-side-transfer allocation (individual rationality and incentive compatibility constraints, no collusion constraints) is introduced to the principal's problem of optimal contract design. Comparisons between different cases is drawn in some situations.

2) Principal's net expected profit (her expected payoff) is maximized subject to constraints introduced in part 1. (Last subsection is an exception to this step.)

3) For our own models, the results related to collusion constraints and optimal contracts is compared with benchmark case (Tirole, 1986) in the light of inequity aversion approach.

4.1 The Benchmark Case, Tirole (1986) (Self Interested Agents, $\lambda_A = 0$, $\lambda_S = 0$)

We start with the introducing all of the constraints to the principal's problem of optimal contract design that maximizes her expected payoff.

The participation constraints for supervisor and agent must be satisfied so that the main contract is accepted by both parties at the first place. The participation (individual rationality) constraints, for the supervisor and the agent respectively, are as follows:

$$(SPC): \quad EV(S) = \sum_i p_i V(S_i) \geq \overline{V} \equiv V(S_0)$$

$$(APC): \quad EU(W - g(e)) = \sum_i p_i U(W_i - g(e_i)) \geq \overline{U} \equiv U(W_0)$$

Expected utilities of both the supervisor and the agent must be at least equal to their corresponding reservation wages. Otherwise, they do not sign the contracts offered by the principal.

There is a hidden action problem in our models since principal and supervisor can not observe the effort level exerted by the agent. In states 1 and 4, principal has the knowledge on productivity levels. Hence, she can deduct the effort level of the agent by looking at the amount of output (profit). However, this is not the case for state 2 and 3. When state 3 is realized agent can claim that it is actually state 2, and the payoff the principal gets is achieved on low level of productivity $\underline{\theta}$ with the hard work of the agent, though true state of nature is actually $\overline{\theta}$. With her false information, she is able to exert lesser effort $e_2 - \Delta\theta$ instead of e_2 but earn the wage W_2 as if she exerts e_2. The principal must provide necessary incentives which make agent reveal true state of nature in her environment when supervisor's monitoring fails. Then, the incentive compatibility for the agent is as follows:

$$(AIC): \quad W_3 - g(e_3) \geq W_2 - g(e_2 - \Delta\theta)$$

By setting the utility of agent in state 3 at least as high as her utility if she falsely claims that state of nature is state 2 instead of saying it is state 3, the principal guarantees that it is not beneficial for the agent to not reveal the true productivity level $\overline{\theta}$.

There are also collusion constraints that must be satisfied to prevent supervisor-agent coalitions. The supervisor has an option to conceal true level of productivity at state 1 and 4 and report $r = \phi$ instead of $r = \theta$. If it is beneficial for an agent, she may try to bribe the supervisor and make the latter announce state 2 instead of state 1 or state 3 instead of state 4. The agent must give at least $t = S_1 - S_2$ at state 1 and

$t = S_4 - S_3$ to persuade the supervisor into forming a coalition so that the supervisor is indifferent between revealing and not revealing the true productivity level. In the case that supervisor-agent coalition becomes a reality, the agent's payoff is $W_2 - t - g(e_2)$ instead of $W_1 - g(e_1)$ at state 1, and $W_3 - t - g(e_3)$ instead of $W_4 - g(e_4)$ at state 4. Moreover, it should be that $W_2 - t - g(e_2) > W_1 - g(e_1)$, and $W_3 - t - g(e_3) > W_4 - g(e_4)$.

To prevent coalition in those states, the principal must design a contract such that when the supervisor is bribed with the smallest possible side transfer t ($t = S_1 - S_2$ and $t = S_4 - S_3$ for respective cases), the utilities of the agent must satisfy $W_2 - (S_1 - S_2) - g(e_2) \leq W_1 - g(e_1)$ (so that the agent have no intention to leave state 1, since it is not beneficial for her.), and $W_3 - (S_4 - S_3) - g(e_3) \leq W_4 - g(e_4)$ (so that the agent have no intention to leave state 4). Then, we have:

$$(CIC1): \quad S_1 + W_1 - g(e_1) \geq S_2 + W_2 - g(e_2)$$

$$(CIC2): \quad S_4 + W_4 - g(e_4) \geq S_3 + W_3 - g(e_3)$$

Look at the state 2 and state 3. It is possible that supervisor attempts to bribe the agent and make the latter behave as if the state of nature is 2 though it is actually state 3, since the supervisor perceives that not being able to observe high productivity environment is greater failure than not being able to monitor low level of productivity. (For mathematical justification, see Tirole (1986)) If agent accepts bribe, since she is working under high productivity conditions her payoff is $W_2 - g(e_2 - \Delta\theta)$. On the other hand, $W_3 - g(e_3)$ is her payoff in the case where she does not accept supervisor's offer to form coalition. Hence, the minimum side payment supervisor must transfer in order to make agent accept forming coalition must be equal to the difference between the utilities above, i.e. $t = W_3 - g(e_3) - W_2 + g(e_2 - \Delta\theta)$. In the case that supervisor-agent coalition becomes a reality, supervisor's pay-off is $S_2 - t$ instead of S_3, where $S_2 - t > S_3$.

The principal must design a contract such that when the agent is to be bribed with smallest possible side transfer, $t = W_3 - g(e_3) - W_2 + g(e_2 - \Delta\theta)$, the pay-off of the supervisor must satisfy $S_2 - (W_3 - g(e_3) - W_2 + g(e_2 - \Delta\theta)) \leq S_3$ which erases supervisor's any intention of leaving state 3 in favour of state 2, since bribing agent to state 2 does not make the supervisor better off. Then we have:

$$(CIC3): \quad S_3 + W_3 - g(e_3) \geq S_2 + W_2 - g(e_2 - \Delta\theta)$$

If AIC is binding, CIC3 turns into:

$$(CIC3'): \quad S_3 \geq S_2$$

Next, we find the optimal contract. The principal's goal is to maximize her expected utility $\sum_i p_i(\theta_i + e_i - S_i - W_i)$ subject to constraints we introduced by choosing optimal S_i, W_i, e_i . In other words, we need to solve the benchmark problem below:

$$\max_{(S_i, W_i, e_i)} \sum_i p_i(\theta_i + e_i - S_i - W_i)$$

$$subject\ to \quad (SPC), (APC), (AIC), (CIC1), (CIC2), (CIC3)$$

Proposition 1: (Tirole (1986)) The solution to principal's problem with self interested supervisor and agent in the hierarchy (benchmark case) has the following properties:

a) $S_4 > S_1 > S_2 = S_3$

b) $W_3 - g(e_3) > W_4 - g(e_4) > W_1 - g(e_1) > W_2 - g(e_2)$ and $W_3 > W_4 > W_1 > W_2$

c) $S_4 + W_4 = S_3 + W_3$

d) $e_1 = e_3 = e_4 = e^* > e_2$

e) All the constraints in the benchmark problem, except (CIC1), are binding.

By offering a contract defined by the benchmark problem's solution (proposition 1), the principal guarantees that there are no pareto-optimal gains for neither the supervisor nor the agent by announcing false state of productivities and there are no gains for the agent from changing her effort level when her productivity is not reported to the principal. Hence, the possibility of forming coalitions and signing of side contracts between the supervisor and the agent ceases to exist, and every party stays loyal to the true state of nature.

Proposition 1.d. states that the optimal effort level in the first best solution is induced by principal at states 1,3 and 4 for benchmark case. However, a suboptimal effort is seen at state 2 when productivity is low and supervisor's report is empty due to the latter's failure to observe productivity level in the environment This result stems from not due to possibility of collusions but because of the standard moral hazard (adverse selection) contract design problem, i.e. this is because of (AIC). Inducing a suboptimal effort in low state of productivity, with the corresponding reduction in W_2, results in the necessary decrease in the attractiveness of shirking from high productivity level state 3 to low productivity level state 2.

Proposition 1.c. is a direct consequence of (CIC2) and the fact that $e_3 = e_4$. Although their total wage payment is same in those states, the supervisor's and the agent's individual wages wary between state 3 and 4 ($S_4 > S_3$, $W_3 > W_4$). Supervisor's monitoring fails at state 3, thus agent has an option to claim that she is working under low productivity environment and generates output with her hard work. In order to prevent this, a higher wage must be paid to the agent at state 3. On the other hand, optimal insurance for the agent tells us that her wage at state 4 should be lower than her wage at state 4. This gives a direct incentive to the agent to bribe supervisor, when the realized state is 4. Hence, the supervisor must earn $S_4 > S_3$ so that the principal can prevent a collusion between the agent and the supervisor. Tirole (1986) explains this situation by telling the fact that supervisor's wage difference between state 4 and 3 can be viewed as a cost of obtaining the true information on the state of productivity.

(CIC1), which prevents a collusion when the realized state is 1, is not binding. It is quite a natural result, since the agent wants it to be known that why she is generating low output is because of low productivity in her working environment. This result, with the fact that (CIC2) is binding, should be interpreted as the supervisor is in a position as if the latter acts like an advocate for the agent according to Tirole (1986).

We have said that S_4 should be higher than S_3 so that the principal can prevent a coalition between the agent and the supervisor. It can be achieved by increasing S_4 or decresing S_3. Since increasing S_4 is costly, the principal tends to give low salary to supervisor at state 3. However, as (CIC'3) implies, you cannot lower S_3 to an amount less than S_2. Otherwise, supervisor offers a side contract to the agent and bribe her when the former fails to observe the productivity level in the environment. The principal sets $S_3 = S_2$ which eliminates the possibility of collusion when the realized state is 3.

Above mentioned reasons make the principal tend to lower both S_3 and S_2 at the same time. Thus, the principal sets $S_1 > S_2$ in order to make sure that supervisor's expected utility is equal to her reservation utility, i.e. so that (SPC) is satisfied. This also explains the fact that although (CIC1) is not binding and the supervisor is already willing to help the agent by reporting low productivity in the environment the principal gives higher wage to supervisor at state 1.

4.2 Other-Regarding Agent ($\lambda_A > 0$, $\lambda_S = 0$)

In this section, we consider the case where the agent compares her wage with the supervisor's wage. Note that the wage of the supervisor is always higher than the agent's wage since the former is at the upper level of the hierarchy ($S_i > W_i$). As a result, the agent can only be inequity averse in our case. Status-seeking is not an option for the agent. ($\lambda_A > 0$)

The participation (individual rationality) constraints are constructed in the same way we follow in the benchmark case. Then, the principal faces with:

$$(SPC^{OA}): \quad EV(S) = \sum_i p_i V(S_i) \geq \overline{V} \equiv V(S_0)$$

$$(APC^{OA}) : EU(W - g(e) - \lambda_A(S - W)) = \sum_i p_i U(W_i - g(e_i) - \lambda_A(S_i - W_i)) \geq \overline{U} \equiv U(W_0)$$

The fact that agent becomes inequity averse does not change the nature of the hidden action problem. The only thing changing is the payoff representations of the agent at state 2 and state 3. The incentive compatibility constraint which makes agent reveal her environment's true level of productivity- when supervisor's monitoring fails- for the other regarding agent is as follows:

$$(AIC^{OA}) : \quad W_3 - g(e_3) - \lambda_A(S_3 - W_3) \geq W_2 - g(e_2 - \Delta\theta) - \lambda_A(S_2 - W_2)$$

Before writing the collusion constraints, we explain the process behind the prevention of collusive behaviour between the supervisor and the agent a bit in detail. There are two main components the briber considers when she attempts to form a coalition with the other party: How much she has to pay and how much she can pay.

How much the briber has to pay is directly related with the minimum amount of side payment necessary which persuades the bribed party into forming a coalition. Any payment lower than minimum acceptable side transfer- which we denote as t_{min} from now on- does not initiate a collusion between the supervisor and the agent. In our cases, the difference between the bribed party's payoff at the true state of nature and her payoff at falsely claimed state of nature is the minimum side transfer that makes her indifferent between accepting the bribe or not accepting it.

How much the briber can pay is directly related with the maximum amount she can transfer to the bribed party without making herself worse off than the case in which she stays loyal to the true state of nature. If the side transfer necessary for coalition forming is higher than this amount, the briber does not prefer to collude with the other party. In our cases, the difference between the briber's payoff at falsely claimed state of nature and her payoff at the true state of nature is the maximum amount of payment she can provide- which we denote as t_{max} from now on- that makes her indifferent between attempting to collude with the other party or not attempting.

In order to cease forming a coalition between the supervisor and the agent, the principal must arrange the payoffs of both parties such that how much the briber has to pay must not be lower than how much she can pay. The principal tries to increase the amount of minimum side transfer at which the bribed party is indifferent to accepting the bribe offer, or tries to decrease the maximum amount of side payment the briber can provide without making herself worse off than the alternative case where she stays loyal to true nature of state, or tries to do a mix of these two strategy. In fact, collusion constraints can be seen as a practice of these two strategies.

We return to the benchmark case to see the tools used in ceasing collusive behaviour.

For the first possible collusion at state 1 (for CIC1) we have: $t_{min} = S_1 - S_2$ and $t_{max} = W_2 - W_1 + g(e_1) - g(e_2)$.

For the second possible collusion at state 4 (for CIC2) we have: $t_{min} = S_4 - S_3$ and $t_{max} = W_3 - W_4 + g(e_4) - g(e_3)$.

For the third possible collusion at state 3 (for CIC3) we have: $t_{min} = W_3 - W_2 + g(e_2 - \Delta\theta) - g(e_3)$ and $t_{max} = S_2 - S_3$.

These equations shows that the principal increases $S_1 - S_2$, $S_4 - S_3$, $W_3 - W_2 + g(e_2 - \Delta\theta) - g(e_3)$ or decreases $W_2 - W_1 + g(e_1) - g(e_2)$, $W_3 - W_4 + g(e_4) - g(e_3)$, $S_2 - S_3$ or mix these two options to prevent bribe actions in benchmark case. Using this fact, we define supervisor's wage difference tool and agent's wage difference tool which principal utilizes in her fight against collusive behaviour in the hierarchy.

Supervisor's wage difference tools:

For (CIC1): $\Delta S_{12} = S_1 - S_2$: Increase S_1, decrease S_2 or do both

For (CIC2): $\Delta S_{43} = S_4 - S_3$: Increase S_4, decrease S_3 or do both

For (CIC3): $\Delta S_{32} = S_3 - S_2$: Increase S_3, decrease S_2 or do both

Agent's wage difference tools:

For (CIC1): $\Delta W_{12} = W_1 - W_2$: Increase W_1, decrease W_2 or do both

For (CIC2): $\Delta W_{43} = W_4 - W_3$: Increase W_4, decrease W_3 or do both

For (CIC3): $\Delta W_{32} = W_3 - W_2$: Increase W_3, decrease W_2 or do both

We now investigate these tools' individual effectiveness and compare them with the ones in the benchmark case throughout the later models. As a side note, we remark that the change in wages is realized through the components independent from the effort level exerted by the agent.

In the case where the agent has other-regarding preferences and considers the wage of the supervisor in her own well-being, we have:

For the first possible collusion the principal faces with, maximum side transfer must satisfy $W_2 - t^{OA}_{max,1} - g(e_2) - \lambda_A(S_2 + t^{OA}_{max,1} - W_2 + t^{OA}_{max,1}) = W_1 - g(e_1) - \lambda_A(S_1 - W_1)$ such that it is not rational for the agent to offer more than $t^{OA}_{max,1}$ when she wants to make supervisor provide false report about productivity to the principal. Then,

$$t^{OA}_{max,1} = \frac{W_2 - g(e_2) - \lambda_A(S_2 - W_2) - W_1 + g(e_1) + \lambda_A(S_1 - W_1)}{1 + 2\lambda_A}$$

and we also have

$$t^{OA}_{min,1} = S_1 - S_2$$

In order to prevent collusion, the principal arranges the main contract such that:

$$t^{OA}_{min,1} \geq t^{OA}_{max,1} \Rightarrow t^{OA}_{min,1} - t^{OA}_{max,1} \geq 0 \quad (CIC1^{OA})$$

$$(CIC1^{OA}): \quad S_1 + \frac{W_1 - g(e_1) - \lambda_A(S_1 - W_1)}{1 + 2\lambda_A} \geq S_2 + \frac{W_2 - g(e_2) - \lambda_A(S_2 - W_2)}{1 + 2\lambda_A}$$

First, note that paying a side transfer not only decrease the agent's monetary payoff but also make her feel worse by increasing the inequality between her and the supervisor. Therefore, the maximum amount of side transfer the agent can provide is reduced for the inequity averse agent comparing the amount with the one in benchmark case. Using agent's wage difference tool (increasing ΔW_{12}) not only directly increases the agents relative monetary payoff at state 1 against state 2 but also results in a better comparative change in inequality between her and the supervisor at state 1. This also creates a decreasing effect on the maximum amount the agent can pay for a bribe. It makes agent more prone to stay at the true state of nature, state 1. On the other hand, increasing ΔS_{12} -from one side- affects and increases minimum side transfer that supervisor accepts to claim false information and- from other side- creates higher comparative inequality at state 1 between agent and supervisor and makes shifting to state 2 a bit more alluring to the agent. It means the positive effect of using supervisor's wage difference tool on preventing bribe is a bit negated when the agent in the hierarchy is inequity averse. To sum up, we can say that individual effectiveness of agent's wage difference tool is increased though things are reverse for the supervisor's wage difference tool. However, the change in both of these tools' individual effectiveness is probably overshadowed by the direct effect of inequity aversion on the maximum amount of side transfer the agent is willing to pay.

For the second possible collusion the principal faces with, maximum side transfer must satisfy $W_3 - t^{OA}_{max,2} - g(e_3) - \lambda_A(S_3 + t^{OA}_{max,2} - W_3 + t^{OA}_{max,2}) = W_4 - g(e_4) - \lambda_A(S_4 - W_4)$ such that it is not rational for the agent to offer more than $t^{OA}_{max,2}$ when she wants to make supervisor provide false report about productivity to the principal. Then,

$$t^{OA}_{max,2} = \frac{W_3 - g(e_3) - \lambda_A(S_3 - W_3) - W_4 + g(e_4) + \lambda_A(S_4 - W_4)}{1 + 2\lambda_A}$$

and we also have

$$t^{OA}_{min,2} = S_4 - S_3$$

In order to prevent collusion, the principal arranges the main contract such that:

$$t^{OA}_{min,2} \geq t^{OA}_{max,2} \Rightarrow t^{OA}_{min,2} - t^{OA}_{max,2} \geq 0 \quad (CIC2^{OA})$$

$$(CIC2^{OA}): \quad S_4 + \frac{W_4 - g(e_4) - \lambda_A(S_4 - W_4)}{1+2\lambda_A} \geq S_3 + \frac{W_3 - g(e_3) - \lambda_A(S_3 - W_3)}{1+2\lambda_A}$$

The nature of the collusion at state 4 is same with the one at state 1. Therefore, changing S_1, S_2, W_1, W_2 with S_4, S_3, W_4, W_3 respectively in the corresponding paragraph above is sufficient to see the changes in the effectiveness of principal's tools.

