A Tale of Two Identities

On the optimal work location of the Internal Control Agent from a principals perspective

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ABSTRACT

Drawing from and contributing to insights in both the auditing and organizational economics literature, this theoretical analysis considers the optimal work setting for the internal control agent from the perspective of the principal. Specifically, it highlights the trade-off in deciding whether to locate this agent close to the fraud-sensitive activities or as separate entity. The crucial assumption of the applied model concerns the incentivizing effect of identity: if placed at the unit, the control agent is assumed to identify himself as a member of the unit and has an incentive to conceal fraud, while if located separately, his identity as an independent controller appears and he is assumed to gain utility from reporting fraud. Due to the "role-dilemma" rooted in the modern internal control profession, balancing these effects carefully is of large significance to the principal. The basic findings indicate that for relatively large expected losses of fraud, locating the internal control agent separately is optimal. However, when taking into consideration the interaction effect of the external auditor with the internal control agent and the potential fraudsters, the case for locating the internal control agent close to the fraud sensitive tasks strengthens.

Master thesis

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1. Introduction

Moral hazard imposes numerous challenges within organizations. Perhaps one of the most severe ones is the incentive it might provide to fraudulent behaviour. Over the past decade, internal fraud scandals have received increasing attention in the media. Some of these even obtained world fame, for example the ‘WorldCom’ and ‘Enron’ scandals. However, also within the Netherlands there are numerous examples of internal fraud of various scales. In the beginning of 2003, national biggest retail company ‘Ahold’ got involved in a large accounting scandal which resulted in substantial fines for the top executives behind the fraudulent activities. More recently, the image of the Dutch bank ‘Rabobank’ got damaged by manipulation of the LIBOR-interest rate within its reporting department.

As a result of the scandals outlined above, the importance of internal control has been greatly acknowledged over the past few years. The role of the internal auditor has evolved from a mere “watchdog” into a value-adding, professional consultant[2]. Diverse research bodies, committees and branch organizations have investigated the concept of internal control, resulting in, amongst others, the well-known Sarbanes-Oxley act (2002) and strict guidelines in corporate behaviour, both nationally and internationally. One of the most influencing guidelines is the COSO report, issued in 1992 by the Committee of Sponsoring Organizations of the Treadway Commission (Vaassen et al. (2009)). Enhanced by its inclusion in the Sarbanes-Oxley act, the COSO framework has gained wide support. It distinguishes five interrelated components of internal control, as reflected in the so called ‘COSO house’. The first component refers to the ‘control environment’ and comprises a variety of organizational characteristics, such as its culture, job set up, hierarchy and management philosophy; altogether forming the foundation of the internal control system.

This work contributes in the field of this first component in two particular ways. For one thing, a theoretical analysis is provided from an organizational economics point of view. Although much of the studies related to these internal control guidelines are mainly accounting or business oriented, the ‘control environment’ component refers to a large degree to behaviour within organizations, driven by both economic and intrinsic incentives. Secondly, in contrast to the standard principal-agent models, this analysis includes an overlapping measure of this intrinsic motivation: the degree of identification, *identity*, with the imposed role.

[2] For an extended overview of the development of the internal audit function, see Ramamoorti (2003).

In order to enhance their control environment, nearly all bigger organizations implement internal control bodies. These bodies are concerned with monitoring and verifying the work of their colleagues. Due to the many interests that relate to this work, both internally as well as externally, these agents fulfil a rather unique and crucial role within the organization. Investigating the optimal organizational set up of these bodies can therefore result in valuable insights for many organizations.

As acknowledged by the international Institute of Internal Auditors (IIA), one of the main considerations in constructing an appropriate control environment is the degree of involvement by the controlling body in the work that is sensitive to fraud: to what extend should the internal control body be operating independently, as a distant party?[3] In order to gain insight in the dynamics of the underlying factors, a theoretic model is introduced. The basic model comprises a principal-agent model with a control agent who is hired to supervise the work of a unit in charge of a fraud-sensitive task. The principal has the choice to either place this agent 'at the unit'; i.e. let the agent work together with the unit or the place the agent independently; i.e. let the agent monitor the unit's work from a distant. Following the stream of literature in organizational economics on identity (e.g. Akerlof (2005) and Alvesson & Willmott (2002)) this decision influences the self-identification of the control agent. If placed at the unit, the control agent identifies himself as a member of the unit and gains utility from the output of the unit. As a result, the internal control agent in this situation has an incentive to silence fraud. However, when placed separately, his identity as an independent controller is emphasized and the control agent is assumed to gain utility from reporting fraud.

The basic model shows that the relative strength of these identification channels is of great importance in deciding where to locate the control agent, together with the chance of fraud and the ease of fraud detection. In addition, when the agent is located at the unit, he will never report fraud. In order to alter this situation, the principal might impose a bonus. The first extension of the model only considers the situation in which the internal control agent is located at the unit and incorporates a bonus for reporting fraud. When the loss of fraud to the principal exceeds the degree of identification with the unit of the internal control agent, the introduction of the bonus increases the payoff to the principal and consequently the likelihood of this work-setting to be optimal.

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[3]For a qualitative overview of the considerations that are relevant in this decision according the Institute of Internal Auditors , see their position paper 'The role of internal auditing in resourcing the internal audit activity'.

In the first two models, only two players are considered and fraud is assumed to be exogenous. The second extension of the model relaxes this assumption, incorporating the unit itself in a binary effort model as a third player which can decide to either commit fraud or not. When the control agent is located independently, a mixed strategy equilibrium exists in which the unit and the control agent mixes in committing fraud and exerting monitoring effort. It appears that the principal is better off placing the agent at the unit when the unit has less incentive to commit fraud, i.e. when the fine for fraud is high or the gain of fraud is low, and the independent internal control agent is less likely to exert effort. Reflecting the interaction between internal and external controlling parties, the last extension of the model includes a third player: the external auditor. For both work settings, two types of equilibria exists: one in which the external auditor replaces the role of the internal control agent, i.e. where the internal control agent does not exert monitoring effort, and one in which all players use a mixed strategy. Irrespective of which equilibrium appears, placing the internal control agent at the unit yields the highest payoff to the principal. However, this assumes equal costs of effort and identity strengths for both controlling parties. When these differ and encourage effort to a larger degree for the separate internal control agent compared to the external auditor, this unambiguous result might shift.

Most closely related to this paper is the work of Caplan and Kirschenheiter (2000). Using a model based on agency theory, they examine incentives for outsourcing the internal control activities in two situations: one in which the risk of fraud is exogenously determined and one in which risk of fraud is endogenous. The results are in line with this paper. For the exogenous fraud case, they find that the incentives to outsource increase with the need for control (i.e., the potential loss of fraud) and the risk of fraud. In case fraud is modelled endogenous, they find the agent located separately exerts more effort. Empirically, the study by Alhawat and Lowe (2004) is most related to this work. In their case study, they found that outsourced internal auditors displayed more objectivity in their judgments.

Nonetheless, this paper differs from and contributes to the existing literature on the "outsourcing trade-off" in four important ways. First, it takes a more general approach in which the precise interpretation of the separate internal control agent is disregarded[4]. Second, this model incorporates the "role dilemma" inherent on the contemporary internal audit

[4] This allows abstracting away from differences in limited liability or reservation wages for both work settings.

function. Consequently, any direct incentives for the internal control agent located at the unit[5] to exert monitoring effort are assumed away. Similarly, the internal control agent located separately has no direct incentive to provide output supporting effort. This results from the third crucial difference of this model with current literature: the incentive system used. While the existing literature on the outsource decision uses extrinsic incentives as main motivation, this study incorporates the effect of identity as an incentive to exert effort. Lastly, this work adds the interaction mechanism between the internal control party and the external auditor to the model.

The remainder of this work is structured as follows. In the following section, an overview of the related literature and the position of this paper therein is provided. Next, the basic model is introduced, followed by the resulting findings. Section five describes the first extension of the basic model where a bonus is included. The second extension in which fraud becomes endogenous is discussed in section six. Lastly, the external auditor is incorporated in the model in section seven. Section eight discusses the results and section nine concludes.

2. Related literature

The central trade-off of this work comprises the choice of the principal in organizational work-setting of the internal control agent: at the unit he needs to control or as a separate entity. This relates to the vast amount of literature, mainly in the field of accounting and auditing, investigating the decision between an in-house internal control agent and the outsourcing of the internal control activities[6]. Although not explicitly specified, the model developed in this paper might be applied to this consideration.

The field of organizational economics provides a vast amount of literature discussing the optimal incentive contracts in order to overcome moral hazard. However, most of these studies include a performance measure, either subjective or objective, and related monetary incentive in their analysis (e.g. Baker et al (1994), Lazaer (2000), Prendergast (1999)). By its very nature, appropriate performance measures are hard to implement for the task of an internal control agent. The internal control function offers a textbook example for moral hazard where effort is likely to be noncontractible and unobservable. This fosters the role for

[5] For comparing purposes, the control agent located at the unit can be interpreted as the ‘in-house internal auditor’ and the internal control agent located separately as the ‘outsourced internal auditor’, as referred to in the in the literature on outsourcing decisions.
[6] Stewart and Subramaniam (2010) provide a clear overview of the literature regarding the internal control trade-offs.

intrinsic incentives such as altruism, reputational concerns or pure intrinsic motivation. In their pioneering work, Akerlof and Kranton (2005) aim to capture those incentives by incorporating the concept of *identity* in organizational economics. Their definition of identity refers to the norms of the specific social category the individual identifies with concerning how to behave in a particular situation and provides an incentive to act along these ideals. Translated into economic vocabulary, an individual is assumed to gain utility from behaving in line with his identity. The potential benefits of identity appear promising for the internal control function: according to Akerlof and Kranton (2005), the value of identity increase when effort is hard to observe, there is much uncertainty and high effort is critical to the organization's output. However, they do not stand alone in promoting the importance of identification effects: Alvesson and Willmott (2002) argue in their extensive treatment of identity regulation, that identity is a pivotal dimension of organizational control. In addition, a number of recent experimental studies confirm the importance of identification on resulting behaviour (e.g. Humlum et al (2007), Masella et al (2012), Kendra et al (2007), Fehrler and Kosfeld (2013)). Specifically for the internal audit function, Kwan and Banks (2004) point out that the job characteristic 'task identity' has a strong positive relationship with professional commitment.[7]

However, acknowledging the role for identity does not provide a solution to another incentive concern: to the 'multi-tasking problem' (Holmstorm and Milgrom, 1991). Dependent on his work setting, the self-identification effect causes the internal control agent to attach more value to one of the imposed tasks: output supportive efforts or controlling efforts. In fact, exerting effort on the less preferred task might even decrease his utility. As argued by Holmstrom and Milgrom (1991), such undesirable consequences can be mitigated by appropriate job design. Correspondingly, this work investigates the optimal work-setting for the internal control agent, taken into account this disruptive effort allocation. This tension in effort allocation resulting from somewhat opposing incentives relates to the work of Dewatripont and Tirole (1999). In their argument for advocacy, the mechanisms at work when an agent has conflicting incentives are shown, resulting in less overall effort. Next to these findings from organizational economics, the auditing literature provides various studies concerning the increasing 'double role' of the internal auditor. Part of these studies mainly provides evidence on the existence of this double role (e.g. Nagy and Cenker (2002), Allegrini

[7] Various studies support the positive effect of professional commitment of employees on diverse dimensions of the organization, see for example Porter et al (1974), Farrel and Rusbult (1981), Mathieu and Zajac (1991) and Anderson and Balzer (1991).

and Bandetti (2006), Selim et al (2009)). However, van Peursem specifically addresses potential issues inherent to this ‘role dilemma’. In her empirical study concerning the perception of internal auditors of their profession (van Peursem, 2004), she finds that internal auditors acknowledge their double role, but do not consider it problematic. In her follow up study (van Peursem, 2005), using diverse qualitative techniques, she attempts to gain insight in how the internal auditors deal with their somewhat conflicting tasks. Her findings indicate that the ability to manage this ambiguity depends on their external professional status, their formal and informal network and autonomy in determining their role. In contrast to these optimistic tendencies concerning the ‘role’ dilemma, studies by Brody and Lowe (2000) and Alhawat and Lowe (2004) provide evidence that the supportive role of the internal auditor impairs objectivity in his monitoring tasks.

One last important mechanism discussed in the internal control literature concerns the interplay between the external auditor and internal control, as captured in the last extension of the model employed here. The auditing literature concerning this interaction can be characterized by rather contrasting views. At first, some disagreement exists whether the external auditor acts as a substitute or a complement of the internal control agent. Illustrative are the studies by Felix et al (2001) and Stewart et al (2006). In their empirical analysis, Felix et al (2001) found a negative relationship between the contribution of the internal control agent in the financial statements audit and the external auditor fee. In contrast, Stewart et al (2006) provide evidence for a positive relation between the use of internal audits and the external audit fees. While Felix et al (2001) remains ignorant concerning the channel by which audit fees decrease for an higher internal control contribution (i.e. whether the auditor charges lower prices or exerts less effort), Stewart et al (2006) interpret the the higher audit fees as an increase in overall testing effort and quality of the external audit, resulting from an overall higher demand for control, both internal and external. Relating to the influence of the internal auditors’ work setting, similar opposing findings exists: Munro and Stewart (2010) found that the external auditor relies more on the internal audit for substantive testing when performed “in-house”, i.e. resulting in less effort by the external auditor. On the other hand, Gramling and Vandervelde (2006) showed that external auditors rate the objectivity of an outsourced internal control party higher compared to an in-house internal control agent. Apart from these effects upon effort exertion, O’Leary and Stewart (2007) found that the quality of the external auditor has a positive influence on ethical behaviour on part of the internal control agent; i.e. on whether or not to report fraud. Overall, the interaction between the internal and external controlling bodies appears to be complex, in which multiple mechanisms are at play.