For the third possible collusion the principal faces with, minimum side transfer must satisfy $W_2 + t^{OA}_{min,3} - g(e_2 - \Delta\theta) - \lambda_A(S_2 - t^{OA}_{min,3} - W_2 - t^{OA}_{min,3}) = W_3 - g(e_3) - \lambda_A(S_3 - W_3)$ so that agent accepts to claim that she is working at state 2, not at the true state of nature, state 3. Then,

$$t^{OA}_{min,3} = \frac{W_3 - g(e_3) - \lambda_A(S_3 - W_3) - W_2 + g(e_2 - \Delta\theta) + \lambda_A(S_2 - W_2)}{1+2\lambda_A}$$

and we also have

$$t^{OA}_{max,3} = S_2 - S_3$$

In order to prevent collusion, the principal arranges the main contract such that:

$$t^{OA}_{min,3} \geq t^{OA}_{max,3} \Rightarrow t^{OA}_{min,3} - t^{OA}_{max,3} \geq 0 \quad (CIC3^{OA})$$

$$(CIC3^{OA}): \quad S_3 + \frac{W_3 - g(e_3) - \lambda_A(S_3 - W_3)}{1+2\lambda_A} \geq S_2 + \frac{W_2 - g(e_2 - \Delta\theta) - \lambda_A(S_2 - W_2)}{1+2\lambda_A}$$

The first thing we should note is the fact that paying a side transfer to an inequity averse agent not only increase her monetary payoff but also make her feel better by decreasing the inequality between her and the supervisor. Thus, a side transfer less than the one in the benchmark case may make the agent accept a bribe offer. On the other hand, using agent's wage difference tool (increasing ΔW_{32}) not only directly increases the agents relative monetary payoff at state 3 against state 2 but also results in a better comparative change in inequality between her and the supervisor. It makes agent more prone to stay at the true state of nature, state 3. Increasing ΔS_{32} -from one side- affects and decreases maximum side transfer that can be offered to the agent and- from other side- creates higher comparative inequality at state 3 and makes shifting to state 2 more alluring to the agent. It means that the positive effect of using supervisor's wage difference tool on preventing bribe is a bit negated when the agent in the hierarchy is inequity averse. To sum up, we can say that individual effectiveness of agent's wage difference tool is increased though things are reverse for the supervisor's wage difference tool. However, the change in both of these tools' individual effectiveness is probably overshadowed by the increasing tendency of inequity averse agent to accept a side transfer.

We now solve the optimal contract problem for the principal. The principal wants to maximize her expected utility, $\sum_i p_i(\theta_i + e_i - S_i - W_i)$, subject to constraints we introduced by choosing the right S_i, W_i, e_i values. In other words, we have to solve the following problem:

$$\underset{(S_i,W_i,e_i)}{max} \sum_i p_i(\theta_i + e_i - S_i - W_i)$$

$$subject\ to \quad (SPC^{OA}), (APC^{OA}), (AIC^{OA}), (CIC1^{OA}), (CIC2^{OA}), (CIC3^{OA})$$

Proposition 2.1: The solution for the effort levels to the principal's problem with an other regarding (inequity averse) agent in the hierarchy has the following properties:

a) $e_1^{OA} = e_3^{OA} = e_4^{OA} > e_2^{OA}$

b) $\frac{\partial e_1^{OA}}{\partial \lambda_A} = \frac{\partial e_2^{OA}}{\partial \lambda_A} = \frac{\partial e_3^{OA}}{\partial \lambda_A} = \frac{\partial e_4^{OA}}{\partial \lambda_A} > 0$

c) $e_1^{OA} = e_3^{OA} = e_4^{OA} > e_2^B = e^*$ and $e_2^{OA} > e_2^B$, there is a threshold $\lambda_A(\Delta\theta)$ value at which $e_2^{OA} = e*$

Proposition 2.1.a. states that the effort level induced by the principal is lower at state 2 when productivity is low, $\underline{\theta}$, and supervisor's report is empty, $r = \phi$, due to the latter's failure to observe the productivity level in the environment. This result is not because of the measures taken to prevent collusive behaviour but to provide necessary incentive to the agent- to satisfy (AIC^{OA}) - which makes her to stay at the the true productivity level $\overline{\theta}$ at state 3. When supervisor fails to monitor the agent, the principal induces lower effort at state 2 than the one at state 3 so that she can make reduction on W_2. The attractiveness of shifting to low productivity state from the higher one is decreased via this way.

Proposition 2.1.b. implies that as the agent cares more about the wage inequality between her and the supervisor, the effort level induced by the principal rises at every state. This is due to the fact that the inequity averse agent does not enjoy being behind in wages and her wage increases with her effort level. The principal can exploit this fact and moderates the increasing cost of effort with the decrease in wage inequality. As agent becomes more sensitive to being behind, it is easier to offset the cost of extra effort with reducing inequality which means the principal induces higher and higher effort levels. Therefore, from the effort side of the principal's problem, we can say that the principal is more prone to choose an agent with higher inequity aversion sensitivity in a pool that consists of identical agents with same properties except their inequity aversion levels, since higher effort means higher output for the principal.

Proposition 2.1.c. is the directly related to Proposition 2.1.b., because we can consider the self interested agent as the one showing zero sensitivity against wage inequality. Thus, principal can induce higher effort levels at every state when agent is inequity averse comparing them with the ones in the benchmark case. The principal makes agent exert more-than-optimal effort levels at state 1, 3 and 4. If the cost moderation effect of reducing wage inequality dominates the need for inducing lower effort and - consequently- lower wage at state 2 to persuade agent stay at state 3 when supervisor fails at monitoring the agent's environment, the principal can also induce more-than-optimal effort at state 2. Since higher the difference between high and low productivity levels are lower the effort level induced at state 2 must be the principal must find an agent with higher inequity aversion sensitivity in order to induce more-than-optimal level of effort at state 2.

Proposition 2.2: All of the constraints, except $CIC1_{OA}$ introduced to the principal's problem with an other regarding (inequity averse) agent in the hierarchy have positive shadow prices, i.e. they are binding.

This is exactly the same result we see in the benchmark problem, since whether the agent is inequity averse or self interested she always prefer to let it known that the reason of lower output (profit) at state 2 is low productivity environment. In that case, the supervisor also supports the agent and acts like an advocate for her by reporting true state of nature which is the one with low productivity.

Proposition 2.3: The solution for the wages of the supervisor to the principal's problem with an other regarding (inequity averse) agent in the hierarchy has the following properties:

a) $S_4^{OA} > S_1^{OA} > S_2^{OA} = S_3^{OA}$

b) $S_1^{OA} < S_1^B$, $S_2^{OA} < S_2^B$, $S_3^{OA} < S_3^B$. S_4^{OA}'s relative position against S_4^B is ambiguous.

Proposition 2.3.a. shows the ranking of the supervisor's wages (which is same with the corresponding part in proposition 1) at different states and the reason behind this result is almost same with the one in corresponding proposition in benchmark case. The difference is that the principal does not consider W_i only while arranging the wages to find optimal contract, but instead try to set $W_i - \lambda_A(S_i - W_i)$ accordingly.

Proposition 2.3.b. implies the fact that when the agent is inequity averse the supervisor's wage at state 1,2 and 3 is lower than the corresponding benchmark wages. This is quite natural since the agent does now care about the wage of supervisor and is affected badly by the wage inequality. To compensate the reduction in agents utility, the principal must increase the agent's wage, and she has also an option to cut supervisor's wage to fortify her former decision. She may want to reduce wage inequality further via a decrease in supervisor's wages, since compensating the wage inequality only through the agent's wages can be very costly. On the other hand, the story at state 4 is a little bit different. First, remember that increasing S_4 is one of the tools to cease bribe activity at state 4 and its individual effectiveness is lower when the agent is inequity averse. It means the principal needs a further increase in S_4 to satisfy collusion constraint at state 4. This negates the effect of principal's decision to reduce supervisor's wages, though which effect is dominant is not certain. Note that this turns S_4 into much more important factor in hiring a supervisor. Since it is good to reduce S_1, S_2 and S_3 when the agent is inequity averse, the principal must increase S_4 to make the same supervisor accept new contract, i.e. to offer her the reservation wage. Otherwise, the principal needs to approach another supervisor candidate with a lower reservation wage. In a world where the higher reservation wage relates with higher skill, this situation can be resulted in working with a low skilled supervisor and loss of profits for the principal. We can consider this result as a disadvantage of having an inequity averse agent in the hierarchy.

Though the ranking between the wages are same, one of the differences lies within the wage dispersion between states. Note that S_1's only purpose is to satisfy participation constraints and there is no use for it in collusion constraints. On the other hand, S_2 and S_3 must decrease further since they are used in to cease bribe for $(CIC2^{OA})$, $(CIC3^{OA})$ and their individual effectiveness is lower for the case with inequity averse agent. The decrease in S_2 and S_3 should be more than before, and it creates a wider wage dispersion between S_1 and $S_2 = S_3$. We have already explained that a further increase in S_4 is needed to satisfy collusion constraint at state 4. This also creates a wider wage dispersion between S_4 and S_1. In the end, although the ranking of supervisor's wages at different states is same with the one in benchmark case, the wage dispersion between them becomes wider when the agent in the hierarchy is inequity averse. This result is definitely not a thing a risk averse supervisor wants.

Proposition 2.4: The solution for the wages of the agent to the principal's problem with an other regarding (inequity averse) agent in the hierarchy has the following properties:

a) $W_3^{OA} - g(e_3^{OA}) - \lambda_A(S_3^{OA} - W_3^{OA}) > W_4^{OA} - g(e_4^{OA}) - \lambda_A(S_4^{OA} - W_4^{OA}) > W_1^{OA} - g(e_1^{OA}) - \lambda_A(S_1^{OA} - W_1^{OA}) > W_2^{OA} - g(e_2^{OA}) - \lambda_A(S_2^{OA} - W_2^{OA})$

and $W_3^{OA} > W_4^{OA} > W_1^{OA} > W_2^{OA}$

b) $W_i^{OA} > W_i^B$

The ranking of agent's utilities and the ranking of agent's wages at different states when the agent is inequity averse is same with the ones in benchmark case's proposition. The reason behind the ranking of utilities is similar to benchmark case's. However, there is an important difference. In the benchmark case the principal was considering the monetary payoff of the agent while arranging her wage. When the agent has other regarding preferences the principal must also think about the sense of inequality between the agent and the supervisor. Proposition 2.4.a. remarks this fact.

Though the ranking of the wages is also same with the one in the benchmark case the difference between wages may change due to inequity aversion. The fact that we have $S_4 > S_1 > S_2$ results in a higher gap between W_4 and W_1, and W_1 and W_2. The compensation for the wage inequality is higher at state 4 than at state 1, and is higher at state 1 than at state 2. The difference between W_3 and W_4 can be lower since $S_4 > S_3$ and the fact that compensating wage inequality is easier at state 3 than at state 4. However, as the difference between S_4 and S_3 increases, the difference between W_3 and W_4 must also increase to satisfy $(CIC3^{OA})$ condition. Therefore, the total change in the gap between these two wages is ambiguous. To sum up, although their ranking is same with the one in proposition 1 the dispersion between the wages at state 1,2 and 4 increases but it is not certain for the states 3 and 4. Remember that as the dispersion between the wages at different states increases it gets harder to work with risk averse agents.

Proposition 2.4.b. states that inequity averse agent's wage is higher than the self interested agents wage so that the participation constraint of the agent is satisfied. This is quite natural since the agent is now worse off due to wage inequality and the principal must compensate her by giving her extra wage payment (and make her better off through both monetary and non-monetary payoff). Moreover, we have already stated that the principal induces higher effort when the agent is inequity averse which also shows why agent gets a wage rise.

4.3 Other Regarding Supervisor ($\lambda_A = 0$, $\lambda_S \neq 0$)

We now consider the case where the supervisor has other-regarding preferences and compares her wage with the agent's wage. Supervisor's wage is always higher than the wage of the agent, since the former is at the upper level of the given hierarchy. ($S_i > W_i$) As a result, the supervisor can show two different behaviour unlike an other-regarding agent. She may either be inequality averse and feels bad about the fact that she is earning a higher wage than her co-worker, or be status-seeker and thrives from being ahead which is a sign of her position (status) against her co-worker. For the status-seeker supervisor we use $\lambda_S < 0$, and for the inequity averse one we use $0.5 \geq \lambda_S > 0$. The reason why $\lambda_S > 0$ is not the only constraint for the inequity aversion parameter of the supervisor is explained later throughout the analyse of principal's problem.

The individual rationality conditions (participation constraints) are constructed with the same approach we take in the previous models. Then, we have:

$$(SPC^{OS}): \quad EV(S - \lambda_S(S - W)) = \sum_i p_i V(S_i - \lambda_S(S_i - W_i)) \geq \overline{V} \equiv V(S_0)$$

$$(APC^{OS}): \quad EU(W - g(e)) = \sum_i p_i U(W_i - g(e_i)) \geq \overline{U} \equiv U(W_0)$$

Whether the supervisor has other regarding preferences or not does not affect the nature of hidden action problem. Thus, for the case the supervisor is other-regarding, the incentive compatibility constraint which makes agent reveal true state of nature in her environment when supervisor's monitoring fails is as follows:

$$(AIC^{OS}): \quad W_3 - g(e_3) \geq W_2 - g(e_2 - \Delta\theta)$$

In the case where the supervisor considers wage of the agent in the former's well-being, now we start to derive collusion constraints and look for the change in effectiveness of the tools the principal uses to cease collusive behaviour.

For the first possible collusion when the realized state is 1, minimum side transfer must satisfy $S_2 + t^{OS}_{min,1} - \lambda_S(S_2 + t^{OS}_{min,1} - W_2 + t^{OS}_{min,1}) = S_1 - \lambda_S(S_1 - W_1)$ so that the supervisor accepts to falsely claim that she does not know the productivity level in the environment. Then,

$$t^{OS}_{min,1} = \frac{S_1 - \lambda_S(S_1 - W_1) - (S_2 - \lambda_S(S_2 - W_2))}{1 - 2\lambda_S}$$

and we also have,

$$t^{OS}_{max,1} = W_2 - g(e_2) - (W_1 - g(e_1))$$

In order to prevent collusion, the principal arranges the main contract such that:

$$t^{OS}_{min,1} \geq t^{OS}_{max,1} \Rightarrow t^{OS}_{min,1} - t^{OS}_{max,1} \geq 0 \quad (CIC1^{OS})$$

$$(CIC1^{OS}): \quad \frac{S_1 - \lambda_S(S_1 - W_1)}{1 - 2\lambda_S} + W_1 - g(e_1) \geq \frac{S_2 - \lambda_S(S_2 - W_2)}{1 - 2\lambda_S} + W_2 - g(e_2)$$

First, note that paying a side transfer to the status-seeker supervisor not only increase her monetary payoff directly but also make her feel better by increasing the wage difference between her and the agent, i.e. by increasing her position (status) against the agent. Hence, a side transfer can show more impact to make supervisor more prone to accept a bribe offer comparing the situation with the one in benchmark case. On the other hand, using supervisor's wage difference tool (increasing ΔS_{12}) not only directly increases the supervisor's monetary payoff at state 1 relative to the one at state 2 but also results in a better comparative change in her status difference at state 1. Moreover, second effect is amplified as the supervisor becomes more status-seeker. She is now more prone to stay at state 1. We can say that individual effectiveness of supervisor's wage difference tool is increased. For the agent's wage difference tool, increasing ΔW_{12} shows the same effect on maximum side transfer the agent can offer comparing it's effect with the one in benchmark case. However, when the supervisor is status-seeker using ΔW_{12} also affects the amount of minimum side payment the supervisor accepts which is not the case for a self-interested supervisor. Increasing ΔW_{12} creates lesser comparative inequality (weaker signal of status) between the supervisor and the agent at state 1, and makes shifting to state 2 more alluring for the supervisor. This tendency also increases as the supervisor becomes more sensitive to the sign of status difference. Thus, the positive effect of increasing ΔW_{12} on the maximum side transfer to prevent bribe is negated a bit. Using agent's wage difference tool -individually- is not effective as if it was in the benchmark case in the prevention of a coalition between supervisor and agent, when state 1 is realized.

Things becomes reverse for an inequity averse supervisor. First, note that paying a side transfer to the inequity averse supervisor make her feel worse due to the increase in inequality between her and the agent, and negates the positive effect on the payoff coming from the monetary side payment. Thus, a side transfer's impact on making the supervisor accept a bribe offer is reduced comparing it with the one in benchmark case.

Using supervisor's wage difference tool (increasing ΔS_{12}) - from one side- increases the monetary payoff of the supervisor at state 1 relative to the one at state 2. However, - from the other side- it results in a higher comparative change in the inequality between the agent and the supervisor at state 1, and makes supervisor feel relatively much more worse since she cares about the agent's well being. This feeling becomes more prominent as the supervisor is more sensitive to inequality (as λ_S increases). In the end, it makes agent become a bit more prone to shifting to state 2. We can say that individual effectiveness of supervisor's wage difference tool is reduced when an inequity averse supervisor is in the hierarchy. Using agent's wage difference tool ΔW_{12}, on the other hand, shows the same effect on the maximum side transfer the agent can offer again. In both benchmark case and current case, the maximum side transfer that can be offered is reduced by the same amount. However, using ΔW_{12} also affects the amount of minimum side transfer the supervisor accepts for a bribe, when the supervisor in the hierarchy is inequity averse. Increasing ΔW_{12} creates lesser comparative inequality between the supervisor and the agent at state 1, and makes shifting to state 2 less alluring for an inequity averse supervisor. This tendency also increases as the supervisor becomes more sensitive to wage inequality. Therefore, the positive effect of increasing ΔW_{12} on preventing collusion at state 1 by decreasing the maximum side transfer the agent can pay is now amplified. Individual effectiveness of using agent's wage difference tool is higher now comparing it with the one in benchmark case to prevent a supervisor-agent collation, when the realized state is 1.

For the second possible collusion- when the realized state is 4- , minimum side transfer must satisfy $S_3 + t^{OS}_{min,2} - \lambda_S(S_3 + t^{OS}_{min,2} - W_3 + t^{OS}_{min,2}) = S_4 - \lambda_S(S_4 - W_4)$ so that the supervisor accepts to falsely claim that she was not able to monitor the productivity level in the environment. Then,

$$t^{OS}_{min,2} = \frac{S_4 - \lambda_S(S_4 - W_4) - (S_3 - \lambda_S(S_3 - W_3))}{1 - 2\lambda_S}$$

and we also have,

$$t^{OS}_{max,2} = W_3 - g(e_3) - (W_4 - g(e_4))$$

In order to prevent collusion, the principal arranges the main contract such that:

$$t^{OS}_{min,2} \geq t^{OS}_{max,2} \Rightarrow t^{OS}_{min,2} - t^{OS}_{max,2} \geq 0 \quad (CIC2^{OS})$$

$$(CIC2^{OS}): \quad \frac{S_4 - \lambda_S(S_4 - W_4)}{1 - 2\lambda_S} + W_4 - g(e_4) \geq \frac{S_3 - \lambda_S(S_3 - W_3)}{1 - 2\lambda_S} + W_3 - g(e_3)$$

Since satisfying $(CIC2^{OS})$ is same with $(CIC1^{OS})$ in nature (the agent tries to bribe the supervisor when the latter successfully monitor the environment of the former) the reasons behind the change in effectiveness of the principal's tools for the second possible collusion are also same with the ones behind we remarked for $(CIC1^{OS})$. ΔS_{43} and ΔW_{43} take the place of ΔS_{12} and ΔW_{12}, state 4 and state 3 take the place of state 1 and state 2 respectively.

Before deriving the necessary conditions to stop collusion between the supervisor and the agent when the supervisor fails to monitor agent, the context of $t^{OS}_{min,1}$ and $t^{OS}_{min,2}$ makes us to state the following:

Proposition 3: It is impossible for the agent to bribe the supervisor in $(CIC1^{OS})$ and $(CIC2^{OS})$ conditions when $\lambda_S = 0.5$.

Proposition 3 implies that when the supervisor's sensitivity to wage inequality between her and the agent reach a certain level (in our case it is 0.5, since we use Fehr and Schmidt's (1999) linear inequity aversion utility formula) she does not accept any coalition offer coming from the agent. It is because of the fact that there exists a certain value for λ_S where the disutility coming from accepting the bribe and increasing the inequality completely offsets the monetary gain of the corresponding side transfer.

We later analyze the principal's problem when there is an inequity averse supervisor with $\lambda_S = 0.5$ in the hierarchy in the next subsection.

$t^{OS}_{min,1}$ and $t^{OS}_{min,2}$ also explain our choice of $0 < \lambda_S < 0.5$ while analyzing the principal's problem with inequity averse supervisor. For $\lambda_S > 0.5$, when the agent comes with a bribe offer, the supervisor pays the side transfer, which the agent supposed to pay, in order to make herself feel better by decreasing inequality. This is completely unrealistic. Thus, we accept that the supervisor's inequity aversion sensitivity cannot be higher than 0.5.

For the third possible collusion when the realized state is 3, maximum side transfer the supervisor can offer must satisfy $S_2 - t^{OS}_{max,3} - \lambda_S(S_2 - t^{OS}_{max,3} - W_2 - t^{OS}_{max,3}) =$

$S_3 - \lambda_S(S_3 - W_3)$ such that it is not rational for the supervisor to offer more than $t_{max,3}$ when she wants to make agent announce wrong level of productivity. Then,

$$t^{OS}_{max,3} = \frac{S_2 - \lambda_S(S_2 - W_2) - (S_3 - \lambda_S(S_3 - W_3))}{1 - 2\lambda_S}$$

and we also have,

$$t^{OS}_{min,3} = W_3 - g(e_3) - (W_2 - g(e_2 - \Delta\theta))$$

In order to prevent collusion, the principal arranges the main contract such that:

$$t^{OS}_{min,3} \geq t^{OS}_{max,3} \Rightarrow t^{OS}_{min,3} - t^{OS}_{max,3} \geq 0 \quad (CIC3^{OS})$$

$$(CIC3^{OS}): \quad \frac{S_3 - \lambda_S(S_3 - W_3)}{1 - 2\lambda_S} + W_3 - g(e_3) \geq \frac{S_2 - \lambda_S(S_2 - W_2)}{1 - 2\lambda_S} + W_2 - g(e_2 - \Delta\theta)$$

Note that when AIC holds with equality, $(CIC3^{OS})$ turns into:

$$(CIC3^{OS'}): \quad S_3 - \lambda_S(S_3 - W_3) \geq S_2 - \lambda_S(S_2 - W_2)$$

First, note that paying a side transfer to the agent not only decrease the monetary payoff of the status-seeker supervisor but also make her feel worse due to disutility coming from the reduction in her relative status against the agent. Thus, the maximum amount of side transfer the supervisor can provide is reduced for the status-seeker supervisor comparing it with the one in benchmark case.

Using supervisor's wage difference tool (increasing ΔS_{32}) not only directly increases the supervisor's relative monetary payoff at state 3 against state 2 but also results in a higher comparative change in inequality between her and the agent at state 3. This also creates a decreasing effect on the maximum amount the supervisor can pay for a bribe. Thus, it makes supervisor more prone to stay at the true state of nature, state 3. On the other hand, increasing ΔW_{32} -from one side- affects and increases minimum side transfer that agent accepts to claim false information and- from other side- creates lesser comparative inequality at state 3 between agent and supervisor and makes shifting to state 2 a bit more alluring to the supervisor. Thus, the positive effect of using agent's wage difference tool on preventing bribe is a bit negated when the supervisor in the hierarchy is status-seeker. To sum up, we can say that individual effectiveness of supervisor's wage difference tool is increased though things are different for the agent's wage difference tool. However, the change in both of these tools' individual effectiveness is probably overshadowed by the effect of status-seeking on the maximum amount of side transfer the supervisor is willing to pay.

Things become reverse for an inequity averse supervisor. First, note that paying a side transfer to agent make her feel better due to the decrease in inequality between her and the agent, and improves the negative effect on the payoff coming from the monetary side payment. Thus, the maximum amount of side transfer the supervisor can provide is risen for the inequity averse supervisor comparing it with the one in benchmark case.

Using supervisor's wage difference tool (increasing ΔS_{32}) - from one side- increases the monetary payoff of the supervisor at state 3 relative to the one at state 2. However, - from the other side- it results in a higher comparative change in the inequality between the agent and the supervisor at state 3, and makes supervisor feel relatively much more worse since she cares about the agent's well being. This feeling becomes more prominent as the supervisor is more sensitive to inequality (as λ_S increases). This makes supervisor become a bit more prone to shifting to state 2. We can say that individual effectiveness of supervisor's wage difference tool is reduced when an inequity averse supervisor is in the hierarchy. Using agent's wage difference tool ΔW_{32}, on the other hand, shows the same effect on the minimum side transfer the agent accepts for a bribe again. In both benchmark case and current case the minimum side transfer that can be accepted is increased by the same amount. However, using ΔW_{32} also affects the amount of maximum side transfer the supervisor is willing to pay for a bribe, when the supervisor in the hierarchy is inequity averse. Increasing ΔW_{32} creates lesser comparative inequality between the supervisor and the agent at state 3, and makes shifting to state 2 less alluring for an inequity averse supervisor. This tendency also increases as the supervisor becomes more sensitive to wage inequality. Thus, the positive effect of increasing ΔW_{32} on preventing collusion at state 3 by increasing the minimum side transfer the supervisor can pay is now amplified. Individual effectiveness of using agent's wage difference tool is higher now comparing it with the one in benchmark case to prevent a supervisor-agent collation, when the realized state is 3. To sum up, we can say that individual effectiveness of supervisor's wage difference tool is decreased though things are different for the agent's wage difference tool. However, the change in both of these tools' individual effectiveness is probably overshadowed by the effect of inequity aversion on the maximum amount of side transfer the supervisor is willing to pay.

Next, we solve principal's problem when the hierarchy has an other-regarding supervisor to find the optimal contract. The principal wants to maximize her expected utility $\sum_i p_i(\theta_i + e_i - S_i - W_i)$, subject to constraints we introduced by choosing the right S_i, W_i, e_i values. In other words, we have to solve the following problem:

$$\underset{(S_i,W_i,e_i)}{max} \sum_i p_i(\theta_i + e_i - S_i - W_i)$$

$$subject\ to \quad (SPC^{OS}), (APC^{OS}), (AIC^{OS}), (CIC1^{OS}), (CIC2^{OS}), (CIC3^{OS})$$

Proposition 4.1: The solution for the effort levels to the principal's problem with an other-regarding supervisor in the hierarchy has the following properties:

For the inequity averse supervisor:

i) $e_1^{OS} = e_3^{OS} = e_4^{OS} > e_2^{OS}$

ii) $e_1^{OS} = e_3^{OS} = e_4^{OS} > e^B = e^*$ and $e_2^{OS} > e_2^B$, there is a threshold $\lambda_S(\Delta\theta)$ value at which $e_2^{OS} = e*$

For the status seeker supervisor:

i) $e_1^{OS} = e_3^{OS} = e_4^{OS} > e_2^{OS}$

ii) $e_1^{OS} = e_3^{OS} = e_4^{OS} < e^B = e^*$ and $e_2^{OS} < e_2^B$

The relationship between effort and λ_S is $\frac{\partial e_i^{OS}}{\partial \lambda_S} > 0$.

For both type of hierarchies which includes the status seeker or the inequity averse supervisor, effort level induced at state 2 is lower than the ones at other states, when productivity is low, $\underline{\theta}$, and supervisor's report is empty, $r = \phi$, due to the latter's failure to monitor the agent's environment. The result is not because of the measures taken to prevent collusive behaviour but due to the necessity to provide an incentive to the agent (to satisfy AIC^{OS}) which makes her announce the true productivity level when it is not observed. Principal induces lower effort at state 2 so that she can reduce W_2 in order to make earning W_3 and state 3 more appalling.

For the inequity averse supervisor, proposition 4.1 implies that the principal induces higher effort levels for the agent than the ones in benchmark case (which means more-than-optimal effort levels at state 1,3 and 4). This is because of the fact that inequity averse supervisor does not enjoy being ahead, and the principal increases wage of the agent in order to reduce wage inequality and to satisfy the supervisor's participation constraint mainly. A rise in the wages makes agent accept exerting higher effort. The increase in agent wages is somewhat compensated with higher agent effort and higher output. Furthermore, as the supervisor becomes more inequity averse the increase in agent wages to satisfy her must be higher. It means that the principal should induce higher and higher effort levels. If the need to satisfy the inequity averse supervisor through an increase in the agent's wage dominates the need for a reduction of her wage at state 2 to satisfy AIC^{OS}, the principal may has to induce more-than-optimal effort at state 2 also.

Note that after the optimal effort level, the cost of effort which induces the same profit increase as the wage increase is higher than the utility gain of the agent coming from a rise in her wage. Therefore, since the principal has to also satisfy the agent's participation constraint at the same time, the principal is probably worse off having an inequity averse supervisor in the hierarchy, and it hurts more as the the supervisor becomes more sensitive to wage inequality. Even if this is the case, it is always better than increasing only supervisor's wages to compensate the disutility coming from the wage inequality, since supervisor is not a productive unit in our hierarchy models.

On the other hand, the induced effort levels are lower in the case where the hierarchy has a status-seeker supervisor. Since the status-seeker supervisor sees the wage inequality as a sign of status, she enjoys being ahead. Thus, principal decreases the agent's wage to use supervisor's this kind of personality and exploits wage inequality. Reduction in wages means that the agent now exerts lower effort than before in order to satisfy her participation constraint. As the supervisor becomes more sensitive to her sign of status, the agent's wage and consequently the exerted effort falls further.

It is possible to think that inducing less-than-optimal effort can be seen as a lost opportunity to get higher output and higher profits. However, we want to remark that supervisor earns a wage without producing anything and lowering agent's wages also opens a path in which the principal can reduce supervisor's wage too thanks to the latter's enjoyment she gets from wage inequality (remember the supervisor always gets higher wage since she is at the upper level in the hierarchy). Lowering a wage that does not provide any output is definitely a thing the principal wants.

Proposition 4.2: All of the constraints, except $(CIC1^{OS})$ introduced to the principal's problem with an other regarding supervisor in the hierarchy are binding, i.e. have positive shadow prices.

This is the same result we see in benchmark case. Since whether the supervisor is other-regarding or self interested, the agent always prefer to make it known as the fact that the reason of lower profits at state 2 is because of low productivity environment. The supervisor also knows the agent's choice and advocates for her and reports the true state of nature, $r = \underline{\theta}$

Proposition 4.3: The solution for the wages of the agent to the principal's problem with an other regarding supervisor in the hierarchy has the following properties:

a) $W_3^{OS} - g(e_3^{OS}) > W_4^{OS} - g(e_4^{OS}) > W_1^{OS} - g(e_1^{OS}) > W_2^{OS} - g(e_2^{OS})$

and

$W_3^{OS} > W_4^{OS} > W_1^{OS} > W_2^{OS}$

b)

$$(CIC2^{OS}): \quad \frac{S_4^{OS} - \lambda_S(S_4^{OS} - W_4^{OS})}{1-2\lambda_S} + W_4^{OS} = \frac{S_3^{OS} - \lambda_S(S_3^{OS} - W_3^{OS})}{1-2\lambda_S} + W_3^{OS}$$

The ranking of the wages is completely same with the results in benchmark case. The reason behind it is also same. The only difference is that principal does not only concern about setting right S_i but also cares about arranging $S_i - \lambda_S(S_i - W_i)$. This also makes the formulas for $(CIC2^{OS})$ and $(CIC2)$ a little bit different, though the fact that both of them binds at optimal solution is the important thing. We refer the reader to look at corresponding explanations for proposition 1.

Though the rankings are same, the main differences lies at the level of these wages and the dispersion between them. With the help of proposition 4.1, we know that the principal needs to reduce agent wages at every state to satisfy the needs of status-seeker supervisor. As a result, there is a decrease in agent's wage at every state coming from this effect. Since W_1 does not play a role in any of the collusion constraints and agent's incentive constraint, it is certain that W_1^{OS} is lower than W_1^B.

W_2 is needed to satisfy (AIC) and $(CIC3)$ constraints. Satisfying (AIC) has the same nature in both benchmark case and the case where the principal deals with other-regarding supervisor. On the other hand, decreasing W_2 is less effective on satisfying $(CIC3)$ when the supervisor is status seeker. Thus, a higher amount of decrease in W_2 is necessary to prevent collusion when the realized state is 3. The result at the end is not only $W_2^{OS} < W_2^B$ but also a higher wage dispersion between W_1^{OS} and W_2^{OS}.

W_4 is important to prevent collusion when the realized state is 4, $(CIC2)$, and we also know that when the supervisor in the hierarchy is status-seeker increasing W_4 now show less impact on ceasing collusive behaviour. As a result, a higher increase in W_4 is needed to satisfy $(CIC2)$. However, whether this effect on W_4 dominates the need of a decrease in W_4 due to status-seeker supervisor's participation constraint or not is ambiguous. We can not make certain statements on the ranking between W_4^{OS} and W_4^B. In any way, the gap between W_4 and W_1 definitely increases for the current case.

Arranging W_3 is the most complicated one for the principal. It is utilized to satisfy (AIC), $(CIC2)$ and $(CIC3)$ at the same time. It's role and effectiveness on the satisfaction of (AIC) has the same nature for both other-regarding and self-interested supervisor. On the other hand, our solution to the principal's problem implies that the need of increasing W_3 to satisfy $(CIC3)$ dominates the need of decreasing it to satisfy $(CIC2)$. We also know that increasing W_3 to prevent collusion at state 3 has less impact when the supervisor in the hierarchy is status-seeker. Hence, a further increase in W_3 is necessary for the satisfaction of $(CIC3)^{OS}$ comparing it with $(CIC3)$. Again, whether the decrease in W_3 coming from the need to satisfy the participation constraint of status-seeker supervisor is dominated by this further increase in W_3 is ambiguous. Thus, the ranking between W_3^{OS} and W_3^B is not certain. On the other hand, the further increase in W_3 to satisfy $(CIC3)$ is less than the further increase needed in W_4 to satisfy $(CIC2)$. (Remember that there is also a downward pressure on W_3 in order to satisfy $(CIC2)$ at the same time.) Thus, the dispersion between W_3 and W_4 decreases a bit when the supervisor in the hierarchy is status-seeker.

To sum up, when the hierarchy has a status-seeker supervisor the ranking of the agent wages is same with the one in benchmark case. However, there is a wider dispersion between W_4, W_1 and W_2 and a bit narrower dispersion between W_3 and W_4. At state 1 and 2, the principal certainly gives lower wages to the agent than the corresponding wages in benchmark case, although the situation is not that clear for state 3 and 4. At these states, benchmark wages (W_3^B, W_4^B) can be higher or lower than current wages of the agent (W_3^{OS} and W_4^{OS}). Note that a wider dispersion between wages at different states disturb risk averse agents. The fact that we have now wider wage dispersion between three states (and only one narrower wage dispersion) can make it difficult for principal to work with risk averse agents, when the hierarchy has a status seeker supervisor.

Things are different when the supervisor in the hierarchy is inequity averse. With the help of proposition 4.1, we know that the principal needs to increase the agent's efforts and wages at every state to satisfy the participation constraint of an inequity averse supervisor. There is an increase in agent's wage at every state coming from this effect. Since W_1 does not play a role in any of the collusion constraints and agent's incentive constraint, it is certain that W_1^{OS} is higher than W_1^B in this case.

W_2 is needed to satisfy (AIC) and $(CIC3)$ constraints. Satisfying (AIC) has the same nature in both benchmark case and the case where the principal deals with other-regarding supervisor. On the other hand, decreasing W_2 is more effective on satisfying $(CIC3)$ when the supervisor is inequity averse. Thus, a lower amount of decrease in W_2 is necessary to prevent collusion when the realized state is 3. The result at the end is not only $W_2^{OS} > W_2^B$ but also a narrower wage dispersion between W_1^{OS} and W_2^{OS}.

W_4 is important to prevent collusion when the realized state is 4, $(CIC2)$, and we also know that when the supervisor in the hierarchy is inequity averse increasing W_4 now show higher impact on ceasing collusive behaviour. As a result, a lesser increase in W_4 is needed to satisfy $(CIC2)$. However, whether this effect on W_4 dominates the need of a increase in W_4 due to inequity averse supervisor's participation constraint or not is ambiguous. We can not make certain statements on the ranking between W_4^{OS} and W_4^B. In any way, the gap between W_4 and W_1 definitely decreases in this case.

Arranging W_3 is the most complicated one for the principal. It is utilized to satisfy (AIC), $(CIC2)$ and $(CIC3)$ at the same time. It's role and effectiveness on the satisfaction of (AIC) has the same nature for both other-regarding and self-interested supervisor. On the other hand, our solution to the principal's problem implies that the need of increasing W_3 to satisfy $(CIC3)$ dominates the need of decreasing it to satisfy $(CIC2)$. We also know that increasing W_3 to prevent collusion at state 3 has more impact when the supervisor in the hierarchy is inequity averse. Hence, a lesser increase in W_3 is necessary for the satisfaction of $(CIC3)^{OS}$ comparing it with $(CIC3)$.