3. The basic model

Consider a unit within an organization, in charge of a fraud-sensitive task. The existence of fraud is exogenous and denoted by $\phi \in \{0,1\}$, where $\phi = 1$ refers to presence of fraud within the unit and this happens with probability α. In a similar vein, $\phi = 0$ reflects a situation of no fraud within the unit with probability $1-\alpha$. In order to detect potential fraud, a risk-neutral control agent is involved with two tasks $t \in \{i, m\}$: gathering information of the work of the unit to provide support (i) and monitoring the unit in order to detect fraud (m)[8]. The control agent does not ex ante observe whether or not fraud occurs. When choosing work-settings, the organizations' principal can decide whether the control agent works at the unit or separately to perform these tasks. The agent can decide to exert effort (e) on both tasks, one task or to exert no effort at all. In line with Caplan and Kirschenheiter (2000), the effort of the internal control agent is assumed to be both noncontractible and unobservable. Exerting effort is costly for the agent and these costs are denoted by $c(e_i, e_m) = \frac{1}{2}\Theta(e_i + e_m)^2$ with $\Theta > 0$. Instead of exerting effort, the agent has an outside option of zero. If exerted effort, there is a positive chance the agent detects committed fraud. Specifically, the probability by which the occurrence of fraud is detected is given by:

$$q(e_i, e_m) = (e_m + \beta e_i)K^A$$

where e_i and e_m denote the effort exerted on information gathering and monitoring activities, respectively. To reflect the relative importance of e_m compared to e_i in fraud detection, the model assumes $\beta < 1$. Next to the agent's efforts, the likelihood of fraud detection is determined by a workplace specific variable K^A which measures the ease of detection, with $A \in$ {unit, separate}, where $K^{unit} > K^{seperate}$, i.e. $K^U > K^O$. This last assumption reflects the additional difficulty in detecting fraud when the control agent is located separate from the unit. If the task performed by the unit is rather complex or hard to monitor from a distant, this increases the difference in fraud detection chance for both work-settings. Thus, ΔK can be seen as a measure of complexity and ease of monitoring for the specific task the unit

[8] This follows the recent trend of an increased scope of activities for the internal auditor, as formally defined by the Institute for Internal Auditors: the internal auditor is not only responsible for control activities, but is expected to actively add value to the organization, via for example consulting activities.

performs. The control agent discovers fraud with the probability αq[9]. In the reporting phase, the control agent sends out a fraud report *r* to the principal. If the control agent detected fraud, he has the choice between reporting fraud or no fraud, formally modeled as $r \in \{r_{fraud}, r_{good}\}$. If no fraud was detected, the report of no fraud, r_{good}, is the only option. Consequently, if the agent reports r_{good}, it can refer to one of the following three situations: there is no fraud, there is fraud but the agent did not detect it or there is fraud, the agent did detect it but decided not to report it. The last two situations are harmful to the principal, denoted by r_{not}. Initially, the control agent is contracted in order to detect fraud. However, if the control agent exerts supportive information gathering effort (e_i), this is assumed to help the unit and increase output. This type of effort can be construed in different ways. One could think of the consulting activities an internal auditor provides to the company concerning efficiency in operations or risk management. Another interpretation could be the principal-advocacy the internal auditor might display: i.e. assisting the unit by providing subjective information to other parties.[10] In contrast to this supportive behaviour, the internal control agent is also in the position to report fraud, which is assumed to decrease output. Output of the unit can thus be modelled as:

$$V\left(e_i, r_{fraud}\right) = e_i - r_{fraud}$$

In order to focus on the interaction between the effort of the control agent and his fraud reporting behaviour, other determinants of the output of the unit are assumed away.

The timing of the basic model is as follows. First, the principal decides whether to locate the agent at the unit or as an independent worker. Second, nature chooses the occurrence of fraud. Next, the agent decide whether to exert effort and for which task(s). After the working period, the unit has produced output and the control agent could have detected fraud. Lastly, the agent decides whether to report the discovered fraud or not.

3.1 Utilities

Control Agent. Along the literature on identity in organizational economics, the control agent faces a utility function which depends on his work location[11]. When located at the unit, the

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[9] $P(r_m) = P(r_m|\phi=1)*P(\phi=1) + P(r_m|\phi=0)*P(\phi=0) = P(r_m|\phi=1)*P(\phi=1) = q\alpha$

[10] In their experiment, Brody and Lowe (2000) found that the role the company of the internal auditor has in an acquisition (buyer/seller), influences their judgement towards the best interest of their company.

[11] Akerlof and Kranton (2005) provide an extensive treatment of the organizational effects of identity

utility of the control agent is positively related with its output as an effect of identification with the unit and decreases in cost of effort. This is given by;

$$U^{U} = I^{U}V\left(e_i, r_{fraud}\right) - c(e_i, e_m)$$

where I^{U} reflects the degree of the agent's identification with the unit. If the control agent is located separately, the agent does identify himself with the unit and his utility is therefore not affected by the output of the unit. As an independent controller, the agent gains utility when reporting fraud, channelled by identification with his fraud detecting function, denoted by I^{o}.[12] Again, his utility decreases in cost of effort, reflected in the following utility function:

$$U^{O} = I^{O}r_{Fraud} - c(e_i, e_m)$$

Principal. It is assumed that the principal's interests are perfectly aligned with the organization's goal: potential discrepancies between the interest of the organization and the principal are thus ignored. Consequently, the principal's goal when choosing where to locate the internal control agent is to maximize the expected organizational payoff. The utility of the principal is positively related with the output of the unit and decreases in unreported fraud as this hurts the organization, formally modelled as:

$$W = V\,(e_i) - \lambda r_{not}$$

where λ denotes the expected loss of fraud. Since losses due to reported fraud r_m are assumed to be reversed, this is not included in the utility function of the principal. Note that in the output V of the unit as included in the principal's utility function, the negative effect of a fraud rapport is omitted, as this does not decrease the principal's utility[13].

4. The optimal work setting

In this section, the basic model in which the existence of fraud is determined exogenously and its results are considered. Here, the work-setting or effort level of the control agent does not influence the probability by which fraudulent behaviour takes place. What will then be the optimal work setting? The main determinants of the answer to this question are identified in this section. By backward induction, the profits for the principal can be retrieved for both workplace situations. It appears that the ease of detection when located independently, the

[12] Kwan and Banks (2004) highlight the importance of 'task identity' on professional commitment. 'Task identity' is here defined as the degree to which an employee completes an identifiable product as a result of the tasks performed, such as a fraud report.
[13] Any negative effects of reported fraud to the organization are thus assumed away.

chance of fraud, the loss of unreported fraud and the identity measures are relevant in deciding which workplace setting is most profitable.

At the unit. In the reporting phase the control agent decides whether to report fraud or not, if detected. Since the utility function of the agent is strictly decreasing in reported fraud, the agent located at the unit will never report fraud, i.e. $r_{fraud} = 0$ and $r_{good} = 1$. Consequently, the chance that fraud exists, but is not reported can be denoted as $r_{not} = \alpha$. Because the agent has no expected utility from exerting monitoring effort, he will only exert information gathering effort. Optimal effort e_i is given by[14]:

$$e_i = \frac{I^u}{\Theta}$$

Since $r_{fraud} = 0$ and $r_{not} = \alpha$, the payoff to the principal when the control agent is located at the unit can be given by:

$$W = \frac{I^u}{\Theta} - \Lambda\alpha$$

Independent. If the control agent is located independent from the unit, his utility is increasing in reported fraud. Therefore, if he detects fraud he will always report it. Therefore, $r_{fraud} = \alpha q$, $r_{good} = 1 - \alpha q$ and $r_{not} = \alpha(1-q)$. Taking into account his expected utility, the control agent chooses the optimal effort levels, given by:

$$e_i = 0$$

$$e_m = \frac{I^O \alpha K^O}{\Theta}$$

Since β < 1, marginal returns on effort are higher for monitoring effort compared to information gathering effort and the control agent will only exert monitoring effort if located independently. Hence, the principals' utility when the control agent is located independently can be described as follows, taking into account that $r_{fraud} = \alpha q$ and $r_{not} = \alpha(1-q)$.

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[14]If the agent located at the unit would have no choice in reporting fraud, i.e. when detecting fraud would automatically lead to a fraud report, the optimal information gathering level would be $e_i = \frac{I^u - \alpha\beta K^U I^U}{\Theta}$. Due to the negative impact of a fraud report on the control agent's utility U^U, the control agent exerts less effort in this case.

$$W = \frac{\lambda I^{o} \alpha^{2} K^{o^{2}}}{\Theta} - \lambda\alpha$$

Optimal work setting In deciding where to locate the control agent at the begin of the period, the principal considers expected utility for both scenario's. The optimal work setting is to locate the agent at the unit if the following condition holds:

$$I^{u} > \lambda I^{o} \alpha^{2} K^{o^{2}}$$

Hence, if the gained utility for the agent due to identification with the unit is strong enough, leading to more information gathering effort and a higher output for the unit, this can outweigh the losses from a situation where fraud is never reported, as is the case when the agent is located at the unit. These losses are measured by the chance of fraud, the chance that fraud is detected once it exists and the expected loss from fraud, as described on the right-hand side of the condition. The chance of fraud and the expected losses from fraud are shown explicitly. Naturally, the easier the fraud can be detected independently and the stronger the identification effect on agent's utility when located independently, the higher is the incentive for monitoring effort, leading to a bigger chance of fraud detection. Surprisingly, the ease of fraud detection when located at the unit and the measure of relative importance of both efforts in fraud detection β is not relevant in deciding upon optimal work setting. As the control agent located at the unit will never report fraud, the ease of fraud detection is irrelevant.

5. Including a bonus

As indicated above, once the agent is situated at the unit, he will never report fraud if he detects it. In order to change this behaviour, the principal could introduce a bonus (*b*) for a fraud report to the internal control agent. Since the internal control agent located independently is already incentivized to detect and report fraud, introducing a bonus in this work-setting would not alter his *type of* behaviour; i.e. he would still only exert monitoring effort. Although it might increase his degree of effort exertion[15], considering the case of a bonus for the independent agent does therefore not yield insights. For the internal control agent located at the unit and the principal, introducing a bonus to the model creates the following utility functions:

[15] There is also a strand of literature on crowding out of intrinsic motivation, putting forward the negative consequences external incentives might have on effort exertion. (see e.g. Deci (1971), Dickinson and Villeval (2008))

$$U^U = I^U V\left(e_i, r_{fraud}\right) - c(e_i, e_m) + br_{fraud}$$

$$W = V(e_i) - Ʌr_{not} - br_{fraud}$$

This extension creates opposing forces of fraud detection on the utility of the unit. Related to the findings of Barra (2010), a similar mechanism can also explain the positive relation between fraud detection chance and fraud value. If the chance of detection increases a higher value of fraud is necessary as an opposing force to induce the unit to commit fraud.

When using a bonus, three cases can be distinguished. (**1**) For a bonus $b < I^U$ it is directly clear from the utility function that the agent will still not report fraud once detected. The above results hold and the agent will only exert information gathering effort. Since in his case the bonus only decreases the principal's utility, the principal sets the bonus equal to zero.

(2) For a bonus $b > I^U$ the agent will always report fraud if he detects it. Therefore, $r_{fraud} = \alpha q$, $r_{good} = 1 - \alpha q$ and $r_{not} = \alpha(1-q)$. In choosing effort levels, the agent considers its costs and benefits. As directly clear from the cost function, his marginal costs of effort are equal for both types of effort, e_i and e_m, while the resulting marginal benefits differ: $I^U + \alpha\beta K^U(b - I^U)$ for information gathering effort and $\alpha K^U(b - I^U)$ for monitoring effort. Consequently, if $I^U + \alpha\beta K^U(b - I^U) > \alpha K^U(b - I^U)$, the agent prefers to exert information gathering effort only. This leads to the following condition concerning the bonus level: if $b < I^U + \frac{I^U}{(1-\beta)\alpha K^U}$, the agent exerts only information gathering effort. If the difference in chances of fraud detection for monitoring effort is small, a higher bonus is necessary in order to induce the agent to exert monitoring effort. When the bonus falls in the interval $I^U < b < I^U + \frac{I^U}{(1-\beta)\alpha K^U}$, the agent exerts only information gathering effort and reports fraud if detected, resulting in the following payoffs for the principal:

$$W = \frac{I^U + \alpha\beta K^U(b - I^U) + Ʌ\alpha\beta K^U I^U) + Ʌ\alpha^2\beta^2 K^{U^2}(b - I^U) - b\alpha\beta K^U I^U - b\alpha^2\beta^2 K^{U^2}(b - I^U)}{\theta} - Ʌ\alpha$$

The principal maximizes the above by choosing the optimal bonus level. This leads to an optimal bonus of:

$$b = \frac{1 - I^U}{2\alpha\beta K^U} + \frac{Ʌ + I^U}{2}$$

Conditionally on being on the interval $I^U < b < \frac{I^U}{(1-\beta)\alpha K^U}$. The above expression reflects the main determinants in setting the bonus. Note that the gain of information gathering effort for the unit is modelled as a direct one-for-one relationship. The '1' in the above expression thus refers to the gain for the unit of an additional information gathering effort level. If this is higher than the utility gain for the agent himself in terms of identity, a bonus can optimally induce the agent to exert more effort. If the utility gain for the agent is higher than the gain of information gathering effort to the unit, the bonus decreases as the agent himself is relatively more incentivized to exert effort then the principal. However, the second term implies I^U has an independent effect on the optimal bonus level as well. When $2 > 2\alpha\beta K^U$[16], the optimal bonus decreases with the identification effect I^U. It can then be seen as an intrinsic substitute of the external bonus incentive and thus a lower bonus is necessary, as is visible in the positive effect I^U has on the optimal effort level of the agent. If $2 < 2\alpha\beta K^U$, i.e. if $K^U > \frac{1}{\alpha\beta}$, the optimal bonus level increases with I^U. In that case, the chance of finding fraud relatively high so that the agent needs to be compensated for the very likely loss in utility due to his identification with the unit if he exerts effort. Naturally, this necessary compensation level increases with this identification effect. This is reflected in the optimal effort level function in the second part, where in this cases the second, negative, effect of I^U on effort takes over. Lastly, the optimal bonus increases with Λ; the higher the loss of undetected fraud, the more beneficial it is to incentivize the control agent to report the detected fraud.

In order to compare the payoff to the principal for the case with a bonus and without, the optimal bonus should be included in the expression for the principal's payoff. However, since this leads to hardly interpretable expressions, using the corner values on the interval at hand, $I^U < b < I^U + \frac{I^U}{(1-\beta)\alpha K^U}$, can be used. If the principal chooses the lowest bonus possible conditionally on letting the control agent report fraud, i.e. if $b = I^U$, this leads to the following payoff[17]:

$$W = \frac{I^U + \alpha\beta K^U I^U(\Lambda - I^U)}{\Theta} - \Lambda\alpha$$

16 Since $\alpha<1$ and $\beta<1$ this is likely to be true, unless K^U is high.
17 If $b = I^U$, the control agent at the unit would in fact be indifferent between reporting detected fraud or not. Here, reporting is assumed, which can be supported by the conjecture that this would be the result of an infinitely small addition to the bonus, i.e. $b = I^U + \epsilon$ without altering the principals payoff significantly.