Again, whether the increase in W_3 coming from the need to satisfy the participation constraint of inequity averse supervisor is dominated by this lesser increase effect on W_3 is ambiguous. Thus, the ranking between W_3^{OS} and W_3^B is not certain. The decrease in the increase in W_3 to satisfy $(CIC3)$ is less than the one we see in W_4 to satisfy $(CIC2)$. (Remember that there was also a downward pressure on W_3 in order to satisfy $(CIC2)$ at the same time, and the individual effectiveness of decreasing W_3 for this case has increased.) Thus, the dispersion between W_3 and W_4 increases a bit when the supervisor in the hierarchy is inequity averse.

To sum up, when the hierarchy has an inequity averse supervisor the ranking of the agent wages is same with the one in benchmark case. However, there is a narrower dispersion between W_4,W_1 and W_2 and a bit wider dispersion between W_3 and W_4. At state 1 and 2, the principal certainly gives higher wages to the agent than the corresponding wages in benchmark case, although the situation is not that clear for state 3 and 4. At these states, benchmark wages (W_3^B, W_4^B) can be higher or lower than current wages of the agent (W_3^{OS} and W_4^{OS}). Note that a narrower dispersion between wages at different states is good for risk averse agents. The fact that we have now narrower wage dispersion between three states (and only one wider wage dispersion case) can make it easier to work with risk averse agents for the principal, when there is an inequity averse supervisor in the hierarchy.

Proposition 4.4: The solution for the wages of the supervisor at different states to the principal's problem with an other regarding supervisor in the hierarchy has the following properties:

a) $S_4^{OS} - \lambda_S(S_4^{OS} - W_4^{OS}) > S_1^{OS} - \lambda_S(S_1^{OS} - W_1^{OS}) > S_3^{OS} - \lambda_S(S_3^{OS} - W_3^{OS}) = S_2^{OS} - \lambda_S(S_2^{OS} - W_2^{OS})$

b) For inequity averse supervisor: $(0 < \lambda_S < 0.5)$

$S_2^{OS} > S_3^{OS}$, $S_4^{OS} > S_3^{OS}$, $S_1^{OS} > S_3^{OS}$, and the ranking between S_1^{OS}, S_2^{OS} and S_4^{OS} is ambiguous.

For status-seeker supervisor: $(0 > \lambda_S)$

$S_4^{OS} > S_1^{OS} > S_2^{OS}$ and $S_3^{OS} > S_2^{OS}$, and the ranking of S_3^{OS} against S_1^{OS} and S_4^{OS} is ambiguous.

c) For inequity averse supervisor: $S_i^{OS} > S_i^B$

For status-seeker supervisor: $S_i^{OS} < S_i^B$

The ranking of the supervisor's utilities at different states in Proposition 4.4.a. is same with the ranking in benchmark proposition 1. The explanation in which we can use $S_i^{OS} - \lambda_S(S_i^{OS} - W_i^{OS})$ instead of S_i is also same. We cannot say the same thing for the ranking of the supervisor's wages at different states as it is seen in Proposition 4.4.b. The reason of these differences stems from the fact that although the utilities of the supervisor is ranked in the same way she is now other regarding and the ranking of agent's wages at different states affects these utilities (and consequently, wages of the supervisor).

For inequity averse supervisor, proposition 4.3.a and 4.4.a guarantee that the minimum wage of the supervisor occurs at state 3 (S_3^{OS}), since W_3^{OS} is the highest wage for the agent and it allows principal to abuse comparatively lower inequality which makes the inequity averse supervisor feel better. In other words, the principal is inclined to use the utility gain from inequity aversion instead of direct monetary wage increase. On the other hand, exact results cannot be extracted for the ranking between S_1^{OS}, S_2^{OS} and S_4^{OS}. The fact that we have $W_4^{OS} > W_1^{OS} > W_2^{OS}$ may not guarantee that there is $S_2^{OS} > S_1^{OS} > S_4^{OS}$, since the probabilities of which state the principal faces with is random (though they are exogenous and known) and the exact shape of the utility function of supervisor is not known. The gap between the utilities in proposition 4.4.a depends on these factors and the principal has to arrange S_1^{OS}, S_2^{OS} and S_4^{OS} accordingly. However, if the principal had faced with almost linear supervisor's utility, and an environment and a supervisor technology with $p_1 = p_2 = p_3 = p_4$, only an infinitesimal gap between $S_4^{OS} - \lambda_S(S_4^{OS} - W_4^{OS})$, $S_1^{OS} - \lambda_S(S_1^{OS} - W_1^{OS})$ and $S_2^{OS} - \lambda_S(S_2^{OS} - W_2^{OS})$ would have been necessary and we would have definitely seen $S_2^{OS} > S_1^{OS} > S_4^{OS}$ due to $W_4^{OS} > W_1^{OS} > W_2^{OS}$.

For status seeker supervisor, proposition 4.4.a and the fact that W_2^{OS} is the smallest wage for the agent guarantee that the minimum wage for the supervisor occurs at state 2, since smallest wage for agent means highest possibility for principal to abuse supervisor's status-seeking behaviour. Due to similar reasons above, we can also rank S_4^{OS} above S_1^{OS}. On the other hand, the ranking between S_3^{OS} against S_1^{OS} and S_4^{OS} is ambiguous because of the same reasons we have in the case for inequity averse supervisor. The utility function's shape and probabilities of state occurrences differ and change the gap between the rankings of supervisor's utilities at different states. For an almost linear supervisor's utility function and $p_1 = p_2 = p_3 = p_4$, we would definitely have $S_1^{OS} < S_4^{OS} < S_3^{OS}$.

Proposition 4.4.c. is the direct result of the fact that the hierarchy has now an other-regarding supervisor. To satisfy supervisor's participation constraint, the principal has to increase supervisor's wage at every state since the inequality hurts the inequity averse supervisor so that the principal can compensate the negative effect of inequality. In contrast, the status-seeker supervisor enjoys being ahead, and the principal abuses the fact that positive feeling for the status-seeker supervisor coming from the wage inequality (sign of status) is substitutable for direct monetary gain. At the end, the principal satisfies the status-seeker supervisor's reservation wage with lower monetary wage than the one in benchmark case and with some sign of status.

4.3.1 Special Case: Inequity Averse Supervisor with $\lambda_S = 0.5$

In previous section, there is a special and an extreme case in which it is impossible for the agent to collude with supervisor since the former is not able to change the latter's utility at state 1 or at state 4 by giving her any amount of side payment. In this section we analyse what happens in this extreme possibility.

The individual rationality conditions (participation constraints) are as follows:

$$(SPC^{0.5}): \quad EV(S - \lambda_S(S - W)) = EV(0.5S + 0.5W) = \sum_i p_i V(0.5S_i + 0.5W_i) \geq \overline{V} \equiv V(S_0)$$

$$(APC^{0.5}): \quad EU(W - g(e)) = \sum_i p_i U(W_i - g(e_i)) \geq \overline{U} \equiv U(W_0)$$

The principal still faces with hidden action problem and she has to give necessary incentive to the agent in order to make the latter announce true productivity level in her working environment, when the supervisor fails to report productivity level:

$$(AIC^{0.5}): \quad W_3 - g(e_3) \geq W_2 - g(e_2 - \Delta\theta)$$

We have already found that it is impossible to form a coalition at state 1 and 4, when $\lambda_S = 0.5$ for the inequity averse supervisor. Thus, satisfying $(CIC1)$ and $(CIC2)$ conditions is not necessary in current case.

For the third possible collusion when the realized state is 3, maximum side transfer the supervisor can offer must satisfy $S_2 - t^{0.5}_{max,3} - 0.5(S_2 - t^{0.5}_{max,3} - W_2 - t^{0.5}_{max,3}) = S_3 - 0.5(S_3 - W_3)$ such that it is not rational for the supervisor to offer more than $t^{0.5}_{max,3}$ when she wants to make agent announce wrong level of productivity (state 2).

Note that paying a side transfer to the agent does not change well-being of the supervisor (which is why we call this case as extreme) until the monetary side of the agent's utility becomes higher than the corresponding part of the supervisor's utility. Because, after that, the supervisor falls behind the agent and start to feel worse-off due to inequity aversion again, but from different side of the coin this time.

Satisfying agent's incentive constraint guarantees that agent does not shift to state 2 at state 3 unless a bigger incentive comes from as a bribe offer from the supervisor to make agent do the reverse. Considering this fact and assuming the possibility of very high reservation wage differences between agent and supervisor, the principal must make sure that the following holds:

$$(CIC3^{0.5}): \quad S_3 - 0.5(S_3 - W_3) \geq S_2 - 0.5(S_2 - W_2)$$

Therefore, the supervisor does not try to attempt colluding and shift from the true state of nature (state 3), since bribing does not change his well being in any way.

The principal's goal to maximize her expected utility then turns into the following problem:

$$\max_{(S_i,W_i,e_i)} \sum_i p_i(\theta_i + e_i - S_i - W_i)$$

$$subject\ to \quad (SPC^{0.5}), (APC^{0.5}), (AIC^{0.5}), (CIC3^{0.5})$$

Note that when the inequity aversion parameter of the supervisor is equal to 0.5, the utility gain for the supervisor from a unit increase in S_i or W_i is same, and she is indifferent between these two options. On the other hand, an increase in S_i does not come with any production, since only productive party in the hierarchy is the agent. The principal can induce extra effort with an increase in agent's wage. As a result, the principal prefers a wage increase for the agent over a wage increase for the supervisor to satisfy the latter's participation constraint. In the end, the most efficient way is to increase the agent's wages at every state until it reaches the supervisor's wage levels. After that, the supervisor starts to feel worse off since she falls behind and she is still inequity averse.

Using the facts given above we can state the following:

Proposition 5: When there is an inequity averse supervisor with $\lambda_S = 0.5$ the solution of the principal's problem has the following properties:

a) $S_i^{0.5} = W_i^{0.5}$

b) $e_1^{0.5} = e_3^{0.5} = e_4^{0.5} > e_2^{0.5}$,

$e_1^{0.5} = e_3^{0.5} = e_4^{0.5} > e^B = e^*$ and $e_2^{0.5} > e_2^B$

c) $W_3^{0.5} - g(e_3^{0.5}) > W_4^{0.5} - g(e_4^{0.5}) = W_1^{0.5} - g(e_1^{0.5}) > W_2^{0.5} - g(e_2^{0.5})$, and

$W_3^{0.5} > W_4^{0.5} = W_1^{0.5} > W_2^{0.5}$

d) $S_3^{0.5} > S_4^{0.5} = S_1^{0.5} > S_2^{0.5}$

e) $(CIC3^{0.5})$ is not binding.

f) The information structure of principal is $\{s_1 = \underline{\theta}, s_2 = s_3 = s_4 = \emptyset\}$

We have already explained the reason of Proposition 5.a. above, and built our solution on this fact. Proposition 5.b. is directly related with proposition 4.1. We know that when the supervisor is inequity averse, the principal needs to raise agent's wages so that it is possible to satisfy the supervisor with a reduction in inequality. This, in turn, gives a chance to principal inducing higher effort levels than optimal effort at state 1,3 and 4, and depending on- $\Delta\theta$- at state 2 sometimes. The reason why the principal induces lower effort at state 2 is due to agent's incentive constraint as always. In order to make state 2 less alluring than state 3, the principal cuts wage at state 2 and reduction in wage comes with a lower effort induced in order to satisfy agent's participation constraint at the same time.

Proposition 5.c. is because of the fact that the supervisor with $\lambda_S = 0.5$ does not involve in collusions at state 1 and state 4. Moreover, due to hidden action problem, the agent's wage must be higher at state 3 than the one at state 2 so that the principal gives enough incentive which makes agent not falsely claim that she is working under low productivity environment, when supervisor's monitoring fails. Hence, optimal insurance implies that the wage of the agent at state 1 and state 4 should be same and between $W_3^{0.5}$ and $W_2^{0.5}$.

Proposition 5.d. is a direct result of Proposition 5.c. and the fact that the principal prefers to increase agent's wages more than to increase supervisor's wages in order to satisfy the latter's participation constraint when both type of wage increase bring same well-being to the supervisor. By the way, the optimal insurance also implies that $S_1^{0.5}$ and $S_4^{0.5}$ should be equal to S_0. Thus, the wage structure for the supervisor and the agent can be written as $W_3^{0.5} > S_0 = W_4^{0.5} = W_1^{0.5} > W_2^{0.5}$ $S_3^{0.5} > S_0 = S_4^{0.5} = S_1^{0.5} > S_2^{0.5}$ respectively. Lastly, it is important to note that the hardest wage contraction between supervisor and agent occurs when the supervisor in the hierarchy has this kind of sensitivity against wage inequality.

Proposition 5.e. and Proposition 5.f. is related with the fact that the agent's and the supervisor's combined well-being reaches to top at state 3. Since the supervisor concerns about the well being of the agent as well as her own she does not try to shirk in state 3 and bribe the agent. It is as if incentive given to the agent at state 3 due to hidden action problem also provides an incentive to the supervisor at state 3. Moreover, same fact is also the reason why the supervisor does not reveal true state of information at state 4 even though there is no bribe attempt coming from the agent. She behaves like an advocate of the agent, again, which is quite a natural thing when we consider the fact that agent's well-being is now as important as her own well-being for the supervisor.

4.4 Multiple Agents

There are experimental evidences on the fact that people show either vertical or horizontal preferences. Until now, we have dealt with vertical social preferences between the supervisor and the agent. In current model we look into the hierarchy which involves two inequity averse, symmetric agents- who can have sole difference in their view on collusion. They care about each other's monetary payoffs but not consider the wage difference between supervisor and themselves into the sense of their well being.

The payoffs for the agents, in this case, can be written as follows:

For Agent A:

$$W_A - g(e_A) - \lambda^{'}(W_B - W_A) \qquad if\ W_B > W_A$$

$$W_A - g(e_A) - \lambda^{"}(W_A - W_B) \qquad if\ W_A > W_B$$

For Agent B:

$$W_B - g(e_B) - \lambda^{'}(W_A - W_B) \qquad if\ W_A > W_B$$

$$W_B - g(e_B) - \lambda^{"}(W_B - W_A) \qquad if\ W_B > W_A$$

where $\lambda^{'}$ and $\lambda^{"}$ are inequity aversion parameters which show the level of sensitivity of agents to the wage inequality between themselves. We have $\lambda^{'} > 0$, $0 < \lambda^{"} \leq 1$ and $\lambda^{'} > \lambda^{"}$ which means an agent does care more about the wage inequality when she is behind than the time when she is ahead. This type of behaviour can be called as behindness aversion.

We can write the individual rationality conditions (participation constraints) of the agents as follows:

For Agent A, (APC^{MA}): (Change λ with λ' when $W_B > W_A$ and with λ'' when $W_A > W_B$)

$$EU(W_A - g(e_A) - \lambda(W_B - W_A)) = \sum_i p_i U(W_{A_i} - g(e_{A_i}) - \lambda(W_{B_i} - W_{A_i})) \geq \overline{U} \equiv U(W_0)$$

For Agent B, (APC^{MA}): (Change λ with λ' when $W_A > W_B$ and with λ'' when $W_B > W_A$)

$$EU(W_B - g(e_B) - \lambda(W_A - W_B)) = \sum_i p_i U(W_{B_i} - g(e_{B_i}) - \lambda(W_{A_i} - W_{B_i})) \geq \overline{U} \equiv U(W_0)$$

Since the agents are symmetric we have same utility functions ($U(.)$), cost of effort functions ($g(.)$) and same reservation wages (W_0) for both of them. Combing this with the fact that inequality between agents creates inefficiency in the allocation of agent's utilities, it is quite straightforward to see that the principal gives same wage to the agents and induce same effort level for both of them. Due to symmetrical properties of the agents, the principal sees two agents as one agent who produces $2e$ output and takes $2W$ wage.

The individual rationality condition (participation constraint) for the supervisor is same with the one in benchmark case:

$$(SPC^{MA}): \quad EV(S) = \sum_i p_i V(S_i) \geq \overline{V} \equiv V(S_0)$$

Now, we look at the possible collusion situations where the agents do care about the wages of their colleagues in their own well-beings.

First consider the case where only one agent tries to bribe supervisor when the latter monitors and successfully observes the low productivity condition (state 1). Consider that agent A is the briber. Agent A has to pay $t^{MA}_{min,1} = S_1 - S_2$ to the supervisor in order to convince her to provide an empty report for principal. Then, agents and supervisor form coalition if:

$$W_2 - (S_1 - S_2) - g(e_2) - \lambda^{'}(W_2 - (W_2 - (S_1 - S_2))) \geq W_1 - g(e_1) \qquad for\ agent\ A$$

and

$$W_2 - g(e_2) - \lambda^{"}(W_2 - (W_2 - (S_1 - S_2))) \geq W_1 - g(e_1) \qquad for\ agent\ B$$

Similarly, for state 4 and $t^{MA}_{min,2} = S_4 - S_3$, coalition is formed if:

$$W_3 - (S_4 - S_3) - g(e_3) - \lambda^{'}(W_3 - (W_3 - (S_4 - S_3))) \geq W_4 - g(e_4) \qquad for\ agent\ A$$

and

$$W_3 - g(e_3) - \lambda^{"}(W_3 - (W_3 - (S_4 - S_3))) \geq W_4 - g(e_4) \qquad for\ agent\ B$$

Investigating the inequalities above helps us to understand the following statement:

Proposition 6: When the hierarchy have two symmetric, inequity averse agents (with same W_0, $U(.)$, $g(.)$, $\lambda^{'}$, $\lambda^{"}$) and one of the agents pay higher portion of the side transfer offered to the supervisor at state 1 or 4 if forming coalition serves to purpose of the agent who pays more, it definitely serves to purpose of the other agent too. Reverse of this statement may not be true.

Proposition 6 is a direct result of behindness aversion ($\lambda^{'} > \lambda^{"}$). When the agents do not supply the side payment symmetrically, there exist an inequality between these agents since their monetary payoffs after the supervisor-agents coalition are not same. Agent A (who pays higher portion of the side transfer) falls behind as the same amount Agent B comes ahead. However, since behindness aversion implies that being behind make the agent suffer more than being ahead agent A's well -being is less comparing it with Agent B's well-being after side payments are delivered. If it is okay for the Agent A to offer a bribe to the supervisor in order to make the latter conceal the information on productivity at stae 1 and 4, it is definitely okay for the agent B too. We can also extend this case for any number of symmetric agent. If it is not a problem to form a coalition for the agent who pays highest price for bribe, the remaining agents do also not deny forming a coalition with the supervisor.

Proposition 6 shows that the principal should try to stop the agent who thinks to pay higher price for a bribe. While constructing collusion constraints at state 1 and 4, the principal must take the constraint of the agent who pays a higher portion of a side payment into consideration when there is an asymmetric allocation of side transfer payments between the agents.

Next, we look at the case where the agents pay the side transfer needed to make supervisor accept forming a coalition at state 1 and 4 equally. Then, collusion occurs at state 1 if:

$$W_2 - (\frac{S_1 - S_2}{2}) - g(e_2) \geq W_1 - g(e_1) \quad for\ both\ of\ the\ agents$$

and collusion occurs at state 4 if:

$$W_3 - (\frac{S_4 - S_3}{2}) - g(e_3) \geq W_4 - g(e_4) \quad for\ both\ of\ the\ agents$$

Now, we can make the following statement:

Proposition 7: If the principal satisfies collusion constraints at state 1 and 4 for the case where both agents pay the side transfer equally, she satisfies ($CIC1^{MA}$) and ($CIC2^{MA}$) for all remaining possible collusion scenarios where the agents share the costs of side payment at differing ratios.

Note that there exist no inequality between the agents when they pay the side transfer equally, though there is some inequality between agents for all remaining scenarios.

Thus, highest enthusiasm for forming a coalition for the agents occurs when they do share the cost of bribing equally and achieve highest combined well-being. The logic says that if principal prevents collusive behaviour when the eagerness of the agents to collude reaches its peak, the principal automatically prevent the collusion in other scenarios where the agents are less eager to attempt forming a coalition between the supervisor. Then, we can write the collusion constraints at state 1 and 4 as follows:

$$(CIC1^{MA}): \quad \frac{S_1}{2} + W_1 - g(e_1) \geq \frac{S_2}{2} + W_2 - g(e_2)$$

$$(CIC2^{MA}): \quad \frac{S_4}{2} + W_4 - g(e_4) \geq \frac{S_3}{2} + W_3 - g(e_3)$$

Note that the principal is now worse off comparing the case including multiple agents with single agent in the prevention of collusion at state 1 and 4 since sharing the cost of bribe allows the agents to increase their capability of giving a higher maximum side transfer individually.

For the their possible collusion when realized state is 3- when the supervisor fails to monitor agents' productivity- the supervisor has to give same side transfer to both agents. Otherwise, she creates inequality between the agents and needs to provide higher side transfer than necessary to compensate disutility coming from an inequality between inequity averse agents. She has to provide at least $2t^{MA}_{min,3} = 2(W_3 - g(e_3) - (W_2 - g(e_2 - \Delta\theta)))$ in order to persuade the agents to form a coalition with her. In order to prevent this collusive behaviour, the principal arranges the main contract such that $t^{MA}_{max,3} \leq 2t^{MA}_{min,3}$. Then, we have:

$$(CIC3^{MA}): \quad S_3 + 2(W_3 - g(e_3)) \geq S_2 + 2(W_2 - g(e_2 - \Delta\theta))$$

Note that the principal is now better off comparing her situation with the case in benchmark case at state 3, since the supervisor has to pay two times of side transfer she is willing to pay in the benchmark case.

Next is to show the principal's problem facing a hierarchy with multiple inequity averse, symmetric agents. The principal wants to maximize her expected utility subject to constraints we introduced above by arranging the contractible variables. In other words, to find optimal contract, she has to solve:

$$\max_{(S_i, W_i, e_i)} \sum_i p_i(2\theta_i + 2e_i - S_i - 2W_i)$$

$$\textit{subject to} \quad (SPC^{MA}), (APC^{MA}), (AIC^{MA}), (CIC1^{MA}), (CIC2^{MA}), (CIC3^{MA})$$

CHAPTER 5

CONCLUSION

Many models in economics literature uses self-interested people approach for the solutions of real life problems. Literature on principal-supervisor-agent hierarchies starting from Tirole (1986) is not an exception. However, especially in recent years, countless experiments on certain topics in economics showed that self-interest approach is not sufficient in explaining all. Moreover, these experiments highlighted the fact that many people show other-regarding preferences while interacting with other people and concern for another's situation is a motivating factor on their decisions in a social environment. Thus, in this thesis, we have implemented Fehr and Schmidt's (1999) distributional approach for other regarding preferences into Tirole's (1986) three level hierarchy model. Our aim was to analyse the effect of having other-regarding supervisor or agent on collusive behaviour in an hierarchy and on collusion-proof optimal contracts prepared by principal.

Other-regarding preferences affect collusive behaviour. Not only it changes the tendency of agent's and supervisor's to offer bribe or take bribe but also it influences the effectiveness of principal's tools she uses in order to prevent collusive actions. In case where the supervisor's sensitivity to wage inequality reaches a certain threshold, she does not accept any request of coalition coming from the agent. However, in this case, the principal also loses the information on high productivity level, since supervisor completely act as an advocate to the agent. On the other hand, when the hierarchy has symmetric and inequity averse multiple agents if principal prevents the case where agents pay the side transfer equally to bribe the supervisor, she prevents all other possible collusion scenarios in which the agents play the role of briber. As number of symmetric and inequity averse agents increases it becomes harder to prevent collusion when supervisor achieves to observe productivity level in the environment. Moreover, it becomes easier to prevent collusion when the supervisor fails to monitor the agent.

For the components of optimal contracts, most prominent impact of other-regarding preferences is on the effort levels. When the agent is inequity averse principal can exploit this fact to make agent exert higher effort level than she would otherwise. In order to satisfy the participation constraint of supervisor, the effort level induced for agent becomes lower when the supervisor is status seeker. On the other hand, it is higher when the supervisor is inequity averse.

Although the ranking of supervisor's or agent's utilities at different states do not differ between self-interested or other-regarding players, the ranking of their wages is not the same due to changes in the representation of utilities. In some cases, the principal may face with the choice of working with less skilled employees. Furthermore, the dispersion between the wages at different states can become wider or narrower than the case with self-interested parties. This is mainly the result of the change in effectiveness of principal's tools used to prevent collusive actions. Change in dispersion has several consequences for risk averse parties since they do not enjoy the cases in which their possible wages are highly different from their reservation wages. In addition, we show that wage compression between the levels occurs when the supervisor or the agent is inequity averse. Most extreme wage compression (agent's wage becomes equal to supervisor's wage) occurs when inequity aversion sensitivity of supervisor reaches to a certain point.

We believe that implementing other-regarding preferences into theoretical models is a fruitful approach to deal with the problems in organizational hierarchies. This kind of approach can help to generate new insights for organizations, as suggested by psychologists, sociologists and economists working on behavioural agency topics. A question for future research can be how the different types of hierarchies interact with other-regarding preferences. This paper investigates the effects of other-regarding parties for only principal-supervisor-agent type of hierarchies, and we think that there is a great scope for implementing other-regarding preferences to the papers like Bac (1996). Moreover, note that we take the inequity aversion parameters of parties as observable and common knowledge- which is not the case in reality- for the sake of simplicity in calculations. More realistic models based on uncertainty of inequity aversion parameter and how the people's sensitivity to inequality can be estimated look like interesting paths to follow for further research. We have taken the parties in multiple agent case as symmetric and inequity averse agents. This, in turn, resulted in equal wages for the agents while designing contracts. We believe that letting symmetric agents be status-seeker when they are ahead or using asymmetric agents in this model can produce more interesting results applicable to real life situations. It is definitely advised to expend our model in this regard. Lastly, adding productive duties to supervisor and making her exert effort for her duties open new aspects for the literature. Note that principal always tries to change effort level exerted by the agent since she is the only productive unit in the hierarchy and this limits the options principal has. Modelling effort and effort cost for the supervisor not only increases the chances of principal to satisfy the needs of other-regarding parties but also introduces a possibility of ex-ante collusion between supervisor and agent. We believe that investigating the changes in the parameters of optimal contracts and in collusive actions between the parties for this new case is worthwhile.

REFERENCES

Agell, J., and Lundborg, P. (1995). Theories of Pay and Unemployment: Survey Evidence from Swedish Manufacturing Firms. *Scandinavian Journal of Economics*, XCVII, 295-308.

Bac, M. (1996). Corruption and Supervision Costs in Hierarchies. *Journal of Comperative Economics 22*, 99-118.

Bac, M. (1996). Corruption, Supervision, and the Structure of Hierarchies. *Journal of Law, Economics, and Organization*, Vol. 12, No. 2, 277-298.

Bac, M., and Kucuksenel, S. (2006). Two Types of Collusion in a Model of Hierarchical Agency. *Journal of Institutional and Theoretical Economics (JITE)*, Vol. 162(2), 262-276.

Baliga, S. (1999). Monitoring and Collusion with 'Soft' Information. *Journal of Law, Economics, and Organization*, Vol. 15, Iss. 2.

Bewley, T. (1999). Why Wages Don't Fall During a Recession. *Harvard University Press*, Cambridge, M.A.

Blinder, A.S., and Choi, D.H. (1990). A Shred of Evidence on Theories of Reward Stickiness. *Quarterly Journal of Economics*, 105, 1003–1016.

Campbell, C.M., and Kamlani, K. (1997). The Reasons for Reward Rigidity: Evidence from a Survey of Firms. *Quarterly Journal of Economics*, CXII, 759–789.

Eisenkopf, G., and Teyssier, S. (2016). Principal-agent and Peer Relationships in Tournaments. *Managerial and Decision Economics*, 37, 127-139.

Fehr, E., and Schmidt, K.M. (1999). A Theory of Fairness, Competition, and Cooperation. *Quarterly Journal of Economics.*

Fehr, E., and Schmidt, K.M. (2006). The Economics of Fairness, Reciprocity and Altruism - Experimental Evidence and New Theories. *Handbook of the Economics of Giving, Altruism and Reciprocity*, Vol. 1, pp. 615–691.

Giebe, T., and Gürtler, O. (2011). Optimal Contracts for Lenient Supervisors. *Social Science Research Network.*

Gore, J., and Pepper, A. (2012). Behavioral Agency Theory: New Foundations for Theorizing About Executive Compensation. *Journal of Management.*

Grund, C., and Przemeck, J. (2008). Subjective Performance Evaluation and Inequality Aversion. *IZA Discussion Paper Series*, No.3382.

Itoh, H. (2004). Moral Hazard and Other-Regarding Preferences. *The Japanese Economic Review*, 55, 18-45.

Kucuksenel, S. (2012). Behavioral Mechanism Design. *Journal of Public Economic Theory*, 14 (5), pp. 767–789.

Ledyard, J,O. (1995). Public goods: A Survey of Experimental Research. *Handbookof Experimental Economics*, pp. 111–194.

Neilson, W.S., and Stowe, J. (2004). Incentive Pay for Other-Regarding Workers. *Fuqua School of Business at Duke University Working Paper.*

Neilson, W.S., and Stowe, J. (2010). Piece Rate Contracts for Other-Regarding Workers. *Economic Inquiry*, Vol. 48, No. 3, 575-586.

Rabin, M. (1993). Incorporating Fairness into Game Theory and Economics. *American Economic Review*, LXXXIII, 1281-1302.

Rey-Biel, P. (2008). Inequity Aversion and Team Incentives. *The Scandinavian Journal of Economics*, 110(2), 297-320.

Tirole, J. (1986). Hierarchies and Bureaucracies: On the Role of Collusion in Organizations. *Journal of Law, Economics and Organization*, 2, 181-214

APPENDIX A

PROOFS

A.1 Solution for the Problem with Inequity Averse Agent

Lagrangian for the solution of principal's problem with inequity averse agent is:

$L = \sum_i p_i(\theta_i + e_i - W_i - S_i) + \nu(\sum_i p_i V(S_i) - \overline{V})$

$+\mu(\sum_i p_i U(W_i - g(e_i) - \lambda_A(S_i - W_i)) - \overline{U})$

$+\gamma(W_3 - g(e_3) - W_2 + g(e_2 - \Delta\theta) - \lambda_A(S_3 - S_2 + W_2 - W_3))$

$+\psi(S_4 + W_4 - g(e_4) - S_3 - W_3 + g(e_3) - \lambda_A(S_3 - S_4 + W_3 - W_4))$

$+\pi(S_3 + W_3 - g(e_3) - S_2 - W_2 + g(e_2 - \Delta\theta) - \lambda_A(S_2 - S_3 + W_2 - W_3))$

Note that we ignore $(CIC1^{OA})$, we later show that the solution to the problem satisfies $(CIC1^{OA})$.

Taking the derivatives of the above Lagrangian with respect to S_i, W_i, e_i results in following FOCs:

$$\nu V'(S_1) = 1 + \mu\lambda_A U'(W_1 - g(e_1) - \lambda_A(S_1 - W_1)) \tag{A.1}$$

$$\nu V'(S_2) = 1 + \mu\lambda_A U'(W_2 - g(e_2) - \lambda_A(S_2 - W_2)) - \frac{\gamma\lambda_A}{p_2} + \frac{\pi(1+\lambda_A)}{p_2} \tag{A.2}$$

$$\nu V'(S_3) = 1 + \mu\lambda_A U'(W_3 - g(e_3) - \lambda_A(S_3 - W_3)) + \frac{\gamma\lambda_A}{p_3} + \frac{(\psi - \pi)(1+\lambda_A)}{p_3} \tag{A.3}$$

$$\nu V'(S_4) = 1 + \mu\lambda_A U'(W_4 - g(e_4) - \lambda_A(S_4 - W_4)) - \frac{\psi(1+\lambda_A)}{p_4} \tag{A.4}$$

$$\mu U'(W_1 - g(e_1) - \lambda_A(S_1 - W_1)) = \frac{1}{1+\lambda_A} \tag{A.5}$$

$$\mu U'(W_2 - g(e_2) - \lambda_A(S_2 - W_2)) = \frac{1}{1+\lambda_A} + \frac{\gamma+\pi}{p_2} \tag{A.6}$$

$$\mu U'(W_3 - g(e_3) - \lambda_A(S_3 - W_3)) = \frac{1}{1+\lambda_A} + \frac{\psi-\gamma-\pi}{p_3} \tag{A.7}$$

$$\mu U'(W_4 - g(e_4) - \lambda_A(S_4 - W_4)) = \frac{1}{1+\lambda_A} - \frac{\psi}{p_4} \tag{A.8}$$

$$\mu U'(W_1 - g(e_1) - \lambda_A(S_1 - W_1))g'(e_1) = 1 \tag{A.9}$$

$$\mu U'(W_2 - g(e_2) - \lambda_A(S_2 - W_2))g'(e_2) - \frac{\gamma+\pi}{p_2}g'(e_2 - \Delta\theta) = 1 \tag{A.10}$$

$$\mu U'(W_3 - g(e_3) - \lambda_A(S_3 - W_3))g'(e_3) + \frac{\gamma+\pi-\psi}{p_3}g'(e_3) = 1 \tag{A.11}$$

$$\mu U'(W_4 - g(e_4) - \lambda_A(S_4 - W_4))g'(e_4) + \frac{\psi}{p_4}g'(e_4) = 1. \tag{A.12}$$

Proof of Proposition 2.1: Substituting 5, 6, 7, 8 into 9, 10, 11, 12 gives us:

$g'(e_1^{OA}) = g'(e_3^{OA}) = g'(e_4^{OA}) = 1 + \lambda_A$ and $g'(e_2^{OA}) < 1 + \lambda_A$

Since $g"(e_i) > 0$, we can rank the efforts as $e_1^{OA} = e_3^{OA} = e_4^{OA} > e_2^{OA}$. Moreover, $\lambda_A > 0$. Thus, we have $e_1^{OA} = e_3^{OA} = e_4^{OA} > e_2^{B} = e^*$.

Upper boundary of $g'(e_2^{OA})$ also increases to $1 + \lambda_A$ in our case. Thus, principal set $g'(e_2^{OA}) = 1 + \lambda_A - \varepsilon$ where $\varepsilon > 0$, in order to get maximum output (profit). Since $g'(e_2^{OA}) > g'(e_2^{B}) = 1 - \varepsilon$ we have $e_2^{OA} > e_2^{B}$.

For a given ε (where $\frac{\partial\varepsilon}{\partial\Delta\theta} > 0$), when we have $\lambda_A = \varepsilon$ we get $g'(e_2^{OA}) = g'(e^*) = 1$. So, there is a threshold value of λ_A which is increasing in $\Delta\theta$ where $e_2^{OA} = e^*$. At the end, we have $e_2^{OA} > e^*$ when $\lambda_A > \varepsilon$, and $e_2^{OA} < e^*$ when $\lambda_A < \varepsilon$.

Proof of Proposition 2.2: First substitute 5, 6, 7, 8 into 1, 2, 3, 4. Then, we have:

$$\nu V'(S_1) = \frac{1+2\lambda_A}{1+\lambda_A} \tag{A.13}$$

$$\nu V'(S_2) = \frac{1+2\lambda_A}{1+\lambda_A} + \frac{\pi(1+2\lambda_A)}{p_2} \tag{A.14}$$

$$\nu V'(S_3) = \frac{1+2\lambda_A}{1+\lambda_A} + \frac{(\psi-\pi)(1+2\lambda_A)}{p_3} \tag{A.15}$$

$$\nu V'(S_4) = \frac{1+2\lambda_A}{1+\lambda_A} - \frac{\psi(1+2\lambda_A)}{p_4} \tag{A.16}$$

To show that (AIC^{OA}) is binding, suppose $\gamma = 0$. Then, from 6, 7 and 14, 15, we have:

$$\frac{V'(S_2)}{V'(S_3)} = \frac{U'(W_2 - g(e_2) - \lambda_A(S_2 - W_2))}{U'(W_3 - g(e_3) - \lambda_A(S_3 - W_3))} \tag{A.17}$$

On the other hand, (AIC^{OA}) implies that:

$$W_3 - g(e_3) - \lambda_A(S_3 - W_3) \geq W_2 - g(e_2 - \Delta\theta) - \lambda_A(S_2 - W_2) > W_2 - g(e_2) - \lambda_A(S_2 - W_2) \tag{A.18}$$

From 17 and 18, we see that:

$$S_3 > S_2 \tag{A.19}$$

18 and 19 means that $S_3 + W_3 - g(e_3) - \lambda_A(S_3 - W_3) > S_2 + W_2 - g(e_2 - \Delta\theta) - \lambda_A(S_2 - W_2)$, i.e. $(CIC3^{OA})$ does not bind. Then, we face with $\pi = 0$.