Below, the comparable payoff to the principal is given where no bonus is involved; i.e. as derived in section three for the situation where the internal control agent was located at the unit.

$$W = \frac{I^u}{\Theta} - ʎ\alpha$$

From the expressions above, it is clear that when the expected loss from undetected fraud to the principal is larger than the gain in utility from the output of the unit for the control agent, when $ʎ > I^U$, implementing this "lower end" bonus would lead to an higher principal's payoff. This effect increases in the chance of fraud, the ease of fraud detection for the control agent located at the unit and identity effect of the control agent.

For the higher end of the bonus interval when the control agent at the unit would report fraud once detected, but exerts only information gathering effort, the bonus would be set equal to *b* = $I^U + \frac{I^U}{(1-\beta)\alpha K^U}$, leading to the following payoff for the principal:

$$W = \frac{I^U + \alpha\beta K^U I^U (ʎ - I^U + I^U \alpha\beta K^U)}{\Theta} + \frac{\beta I^U (1 + ʎ\alpha\beta K^U - I^U - I^U \alpha\beta K^U)}{\Theta(1-\beta)} - ʎ\alpha$$

When $ʎ > \alpha K^U I^U (\beta - 1) + I^U + \frac{I^U - 1}{\alpha\beta K^U}\ \beta$ holds, the principal prefers the higher bonus compared to the lower bonus. Similarly, if $ʎ > \alpha K^U I^U \beta(\beta - 1) + I^U + \frac{I^U - 1}{\alpha\beta K^U}$ holds, the principal prefers the the higher bonus to no bonus at all. Since $\beta < 1$ holds and the first term is always negative, the second condition is stricter compared to the first one. Thus, if the principal prefers the higher bonus to no bonus, he automatically prefers this to the lower level bonus. Intuitively, the higher the loss of undetected fraud, the more likely the principal is to introduce the higher bonus as the increased effort of the control agent then is more beneficial. Also, the higher chance of fraud detection, as shown by the chance of fraud, the ease of fraud detection and the incentive the control agent has in exerting effort, increases the chance of the higher bonus to be optimal and the condition to hold. However, when the agent's utility gain of exerting effort is higher than the gain of the principal via the output of the unit, standardized to 1, the expected loss of undetected fraud needs to be higher in order to justify the higher bonus.

In order to highlight the mechanism in determining the optimal bonus level, the two payoffs above can be compared, distinguishing two situations. First, when $ʎ > I^U$, implementing the lower bonus b = I^U is preferable compared to the situation in which no bonus is put in place. Thus, the principal will always introduce a bonus. If $\Lambda > \alpha K^U I^U(\beta - 1) + I^U + \frac{I^U - 1}{\alpha\beta K^U}$ then holds as well, the principal is better off choosing the higher effort level. Note that in case $1 > I^U$, the last term becomes negative and this condition will always hold for $\Lambda > I^U$. Thus, when the agents utility gain of exerting effort via his identification effect is lower than the gain of effort to the principal via the output of the unit, standardized to 1, the higher bonus will always be more beneficial to the principal.

Second, when $\Lambda < I^U$, the principal prefers no bonus to the introduction of the lower bonus. However, when $\Lambda > \alpha K^U I^U \beta(\beta - 1) + I^U + \frac{I^U - 1}{\alpha\beta K^U}$ holds, the principal is better off introducing the higher bonus. Again, this condition is more likely to hold when the gain in utility to the agent of exerting effort is lower than the gain of effort to the principal. In addition, the lower the chance of detecting fraud at the unit compared to an independent control agent (β), more negative the first term becomes and the easier the condition holds.

(3) For a bonus b > I^U + $\frac{I^U}{(1-\beta)\alpha K^U}$, the agent exerts only monitoring effort and will report fraud once detected. The payoff for the principal is as follows:

$$W = \Lambda(\frac{(b - I^U)\alpha^2 {K^U}^2}{\Theta} - \alpha) - \frac{b{K^U}^2\alpha^2(b - I^U)}{\Theta}$$

The principal then sets the bonus optimally at:

$$b = \frac{\Lambda + I^U}{2}$$

Conditionally on b > I^U + $\frac{I^U}{(1-\beta)\alpha K^U}$. In this situation, the control agent at the unit acts similar to the independent agent: he only exerts monitoring effort, does not help the unit and will report fraud once detected. However, since this agent still identifies with the unit and not as an independent controller, the bonus is the only incentive to monitor and detect fraud. Since placing the control agent independently would lead to the similar behaviour but less incentivizing costs, it is intuitively very likely that this is preferable compared to incentivizing the control agent at the unit to exert only monitoring effort. More formally, from the optimal monitoring effort levels in the case the control agent is located independently without a bonus and the case where the control agent is located at the unit using a bonus, it is clear that in order to reach an higher monitoring effort level in the latter case, the following condition needs to hold: $(b - I^U)K^U > I^O K^O$. The bonus thus needs to be rather high compared to the utility gained by identity in order to induce an higher monitoring effort. This might only be feasible when the identification effects are very low and the bonus easily replaces this. Also, when it is much easier to detect fraud at the unit, i.e. when K^U is very high compared to K^O, this strict condition might hold. Thus, only for rather complex, hard to monitor tasks in which an internal control agent located at the unit has much more monitoring possibilities, it might be worth the incentivizing costs to locate him at the unit. On the level of the principal's payoff, the condition is even stricter. As reported in part 4, when the agent is located independently and there is no bonus put in place, the principal receives a payoff of:

$$W = \Lambda(\frac{I^o \alpha^2 K^{o^2}}{\Theta} - \alpha)$$

In order to have an overall higher utility for the principal when placing the agent at the unit and using a bonus, the following thus needs to hold:

$$K^{U^2}(b - I^U) - \frac{bK^{U^2}\alpha^2(b - I^U)}{\Theta} > I^O K^{O^2}$$

Since $b > I^U$, the second term is negative, reflecting the direct negative impact of the bonus on the principals payoff. Only for relatively high levels of K^Ucompared to K^O, high costs of effort, a low chance of fraud or low identification effects, this condition might hold and implementing a bonus with $b > I^U + \frac{I^U}{(1-\beta)\alpha K^U}$ is optimal. However, as this condition is rather strict, for most parameter values, a bonus on the interval $I^U < b < I^U + \frac{I^U}{(1-\beta)\alpha K^U}$ or no bonus at all is preferable.

To conclude, the introduction of a bonus can be an optimal strategy for the principal to increase his payoff by incentivizing the control agent at the unit to report fraud. For most parameter values, this bonus needs to be on the interval $I^U < b < I^U + \frac{I^U}{(1-\beta)\alpha K^U}$ and increases when the resulting gain in output from the agents effort is bigger than the utility gain for the agent himself.

Optimal work setting. Via the introducing of a bonus, the principal can alter the reporting behaviour of the internal control agent located at the unit, which potentially could increase his payoff. Naturally, this is only beneficial if the resulting payoff exceeds the principals' payoff when locating the internal control agent separately, as derived in section 3. As the above mechanisms display a rather complex relation between certain parameters, the optimal "benchmark" bonus (i.e. high or low) and the resulting payoffs, this section ends with somewhat simplified comparative discussion.

If $\Lambda > I^U$, a bonus certainly increases the principal's payoff when placing the internal control agent at the unit and thereby the likelihood of being the preferred work-setting decision. Placing the internal control agent at the unit in this case is optimal if the following condition holds:

$$I^U + \alpha\beta K^U I^U(\Lambda - I^U) > \Lambda I^o \alpha^2 {K^o}^2$$

Compared to the situation without a bonus, this condition is more likely to hold. Note that in this case both the ease of fraud detection when located at the unit (K^U) and the measure of relative importance of both efforts in fraud detection (β) become relevant in the optimal work place decision. As now the internal control agent located at the unit will report fraud if detected, the chance of fraud detection when exerted information gathering effort influences total payoff to the principal.

If both $\Lambda > I^U$ and $1 > I^U$ hold, the principal increases his payoff even more by increasing the bonus to the highest end of the interval that secures information gathering effort. Once again, this increases the likelihood of locating the internal control agent at the unit to be optimal according to the following condition:

$$I^U + \alpha\beta K^U I^U(\Lambda - I^U + I^U\alpha\beta K^U) + \frac{\beta I^U(1 + \Lambda\alpha\beta K^U - I^U - I^U\alpha\beta K^U)}{(1-\beta)} > \Lambda I^o \alpha^2 {K^o}^2$$

In conclusion, when the loss of fraud to the principal exceeds the degree of identification with the unit of the internal control agent, a bonus will always be beneficial if the internal agent is located at the unit. In that case, locating the agent at the unit is more likely to be optimal. This effect increases in the impact of information gathering effort on fraud detection. When the gain in output for the unit due to information gathering effort exceeds the degree of identification with the unit of the internal control agent as well, locating the agent at the unit becomes even more beneficial.

6. Endogenous fraud

The previous section considered the chance of fraud as exogenously determined. However, the presence of an internal control agent in itself might work as a control system and influences the chance the unit will commit fraud. This desired fraud deterrence effect is likely to depend on characteristics of the internal control party. Hillison et al (1999) identify a number of channels through which the internal auditor can prevent the organizational unit from committing fraud, such as data encryption or exerting surprise fraud audits. However, this effect is rather hard to measure empirically: by definition, prevented fraud will never be displayed. Nonetheless, there are a few studies in the field of accounting and auditing, which attempt the highlight the effect the internal audit system has on fraud occurrence. For example, Abbott et al (2000) found that firms with an active and independent internal audit committee are less likely to commit fraud. Although not supported empirically, in her analytical model Barra (2010), concluded that the likelihood of fraud decreases in effort necessary to commit fraud and the chance of detection; factors which are likely to be influenced by the internal control system.

In this section, the exogenous fraud assumption is therefore relaxed. This creates a new player in the game: the unit itself. Since in this case, fraudulent behaviour is modelled as choice of the unit, the unit takes into account the expected actions of the control agent. In addition, some specifications of the basic model are adjusted. A discrete effort model is considered, where $e_m \in \{0, 1\}$ and $e_i \in \{0, 1\}$. The chance of fraud detection when it exists and the agent exerts monitoring effort is set equal to one, i.e. $q = e_m$. Exerting effort is costly to the agent, according to the same cost function as in the basic model: $c(e_i, e_m) = \frac{1}{2}\Theta(e_i + e_m)^2$, with $\Theta > 0$. In contrast to the basic model, here it is assumed that the internal control agent located at the unit observes fraudulent behaviour, while the internal control agent located separately does not. Note that the reporting decision phase still exists: if the internal control agent located at the unit observes fraud, he does not necessary report it. Regarding the output of the unit, two measures can be distinguished: the true output V_w which increases in information gathering effort of the agent and the observable output V_o.

$$V_w = V(e_i^+)$$

$$V_o = V(e_i^+) + \Delta\phi$$

Similar to the basic model, other determinants of the output of the unit are assumed away. The latter term in the observable output description refers to the part of the output that has been subject to fraud and is therefore not part of the true unit output. The gain in fraud for the unit is assumed to be less than the loss of fraud for the principal, i.e. $\Delta < \Lambda$. This assumption reflects the harmful nature of fraud existence with regard to total welfare[18]. In deciding whether to commit fraud, the unit takes into account the expected utility following from the observable output (V_o) and the expected fine (S) if the fraud would be detected, formally modelled as:

$$V = V_o - Sr_{Fraud}$$

Since the objective of the fine is to detect fraud, it is assumed that $\Delta < S < \Lambda$. Thus, undetected fraud hurts the principal most, but the potential loss for the unit if fraud is detected is bigger than the gain of undetected fraud.

The timing of this model is as follows. First, the principal decides whether to place the control agent at the unit or independently. Second, the unit chooses to commit fraud or to act honestly. If he is located at the unit, the control agent observes whether fraud was committed or not. Next, the control agent decides whether to exert effort or not and fraud might be detected. Lastly, the control agent sends out a report $r \in \{r_{fraud}, r_{good}\}$. It is assumed that the agent always sends out a report, even when no effort is exerted.

6.1 Utilities

Control Agent. The utilities are similar to the basic model. When located at the unit, the utility of the control agent is positively related with its output due to his identity. In this model, the output of the unit with which the agent identifies is set equal to the payoff of the unit $V = V_o - Sr_{Fraud}$. This is given by[19];

$$U^U = I^U V - c(e_i, e_m)$$

If the control agent is located separately, his utility function is similar to the basic model, i.e.;

[18] In case this condition is violated, fraud would in fact result in an overall efficiency gain, which might be even desirable with an adequate allocation system.
[19] Similar to the basic model, note that the internal control agent located at the unit has no benefit from exerting monitoring effort and will thus never exert this type of effort. Nonetheless, he has the possibility to do so in theory and therefore potential cost of effort e_m is included in the utility function. In a similar vein, even though unlikely exerted, cost of effort for information gathering effort is included in the utility function of the control agent located independently.

$$U^O = I^O r_{Fraud} - c(e_i, e_m)$$

Unit. In deciding whether to commit fraud, the unit takes into account the expected utility following from the observable output (V_o) and the expected fine (*S*) if the fraud would be detected, formally modelled as:

$$V = V_o - S r_{Fraud}$$

Principal. The principals payoff increases in the true output of the unit and decreases in unreported fraud;

$$W = V_w - ʎ r_{not}$$

where ʎ denotes the expected loss of fraud. Since losses due to reported fraud r_m are assumed to be reversed, this is not included in the utility function of the principal.

6.2 The optimal work setting

Using the adjustments as described above, this section describes the mechanisms implied by an endogenous chance of fraud commitment, i.e. the unit decides upon ϕ, taking into account the workplace of the control agent and his subsequent behaviour. Following backward induction, the optimal work setting can be retrieved, depending on a number of characteristics. For the situation in which the agent is located at the unit, a pure equilibrium can be found. In case the agent is located independently, both a pure and a mixed equilibrium exist in which the unit uses a mixed strategy with α in committing fraud and the control agent mixes in exerting effort with γ. In deciding where to optimally locate the internal control agent, the principal faces a trade-off between a positive chance of fraud detection by placing the agent separately and an increase in output of the unit by placing the agent at the unit. It turns out that when the loss of undetected fraud is high and the control agent located separately is likely to exert effort, placing the agent independently is optimal for the principal.