Then 6 and 7 mean that:

$$W_2 - g(e_2) - \lambda_A(S_2 - W_2) \geq W_3 - g(e_3) - \lambda_A(S_3 - W_3) \tag{A.20}$$

When we look at 18 and 20, we see that there is a contradiction which completes this part of our proof and shows that $\gamma > 0$, i.e. (AIC^{OA}) is binding.

Next, suppose second collusion constraint is not binding, i.e. $\psi = 0$.

From 7 and 8, we have $W_3 - g(e_3) - \lambda_A(S_3 - W_3) > W_4 - g(e_4) - \lambda_A(S_4 - W_4)$. $\lambda_A > 0$, so we can writre:

$$\frac{W_3 - g(e_3) - \lambda_A(S_3 - W_3)}{1 + 2\lambda_A} > \frac{W_4 - g(e_4) - \lambda_A(S_4 - W_4)}{1 + 2\lambda_A} \tag{A.21}$$

From 15 and 16, we have:

$$S_3 \geq S_4 \tag{A.22}$$

Then 21 and 22 implies that:

$$S_3 + \frac{W_3 - g(e_3) - \lambda_A(S_3 - W_3)}{1 + 2\lambda_A} > S_4 + \frac{W_4 - g(e_4) - \lambda_A(S_4 - W_4)}{1 + 2\lambda_A} \tag{A.23}$$

which violates $(CIC2^{OA})$ completely. Thus, we must have $\psi > 0$. $(CIC2^{OA})$ is binding.

We now look at whether $(CIC3^{OA})$ is binding or not. Assume that $(CIC3^{OA})$ does not bind, i.e. $\pi = 0$. Then, from 14 and 15, we have $S_2 > S_3$.

We know that (AIC^{OA}) is binding, so $(CIC3^{OA})$ can be represented as $(CIC3^{OA'})$: $S_3 \geq S_2$. Now, with the result in the paragraph above, we can say that when $\pi = 0$ $(CIC3^{OA})$ is violated. Therefore, $\pi > 0$ and $(CIC3^{OA})$ is binding.

With the proof of proposition 2.4, we show that $(CIC1^{OA})$ is already satisfied with the current solution.

Proof of Proposition 2.3: We know that both (AIC^{OA}) and $(CIC3^{OA})$ is binding. Then, it means $S_2 = S_3$. Moreover, from 13, 14 and 16, we have $S_4 > S_1 > S_2$.

Therefore, at the end, the ranking of supervisor's wages at different states is $S_4 > S_1 > S_2 = S_3$.

Comparing 13, 14, 15 and 16 between the cases in which we take $\lambda_A > 0$ and $\lambda_A = 0$ (self-interested agent, benchmark case) with the fact that $S_2 = S_3$ in both cases, we see that $V'(S_1^{OA}) > V'(S_1^B)$, $V'(S_2^{OA}) > V'(S_1^B)$ and $V'(S_3^{OA}) > V'(S_3^B)$. Since $V''(.) < 0$, we have $S_1^{OA} < S_1^B$, $S_2^{OA} < S_2^B$, $S_3^{OA} < S_3^B$. However, it is not certain that $V'(S_4^{OA})$ is higher than $V'(S_4^B)$. Thus, the ranking between S_4^{OA} and S_4^B is ambiguous.

Proof of Proposition 2.4: From 5, 6 and 8, we have

$$W_4 - g(e_4) - \lambda_A(S_4 - W_4) > W_1 - g(e_1) - \lambda_A(S_1 - W_1) > W_2 - g(e_2) - \lambda_A(S_2 - W_2) \tag{A.24}$$

We know that $(CIC2^{OA})$ binds and $g(e_3^{OA}) = g(e_4^{OA})$. Then, it means:

$$S_4 + \frac{W_4 - \lambda_A(S_4 - W_4)}{1 + 2\lambda_A} = S_3 + \frac{W_3 - \lambda_A(S_3 - W_3)}{1 + 2\lambda_A}$$
$$\Rightarrow (1 + \lambda_A)(S_4 + W_4) = (1 + \lambda_A)(S_3 + W_3)$$

Since $S_4 > S_3$, we have both $W_3 - g(e_3) - \lambda_A(S_3 - W_3) > W_4 - g(e_4) - \lambda_A(S_4 - W_4)$ and $W_3 > W_4$. This completes the proof for $W_3 - g(e_3) - \lambda_A(S_3 - W_3) > W_4 - g(e_4) - \lambda_A(S_4 - W_4) > W_1 - g(e_1) - \lambda_A(S_1 - W_1) > W_2 - g(e_2) - \lambda_A(S_2 - W_2)$.

From 24, we have:

$$W_4 - W_1 > \frac{\lambda_A}{1 + \lambda_A}(S_4 - S_1) > 0 \Rightarrow W_4 > W_1$$

and

$$W_1 - W_2 > \frac{\lambda_A}{1 + \lambda_A}(S_1 - S_2) + \frac{\lambda_A}{1 + \lambda_A}(g(e_1) - g(e_2) > 0 \Rightarrow W_1 > W_2$$

Therefore, at the end, we have $W_3^{OA} > W_4^{OA} > W_1^{OA} > W_2^{OA}$.

To satisfy the participation constraint of the agent when she is inequity averse, it must be that $W_i^{OA} - g(e_i^{OA}) - \lambda_A(S_i^{OA} - W_i^{OA}) \geq W_i^B - g(e_i^B)$. We know $(S_i - W_i) > 0$ always, and $g(e_i^{OA}) > g(e_i^B)$. Then, we can write:

$$W_i^{OA} > W_i^B$$

Now, it is quite straightforward to show that $(CIC1^{OA})$ is already satisfied and not binding, since $S_1^{OA} > S_2^{OA}$ and $W_1 - g(e_1) - \lambda_A(S_1 - W_1) > W_2 - g(e_2) - \lambda_A(S_2 - W_2)$.

A.2 Solution for the Problem with Other Regarding Supervisor

Proof of Proposition 3: When $\lambda_S = 0.5$:

$t_{min,1}^{OS} = \frac{S_1 - \lambda_S(S_1 - W_1) - (S_2 - \lambda_S(S_2 - W_2))}{1 - 2\lambda_S} \to \infty$

and

$t_{min,2}^{OS} = \frac{S_4 - \lambda_S(S_4 - W_4) - (S_3 - \lambda_S(S_3 - W_3))}{1 - 2\lambda_S} \to \infty$

Q.E.D.

Lagrangian for the solution of the principal's problem with other regarding supervisor is as follows:

$L = \sum_i p_i(\theta_i + e_i - W_i - S_i) + \nu(\sum_i p_i V(S_i - \lambda_S(S_i - W_i)) - \overline{V})$

$+\mu(\sum_i p_i U(W_i - g(e_i)) - \overline{U})$

$+\gamma(W_3 - g(e_3) - W_2 + g(e_2 - \Delta\theta))$

$+\psi(S_4 - \lambda_S(S_4 - W_4) + (1 - 2\lambda_S)(W_4 - g(e_4)) - S_3 + \lambda_S(S_3 - W_3) - (1 - 2\lambda_S)(W_3 - g(e_3)))$

$+\pi(S_3 - \lambda_S(S_3 - W_3) + (1 - 2\lambda_S)(W_3 - g(e_3)) - S_2 + \lambda_S(S_2 - W_2) - (1 - 2\lambda_S)(W_2 - g(e_2 - \Delta\theta)))$

Note that we ignore ($CIC1^{OS}$), we later show that the solution of the problem above satisfies ($CIC1^{OS}$).

Taking the derivatives of the above Lagrangian with respect to S_i, W_i, e_i results in following FOCs:

$$\nu V'(S_1 - \lambda_S(S_1 - W_1)) = \frac{1}{1-\lambda_S} \tag{A.25}$$

$$\nu V'(S_2 - \lambda_S(S_2 - W_2)) = \frac{1}{1-\lambda_S} + \frac{\pi}{p_2} \tag{A.26}$$

$$\nu V'(S_3 - \lambda_S(S_3 - W_3)) = \frac{1}{1-\lambda_S} + \frac{(\psi - \pi)}{p_3} \tag{A.27}$$

$$\nu V'(S_4 - \lambda_S(S_4 - W_4)) = \frac{1}{1-\lambda_S} - \frac{\psi}{p_4} \tag{A.28}$$

$$\mu U'(W_1 - g(e_1)) = 1 - \nu\lambda_S V'(S_1 - \lambda_S(S_1 - W_1)) \tag{A.29}$$

$$\mu U'(W_2 - g(e_2)) = 1 - \nu\lambda_S V'(S_2 - \lambda_S(S_2 - W_2)) + \frac{\gamma}{p_2} + \frac{\pi(1-\lambda_S)}{p_2} \tag{A.30}$$

$$\mu U'(W_3 - g(e_3)) = 1 - \nu\lambda_S V'(S_3 - \lambda_S(S_3 - W_3)) - \frac{\gamma}{p_3} - \frac{(\pi - \psi)(1-\lambda_S)}{p_3} \tag{A.31}$$

$$\mu U'(W_4 - g(e_4)) = 1 - \nu\lambda_S V'(S_4 - \lambda_S(S_4 - W_4)) - \frac{\psi(1-\lambda_S)}{p_4} \tag{A.32}$$

$$\mu U'(W_1 - g(e_1))g'(e_1) = 1 \tag{A.33}$$

$$\mu U'(W_2 - g(e_2))g'(e_2) - \frac{\gamma + \pi(1-2\lambda_S)}{p_2} g'(e_2 - \Delta\theta) = 1 \tag{A.34}$$

$$\mu U'(W_3 - g(e_3))g'(e_3) + \frac{\gamma + (\pi - \psi)(1-2\lambda_S)}{p_3} g'(e_3) = 1 \tag{A.35}$$

$$\mu U'(W_4 - g(e_4))g'(e_4) + \frac{\psi(1-2\lambda_S)}{p_4} g'(e_4) = 1. \tag{A.36}$$

First, substitute 25, 26, 27, 28 into 29, 30, 31, 32. Then, we have:

$$\mu U'(W_1 - g(e_1)) = \frac{1-2\lambda_S}{1-\lambda_S} \tag{A.37}$$

$$\mu U'(W_2 - g(e_2)) = \frac{1-2\lambda_S}{1-\lambda_S} + \frac{\gamma}{p_2} + \frac{\pi(1-2\lambda_S)}{p_2} \tag{A.38}$$

$$\mu U'(W_3 - g(e_3)) = \frac{1-2\lambda_S}{1-\lambda_S} - \frac{\gamma}{p_3} - \frac{(\pi-\psi)(1-2\lambda_S)}{p_3} \tag{A.39}$$

$$\mu U'(W_4 - g(e_4)) = \frac{1-2\lambda_S}{1-\lambda_S} - \frac{\psi(1-2\lambda_S)}{p_4} \tag{A.40}$$

Proof of Proposition 4.1: Substituting 37, 38, 39, 40 into 33, 34, 35, 36 gives us:

$g'(e_1^{OS}) = g'(e_3^{OS}) = g'(e_4^{OS}) = \frac{1-\lambda_S}{1-2\lambda_S}$ and $g'(e_2^{OS}) < \frac{1-\lambda_S}{1-2\lambda_S}$

Since $g"(e_i) > 0$, we can rank the efforts as $e_1^{OS} = e_3^{OS} = e_4^{OS} > e_2^{OS}$.

For $0 < \lambda_S < 0.5$, $\frac{1-\lambda_S}{1-2\lambda_S} > 1$. Thus, we have $e_1^{OS} = e_3^{OS} = e_4^{OS} > e^*$

Upper boundary of $g'(e_2^{OS})$ is $\frac{1-\lambda_S}{1-2\lambda_S}$. To maximize the output, the principal sets $g'(e_2^{OS}) = \frac{1-\lambda_S}{1-2\lambda_S} - \varepsilon$ where $\varepsilon > 0$ and increasing with $\Delta\theta$. Since $g'(e_2^{OS}) > g'(e_2^B) = 1-\varepsilon$ we have $e_2^{OS} > e_2^B$. Moreover, for a given ε (where $\frac{\partial\varepsilon}{\partial\Delta\theta} > 0$), there is a threshold $\lambda_S = f(\varepsilon)$ which makes $g'(e_2^{OS}) = g'(e^*) = 1$. Thus, we have $e_2^{OS} > e^*$ where $\lambda_S > f(\varepsilon)$, and $e_2^{OS} < e^*$ where $\lambda_S < f(\varepsilon)$.

For $\lambda_S < 0$, $\frac{1-\lambda_S}{1-2\lambda_S} < 1$. Thus, we have $> e^* > e_1^{OS} = e_3^{OS} = e_4^{OS} > e_2^{OS}$. For this case, $g'(e_2^B) = 1 - \varepsilon > g'(e_2^{OS})$. Thus, we have $e_2^B > e_2^{OS}$.

Proof of Proposition 4.2: To show that (AIC^{OS}) is binding, first, suppose that $\gamma = 0$. Then, from 26, 27 and 38, 39, we have:

$$\frac{V'(S_2 - \lambda_S(S_2 - W_2))}{V'(S_3 - \lambda_S(S_3 - W_3))} = \frac{U'(W_2 - g(e_2))}{U'(W_3 - g(e_3))} \tag{A.41}$$

On the other hand, (AIC^{OS}) implies that:

$$W_3 - g(e_3) \geq W_2 - g(e_2 - \Delta\theta) > W_2 - g(e_2) \tag{A.42}$$

From 41 and 42, we see that:

$$S_3 - \lambda_S(S_3 - W_3) > S_2 - \lambda_S(S_2 - W_2) \tag{A.43}$$

42 and 43 mean that $\frac{S_3 - \lambda_S(S_3 - W_3)}{1 - 2\lambda_S} + W_3 - g(e_3) > \frac{S_2 - \lambda_S(S_2 - W_2)}{1 - 2\lambda_S} + W_2 - g(e_2 - \Delta\theta)$, i.e. ($CIC3^{OS}$) does not bind. Then, we have $\pi = 0$. In this case, 38 and 39 mean that $W_3 - g(e_3) < W_2 - g(e_2)$ which is a contradiction to 42. Thus, $\gamma > 0$ and (AIC^{OS}) is binding.

Now, suppose ($CIC2^{OS}$) is not binding, i.e. $\psi = 0$. From 39 and 40, we have:

$$W_3 - g(e_3) > W_4 - g(e_4) \tag{A.44}$$

From 27 and 28, we also have $S_3 - \lambda_S(S_3 - W_3) > S_4 - \lambda_S(S_4 - W_4)$. Then, we can write:

$$\frac{S_3 - \lambda_S(S_3 - W_3)}{1 - 2\lambda_S} > \frac{S_4 - \lambda_S(S_4 - W_4)}{1 - 2\lambda_S} \tag{A.45}$$

Then, 44 and 45 imply that $\frac{S_3 - \lambda_S(S_3 - W_3)}{1 - 2\lambda_S} + W_3 - g(e_3) > \frac{S_4 - \lambda_S(S_4 - W_4)}{1 - 2\lambda_S} + W_4 - g(e_4)$ which violates ($CIC2^{OS}$) completely. Thus, we have $\psi > 0$. ($CIC2^{OS}$) is binding.

Now, assume that ($CIC3^{OS}$) does not bind, i.e. $\pi = 0$. From 26 and 27, we have $S_2 - \lambda_S(S_2 - W_2) > S_3 - \lambda_S(S_3 - W_3)$. We also know that ($AIC^{OS}$) is binding. Then, we have ($CIC3^{OS'}$) : $S_3 - \lambda_S(S_3 - W_3) \geq S_2 - \lambda_S(S_2 - W_2)$. It is straightforward to see that taking $\pi = 0$ violates ($CIC3^{OS'}$). It means $\pi > 0$ and ($CIC3^{OS}$) is binding.

We later show that $(CIC1^{OS})$ condition is already satisfied with the solution of the problem.

Proof of Proposition 4.3 and 4.4: Both (AIC^{OS}) and $(CIC3^{OS})$ is binding. Then, it means that $S_3 - \lambda_S(S_3 - W_3) = S_2 - \lambda_S(S_2 - W_2)$. Moreover, from 1, 2 and 4, we have $S_4 - \lambda_S(S_4 - W_4) > S_1 - \lambda_S(S_1 - W_1) > S_2 - \lambda_S(S_2 - W_2)$. Therefore, at the end, we have the following ranking:

$$S_4^{OS}-\lambda_S(S_4^{OS}-W_4^{OS}) > S_1^{OS}-\lambda_S(S_1^{OS}-W_1^{OS}) > S_2^{OS}-\lambda_S(S_2^{OS}-W_2^{OS}) = S_3^{OS}-\lambda_S(S_3^{OS}-W_3^{OS}) \tag{A.46}$$

From 37, 38 and 40, we have $W_4 - g(e_4) > W_1 - g(e_1) > W_2 - g(e_2)$.

We know that $e_3^{OS} = e_4^{OS}$. Then, we can write $(CIC2^{OS})$ as: $\frac{S_4-\lambda_S(S_4-W_4)}{1-2\lambda_S} + W_4 = \frac{S_3-\lambda_S(S_3-W_3)}{1-2\lambda_S} + W_3$. We have found that $S_4 - \lambda_S(S_4 - W_4) > S_3 - \lambda_S(S_3 - W_3)$. Thus, we have both $W_4 < W_3$ and $W_4 - g(e_4) < W_3 - g(e_3)$, since $e_3 = e_4$. Then, the complete ranking is $W_3^{OS}-g(e_3^{OS}) > W_4^{OS}-g(e_4^{OS}) > W_1^{OS}-g(e_1^{OS}) > W_2^{OS}-g(e_2^{OS})$. Since $g(e_1^{OS}) = g(e_3^{OS}) = g(e_4^{OS}) > g(e_2^{OS})$, we can write it as:

$$W_3^{OS} > W_4^{OS} > W_1^{OS} > W_2^{OS} \tag{A.47}$$

With the help of 46 and 47, we have:

For the inequity averse supervisor ($0 < \lambda_S < 0.5$):

$S_2^{OS} - S_3^{OS} = \frac{\lambda_S(W_3^{OS}-W_2^{OS})}{1-\lambda_S} > 0 \to S_2^{OS} > S_3^{OS}$, $S_4^{OS} - S_3^{OS} > \frac{\lambda_S(W_3^{OS}-W_4^{OS})}{1-\lambda_S} > 0 \to S_4^{OS} > S_3^{OS}$, $S_1^{OS} - S_3^{OS} > \frac{\lambda_S(W_3^{OS}-W_1^{OS})}{1-\lambda_S} > 0 \to S_1^{OS} > S_3^{OS}$

For status seeker supervisor ($0 > \lambda_S$):

$S_2^{OS} - S_3^{OS} = \frac{\lambda_S(W_3^{OS}-W_2^{OS})}{1-\lambda_S} < 0 \to S_2^{OS} < S_3^{OS}$, $S_2^{OS} - S_1^{OS} = \frac{\lambda_S(W_1^{OS}-W_2^{OS})}{1-\lambda_S} < 0 \to S_2^{OS} < S_1^{OS}$ and $S_1^{OS} - S_4^{OS} = \frac{\lambda_S(W_4^{OS}-W_1^{OS})}{1-\lambda_S} < 0 \to S_1^{OS} < S_4^{OS}$ which mean $S_2^{OS} < S_1^{OS} < S_4^{OS}$.

Note that for an other regarding supervisor, to make it sure that her participation constraint is satisfied, we should have $S_i^{OS}-\lambda_S(S_i^{OS}-W_i^{OS}) = S_i^B$. Since $S_i^{OS} > W_i^{OS}$:

For inequity averse supervisor with $0 < \lambda_S < 0.5$, we have $S_i^{OS} > S_i^B$.

For status-seeker supervisor with $\lambda_S < 0$, we have $S_i^{OS} < S_i^B$.

Lastly, it is quite straightforward to show that $(CIC1^{OS})$ is already satisfied and not binding, since $S_1^{OS} - \lambda_S(S_1^{OS} - W_1^{OS}) > S_2^{OS} - \lambda_S(S_2^{OS} - W_2^{OS})$ and $W_1^{OS} > W_2^{OS}$.

Proof of Proposition 5: We have already explained the logic behind Proposition 5.a. and we know the reason behind the ranking in Proposition 5.b. from the proof of proposition 4.1 and since $\lambda_S > 0$ in this case.

We have no collusion constraints for $(CIC1)$ and $(CIC2)$. Thus, $\psi = 0$ when $\lambda_S = 0.5$. Moreover, ignore $(CIC3^{0.5})$ for the moment and take $\pi = 0$ too. We later show that the solution of the problem satisfies $(CIC3^{0.5})$.

From 37, 38, 39 and 40 we have:

$$W_3^{0.5} - g(e_3^{0.5}) > W_4^{0.5} - g(e_4^{0.5}) = W_1^{0.5} - g(e_1^{0.5}) > W_2^{0.5} - g(e_2^{0.5})$$

We know that $e_1^{0.5} = e_3^{0.5} = e_4^{0.5} > e_2^{0.5}$. Then, we can also write:

$W_3^{0.5} > W_4^{0.5} = W_1^{0.5} > W_2^{0.5}$

Since $S_i^{0.5} = W_i^{0.5}$, we also have:

$S_3^{0.5} > S_4^{0.5} = S_1^{0.5} > S_2^{0.5}$

Since $S_3^{0.5} = W_3^{0.5} > S_2^{0.5} = W_2^{0.5}$, it is quite straightforward to see that $(CIC3^{0.5})$ is satisfied already.

Moreover, since $S_3^{0.5} = W_3^{0.5} > S_4^{0.5} = W_4^{0.5}$ we have:

$S_3 - 0.5(S_3 - W_3) > S_4 - 0.5(S_4 - W_4)$

which means the supervisor always wants to hide the true information at state 4 and acts like it is state 3, i.e. $s_4 = \{\emptyset\}$.

A.3 The Case of Inequity Averse, Symmetric Multiple Agents

Proof of Proposition 6: Consider that Agent A offers α (where $\alpha > 0.5$) portion of the side transfer and Agent B offers the remaining $1-\alpha$ portion. Then, we can write the payoffs of the agents after they pay the minimum side transfer for the collusion at state 1 as follows:

For Agent A: $W_2 - \alpha(S_1 - S_2) - g(e_2) - \lambda^{'}(W_2 - (1-\alpha)(S_1 - S_2) - (W_2 - \alpha(S_1 - S_2)))$

$$= W_2 - g(e_2) - (\alpha + \lambda^{'}(2\alpha - 1))(S_1 - S_2)$$

For Agent B: $W_2 - (1-\alpha)(S_1 - S_2) - g(e_2) - \lambda^{''}(W_2 - (1-\alpha)(S_1 - S_2) - (W_2 - \alpha(S_1 - S_2)))$

$$= W_2 - g(e_2) - ((1-\alpha) + \lambda^{''}(2\alpha - 1))(S_1 - S_2)$$

Since $\alpha > 0.5$ and $\lambda^{'} > \lambda^{''}$, we have $(\alpha + \lambda^{'}(2\alpha - 1)) > ((1-\alpha) + \lambda^{''}(2\alpha - 1))$. Then, it means payoff of agent A is smaller than payoff of agent B. Thus, if payoff of Agent A is greater than or equal to $W_1 - g(e_1)$, payoff of Agent B is greater than $W_1 - g(e_1)$. On the other hand, a payoff for Agent B greater than or equal to $W_1 - g(e_1)$ does not guarantee that payoff of Agent A is greater than or equal to $W_1 - g(e_1)$. For example in the case where payoff of Agent B is equal to $W_1 - g(e_1)$, payoff of Agent A is definitely lower than $W_1 - g(e_1)$ and she does not try to shift from state 1 to state 2 via forming a coalition.

The proof structure for collusion at state 4 is completely same with the one above. Just change S_1, S_2, W_1, W_2 with S_4, S_3, W_4, W_3 respectively.

Proof of Proposition 7: Proof of proposition 6 implies that to prevent collusion at state 1 and 4, the principal satisfies the collusion constraint for the agent who pays higher portion of the side transfer when the agents provides the side payment unequally. Then, $(CIC3^{MA})$ for the case where agents pay side transfer in differing amounts can be written as follows:

$$W_1 - g(e_1) - W_2 + g(e_2) + (\alpha + \lambda^{'}(2\alpha - 1))(S_1 - S_2) \geq 0 \qquad \text{(A.48)}$$

and $(CIC3^{MA})$ when the agents pays the same amount of side transfer is as follows:

$$W_1 - g(e_1) - W_2 + g(e_2) + \frac{1}{2}(S_1 - S_2) \geq 0 \tag{A.49}$$

Since $\alpha > 0.5$ and $\lambda^{'} > 0$, we have $(\alpha + \lambda^{'}(2\alpha - 1)) > \frac{1}{2}$. Then we can write $W_1 - g(e_1) - W_2 + g(e_2) + (\alpha + \lambda^{'}(2\alpha - 1))(S_1 - S_2) > W_1 - g(e_1) - W_2 + g(e_2) + \frac{1}{2}(S_1 - S_2) \geq 0$. Thus, satisfying 49 always satisfies 48.

The proof structure for collusion at state 4 is completely same with the one above. Just change S_1, S_2, W_1, W_2 with S_4, S_3, W_4, W_3 respectively.

APPENDIX B

TURKISH SUMMARY

Ekonomi alanındaki bir çok akademik makale, gerçek hayatta karşılaşılan problemleri modellerken çalışmalarında sadece kendi faydasını düşünen insanlar yaklaşımına yer vermektedir. Fakat bir çok deneyin sonucu, etkileşimin olduğu bir ortamda insanların kendi faydalarını hesaplarken başkalarının durumunu da göz önüne aldığı gerçeğini sunmaktadır. Diğer insanların konumu hakkındaki ilgi ve alaka, bireylerin sosyal bir ortam içerisinde karar verme mekanizmalarında önemli bir motivasyon faktörüdür.

Sadece kendi faydasını düşünen insanlar yaklaşımı, İşveren-Denetçi-Çalışan tarzı standart hiyerarşi modellerinde de sıklıkla kullanılmaktadır. Bu duruma nazaran, ekonomi literatürünün hiyerarşi modellemelerinde ciddi bir teorik çalışmayla sosyal tercihler yaklaşımına gerekli ilgiyi göstermediğini düşünmekteyiz. Sonuç olarak bu tez çalışmasında, başkalarının durumunu da göz önüne alan tercihlerin İşveren-Denetçi-Çalışan tipi hiyerarşileri nasıl etkilediğini araştırdık. Özellikle de bu tür tercihlerin hiyerarşinin basamakları arasındaki gizli anlaşmalar üzerindeki etkisine ve işverenin denetçi ve çalışana sunduğu optimal kontrat parametrelerini nasıl değiştirdiğine odaklandık.

Bu çalışma ekonomi literatürünün iki önemli başlığından büyük ölçüde faydalanmaktadır. Bunlardan ilki Kontrat Teorisi olmakla beraber, daha çok bu alandaki İşveren-Denetçi-Çalışan tarzı hiyerarşilere yoğunlaşmaktayız. İkinci literatür ana başlığı olarak da Sosyal Tercih Modellerini gösterebiliriz.

Hiyerarşi modellerinin başlangıcı olarak Tirole'ün (1986) literatüre yön veren makalesi kabul edilebilir. Tirole (1986), kontrat teorisi içindeki standart gizli aksiyon problemine gizli bilgi (çalışma ortamının verimlilik seviyesi) problemini de eklemiş ve bu bilginin kontrolünü sağlamak için de klasik İşveren-Çalışan modeline ara basamak olarak bir Denetçi kullanmıştır. Böylece bir yandan üç basamaklı bir hiyerarşi oluşurken bir yandan da gizli bilgiye sahip partiler arasında (denetçi ve çalışan) rüşvete dayalı gizli anlaşmaların yapılması olasılığı ortaya çıkmıştır. Tirole (1986), makalesinde bu gizli anlaşmaların doğasını inceleyerek hiyerarşi içi rüşveti önleyici optimal kontratların yapısının nasıl olması gerektiğini gösterir.

Sosyal Tercih modellerini incelerken öncelikli olarak bu literatürün temel taşlarından Fehr ve Schmidt'in (1999) makalesinden yararlanmayı tercih ettik. Fehr ve Schmidt (1999) sadece kendi faydasını düşünen insan modelleriyle çelişen deney sonuçlarını açıklamada fayda fonksiyonları için eşitsizlikten kaçınma modelini kurmuş ve bu konuda başarılı olmuştur. Kendilerinin, sosyal tercihleri gösteren, iki oyuncu için modelledikleri parça parça lineer fayda fonksiyonu aşağıdaki gibi belirtilebilir:

$$u_i(x_1, x_2) = x_i - \alpha_i max\{x_j - x_i, 0\} - \beta_i max\{x_i - x_j, 0\}, \quad i \neq j$$

Burada $\alpha_i > 0$ ve $0 < \beta_i \leq 1$ sırasıyla oyuncu i gerideyken ve ilerideyken eşitsizlikten kaçınma parametrelerini göstermektedir. Ayrıca bu fonksiyonda $\alpha_i \geq \beta_i$ şartı sağlanmaktadır. Bu durum kişinin gerideyken ileride olma durumuna göre eşitsizlikten daha kötü etkilendiğini belirtmektedir. Neilson ve Stowe (2004) β_i üzerindeki varsayımı gevşeterek ileride olma durumunda insanların bundan keyif alabileceğini söylemiş ve $\beta_i < 0$ olduğu durumları da göz önüne almıştır. Bu tür tercihlere sahip olan insanları statü arayan ve ya rekabetçi oyuncular olarak adlandırabiliriz.

Yukarıda belirtilenlere ek olarak Eisenkopf ve Teyssier (2016) de yaptıkları bir deneyde insanların ya dikey (kişi kendinden üst basamaktaki bir başka kişinin kazancını önemsemekte) ya da yatay (kişi kendiyle yakın seviyedeki bir başka kişinin kazancını önemsemekte) sosyal tercihler gösterdiklerini ortaya koymuşlardır. Bu çalışmaya göre insanlar aynı anda tek bir tarafa odaklanmakta iki tarafı birden aynı anda dikkate almamaktadır. Biz de modellerimizi kurarken bu durumu göz önüne aldık ve çalışanların ya başlarındaki denetçinin ya da diğer çalışanın kazancını göz önüne aldığını, iki kişinin kazançlarını da aynı anda önemsemediklerini varsayıyoruz.

Bu tezde kurduğumuz hiyerarşi modelleri Tirole'ün (1986) çalışmasındaki gibi üretken parti olarak sadece çalışanı göz önüne almaktadır. Belirli bir efor sarf eden çalışan işverene

$$x = \theta + e$$

şeklinde bir kazanç sağlamaktadır. Çalışan, sarf ettiği efordan kaynaklı, $g(e)$ kadar fayda fonksiyonunda bir kayıp yaşarken işverenin kazancı olan x'ten ödediği W kadar bir maaşı pozitif olarak fayda fonksiyonunda gözlemlemektedir. (Burada g tam olarak konveks ve efor değeriyle artan bir fonksiyondur.)

Modellerimizde, denetçi çalışma ortamının verimlilik seviyesini, θ, gözlemlemekte ve bunun hakkındaki raporunu işverene sunmaktadır. Denetçi gözlemlerini yaparken herhangi bir efor sarf etmez ve herhangi bir gözlem maliyeti ile karşılaşmaz. Çalışanın durumuyla benzer olarak denetçi de işverenin kendi kazancından ödediği S kadar bir maaş almaktadır.

Fehr ve Schmidt'in (1999) iki oyunculu eşitsizlikten kaçınmalı fayda fonksiyonunu baz alan modellerimizde, denetçi ve çalışanın sadece ödenen maaşları göz önünde bulundurup efordan kaynaklı maliyetleri dikkate almadığını varsayıyoruz. Buna ek olarak denetçi hiyerarşide üst basamakta yer aldığından denetçi maaşlarının tüm bilgi durumlarında çalışan maaşından daha yüksek olduğunu da farz ediyoruz. (Diğer bir deyişle $S_i > W_i$.) Tüm bunlardan yola çıkarak çalışanın fayda fonksiyonunu

$$U(W - g(e) - \lambda_A(S - W))$$

şeklinde belirtirken denetçinin fayda fonksiyonunu da

$$V(S - \lambda_S(S - W))$$

şeklinde belirtmekteyiz. (Burada U ve V türevi her yerde alınabilen, tam olarak konkav ve artan birer Von Neumann Morgenstern tipi fayda fonksiyonudur. Ayrıca λ_A ve λ_S sırasıyla çalışan ve denetçinin eşitsizlikten kaçınma parametrelerini göstermektedir. Bunlara çalışan ve denetçinin maaş dağılımındaki adaletsizliğe karşı hassasiyetleri gözüyle de bakılabilir.)

Hiyerarşinin en üst basamağında yer alan işveren, çalışana üzerinde çalışacağı projeyi ayarlar ve denetçi ile çalışana önereceği kontratların içeriğini kendine en uygun şekilde hazırlamaya uğraşır. İşverenin riske karşı nötr olduğunu kabul ettiğimizden kendisinin fayda fonksiyonu aşağıdaki şekilde yazılabilir:

$$x - S - W = \theta + e - S - W$$

Bu tezde kullanılan modellerin en önemli bileşenlerinden biri de gizli bilgi problemidir. Modellerimizde işveren düşük ($\underline{\theta}$) ve yüksek ($\overline{\theta}$) düzey olarak iki farklı verimlilik düzeyiyle karşı karşıya kalmaktadır; fakat kendisi bunlardan direkt olarak haberdar değildir. Bu iş için denetçiyi tuttuğunu daha önceden belirmiştik. Çalışan hangi verimlilik altında iş yaptığından her durumda haberdar olmakta fakat denetçi ise gözlemleme görevini her zaman başarılı olarak yerine getirememesinden kaynaklı olarak bazı durumlarda verimlilik düzeyi hakkında bilgi sahibi olamamaktadır. Tüm bu anlatılanlar ışığında (i harfi ile notasyonunu yaptığımız) dört farklı durumla karşılaşmaktayız:

Durum 1: Hem çalışan hem de denetçi düşük düzey verimliliği $\underline{\theta}$ öğrenir.

Durum 2: Çalışan düşük düzey verimliliği $\underline{\theta}$ öğrenir. Denetçi ise gözlem görevinde başarısız olur.

Durum 3: Çalışan yüksek düzey verimliliği $\overline{\theta}$ öğrenir. Denetçi ise gözlem görevinde başarısız olur.

Durum 4: Hem çalışan hem de denetçi yüksek düzey verimliliği $\overline{\theta}$ öğrenir.

Tüm bu durumlar $\sum_{i=1}^{i=4} p_i = 1$ şartını sağlayan p_i olasılıkla ortaya çıkmaktadır. Ayrıca modelimizde, çalışanın denetçinin ortamdaki verimlilik düzeyini gözlemleyip gözlemleyemediğine dair bilgiye sahip olduğunu varsaymaktayız.

Son olarak modelimizde olayların gerçekleşme sırasını belirtelim. İlk olarak işveren, denetçi ve çalışana hazırladığı kontratları önerir. Denetçi ve çalışan, kendilerine uygunsa bu kontratları kabul eder ve bir sonraki aşamaya geçilir. (Bu arada, kontrat görüşmeleri sırasında maaşlar tüm partiler için ortak bilgi haline gelmektedir.) Kontratların kabul edilmesinden sonra çalışan iş başı yaparak ortamdaki verimlilik düzeyini öğrenir. Öte yandan bu bilgiyi gözlemlemeye çalışan denetçi, verimlilik düzeyini öğrenir ya da öğrenemez. Daha sonra, ortaya çıkan durumlara göre denetçi ve çalışan gizli anlaşma aşamasına geçerler. Eğer her iki partiye de pareto optimal olan bir yan ödeme ayarlanabilirse taraflar arasında rüşvet alış verişi gerçekleşir. Bu aşamanın sonucuna göre de işverenin kazanç miktarı belirli olur. Ayrıca, yine bu aşamanın sonucuna göre denetçi işverene vereceği raporun (r) içeriğini ayarlar ve raporunu sunar. (Denetçinin verimlilik düzeyini başarıyla gözlemlediği durumlarda bu bilgiyi gizleme opsiyonuna sahip olduğunu belirtelim.) Son iki olayın yaklaşık aynı zamanda gerçekleştiği kabul edilebilir. En son aşamada ise kontratların (ana veya gizli) şartlarının yerine getirilmesi yer almaktadır. Bir diğer deyişle, işveren kazancını gördükten sonra çalışana $W(x, r, \lambda_S, \lambda_A)$'yu, denetçiye de $S(x, r, \lambda_S, \lambda_A)$'yi öder. Ayrıca rüşvet aşamasında gizli anlaşmalar yapıldıysa denetçi ve çalışan arasındaki yan transferler $t(x, r, \lambda_S, \lambda_A)$ de bu son aşamada gerçekleştirilir.