At the unit. As the utility function of the control agent located at the unit is strictly decreasing in reported fraud, he will never sent out a fraud report. Thus, $r_{fraud} = 0$, $r_{good} = 1$ and $r_{not} = \phi$. When choosing effort levels, two situations can be distinguished (See Appendix A1). **(1)** If the participation constraint for one effort level ($e_m$or $e_{i)}$ is fulfilled, i.e. $I^U > \frac{1}{2}\theta$, the agent optimizes his expected utility by exerting only information gathering effort, i.e. $e_i = 1$ and $e_m = 0$. **(2)** If $I^U < \frac{1}{2}\theta$, the agent exerts no effort at all, $e_i = 0$ and

$e_m = 0$. For both situations, the unit maximizes expected utility by committing fraud, i.e. $\phi = 1$, as no monitoring effort is exerted and the chance of fraud detection thus is equal to zero. This does not change the effort preferences for the control agent. Intuitively, this reflects a situation in which the internal control agent is "captured": allowing the occurrence of fraud to increases his utility as he identifies himself with output of the unit. Thus, an equilibrium exists in which the payoff to the principal when $I^U > \frac{1}{2}\theta$, and $I^U < \frac{1}{2}\theta$, , respectively, equals:

$$W = 1 - \Lambda$$

$$W = -\Lambda$$

Hence, when the agent does not exert effort at all, the principal's loss equals the expected loss of undetected fraud. If the agent does exert information gathering effort, the principal's payoff can still be positive as long $\Lambda < 1$ holds, since the gain in output of the unit from information gathering effort is standardized to 1.

Independent For a control agent located separately, it is always best in the reporting phase to report fraud if detected, since his utility is strictly increasing in the occurrence of a fraud report. Therefore, $r_{fraud} = \phi e_m$, $r_{good} = 1 - \phi e_m$ and $r_{not} = \phi(1 - e_m)$. When choosing efforts, the control agent optimizes expected utility. Again, two situations can be distinguished (Appendix).

(1) When $I^O < \frac{1}{2}\theta$, he prefers to exert no effort at all; $e_i = 0$ and $e_m = 0$. In that case, the unit is better off committing fraud as no monitoring effort is exerted. Since his increase in utility when detected this fraud, I^O, in this case is lower than his costs of effort, the control agent still does not have a profitable deviation by exerting effort. Therefore, a pure equilibrium exists in which the independent control agent does not exert effort and the unit commits fraud, resulting in the following payoff to the principal:

$$W = -\Lambda$$

Just as for the case where the internal control agent is located at the unit, the principal's loss equals the expected loss of undetected fraud.

(2) If $I^O > \frac{1}{2}\theta$, the control agent located independently chooses $e_i = 0$ and $e_m = 1$ if he expects fraud to occur. However, when $e_m = 1$, the unit prefers to act honestly since monitoring effort automatically leads to fraud detection if it exists and $\Delta - S < 0$ by assumption; the fine when fraud is detected is higher than the gain of fraud for the unit. In that case, the control agent does not expect fraud to occur and is better off not exerting effort at all as he will never detect fraud and thus gain utility; resulting in $e_m = 0$. Then again, when no monitoring effort is exerted, the unit prefers to commit fraud and the control agent prefers to change is behavior. To conclude, no pure equilibrium exists when $I^O > \frac{1}{2}\theta$. Both the unit and the internal control agent play a mixed strategy in equilibrium. In this equilibrium, the unit mixes in committing fraud with (α, 1- α) where α refers to the probability of $\phi = 1$ with α ϵ [0, 1]. The internal control agent mixes in exerting monitoring effort with (γ, 1- γ) where γ refers to the probability of $e_m = 0$ with γ ϵ [0, 1]. In Appendix A2, it is shown that in equilibrium the following values for α and γ hold: $\alpha = \frac{\Theta}{2I^O}$ and $\gamma = \frac{S-\Delta}{S}$ (Appendix). Intuitively, when the fine for detected fraud is relatively high, the unit commits fraud less often and it is thus more beneficial for the control agent to exert no effort, i.e. play $e_i = 0$ and $e_m = 0$ more often, instead of bearing the cost of effort without any gain in utility due to a fraud report. When the cost of effort is high or the utility gained from a fraud report (I^O) is low, the agent is less likely to exert effort and it becomes more beneficial for the unit to commit fraud more often; increase α. This mixed equilibrium leads to the following payoff for the principal[20]:

$$W = \frac{\Theta \acute{\Lambda}(\Delta - S)}{2I^o S}$$

The payoff for the principal decreases in the fine S: since a higher fine leads the control agent to exert less effort, this increases the chance of undetected fraud and thus the chance of losses to the principal. Naturally, the term between brackets is negative as $\Delta < S$ by assumption. Therefore, the cost of effort for the agent and the loss of undetected fraud have in fact a negative influence on the payoff to the principal. Intuitively, when the cost of effort for the agent increase, the unit expects less monitoring effort and is therefore more likely to commit fraud. Lastly, the identification effect of the agent (I^o), has a positive influence on the principals payoff as this increases the chance of honest behavior on part of the unit as the control agent is more likely to exert monitoring effort.

[20] As $\Delta - S < 0$, this results in a negative payoff to the principal and might seem inferior to the payoff when the agent is located at the unit, which can be positive. However, this expression should not be seen in isolation: in comparing it with the situation where the agent is located at the unit, the main determinants in choosing optimal work location become clear.

Optimal work setting. In deciding where to locate the control agent, the principal chooses based on his expected payoff. Four cases can be distinguished, dependent on the level of identification with the work location on side of the control agent as these determine effort exertion.

(1) When $I^O < \frac{1}{2}\theta$ and $I^U < \frac{1}{2}\theta$ the participation constraint for either effort level is not fulfilled and the control agent will not exert effort, independent from its work location. The unit will commit fraud. This results in the following payoff for both the situation where the agent is located at the unit or independently:

$$W = -ʎ$$

Here, the principal is indifferent between the two work settings and the control agent does not have an influence on either fraud occurrence or fraud detection.

(2) In case $I^O < \frac{1}{2}\theta$ and $I^U > \frac{1}{2}\theta$ the participation constraint for the agent located at the unit is fulfilled, but not for the control agent located independently. Therefore, if located at the unit, the control agent will exert information gathering effort, but if located independently, no effort will be exerted at all. The payoff for the principal when locating the agent at the unit will therefore be bigger, since the following condition always holds:

$$1 - ʎ > -ʎ$$

(3) If $I^O > \frac{1}{2}\theta$ and $I^U < \frac{1}{2}\theta$ the control agent located at the unit will exert no effort at all, while the control agent located independently will exert some monitoring effort. This leads to the mixed equilibrium in which the independent control agent mixes in exerting monitoring effort with γ and the unit mixes in committing fraud with α. The principal decides upon locating the agent independently if $\frac{\Theta ʎ(\Delta - S)}{2I^o S} > -ʎ$, i.e. if:

$$\frac{\Theta(S - \Delta)}{2I^o S} < 1$$

The higher the identity effect for an independent control agent, the more beneficial it is for the principal to locate the agent separately. When the cost of effort is high or the difference between the gain of fraud and the fine is high, the control agent located independently will exert less effort, decreasing the benefits from this work setting. However, as $I^O > \frac{1}{2}\Theta$, the above condition will always hold and placing the agent separately is thus most profitable for the principal in this case.

(4) When $I^O > \frac{1}{2}\theta$ and $I^U > \frac{1}{2}\theta$ the participation constraint is fulfilled for both work settings and the control agent will exert some effort, regardless of which work location he is placed in. Comparing the two resulting payoffs for both workplace settings, it appears that it is optimal for the principal to locate the agent independently if the following condition holds:

$$\frac{ʎ\Theta(S-\Delta)}{2I^{o}S} < ʎ - 1$$

From the above, it logically follows that when the incentive for the independent control agent to exert monitoring effort is low, the principal prefers placing the agent at the unit. Thus, if the utility gain of detecting fraud (I^o) is low, the cost of effort are high and the unit is less likely to commit fraud (when the fine is relatively high or the gain of fraud is low), the agent is better off placing the agent at the unit. In addition, when the loss from undetected fraud is high, the principal is more likely to place the internal control agent independently as only then there is a chance this fraud will be detected.

In conclusion, by allowing the chance of fraud to be determined endogenously, the factors describing the optimal work-setting slightly change. Note that the identification effect of the internal control agent located at the unit becomes irrelevant, as he uses a pure strategy in which he exerts a fixed degree of effort as long as his participation constraint is fulfilled. However, the remainder of the decision criterion above proves similar factors to be relevant as derived in the basic model. First, the expected losses of fraud decrease the likelihood of locating the agent at the unit to be optimal. Second, a higher chance of fraud and that it will be detected by effort exertion of the independent control agent, the more likely it is the principal locates the agent independently. However, in contrast to the basic model, these factors are shown in their mixed strategy expressions as shown above, allowing to distinguish their separate effects as well. Thus, for example, when the principal expects large identification effects on part of the separate internal control agent, it strengthens the case for locating the agent independently. Contrary to the basic model, in which this would lead to a higher degree of effort, here this effect is channelled via a lower chance of fraud on part of the unit.

7. External auditor

As shown in the previous section, once fraud becomes endogenous, the unit always commits fraud if the control agent is located at the unit. Naturally, one solution to this problem would be to locate the control agent independently, as discussed above. However, this independent agent does not help in increasing the output of the unit by exerting information gathering effort. Therefore, the principal might alternatively decide to employ an external auditor in charge of monitoring the output of the unit in order to detect fraud. Since the practice of business reporting is subject to strict regulations and nearly all sizable organizations are obliged to hire an auditing firm in validating their financial statements, this scenario is fairly relevant. There exists a vast amount of literature providing evidence for the interaction effects between the internal and external auditor[21]. However, the results concerning the nature of these effects are mixed.

Again, this extension leads to an additional player in the model: the external auditor. Similar to the other players, the external auditor is assumed to be incentivized by identification with his occupation, which induces him to detect fraud. One might think of a professional code or reputational effect that increases when fraud is detected. In order to detect fraud, the external auditor needs to exert effort (e_A). Just as in the previous section, a discrete effort model is considered, where $e_m \in \{0, 1\}$, $e_i \in \{0, 1\}$ and $e_A \in \{0, 1\}$. The chance of fraud detection when it exists and either the internal control agent or the external auditor exerts *monitoring* effort is set equal to one, i.e. $q = \max\{e_m, e_A\}$. Exerting effort is costly to the agent, according to the same cost function as in the basic model: $c(e_i, e_m) = \frac{1}{2}\Theta(e_i + e_m)^2$, with $\Theta > 0$. In line with previous section, it is assumed that the internal control agent located at the unit observes whether fraud took place before he decides upon effort, while the internal control agent located separately does not. If the internal control agent at the unit observes fraud, he still needs to exert monitoring effort in order to report it. One might think of listing the observed fraud or collecting evidence. The above results in the following expressions for the possible reports by the internal control agent: $r_{fraud} = \phi e_m$, $r_{good} = 1 - \phi e_m$ and $r_{not} = (1 - e_m)\phi$. If the internal control agent already reported fraud, fraud cannot be reported a second time by the external control agent; in other words, only undetected fraud by the internal control agent can be reported by the external auditor. Therefore, $A_{fraud} = e_A r_{not}$ with

[21] See e.g. Felix et al (2001), Stewart et al (2006), Gramling and Vandervelde (2006), Munro and Stewart (2010), O'Leary and Stewart (2007)

$r_{not} = (1 - e_m)\phi$. Consequently, if the external auditor reports fraud, this automatically indicates the internal control agent did not exert monitoring effort. As this is one of his main tasks, he falls short in his profession, noticeable by both the external auditor and the principal. The model assumes resulting negative effects to the internal control agent in such situations, denoted by Z.

Since the external auditor is the final control party, he already observes the work of the internal control agent; i.e., he observes either a good report or a fraud report $r \in \{r_{fraud,} r_{good}\}$. Based on this report, the external auditor decides on effort. Corresponding to the previous section, two measures of output of the unit can be distinguished: the true output (V_w) and the observable output (V_o).

$$V_w = V(e_i^+)$$

$$V_o = V(e_i^+) + \Delta\phi$$

Once more, other determinants of the output of the unit are assumed away and $\Delta < S < \Lambda$ holds.

The timing of this model is as follows. First, the principal decides whether to place the control agent at the unit or independently. Second, the unit chooses to commit fraud or to act honestly, i.e. $\phi \in \{0,1\}$. If he is located at the unit, the control agent observes whether fraud was committed or not. Next, the control agent decides whether to exert effort or not and fraud might be detected. Then, the control agent sends out a report $r \in \{r_{fraud,} r_{good}\}$. It is assumed that the agent always sends out a report, even when no effort is exerted. Based on the observed report, the external auditor decides on exerting effort and sends out a report $A \in \{A_{fraud}, A_{good}\}$.

7.1 Utilities

Control Agent. When located at the unit, the utility of the control agent is positively related with its output as he identifies himself with the unit. In contrast to the previous model, here the effect of the external auditor's report is included. When the external auditor detects fraud, the utility of the agent at the unit decreases in Z. This is given by[22];

[22] In contrast to the previous section, the control agent located at the unit now has potential benefits from exerting monitoring effort, as this decreases the chance of a fraud report by the external auditor, i.e. A_{fraud}. Therefore, cost of monitoring effort become relevant in determining optimal work location.

$$U^U = I^U V - ZA_{fraud} - c(e_i, e_m)$$

Where the output of the unit with which the internal control agent identifies can be given by:

$$V = V_o - Sr_{Fraud}$$

Detected fraud by the external auditor is assumed to be more harmful to the control agent than the decrease in utility of the unit when the internal control agent reports the fraud himself, even when taking into account the cost of effort for the internal control agent; i.e. $Z > I^U S + \frac{1}{2}\theta$. This assumption assures that in case of fraud, the internal control agent is better off reporting it himself, compared to letting the external auditor reporting it. One might think of a reputational loss or career concerns for the internal control agent as the principal notices his lack in effort.

If the control agent is located separately, his utility also decreases when the external auditor reports fraud. The remaining parts of the utility function are similar to the previous section, resulting in the following expression;

$$U^O = I^O r_{Fraud} - ZA_{fraud} - c(e_i, e_m)$$

For both the internal control agent located at the unit, as well as the internal control agent located separately, the participation constraint is assumed to hold: i.e.$I^U > \frac{1}{2}\theta$ and $I^O > \frac{1}{2}\theta$.

Unit. In deciding whether to commit fraud, the unit takes into account the expected utility following from the observable output (V_o) and the expected fine (S) if the fraud would be detected, formally modelled as:

$$V = V_o - Sr_{Fraud} - SA_{fraud}$$

Here, the utility of the unit decreases equally when fraud is detected either by the internal control agent or by the external auditor.

External auditor. The external auditor gains utility from detecting fraud, i.e. when he reports fraud A_{fraud} and his utility decreases in his cost of effort. The benefit the external auditor receives from detecting fraud can be interpreted as a bonus, reputational gain or gain in utility due to identification with the mission of its profession, i.e. detecting fraud. For example, Elias (2008) reports that the increased chance of fraud reporting among recently graduated auditors is due to a higher commitment their profession. In the model, the variety of utility channels possible is standardized in line with the rest of the model: using an identification effect(I^{ex}). By holding this as only incentivizing force, any concerns related to the objectivity of the external auditor are assumed away. When working with an independently located internal control agent, the external auditor is assumed to have a lower cost of effort in exerting effort compared to when he works with an internal control agent located at the unit, i.e. $c_o < c_u$.[23]

$$U^{exo} = I^{ex} A_{fraud} - \frac{1}{2} c_o^2$$

$$U^{exu} = I^{ex} A_{fraud} - \frac{1}{2} c_u^2$$

Similar to the internal control agent, the participation constraint for the external auditor is assumed to hold, i.e. $I^{ex} > \frac{1}{2} c_u$ and $I^{ex} > \frac{1}{2} c_o$.

Principal. The principal's payoff increases in the true output of the unit and decreases in unreported fraud;

$$W = V_w - \Lambda r_{not}(1 - e_A)$$

where Λ denotes the expected loss of fraud. Note that here, the principal only suffers from the situation in which fraud was committed but not detected by either the internal control agent (r_{not}) or the external control agent $(1 - e_A)$. Since losses due to reported fraud (r_{fraud}) are assumed to be reversed, this is not included in the utility function of the principal.

7.2 The optimal work setting

In order to find the optimal work setting for the principal, this section describes the equilibrium behaviour of the unit, the internal control agent and the external auditor. Since the external auditor does not observe the choices of the unit and the internal control agent, this model can be classified as an imperfect information game and can thus be solved by backward induction, using the perfect Bayesian equilibrium concept. Again, in the beginning, a distinction is made between the situation where the internal control agent is located at the unit and where he is located separately. By comparing the resulting payoffs, the determinants of the optimal work setting can be brought to light. It appears that including the effect of the external auditor in the principal's decision makes locating the internal control agent at the unit

[23] Gramling and Vandervelde (2006) found that the external auditor rates the objectivity of an outsourced, independent internal control agent higher; making it more trustworthy to rely on in their control activities, thereby decreasing their cost of effort.

more attractive. However, this result only holds with the underlying condition of equal incentives for the external auditor and the internal control agent.

At the unit. In the last stage, the external auditor decides upon reporting detected fraud. As the utility of the external auditor is strictly increasing in auditor's fraud report, he will always report fraud if detected. In deciding whether to exert effort or not, the external auditor considers the report from the internal control agent. When he observes a fraud report by the internal control agent, this indicates that the unit committed fraud and the internal control agent exerted monitoring effort. Therefore, exerting effort by the external auditor will not result in an auditor's fraud report and will thus never increase his utility: he does not exert effort. This gives the SPNE in which the unit commits fraud, the internal control agent detects it and the external auditor does not exert effort (Appendix). When the external auditor observes a good report, this can be the result of three situations: the unit did not commit fraud and the internal control agent did exert effort, the unit did not commit fraud and the internal control agent did not exert effort or the unit did commit fraud but the internal control agent did not exert effort. Only in the last situation, there is a potential gain for the external auditor in exerting effort is as he then will detect the fraud. Consequently, his behaviour depends on his beliefs concerning the situation he is in, i.e. p and q (Appendix)[24]. This, in turn, influences the effort decision of the internal control agent, together with his fraud observation. If the control agent does not observe fraud, he prefers to exert information gathering effort only as long as $I^U > \frac{1}{2}\theta$ and will never prefer to also exert monitoring effort as he will not detect fraud anyways. If the control agent does observe fraud, he prefers to exert monitoring effort when he expects the external auditor to exert effort as well, since $Z > I^U S + \frac{1}{2}\theta$. If $I^U > 1\frac{1}{2}\theta$, he also exerts information gathering effort (Appendix). Since the behaviour of the external auditor does only depend on the exerted *monitoring* effort of the internal control agent, in the following model only the choice of the internal control agent in exerting monitoring effort or not is taken into account At the start of the game, based on the resulting behaviour of the internal control agent and the external auditor, the unit decides whether to commit fraud or not.

[24] Note that as the internal control agent observes the behavior of the unit, he will never exert effort if he does not observe fraud, i.e. if $\phi = 0$. In other words, $e_m = 1$ after $\phi = 0$ is a never best response strategy and will not be played. Thus, the external auditor will always hold belief $q = 0$.

All the above results in two mixed perfect Bayesian equilibria. In both equilibria, the external auditor and the unit use a mixed strategy. The internal control agent mixes in exerting effort in one of the equilibria (See equilibrium 3ciii in Appendix B1), while does not exert effort in the other equilibrium (3biii). For the latter, the external auditor mixes in exerting effort with (x, 1-x) where x refers to $e_A = 1$ and $x = \frac{\Delta}{S}$. Intuitively, if the fine for detected fraud is high or the payoff of fraud is low, it is less attractive for the unit to commit fraud, and thus less appealing for the external auditor to exert effort, resulting in a lower x. For this equilibrium to hold, the internal control agent must have no incentive to exert monitoring effort; i.e. $x < \frac{I^U S + \frac{1}{2}\theta}{Z}$ needs to hold. The lower the costs of "own" fraud discovery compared to the costs of fraud detection by the external auditor, the sooner the internal control agent prefers to exert effort himself and thus the less stable this equilibrium would be. Also, when the external auditor is relatively unlikely to exert effort (i.e. lower x), the chance being caught for "capture" is less likely to happen, making it more attractive to not exert monitoring effort for the internal control agent. The unit mixes with (α, 1- α) where α indicates ϕ = 1 and $\alpha = \frac{c_u}{2I^{ex}}$, reflecting the costs of detecting fraud relative to its benefits for the external control agent; if detecting fraud is relatively cheap or the benefits in terms of identity are large, the external auditor is more likely to exert effort and consequently the unit commits fraud less often. Note that since the internal control agent here does not exert effort, this equilibrium behaviour is, except from the condition upon beliefs, very similar to the two player mixed equilibrium in the previous section where the internal control agent is located separately. In other words, when an external auditor is hired in case the internal control agent is located at the unit, an equilibrium exists in which he adopts the role of the independent internal control agent, resulting in similar equilibrium behaviour. However, in contrast to the two player equilibrium from previous section, as the internal control agent still exerts information gathering effort, the output of the unit will increase. The resulting payoff for the principal is as follows[25]:

$$W = 1 - \frac{c_u \Lambda (S - \Delta)}{2 I^{ex} S}$$

The relevant factors show the expected signs: if the costs of detecting fraud for the external auditor are high or the benefits in terms of identity are small, the payoff will decrease as the external auditor is less likely to detect fraud, resulting in a higher chance of fraudulent

[25] Since the information gathering effort participation is assumed to be fulfilled, the internal control agent is assumed to exert information gathering effort, i.e. $e_A = 1$. Therefore, V_w as included in the principals 'payoff function is equal to 1.

behaviour on part of the unit. In addition, when the potential gain of fraud for the unit is high or the fine when fraud detected is low, the more likely the unit is to commit fraud and thus the more likely the external control agent is to exert monitoring efforts, resulting in a higher payoff to the principal will be. The overall effect of the fine for the unit if fraud detected (S) is negative[26]. Thus, an increase in the fine for the unit in fact decreases the payoff for the principal, due to the negative effect it has on the effort exertion of the external auditor. As derived in section 6, the payoff to the principal in the two player equilibrium was $W = \frac{\Theta \acute{\Lambda}(\Delta - S)}{2I^o S}$, or:

$$W = -\frac{\Theta \acute{\Lambda}(S - \Delta)}{2I^o S}$$

Consequently, when the cost of effort and gain in utility are the same for the external auditor as for the internal control agent, the principal increases his payoff by hiring the external auditor, as the internal control agent now exerts information gathering effort while the external auditor exerts monitoring effort. However, the above expression does not take into account two rather important implications of hiring an external auditor who might detect fraud. First of all, the external auditor audit is very likely to charge an audit fee for his service, which would decrease the principal's payoff and would be relevant for a fair comparison. Second of all, by letting an external auditor detecting fraud instead of the internal auditor, certain reputational losses can be expected[27]. Nevertheless, from the expressions above, the maximum audit fee and reputational losses for which hiring an external auditor would still be optimal is rather clear. Under the, perhaps questionable, condition that the costs of effort and utility gain out of identification are the same for the external auditor and the internal control agent, the auditors fee and the value of reputational loss should be less than the gain in the output of the unit from information gathering effort, here standardized to 1, for the hiring of an external auditor to be optimal.

In the "all-mixing" equilibrium where the internal control too exerts monitoring effort with a positive chance (3ciii), the external auditor mixes in exerting effort with (x, 1-x) where x indicates $e_A = 1$ and with $x = \frac{I^U S + \frac{1}{2}\theta}{Z}$ for beliefs $p = \frac{c_u}{2I^{ex}}$. This reflects the expected

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[26] As $\frac{\partial W}{\partial S} = -\frac{c_u \acute{\Lambda} \Delta}{2I^{ex} S^2}$, this will always be negative.

[27] For example, Hogan & Wilkins (2008) found that the fee an external auditor charges increases when internal control problems, i.e. fraud, was detected in the previous year. Similarly, Hammersley et al (2007) reported an decrease in stock price after the disclosure of certain internal deficiencies.

behaviour of the internal control agent: the lower the costs of "own" fraud discovery compared to the costs of fraud detection by the external auditor, the sooner the internal control agent prefers to exert effort and thus the less beneficial it is for the external auditor to exert effort, resulting in a smaller x. The internal control agent mixes with (γ, 1- γ), where γ indicates $e_m = 1$. This leads to the following value for γ:

$$\gamma = \frac{\Delta Z - I^U S^2 - \frac{1}{2}\theta S}{SZ - I^U S^2 - \frac{1}{2}\theta S}$$

Intuitively, when the gain of fraud for the unit is high compared to the fine when fraud is detected, the unit is more likely to commit fraud. Since exerting monitoring effort is never optimal for the control agent if he does not observe fraud, only in case of fraud exerting effort might be beneficial for the internal control agent. This effect is similar to the previous equilibrium in which the external control agent mixes in $x = \frac{\Delta}{S}$. However, here, another controlling party exerts effort with a positive chance as well. This results in the possibility of a fine, Z, if the unit commits fraud and the internal control agent does not exert effort himself. Therefore, in his mixing strategy, the internal control agent takes this into account, reflected in the effect of Z, I^U, S and $\frac{1}{2}\theta$ in the expression above. When the loss of utility for the internal control agent if fraud is detected by the external control agent (Z) increases, the internal control agent will exert monitoring effort more often[28]. Clearly, this is very intuitive as the internal control agent prevents this loss in utility by exerting effort himself. The opposite effect holds for the loss in utility of the internal control agent reports fraud himself ($I^U, S \; and \; \frac{1}{2}\theta$): if these parameters increase, the internal control agent will exert effort less often. Note that as similar variables determine the effort exertion of both controlling parties, an interaction between their behaviours exists. In particular, an increase in the likelihood of effort exertion by the internal control agent implies that the external auditor is less likely to exert effort.

In this equilibrium, the unit mixes with (α, 1- α) where α indicates ϕ = 1. This leads to the following value for α:

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[28] As $Z > I^U S + \frac{1}{2}\theta$holds, the result of $\gamma = \frac{\Delta Z - I^U S^2 - \frac{1}{2}\theta S}{SZ - I^U S^2 - \frac{1}{2}\theta S}$ is always on the right side of the asymptote and thus increasing in Z.

$$\alpha = \frac{c_u S(Z - I^U S - \frac{1}{2}\theta)}{2I^{ex}Z(S - \Delta)}$$

As $S > \Delta$ and $Z > I^U S + \frac{1}{2}\theta$, both the nominator and the denominator of this expression will be positive. In contrast to previous equilibria, in the case the chance of fraud is not determined by the behaviour of one controlling party, but by a combination of the behaviour of both players. The external auditor influences the strategy of the unit in two ways. In the first place, similar to previous equilibriums, via a direct effect of his costs of effort relative to his gain in identity: if these are low, the unit commits fraud less often as it expects the external auditor to exert effort more often. Second, the mixing strategy of the external control agent influences the chance of fraud: as $x = \frac{I^U S + \frac{1}{2}\theta}{Z}$, the auditor is more likely to exert effort if Z is low or I^U, S and $\frac{1}{2}\theta$ are high, which in turn lowers the chance of fraud commitment at the unit. The behaviour of the internal control agent has less influence on the strategy of the unit: since for both the internal control agent located at the unit and the unit itself there is a mutual gain in undetected fraud, it creates a less opposing force. However, the internal control agent does provide a contrasting effect of Z on the chance of fraud: unlike the external auditor, Z increases the chance of monitoring effort by the internal control agent, thereby lowering the incentive of the unit to commit fraud. Lastly, there is the direct effect of the potential net loss of fraud: if the gain of fraud is high or the fine low, this increases the chance overall effect is determined[29]. In line with intuitive argumentation, it shows a negative effect: an increase in the fine for the unit when fraud is detected lowers the chance of fraud.

Although most parameters create the expected effects, one mechanism at play in determining the chance of fraud is remarkable. The loss in utility for the internal control agent when fraud is detected by the external auditor (*Z*) has an interesting effect on the chance the unit commits fraud. On the one hand, it decreases the chance of fraud since the internal control agent is more likely to exert monitoring effort. However, this effect is overshadowed by the decrease in monitoring effort by the external auditor, resulting in an overall lower chance of monitoring. Overall, an increase in this "fine" to the internal control agent for not detecting

[29] As $\frac{\partial \alpha}{\partial S} = -\frac{c_u S}{2I^{ex}Z(S-\Delta)^2}$ and $s > \Delta$ holds, the overall effect of the fine for the unit when fraud is detected on the likelihood of fraud will be negative.

fraud himself thus increases the chance of fraud[30]. It appears that the behaviour of the external auditor is the predominant factor in the fraud decision of the unit. This result can be explained by comparing the preferred outcomes of all players: for both the unit and the internal control agent located at the unit, the case in which fraud is committed but undetected is optimal. Only in case the fine for the internal control agent Z plays a role, a misalignment of interests exists between the internal control agent and the unit and the latter might have an incentive to base its fraud decision upon the internal control agent's behaviour. However, Z is merely relevant in case the external auditor exerts effort. Thus, when the effort strategy of the internal control agent becomes relevant, the importance of the external auditor's strategy increases to a larger extends.

The above mixing strategies result in the following payoff to the principal[31]:

$$W = 1 - \frac{c_u \Lambda (Z - I^U S - \frac{1}{2}\theta)}{2 I^{ex} Z}$$

Naturally, similar relations hold as in the previous equilibrium. The higher the costs of detecting fraud for the external agent relative to his benefits from detected fraud, the less fraud will be detected, decreasing the principal's payoff. Reflecting the opposing forces as outlined above, when the loss in utility of the internal control agent as a result of fraud detection by the external auditor (Z) increases, the effects on overall principal payoff appear to be mixed. In the end, the effect on the external auditor is stronger and the likelihood of fraud increases in Z, decreasing the resulting overall payoff to the principal.[32]

Comparing the principals' payoff for both equilibria as derived above, shows that the principal is better off in case both control parties exert effort with a positive chance (3ciii) if[33]:

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[30] As $\frac{\partial \alpha}{\partial Z} = \frac{c_u S(\theta + 2 I^U S)}{2 I^{ex} Z^2 (S - \Delta)}$ and $s > \Delta$ holds, the overall effect of the loss in utility of the control agent when fraud is detected by the external auditor on the likelihood of fraud will be positive.

[31] Note that here $e_i = 1$ is assumed, even though the internal control agent does exert monitoring effort with a positive chance as well. This implies that for the participation constraint to be fulfilled, that $I^U > \frac{1}{2}\theta (\frac{SZ - 2I^u S^2 - \theta S + \Delta Z}{SZ - I^U S^2 - \frac{1}{2}\theta S})^2$ needs to hold.

[32] As $\frac{\partial W}{\partial Z} = -\frac{I^U S + \frac{1}{2}\theta}{2 I^{ex} Z^2}$, will always be negative.

[33] This expression can be rewritten as: $1 - \left(\frac{I^U S + \frac{1}{2}\theta}{Z}\right) < 1 - \frac{\Delta}{S}$, clearly showing the effect of the terms for x.

$$\frac{Z - I^U S - \frac{1}{2}\theta}{Z} < \frac{S - \Delta}{S}$$

Since the external auditor for the all-mixing equilibrium mixes with $x = \frac{I^U S + \frac{1}{2}\theta}{Z}$, while $x = \frac{\Delta}{S}$ in equilibrium when the internal control agent does not exert effort, it is clear that the principal prefers the equilibrium in which the external auditor is the most likely to exert effort, i.e. with the highest x. However, for equilibrium in which the internal control agent does not exert effort (3biii), the following condition needs to hold concerning the beliefs of the internal control agent: $\frac{\Delta}{S} < \frac{I^U S + \frac{1}{2}\theta}{Z}$. Consequently, when locating the internal control agent at the unit, the principal always prefers the all-mixing equilibrium (3ciii) where all players exert effort with a positive chance.

As derived above, the model supports the existence of an effort substitution effect between the external auditor and the internal control agent; i.e., the external auditor is less likely to exert effort if the internal control agent is probable to do so. Since the exertion of effort of both agents increases the chance of fraud detection and this effect is therefore not to the benefit of the principal However, it appears that his impact is not too strong; namely, the resulting payoff for the principal is still higher when both controlling parties exert effort with a positive chance.

Independent. Similar to the case in which the internal control agent is located at the unit, in the last stage, the external auditor will always report fraud if he detects it after exerting effort as his utility is strictly increasing in a fraud report. In deciding whether to exert effort or not, the external auditor considers the report from the internal control agent. Again, if he observes a fraud report by the internal control agent, he will never exert effort, leading to the SPNE (Appendix). When the external auditor observes a good report, his behaviour again depends on his beliefs concerning which situation he is in: the unit did commit fraud, but the internal control agent did not exert effort (*p*), the unit did not commit fraud and the internal control did exert effort (*q*) or the unit did not commit fraud and the internal control agent did not exert effort (*1-p-q*) (Appendix). Again, only in the situation where the unit committed fraud but the internal control agent did not exert effort, there is a potential gain for the external auditor in exerting effort is as he then will detect the fraud. Based on his beliefs and the observed report of the internal control agent the external auditor decides upon effort. This, in turn, influences the effort decision of the internal control agent. In contrast to the situation in which the internal control agent was located at the unit, here the internal control agent does not observe whether fraud was committed or not. Therefore, he decides upon effort based on his beliefs as well, denoted by d. (Appendix). Since the internal control agent located separately does not gain utility from exerting information gathering effort, his only decision is whether to exert monitoring effort or not. At the start of the game, based on the resulting behaviour of the internal control agent and the external auditor, the unit decides whether to commit fraud or not. All the above results in three mixed perfect Bayesian equilibriums (Appendix): one in which the external control agent does not exert effort and the other players use a mixed strategy (2ciii), one in which the internal control agent does not exert effort and the other players use a mixed strategy (3biii) and one in which all players are mixing (3ciii). Note that the additional equilibrium here compared to the situation where the control agent was located at the unit results from the fact that the internal control agent in the independent situation cannot observe whether fraud was committed or not.

In the equilibriums where only one of the "controllers" (internal or external) is mixing, he mixes with $\gamma = x = \frac{\Delta}{S}$. The higher the fine when fraud is detected and the lower the benefits of fraud, the less inclined the unit would be to commit fraud and thus the less beneficial it is for the controllers to exert effort. The behaviour of the unit in these two equilibriums is a mixing strategy where the unit mixes with (α, 1- α) where α indicates ϕ = 1. For the equilibrium where the internal control agent is mixing, $\alpha = \frac{\theta}{2I^{O}}$ and for the equilibrium where the external auditor is mixing, $\alpha = \frac{c_O}{2I^{ex}}$. If the costs of effort are high or the benefits in terms of identity for the controllers are low, the unit commits fraud more often as it expects the controllers to exert effort less often. Clearly, for both the unit and the internal control agent, this is the same behaviour as derived previously in this section where the control agent was located at the unit and the internal control agent did not exert effort. However, as in this case the internal control agent does not exert information gathering effort since he is located independently, these equilibriums are even more similar to the two player mixing equilibrium from section 6, where the control agent was located separately as well. When comparing their resulting payoffs to the principal, this becomes even clearer. The equilibrium in which the internal control agent exerts effort with a positive chance and the external auditor exerts no effort at all (2ciii) leads to the following payoff for the principal:

$$W = -\frac{\lambda \Theta (S - \Delta)}{2I^{O} S}$$

As in this case the external auditor does not exert effort at all, he does not change the equilibrium behaviour of the other players compared to the case without an external auditor, as described in section 6. Therefore, the resulting payoff is exactly the same as derived in this section, where the internal control agent is located separately, mixing in exerting effort and where the unit mixes in committing fraud. Hiring an external auditor while the internal control agent is located separately would for this equilibrium thus be useless or even worse if the external auditor charges fees.

For the equilibrium where the external auditor exerts effort with a positive chance and the internal control agent exerts no effort at all (3biii), the principal receives the following payoff:

$$W = -\frac{\Lambda c_O(S - \Delta)}{2I^{ex}S}$$

Here, the external control agent is the one who exerts effort with a positive chance and thus his incentives determine the principals' payoff. Under the condition that the costs of effort and utility gain in terms of identity as a result of effort are the same for the internal control agent as for the external auditor, the same holds as for the equilibrium above: hiring an external auditor does not increase payoffs in this equilibrium. In this case this is due to the fact that the external auditor's effort replaces the internal control agent efforts. However, if the external control agent has an higher incentive to exert effort, i.e. if $\frac{c_o}{I^{ex}} < \frac{\theta}{I^O}$, the payoff to the principal might be bigger.

In the third possible equilibrium, all players follow a mixing strategy (3ciii). For beliefs $p = \frac{c_o}{2I^{ex}}$, the external auditor mixes in exerting effort with x, where x indicates $e_A = 1$ and $x = \frac{I^{ex}\theta(1-\gamma) - c_o I^O}{Zc_o}$. Note that this equilibrium only holds if there is a solution to x [34] (Appendix). When deciding his mixing strategy, the external auditor takes into account his direct incentives and the behaviour of the internal control agent. He is more likely to exert effort when he expects the internal control agent to be less likely to exert effort. This is directly reflected in the expression above via (1- γ) in the nominator and indirectly via the effect of I^O, θ and Z. In addition, his own interests influence his optimal likelihood of effort exerting, as visible in the effect of c_o and I^{ex}. As the expression for x without any endogenous parameters, i.e. by plugging in the exogenous expression for γ) results in hardly interpretable terms, the remainder of this discussion will show x explicitly in the subsequent

[34] This is the case for $(c_o S(Z - I^O))^2 - 4SZc_o(\theta I^O S - I^O c_o S - \theta I^{ex}\Delta) > 0$.

conditions. The internal control agent mixes in exerting monitoring effort with (γ, 1- γ), where γ indicates $e_m = 1$ and $\gamma = \frac{xS-\Delta}{xS-S} = 1 - \frac{c_o(I^o+Zx)}{\Theta I^{ex}}$[35]. Again, the first expression for γ is similar to the mixing strategy in previous equilibriums: the higher the chance of fraud committing by the unit, reflected in the attractiveness of fraud via the relative value of the potential gain of fraud to the fine when detected, the more likely the internal control agent is to exert effort. However, in this situation the internal control agent takes into account the behaviour of the external auditor as well. If the external auditor is more likely to exert effort, resulting in an higher x, the unit is less likely to commit fraud, making it less attractive for the internal control agent to exert effort. This is reflected in the negative effect x has in both expressions for γ. It appears that similar opposing mechanisms play along as were found in the previous case, where the internal control agent was located at the unit. One might conjecture that an increase in x increases the chance of loss in utility (*Z)* in case the unit commits fraud and the internal control agent does not exert effort. This could create an incentive for the internal control agent to exert effort when the external auditor is more likely to exert effort. However, similar to the previous findings, as this utility loss (*Z*) is only possible in case the unit commits fraud, the chance of fraud committing appears to mainly determine the behaviour of the internal control agent, which decreases in x.

The interplay outlined above is reflected in the mixing strategy of the unit: the unit mixes with (α, 1- α) where α indicates ϕ = 1 and $\alpha = \frac{\theta}{2(I^O+Zx)}$. If the unit expects the internal control agent to exert less effort due to high costs of effort, a low potential fine if fraud is detected by the external auditor or a low gain in utility, the unit commits fraud more often. Also, when the unit expects the auditor to exert effort less often, committing fraud is more attractive. All the above results in the following payoff to the principal[36]:

$$W = -\frac{\kappa\theta(S-\Delta)(1-x)}{2(I^o+Zx)(S-xS)}$$

As in this case all players' behaviour is relevant in determining the principal's payoff, a large number of parameters are included. In line with the above payoffs and common intuition, the

[35] As γ cannot be negative, this equilibrium only holds if there is a positive solution to this expression, i.e. if $\Delta > Sx$.

[36] As plugging in the expression for x (Appendix) creates a hardly interpretable expression for the principals payoff, this is not included. However, as $\frac{\partial W}{\partial x} = -\frac{2ZS\kappa\theta(\Delta-S)(1-x^2)}{(2(I^o+Zx)(xS-S))^2}$ and $s > \Delta$ holds, the effect of x on the principals payoff will always be positive.

principal is better off the loss of undetected fraud is low, the internal control agent has a higher incentive to exert effort and when the external auditor is more likely to exert effort.

To sum up, three equilibria can be found for the case where the internal control agent is located independently. In comparing the resulting payoffs to the principal it appears that the principal prefers the equilibrium in which all three players exert effort with a positive chance, i.e. the all-mixing equilibrium compared to the one in which only the internal control agent might exert effort (2ciii), if the following condition holds:

$$Z(1+x) > I^O$$

Thus, if the internal control agent located at the unit is little incentivized to exert effort, the negative effort substation effect of an active auditor is low, increasing the benefits of the all-mixing equilibrium. Adding the assumption of equal identification effects and costs of effort for the external auditor and the internal control agent, i.e. $I^O = I^{ex}$ and $c_o = \theta$, this condition would hold for the equilibrium in which the external control agent exerts effort as well. Since $Z > I^O S + \frac{1}{2}\theta$, note that this condition is rather likely to hold. Consequently, a similar conclusion holds as for the situation in which the internal control agent was located at the unit. Again, as a negative relation exists between the likelihood of effort by the internal control agent and the external auditor, an effort substitution effect appears. Since the all-mixing equilibrium once more is likely to be optimal, this effect is not too strong, to the benefit of the principal.

Optimal work setting. The above equilibria show the significant effect the external auditor has on the behaviour of the internal control agent and on the overall payoff to the principal. Therefore, in deciding where to optimally locate the internal control agent, he should take this into account. Analysis of the model yields multiple equilibrium situations for both work-settings. Various methods can be used in in identifying the most probable equilibrium, all with their potential benefits and shortcomings. In order to avoid any influencing consequences of method choice, all five equilibriums and their impacts dare considered explicitly.

Overall, it can be concluded that under the strict assumption that $I^O = I^{ex}$and $c_o = c_u = \theta$, the principal is *always* better off locating the internal control agent at the unit when an external auditor is hired. This can be derived as follows. At the unit, the payoff of the least beneficial equilibrium for the principal (3ciii - unit) will always be higher compared to the payoffs when locating the agent separately and only two players use a mixed strategy (2ciii &

3biii – independent). That is, since under the stated condition, the negative term in these equilibriums becomes identical, the additional '1' in the principals' payoff function when locating the agent at the unit secures its superiority. Comparing this least beneficial 'at the unit' payoff with the only other equilibrium possibility left for the case when the agent is located separately yields a similar conclusion. It appears that the condition under which the payoff to the principal for separate internal control agent would be optimal never holds[37]; placing the agent at the unit is thus always optimal when the all-mixing equilibrium in the case of a separate internal control agent would result. Although the precise channel through which this appears is hard to identify as a result of the complex expression for x, a considerate look at the difference in models raises a probable intuitive explanation. The internal control agent located at the unit observes fraud committing and thus knows whether effort exertion is fruitful, this in contrast to the separate internal control agent. Therefore, the expected scope in which is optimal to exert effort for the agent, is expected to be wider when located he is independently. Due to the substitution effect, this results in less effort on part of the external auditor. As derived above, the effort exertion of the external auditor appears to have more impact on the overall payoff to the principal. Therefore, the principal is likely to be better off for a relative higher effort exertion chance on part of the external auditor, which is thus line with the superiority of the 'at unit' work setting. On top of this, as the internal control agent located at the unit is also assumed to exert information gathering effort, the relative principal's payoff increases even more.

Relaxing the condition above shows the influence of the controlling party's identification effect and cost of efforts. As the payoff expression for the last, all-mixing, equilibrium with a separate internal control agent includes an endogenous variable (x) and the complete expression for x as included in the appendix barely sheds light on the determining factors and their impact, from now on this equilibrium is neglected[38]. First, as the costs of effort for the external auditor when working with an independently located control agent are assumed to be lower compared to the situation in which the internal control agent is located at the unit, i.e. $c_o < c_u$, the effect of a potential difference in cost of effort on the optimal work setting cannot be left out. For a big enough difference, locating the agent separately might be optimal

[37] Comparing the payoffs for equilibrium 3biii – at unit and 3ciii – seperate results in the following condition for which the 3ciii equilibrium payoff would be optimal from a principal's perspective: $1 < -\frac{\theta \lambda Zx(S-\Delta)}{2I^{ex}S(I+Zx)}$. As all variables included are positive and $S > \Delta$ holds, this condition can never hold.

[38] For $Z(1+x) > I^{O}$ this is de preferred equilibrium and since this condition is likely to hold, the case for the separate control agent might thus be stronger as depicted, providing a significant limitation of the results.

if it results in the equilibrium outcome where the external auditor exerts effort with a positive chance. More specifically, comparing the payoff for the "worst" equilibrium possible when locating the internal control agent at the unit (3biii – unit) with the situation in which he is located independently (3biii – separate), it appears that the principal is still better off locating the agent at the unit when the following holds[39]:

$$c_u - c_o < \frac{2I^{ex}S}{\Lambda(S - \Delta)}$$

On the right hand side of this condition, the chance of fraud is visible via the effect of S and Δ: if the unit has a lower incentive to commit fraud, this condition loses rigor and the principal is more likely to place the internal control agent at the unit for wider range of effort cost differences. This is due to the fact that in this case the benefits of effort for the principal are lower, decreasing the importance of costs of effort.

Second, as outlined above, the effort exertion strategy of the internal control agent and the external auditor are highly influenced by their direct utility payoffs. Therefore, the effect of these variables is interesting to explore a bit further. In case the control agent is located at the unit, this section showed that how the external auditor then takes on the role of an independent control agent. Therefore, one might argue that a higher identification effect the internal control agent located separately compared to the external auditor could strengthen the case for an independent internal control agent. In a similar vein as for the cost of effort difference above, if the following condition the difference in identification effects relative to corresponding costs of effort for the controlling parties holds, the principal still prefers locating the internal control agent at the unit[40]:

$$\frac{c_u}{I^{ex}} - \frac{\theta}{I^o} < \frac{2S}{\Lambda(S - \Delta)}$$

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[39] Note that the opposite not necessarily holds; i.e., in case $c_u - c_o > \frac{2I^{ex}S}{\Lambda(S-\Delta)}$ locating separately does not have to be superior as the payoff of the separate case (3biii) might still be lower compared to best equilibrium possible when locating the agent at the unit from a principals' perspective (3ciii – at unit).

[40] Again, note that the opposite not necessarily holds as this condition results from comparing the equilibrium payoff of "worst" case equilibrium possible at the unit (3biii) with the equilibrium where the control agent is located separately and exerts effort with a positive probability (2ciii); i.e., in case $\frac{c_u}{I^{ex}} - \frac{\theta}{I^o} < \frac{2S}{\Lambda(S-\Delta)}$, locating separately does not have to be superior as the payoff of the separate case (2ciii) might still be lower compared to best equilibrium possible when locating the agent at the unit from a principals' perspective (3ciii – at unit).

Intuitively, when the internal control agent located independently has a stronger incentive to exert effort, resulting from low cost of effort relative to his identification gain, compared to the external auditor, the benefits of locating the agent separately increase.

To conclude, involving the effect of the external auditor in the work-setting decision of the principal strengthens the case for locating him at the unit. Conditionally upon equal direct incentives for the controlling parties ($I^O = I^{ex}$ and $c_o = c_u = \theta$), the latter is shown to be optimal irrespective of which equilibrium appears. Only when cost of effort for the external auditor when working with an independently located internal control agent are lower or the direct incentives to exert effort are higher for the separate internal control agent, the separate internal control agent might be preferred by the principal. However, as not all equilibria have been taken into account, this last finding is tentative.

8. Discussion

8.1 Results

In his decision where to locate the internal control agent, the principal clearly faces a trade-off between the two main roles the agent fulfils. The contrasting forces inherent in these roles can be clearly displayed by including identity as an incentive mechanism. Corresponding to the findings of Alhawat and Lowe (2004), a separate internal control agent will perform his controlling task objectively. However, this comes with a cost: no supportive efforts in order to increase the output of the unit will be exerted. Consequently, in the resulting payoff, the relative benefits of these efforts are clearly visible. When the expected losses of fraud are high, the separate internal control agent is likely to detect it and the forgone supportive effort is not too big, the principal is more likely to prefer locating the agent independently. This also reflects the effect of the impact of identity: if the internal control agent located at the unit identifies himself more strongly with the unit, compared to the professional identity of a separate control agent, locating the agent at the unit might be optimal. However, note that the framework of the model used lends itself for other incentivizing mechanisms as well. Since only few empirical studies underpin the incentivizing effect of identity, this substitutability of incentive system in the model is reassuring. Nevertheless, it is arguable that identification effects are of particular relevance for the internal audit function, as outlined in section two.

In order to ease the effort-dilemma, implementing a bonus appears to be fruitful. Although this does not imply that the effort exertion on both tasks can be obtained, it has the potential to alter the reporting decision of the internal control agent located at the unit: to such a degree that he will report fraud if detected. Implementing the bonus is only beneficial if the loss of fraud to the principal exceeds the loss of utility for a fraud report to the agent and these additional benefits thus increase the chance of locating the control agent at the unit to be optimal.

When allowing for the chance of fraud to be endogenous, the behaviour of the internal control agent located at the unit remains similar: no monitoring effort exertion and no reporting of fraud. Locating the internal control agent separately however will yield another outcome in which both the unit and the internal control agent use a mixed strategy. In deciding where to locate the agent, now the difference in identification effects loses its pertinence. However, the expected losses of fraud show the same effect: if these are high, the principal prefers locating the agent independently. This chance increases when the independent control agent largely identifies himself with his profession or when his costs of effort are low. Although including the endogenous chance of fraud in the analysis does provide additional insights, the outcome still suffers from opposing effort incentives and only one type of effort will be exerted. These findings are thus in line with the organizational economics literature (Dewatripont and Tirole (1999)) and part of the auditing literature (Brody and Lowe (2000), Alhawat and Lowe (2004)).

The last section of this work provides comforting results for the seemingly unsolvable "role-dilemma". Namely, when the internal control agent located at the unit faces the thread of being controlled by an external auditor, an equilibrium situation exists in which he has an incentive to exert *both* controlling monitoring effort and supportive information gathering effort. This in contrast to the separate internal control agent: he will still never show supportive behaviour to the unit. Recall that the auditing literature concerning the interplay between the external and internal auditor provides mixed result. First, it is not directly clear from the literature whether the external auditor acts as an substitute or a complement of the internal control agent. The findings as presented in this work are in line with the substitution effect: for both possible work locations of the internal auditor, the model unambiguously shows negative relation between the likelihood of monitoring effort between the two controlling parties. Second, opposing views exist in the literature concerning the influence of work-setting of the internal control agent on the behaviour of the external auditor. Although not explicitly traceable in the findings, by conjecture the analysis supports the view of Gramling and Vandervelde (2006) in that the external auditor attaches more trust to the work of a separate internal control agent, making it less likely to exert effort himself. The results show that the effort of the external auditor is more important for the overall payoff to the principal. This contributes to the overall conclusion: placing the internal control agent at the unit will always be optimal under the equal direct incentives assumption. When relaxing this assumption, placing the internal agent separately might only be optimal if it yields significantly lower costs of effort to the external auditor or in case he has relatively high direct incentives. In line with the importance of effort exertion by the external auditor, his identification effect has a positive effect on the principals' payoff. Thus, the results indicate that the principal benefits from a higher professional identity on part of the auditor. In contrast, when the professional identity of the internal control agent located separately, this might be different. However, van Peursem (2004) found that internal auditors have a lower identification effect with their profession compared to external auditors. This could provide even more support for the superiority of the "at the unit" work location. A last finding from including the external auditor in the model, is the effect of Z. It appears that the loss in utility for the internal control agent when fraud is detected by the external auditor has a negative influence to the principal. This could provide a rationale for being lenient with the internal control agent if he did not detect fraud while the external auditor did. However, as this mechanism results from the expectations of the external auditor, another "solution" for the principal could be to keep silent any possible punishments of the internal agent to the external auditor. Naturally, if the loss in utility to the internal control agent results from a reputational loss, the principal cannot influence that.

In conclusion, this work suggests potential merits of applying game theory in explaining fraud commitment and the behaviour of controlling parties. By using identity as an incentive system, some first insights in the underlying mechanisms can be found. In placing the internal control agent in a certain work-setting, the principal faces an crucial trade-off due to the two tasks imposed on the agent. When neglecting the effect of the external auditor, locating the internal control agent separately and investing his "identity" can be highly valuable if the potential losses of fraud are big. Also, when the 'at the unit' work setting is chosen, the principal might benefit from imposing a bonus if the identification effect of the internal auditor is relatively low. If the organization however deals with an external auditor as well, the optimal decisions for the principal change. For trustworthy, objective and professionally committed external auditors locating the internal control agent at the unit seems optimal.

8.2 Limitations

Like all analytical models, the results are only as generalizable as the assumptions underlying it. One potential bias in the model including the external auditor (section 7), might result from the complete omission of any consequences of reported fraud to the principal. This assumption might be quite rigorous, as various studies highlight the negative consequences of reported fraud cases on the organization (e.g. Hogan and Wilkins (2008), Hamersley et al. (2007)). Moreover, fraud scandals are widely reported in the media, overtly harming the organization's reputation. In that, one might conjecture that fraud cases detected by the external auditor impairs the organization to a larger extend than when the fraud is detected by the internal control agent. As the model applied here does not allow for this distinction, the results are potentially biased towards the work-setting where the internal control agent is located at the unit, as here the external auditor is likely to adopt the role of the controlling party and exert monitoring effort.

Another strict assumption of the model relates to the somewhat optimistic utility function of the external auditor employed. In here, it is assumed that the external auditor gains identity from discovering fraud and has no further interest in the client's success. This strong independence assumption is likely to be somewhat stern, as widely suggested by a vast strand of literature in the field of accounting[41]. As this would result in less opposing interests of the parties included, allowing for these effects potentially decreases the weight of the findings in section 7.

Paradoxically but common in theoretical analysis, the broad approach of this work by generalizing the exact interpretation of the work-setting trade-off creates a third limitation in the relevance of the results. When applying this model to the outsourcing decision of the principal, in particular the assumption of equal losses to the internal control agent when fraud is detected by the external auditor (Z) might be too strict. As the in-house internal control is in any event protected by limited liability and bears potentially less reputational risks, his losses in case the the external auditor discovers fraud can be argued to be lower. As (Z) appeared to have a negative overall effect on the principals' payoff in the equilibrium where all players use a mixed strategy[42], a lower Z for the agent located at the unit might benefit the benefits of an in-house internal control agent.

[41] See for example Simunic (1984) and Gendron et al (2006).

[42] Note that this effect is only assured in case the internal control agent is located at the unit.

In a similar vein, when using an external party for the internal audit, the identity of the chosen party might be of influence to the overall payoff of the organization. When the same company performs both the internal and the external audit, this could potentially harm the perceived and actual objectivity which has a negative influence on the organization[43] (Lowe et al (1999), Swanger and Chewning (2001)). This effect of external auditor choice in case of locating the internal control agent separately is neglected in the model. If included, the case for locating the agent at the unit might become even more profound if the external auditor's firm is chosen as outsourcing party. However, one might consider another, opposing, possible effect of choosing the external auditors' firm for the internal audit: lower costs of effort to the external auditor as a result of familiarity with their client's practices. As derived in the previous section, this could improve the case for locating the internal control agent separately.

At last, two shortcomings of this model result from the rather basic mathematical approach. Although the case in which a bonus is included (section 5) does yield some insightful findings, including the optimal bonus value in the principal's payoff for the subsequent analysis would be more accurate. Next, applying the expression for x in which only exogenous parameters are used in interpreting the findings is very likely to provide a more dependable identification of the mechanism at work.

8.3 Future research

Applying game theoretic insight from the field of organizational economics to the area of accounting and auditing appears to be a promising research area. Resulting from the limitations of the model employed here and the mass of valuable literature suggesting diverse mechanisms, plenty alternatives are left for both theoretical and empirical studies.

For theoretical analysis, some suggestions can be made. As shortly mentioned in section 5, the bonus situation with a continuous effort model could also serve as a framework describing the effect of fraud value and control by an external auditor on the fraud reporting decision of the internal control agent; i.e. fraud is more likely to be reported for low values of fraud to the unit and a low chance of external fraud detection. This area might provide an interesting field for future research. For example, by combining this basic model with inclusion of the external auditor, i.e. making the chance of fraud detection by an external party endogenous could

[43] This possibility resulted in the current position of the Institute for Internal Auditors against the employment of the same auditing firm for both the internal and external audit. (Position Paper 'The role of internal auditing in resourcing the internal audit activity', IIA).

display the underlying mechanisms of this first sight result. In addition and iin line with the above discussion on limitations, to increase the applicability of the analysis on the outsourcing decision of an organization, a number of considerations could be included. One potentially compelling mechanism to further explore is the influence of outsourcing firm-choice has on the overall payoff to the principal, thereby taking into account. Lastly, this work shows the multiplicity of possible equilibriums when including the external auditor in the analysis. As indicated, which equilibrium will result depends on the most widely supported beliefs of the players included. Another potential extension of the model employed here might therefore consider a repeated game in which the beliefs of these players become endogenous. Since these are based on the direct incentives to exert effort of the other players, there might be perceived benefits in altering these beliefs, i.e. in signalling false values of these direct incentives by stirring their effort exertion strategies.

As fraud occurrence is a rather sensitive subject, especially concerning its relation with internal control, empirical research encounters some barriers. Much of the field research done in this area considers only the fraud as detected by external auditors, media or other stakeholders. Fraud detected by the internal control agent is likely to be concealed from the public. Similarly, fraud prevented by the internal control agent is unmeasurable by definition. However, the model introduced here suggests some interesting areas in which empirical evidence would be valuable. For example, few studies concern the effect of using a bonus in inducing the "in-house" internal control agent to exert effort. In addition, more research would be desirable on the strength of identification effects, professional identity and ease of "capture" for the internal audit profession and how it can be affected. Lastly, although this is the area relevant for this work in which already various empirical studies have taken place, the interaction between the internal control agent and the external auditor lends itself for further research. In particular, the difference in direct incentives for the internal and external control party could be relevant. To conclude, this work suggests that overcoming some of the empirical barriers could highlight some worth-knowing results.

Appendix

Appendix A

A.1

Expected payoffs for the internal control agent located at the unit (rows) and the unit (columns).

	$\boldsymbol{\phi = 1}$	$\boldsymbol{\phi = 0}$
$e_i = 0, e_m = 0$	$I^U\Lambda, \Lambda$	0, 0
$e_i = 1, e_m = 0$	$I^U + I^U\Lambda - \frac{1}{2}\theta, 1 + \Lambda$	$I^U - \frac{1}{2}\theta, 1$
$e_i = 0, e_m = 1$	$I^U\Lambda - \frac{1}{2}\theta, \Lambda$	$-\frac{1}{2}\theta, 0$
$e_i = 1, e_m = 1$	$I^U + I^U\Lambda - 2\theta, 1 + \Lambda$	$I^U - 2\theta, 1$

A.2

Expected payoffs for the internal control agent located separately (rows) and the unit (columns).

	$\boldsymbol{\phi = 1}$	$\boldsymbol{\phi = 0}$
$e_i = 0, e_m = 0$	$0, \Lambda$	0, 0
$e_i = 1, e_m = 0$	$-\frac{1}{2}\theta, 1 + \Lambda$	$-\frac{1}{2}\theta, 1$
$e_i = 0, e_m = 1$	$I^O - \frac{1}{2}\theta, \Lambda - S$	$-\frac{1}{2}\theta, 0$
$e_i = 1, e_m = 1$	$I^U - 2\theta, 1 + \Lambda - S$	$-2\theta, 1$

- If $I^o - \frac{1}{2}\theta < 0$, there is a pure equilibrium where the control agent exerts no effort and the unit commits fraud.

- If $I^o - \frac{1}{2}\theta > 0$, no pure equilibrium exists. Since the strategy for the agent ($e_i = 1$, $e_m = 0$) is strictly dominated by ($e_i = 0$, $e_m = 0$) and ($e_i = 1$, $e_m = 1$} is strictly dominated by ($e_i = 0$, $e_m = 1$), these can be eliminated. In this set up, the control agent located at the unit will never exert information gathering effort. This gives the following reduced normal form:

		A	1-α
		ϕ = 1	**ϕ = 0**
γ	$e_i = 0, e_m = 0$	$0, \acute{\Lambda}$	0, 0
$1\text{-}\gamma$	$e_i = 0, e_m = 1$	$I^O - \frac{1}{2}\theta, \acute{\Lambda} - S$	$-\frac{1}{2}\theta, 1$

Since no pure equilibrium exists, the unit follows a mixed strategy (α, 1- α) where α refers to ϕ = 1 and the agent follows mixed strategy (γ, 1- γ) where γ refers to $e_m = 0$. The expected payoffs for the agent are as follows:

$$U^O(e_i = 0, e_m = 0) = 0$$

$$U^O(e_i = 0, e_m = 0) = I^o\alpha - \frac{1}{2}\theta$$

The best responses of the agent are thus as follows:

$\gamma = 1$ if $\alpha < \frac{\theta}{2I^O}$

$\gamma \epsilon [0,1]$ if $\alpha = \frac{\theta}{2I^O}$

$\gamma = 0$ if $\alpha > \frac{\theta}{2I^O}$

The expected payoffs for the unit are:

$$V(\phi = 1) = \gamma S - S + \acute{\Lambda}$$

$$V(\phi = 0) = 0$$

The best responses of the unit are thus as follows:

$\alpha = 1$ if $\gamma > \frac{S - \acute{\Lambda}}{S}$

$\alpha \epsilon [0,1]$ if $\gamma = \frac{S - \acute{\Lambda}}{S}$

$\alpha = 0$ if $\gamma < \frac{S - \acute{\Lambda}}{S}$

Since $\text{Ƙ} > 0$ and $S > \text{Ƙ}$, $0 < \gamma < 1$ and since $I^o - \frac{1}{2}\theta > 0$, $0 < \alpha < 1$ holds as well. There exists a mixed equilibrium where the agent plays strategy (γ, 1- γ) with $\gamma = \frac{S - \text{Ƙ}}{S}$ and where the unit plays strategy (α, 1- α) with $\alpha = \frac{\theta}{2I^o}$..

Appendix B

B.1

Utility level of the internal control agent located at the unit for different effort combinations:

$\underline{e_i = 0 \;\&\; e_m = 0}$

$$U^u = I^U \Delta\phi - Z e_A \phi$$

$\underline{e_i = 1 \;\&\; e_m = 0}$

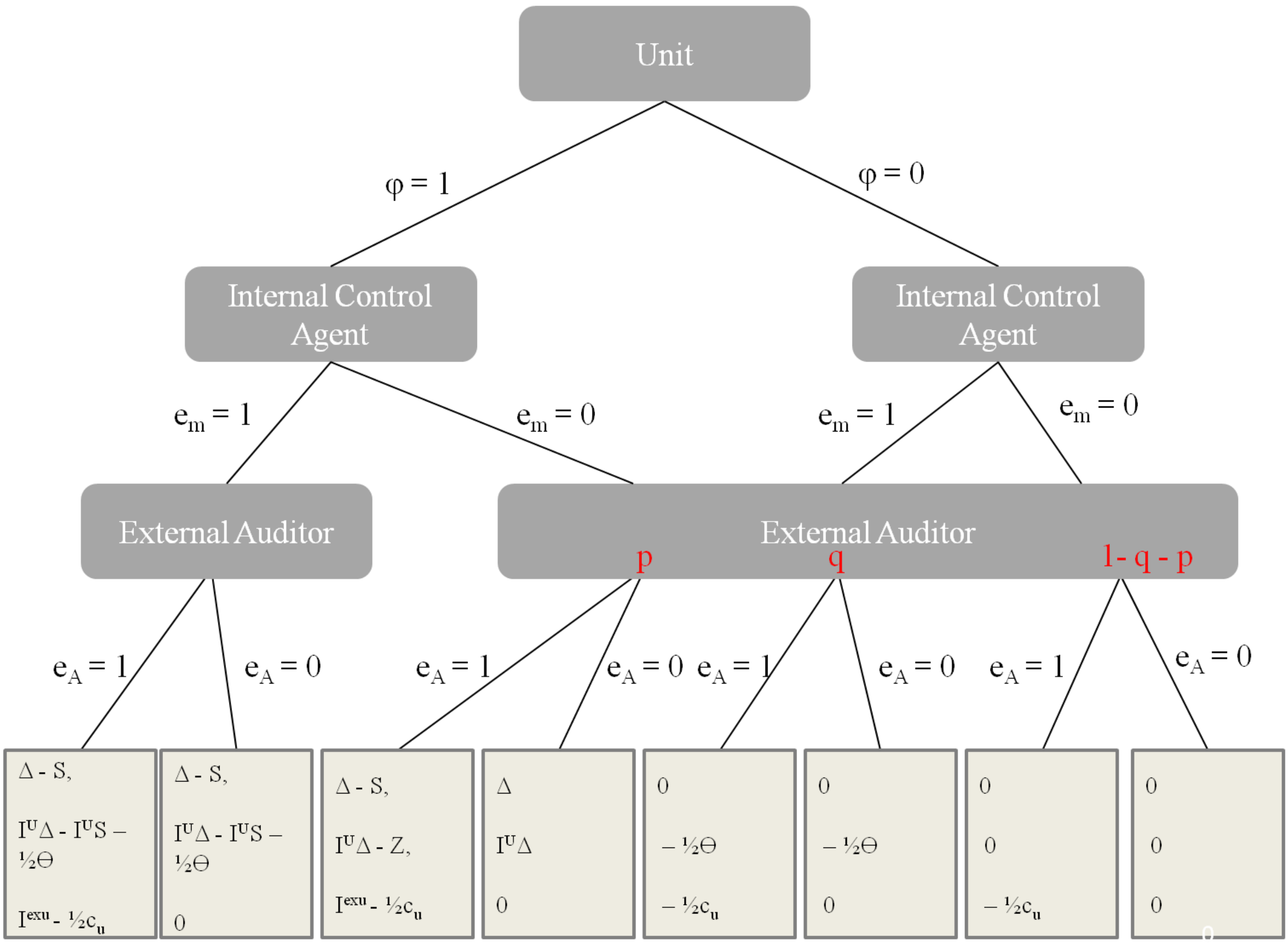
$$U^u = I^U + I^U \Delta\phi - Z e_A \phi - \frac{1}{2}\theta$$

$\underline{e_i = 0 \;\&\; e_m = 1}$

$$U^u = I^U \Delta\phi - Z e_A \phi - \frac{1}{2}\theta$$

$\underline{e_i = 1 \;\&\; e_m = 1}$

$$U^u = I^U + I^U \Delta\phi - I^U S\phi - 2\theta$$



Perfect Bayesian Equilibriums

Assumption: participation constraint for the external auditor holds i.e. $I^{ex} > \frac{1}{2}c_u$.

- If the external auditor observes a fraud report, he will not exert effort, leading to the SPNE where $e_A = 0$ and the following payoffs for the unit, the internal control agent and the external auditor, respectively: $(\Delta - S, I^U - \frac{1}{2}\theta, 0)$

- If the external auditor observes a good report, his effort exertion depends on his beliefs p, q and 1-p-q.
  - $U^{exu}(e_A = 1) = p\left(I^{ex} - \frac{1}{2}c_u\right) + q\left(-\frac{1}{2}c_u\right) + (1-p-q)\left(-\frac{1}{2}c_u\right) = pI^{ex} - \frac{1}{2}c_u$
  - $U^{exu}(e_A = 0) = 0$

  1. If $p > \frac{c_u}{2I^{ex}}$, the external auditor exerts effort, i.e. $e_A = 1$
  2. If $p < \frac{c_u}{2I^{ex}}$, the external auditor does not exert effort, i.e. $e_A = 0$
  3. If $p = \frac{c_u}{2I^{ex}}$, the external auditor mixes in exerting effort with x.

1. If $p > \frac{c_u}{2I^{ex}}$***, the external auditor exerts effort, i.e.*** $e_A = 1$

<u>If the internal control agent observes fraud:</u>

- $U^u(e_m = 1) = I^U\Delta - I^U S - \frac{1}{2}\theta$
- $U^u(e_m = 0) = I^U\Delta - Z$

  → As $Z > I^U S + \frac{1}{2}\theta$ by assumption, the internal control agent exerts effort, $e_m = 1$. Then, the external auditor could have never observed a good report. Therefore, no equilibrium.

<u>If the internal control agent does not observe fraud:</u>

- $U^u(e_m = 1) = -\frac{1}{2}\theta$
- $U^u(e_m = 0) = 0$

  → The internal control agent does not exert effort, $e_m = 0$

➔ This would lead to p = 0, which contradicts $p > \frac{c_u}{2I^{ex}}$. Therefore, there exists no equilibrium where $p > \frac{c_u}{2I^{ex}}$.

2. ***If $p < \frac{c_u}{2I^{ex}}$, the external auditor does not exert effort, i.e. $e_A = 0$***

<u>If the internal control agent observes fraud:</u>

- $U^u(e_m = 1) = I^U\Delta - I^U S - \frac{1}{2}\theta$
- $U^u(e_m = 0) = I^U\Delta$

  → The internal control agent exerts no effort, $e_m = 0$

<u>If the internal control agent does not observe fraud:</u>

- $U^u(e_m = 1) = -\frac{1}{2}\theta$
- $U^u(e_m = 0) = 0$

  → The internal control agent does not exert effort, $e_m = 0$

➔ This would lead to p = α and q = 0. If $\alpha < \frac{c_u}{2I^{ex}}$, this could be an equilibrium. (α is the chance that the unit commits fraud)

However, both the external auditor as well as the internal control agent do not exert effort. Therefore, the unit will always commit fraud in this scenario:

- $V(\phi = 1) = \Delta$
- $V(\phi = 0) = 0$

  → As Δ > 0, the unit commits fraud. → α = 1, p = 1.

  Since the participation constraint of the external auditor implies $I^{ex} > \frac{1}{2}c_u$ and □ $< \frac{c_u}{2I^{ex}}$implies $1 < \frac{c_u}{2I^{ex}}$, this condition cannot hold in equilibrium. Therefore, there exists no equilibrium where $p < \frac{c_u}{2I^{ex}}$.

3. ***If $p = \frac{c_u}{2I^{ex}}$, the external auditor mixes in exerting effort with (x, 1-x), where x indicates $e_A = 1$.***

<u>If the internal control agent observes fraud:</u>

- $U^u(e_m = 1) = I^U\Delta - I^U S - \frac{1}{2}\theta$
- $U^u(e_m = 0) = x(I^U\Delta - Z) + (1 - x)I^U\Delta = I^U\Delta - Zx$

  a. If $x > \frac{(I^U S + \frac{1}{2}\theta)}{Z}$, the internal control agent exerts effort, i.e. $e_m = 1$.

b. If $x < \frac{(I^U S+\frac{1}{2}\theta)}{Z}$, the internal control agent does not exert effort