İşverenin çözmek zorunda olduğu problemin analizini yaptığımızda, öncelikle çalışan ve denetçi arzının rekabetçi bir doğaya sahip olduğunu ve çalışanların W_0 kadar minimum kabul edeceği maaşa ve $\overline{U} \equiv U(W_0)$ kadar minimum kabul edebileceği fayda fonksiyonuna, denetçilerin ise S_0 kadar minimum kabul edeceği maaşa ve $\overline{V} \equiv V(S_0)$ kadar minimum kabul edebileceği fayda fonksiyonuna sahip olduklarını göz önünde bulundurduk. Bunları dikkate alarak çalışan ve denetçinin katılım kısıtlarını aşağıdaki şekillerde yazabiliriz:

$$(APC) : EU(W - g(e) - \lambda_A(S - W)) \geq \overline{U}$$

$$(SPC) : EV(S - \lambda_S(S - W)) \geq \overline{V}$$

Bu tezde yer alan modellerimizin hepsinde, işveren gizli aksiyon problemiyle karşı karşıya kalmaktadır. Durum 1 ve 4'te işveren verimlilik düzeyi bilgisine sahip olacağından çalışanın harcadığı eforu kendi kazancına da bakarak hesaplayabilir; ama Durum 2 ve 3'te işveren böyle bir hesaplamayı yapacak bilgiye sahip değildir. Bu yüzden, denetçi ortamdaki verimlilik düzeyini gözlemleyemediği zaman, işverenin çalışana içinde bulunduğu ortamın verimlilik bilgisini doğru aktarmasını sağlaması amacıyla bir tür teşvik vermesi gerekmektedir. Teşvik kısıtı olarak adlandırabileceğimiz bu durumu aşağıdaki eşitsizlik ile belirtebiliriz:

$$(AIC) : W_3 - g(e_3) - \lambda_A(S_3 - W_3) \geq W_2 - g(e_2 - \Delta\theta) - \lambda_A(S_2 - W_2)$$

Bu tür bir hiyerarşide gizli anlaşmaların olabileceğini belirtmiştik. Bu durumdan kaynaklı olarak işveren kontrat hazırlama problemini çözerken gizli anlaşma kısıtları ile de karşı karşıyadır. Durum 1 (birinci olası gizli anlaşma durumu) ve 4'te (ikinci olası gizli anlaşma durumu), çalışan vereceği rüşvetle denetçiyi satın almayı ve denetçinin işverene boş rapor vermesini amaçlayabilir. Durum 3'te (üçüncü olası gizli anlaşma durumu) ise denetçi rüşvetle çalışanı satın almayı ve çalışanın Durum 2'de olduklarını söylemesini amaçlayabilir. Bu durum, denetçinin yüksek düzey verimliliği gözlemleyememiş olmasını düşük düzey verimliliği gözlemleyememiş olmasından daha büyük başarısızlık olarak görmesinden kaynaklı gelmektedir.

Rüşveti veren kişinin dikkate aldığı iki ana etmen vardır: Karşısındakini rüşvet almaya ikna edebilmek için en az ne kadar ödemesi gerektiği (t_{min}) ve kendisini zarara sokmadan en fazla ne kadar rüşvet ödeyebileceği (t_{max}). İşverenin gizli anlaşmaları önleyebilmesi için kontrat hazırlama problemini çözerken aşagıdaki eşitsizliği sağlaması şarttır (Gizli anlaşma kısıtları):

$$t_{min} \geq t_{max} \Rightarrow t_{min} - t_{max} \geq 0$$

t_{min} ve t_{max}'ın çeşitli durumlarda incelenmesiyle işverenin gizli anlaşmaları önlemesi için aşağıda tanımladığımız araçları kullanmakta olduğunu söyleyebiliriz:

Denetçi maaşları araçları:

Birinci olası gizli anlaşma durumu (CIC1) için: $\Delta S_{12} = S_1 - S_2$

İkinci olası gizli anlaşma durumu (CIC2) için: $\Delta S_{43} = S_4 - S_3$

Üçüncü olası gizli anlaşma durumu (CIC3) için: $\Delta S_{32} = S_3 - S_2$

Çalışan maaşları araçları:

Birinci olası gizli anlaşma durumu (CIC1) için: $\Delta W_{12} = W_1 - W_2$

İkinci olası gizli anlaşma durumu (CIC2) için: $\Delta W_{43} = W_4 - W_3$

Üçüncü olası gizli anlaşma durumu (CIC3) için: $\Delta W_{32} = W_3 - W_2$

Tüm bu anlattıklarımızın ışığında gizli anlaşma kısıtlarını aşağıdaki eşitsizlikler şeklinde yazabiliriz:

$$(CIC1): \frac{S_1 - \lambda_S(S_1 - W_1)}{1 - 2\lambda_S} + \frac{W_1 - g(e_1) - \lambda_A(S_1 - W_1)}{1 + 2\lambda_A} \geq \frac{S_2 - \lambda_S(S_2 - W_2)}{1 - 2\lambda_S} + \frac{W_2 - g(e_2) - \lambda_A(S_2 - W_2)}{1 + 2\lambda_A}$$

$$(CIC2): \frac{S_4 - \lambda_S(S_4 - W_4)}{1 - 2\lambda_S} + \frac{W_4 - g(e_4) - \lambda_A(S_4 - W_4)}{1 + 2\lambda_A} \geq \frac{S_3 - \lambda_S(S_3 - W_3)}{1 - 2\lambda_S} + \frac{W_3 - g(e_3) - \lambda_A(S_3 - W_3)}{1 + 2\lambda_A}$$

$$(CIC3): \frac{S_3 - \lambda_S(S_3 - W_3)}{1 - 2\lambda_S} + \frac{W_3 - g(e_3) - \lambda_A(S_3 - W_3)}{1 + 2\lambda_A} \geq \frac{S_2 - \lambda_S(S_2 - W_2)}{1 - 2\lambda_S} + \frac{W_2 - g(e_2 - \Delta\theta) - \lambda_A(S_2 - W_2)}{1 + 2\lambda_A}$$

İşverenin nihai amacı önündeki kısıtları dikkate alarak ve kontrat parametrelerini optimal şekilde ayarlayarak beklenen fayda fonksiyonunu maksimize etmektir. Diğer bir deyişle, işverenin ağaşıdaki maksimizasyon problemini çözmesi gerekmektedir:

$$\max_{(S_i, W_i, e_i)} \sum_i p_i(\theta_i + e_i - S_i - W_i)$$
$$s.\ t. \quad (SPC), (APC), (AIC), (CIC1), (CIC2), (CIC3)$$

Modellerimizin verdiği sonuçları incelerken Tirole'ün (1986) modelini kıyaslama noktamız alarak çıkarımlarda bulunduk. Tirole'ün (1986) modeline $\lambda_A = 0$ ve $\lambda_S = 0$ alınarak ulaşılabilir. Kıyaslama ölçütü olarak aldığımız sonuçları incelemek isteyen okurlarımız Tirole'ün (1986) makalesine başvurabilirler.

Tezimizde $\lambda_A > 0$ ve $\lambda_S = 0$ alarak çalışanın denetçinin maaşını kendi fayda fonksiyonunda dikkate aldığı ve maaş eşitsizliğinden mutsuz olduğu durumu inceledik. Bu vakada, denetçinin ortamdaki verimlilik düzeyini başarıyla gözlemlediği durumlarda çalışanın ödeyebileceği en yüksek rüşvet miktarının kıyaslama noktamıza göre daha düşük değerlerde olduğu görülmüştür. Ayrıca, denetçinin başarısız olduğu durumda çalışana vermesi gereken en düşük rüşvet miktarında da kıyaslama noktasındakine göre azalma vardır. Olası tüm gizli anlaşma durumlarını önlemede, çalışan maaşları aracının kendi başına etkinliğinde artma görülürken denetçi maaşları aracının kendi başına etkinliğinde azalma görülmektedir.

Optimal kontrat kısmında en büyük değişim, işverenin çalışan üzerinde indüklediği efor seviyelerinde gözlemlenmiştir. Eforların durumlara göre sıralamasında değişiklik olmazken incelediğimiz vakada işveren her durumda kıyaslama noktasındaki değerlerden daha fazla efor sarf ettirebilmektedir. Ayrıca indüklenebilen efor değeri, çalışanın maaş eşitsizliğine karşı hassasiyeti arttıkça daha da artmaktadır. Denetçi maaşının durumlara göre sıralamasında değişiklik olmazken Durum 1, 2 ve 3'teki maaşı kıyaslama noktasındakinden daha düşüktür. Durum 4'teki maaşın kıyaslama noktasına göre pozisyonu ise belirsizdir. Çalışan maaşının durumlara göre sıralamasında değişiklik olmazken, maaş seviyeleri ise kıyaslama noktasındakinden yüksektir.

Bu vakada, işveren ya denetçinin Durum 4'teki maaşını kıyaslama noktasından yükseğe çıkarmalı ya da daha az yetenekli bir denetçiyle anlaşmak durumundadır. Ayrıca, denetçi maaşları aracının etkinliğinin azalmasından dolayı durumlar arasındaki denetçi maaş farkı artmaktadır. Çalışan maaşlarında ise Durum 1,2 ve 4'teki maaşlar arasında açılma gözlemlenirken Durum 3 ve 4 arasındaki maaş farkına ne olduğu ise belirsizdir.

Tezimizde $\lambda_A = 0$ ve $\lambda_S \neq 0$ alarak denetçinin çalışanın maaşını kendi fayda fonksiyonunda dikkate aldığı durumu inceledik. $\lambda_S > 0$ denetçinin maaş eşitsizliğinden rahatsız olduğu durumu belirtirken (eşitsizlikten kaçınan denetçi), $\lambda_S < 0$ de denetçinin maaş eşitsizliğinden hoşlandığı durumu belirtir (statü arayan ya da rekabetçi denetçi). Bu vakada, statü arayan denetçi ($\lambda_S < 0$) için, denetçinin ortamdaki verimlilik düzeyini başarıyla gözlemlediği durumlarda denetçiye verilmesi gereken en düşük rüşvet miktarının kıyaslama noktamıza göre daha düşük değerlerde olduğu görülmüştür. Ayrıca, denetçinin başarısız olduğu durumda denetçinin önerebileceği en yüksek rüşvet miktarında da kıyaslama noktasındakine göre azalma vardır. Olası tüm gizli anlaşma durumlarını önlemede, çalışan maaşları aracının kendi başına etkinliğinde azalma gözlemlenirken denetçi maaşları aracının kendi başına etkinliğinde artma görülmektedir. Eşitsizlikten kaçınan denetçi ($0 < \lambda_S < 0.5$) için ise yukarıda belirttiğimiz sonuçların tam tersinin gözlemlendiğini belirtebiliriz.

Optimal kontrat kısmında en büyük değişim, işverenin çalışan üzerinde indüklediği efor seviyelerinde gözlemlenmiştir. Eşitsizlikten kaçınan denetçi için, eforların durumlara göre sıralamasında değişiklik olmazken incelediğimiz vakada işveren her durumda kıyaslama noktasındaki değerlerden daha fazla efor sarf ettirebilmektedir. Statü arayan denetçi için ise eforların durumlara göre sıralamasında yine değişiklik olmazken işveren her durumda kıyaslama noktasındaki değerlerden daha az efor sarf ettirmektedir. Ayrıca incelediğimiz vakada, indüklenebilen efor değeri çalışanın maaş eşitsizliğine karşı hassasiyeti arttıkça daha da artmaktadır.

Eşitsizlikten kaçınan denetçi için, en düşük denetçi maaşı Durum 3'te görülürken Durum 1, 2 ve 4'teki maaşların kendi arasındaki sıralaması belirsizdir. Denetçi maaş seviyesi her durumda kıyaslama noktasındakinden daha yüksektir. Statü arayan denetçi için, en düşük denetçi maaşı Durum 2'de görülmektedir. Durum 4'teki maaşın Durum 1'deki maaştan daha yüksek olduğu söylenebilirken Durum 3'teki maaşın bu iki durumdaki maaşa göre pozisyonu ise belirsizdir. Denetçi maaş seviyesi her durumda kıyaslama noktasındakinden daha düşüktür.

Hem statü arayan denetçi için hem de eşitsizlikten kaçınan denetçi için çalışan maaşının durumlara göre sıralamasında değişiklik yoktur. Statü arayan denetçi için, çalışan maaşları aracının etkinliğinin zayıflamış olmasından dolayı Durum 4, 1 ve 2 arasındaki maaş farkları daralırken Durum 3 ve 4 arasındaki maaş farkı ise genişlemektedir. Eşitsizlikten kaçınan denetçi için ise çalışan maaşları aracının etkinliğindeki güçlenmeden kaynaklı, Durum 4, 1 ve 2 arasındaki maaş farkları artarken Durum 3 ve 4 arasındaki maaş farkı azalmaktadır.

Eşitsizlikten kaçınan denetçi vakasında, denetçinin maaş eşitsizliğine olan hassasiyeti belirli bir eşiğe geldiğinde (modellediğimiz lineer durumda bu değer 0.5 bulunmuştur) denetçinin başarıyla ortamdaki verimlilik düzeyini gözlemlediği durumlarda çalışanın denetçiyi rüşvetle gizli anlaşmaya ikna etmesi imkansız hale gelmektedir. Bu uç vakayı ayrı bir parantez açıp özel olarak incelediğimizde denetçinin katılım kısıtını sağlamada en efektif yöntemin çalışanın maaşını her durum için denetçinin maaşına eşitleninceye kadar artırmak olduğu görülmüştür. Bu yaklaşım ışığında baktığımızda, çalışan ve denetçi maaşlarının en yüksek seviyeye Durum 3'te, en düşük seviyeye ise Durum 2'de ulaştığını ve Durum 4 ve 1'deki maaşların birbirine eşit olduğunu görürüz. Ayrıca (CIC3)'ün de bu vakanın çözümüyle kendiliğinden sağlandığını ve işverenin denetçiden aldığı bilginin $\{s_1 = \underline{\theta}, s_2 = s_3 = s_4 = \emptyset\}$ yapısında olduğunu, yani işverenin hiç bir zaman denetçiden yüksek verimlilik düzeyi bilgisine erişemediğini de gözlemlemekteyiz. Bu durumu, denetçinin tamamen çalışan çıkarına kararlar vermesi olarak algılamakta bir sakınca olmadığına inanıyoruz.

Bu tezde son olarak da hiyerarşinin en alt basamağında birden fazla, simetrik yapıdaki eşitsizlikten kaçınan çalışanın olduğu vaka incelenmiştir. Eisenkopf ve Teyssier'in (2016) makalesine uygun olarak bu vakada sadece yatay sosyal tercihlerin gerçekleştiği durum analiz edilmiştir. Çalışanların denetçiyi gizli anlaşmaya ikna etmek için gereken yan ödemeyi farklı oranlarda ödediği durumlarda, işverenin yüksek oranda ödemeyi yapan çalışanın gizli anlaşma kısıtını sağlaması yeterli ve gereklidir. Öte yandan işverenin, çalışanların denetçiyi rüşvete yanaştırmak için gereken yan ödemeyi eşit miktarda paylaştıkları durumda gizli anlaşma kısıtını sağlaması takdirinde, çalışanların yan ödemeyi değişik oranlarda paylaştıkları olabilecek tüm diğer ödeme senaryolarının bu kısıtı da sağlanmış olur. Bu yüzden işverenin gizli anlaşmaların yapılmasını önlemede asıl hedeflemesi gereken durum çalışanların denetçiye teklif edilen yan ödemeyi yarı yarıya paylaştığı durumdur. Bu bulgulara ek olarak, simetrik ve eşitsizlikten kaçınan bu çalışanların sayısının artması halinde, denetçinin başarısız olduğu durumlarda gizli anlaşmaları önlemek kolaylaşırken başarılı olduğu durumlarda ise rüşvet aktivitelerinin önüne geçmek zorlaşmaktadır.

Sonuç olarak, sosyal tercihlerin çalışanların ve denetçinin rüşvet teklif etme veya rüşvet alma yatkınlıklarını etkilediği açıkça görülmektedir. Ayrıca, bu tür tercihler işverenin gizli anlaşmaları önlemede kullandığı araçları da etkilemektedir. Çalışanın eşitsizlikten kaçınan yapıda olduğu vakada, işveren bu durumdan faydalanarak çalışana daha fazla efor sarf ettirebilmektedir. Denetçinin statü arayan yapıda olduğu vakada indüklenen efor seviyeleri azalırken kendisinin eşitsizlikten kaçan yapıda olması halinde efor seviyeleri yükselmektedir. Denetçinin veya çalışanın değişik durumlardaki fayda seviyeleri arasındaki sıralama her durumda aynı kalırken maaşların sıralaması fayda fonksiyonlarının yapısındaki farklılıklardan dolayı değişmektedir. Bazı vakalarda, işveren daha az yetenekli insanlarla çalışmak durumunda kalabilmektedir. İşverenin rüşveti önlemede kullandığı araçların efektifliğindeki değişiminden dolayı, durumlar arasındaki maaş aralıkları daha geniş ya da daha dar hale gelebilmektedir ve bu sonucun riskten kaçınan partiler üzerinde etkileri olduğu açıktır. Hiyerarşinin basamakları arasında maaş değerlerinin birbirine yaklaşması, denetçinin veya çalışanın eşitsizlikten kaçınan tipte olduğu vakalarda görülmektedir. Bu durumun en uç şekli, denetçinin maaş adaletsizliğine hassasiyetinin belirli bir eşiğe çıktığı noktada gözlemlenmiştir (Modelimizde bu değer 0.5'tir).

Tezimizi bitirirken modellerimizin gelecek çalışmalar için nasıl daha iyi hale getirilebileceğine değinecek olursak izlenecek yollardan birinin değişik hiyerarşi tiplerinde sosyal tercihlerin nasıl etkileşimler göstereceğine bakılması olduğunu söyleyebiliriz. Modellerimizde maaş eşitsizliğine hassasiyetler ortak bilgi olarak alındığından, bu parametrenin aslında belirsiz olduğuna dayalı daha gerçeğe yakın modeller de önemli bir çalışma alanı olabilir. Birden fazla çalışanın olduğu vaka için, maaş olarak önde olan çalışanı rekabetçi olabilecek şekilde de modellemek ya da modelde asimetrik yapıda çalışanlar kullanmak bu çalışmadaki yapılanları ekonomi literatürüne daha yararlı hale getirebilir. Son olarak, denetçiye de üretkenlik görevi yüklemenin modelleri çok daha ilginç hale getireceğini belirtmekteyiz. Bu tür bir yaklaşım, işverene hiyerarşideki partilerin isteklerini karşılamada daha fazla seçenek sunarken bir yandan da öncül gizli anlaşmaların gerçekleşmesi olasılığını da modellere eklemektedir.

APPENDIX C

TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ☐

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı :
Adı :
Bölümü :

TEZİN ADI (İngilizce) :

TEZİN TÜRÜ : Yüksek Lisans ☐ Doktora ☐

1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
3. Tezimden bir bir (1) yıl süreyle fotokopi alınamaz. ☐

TEZİN KÜTÜPHANEYE TESLİM TARİHİ: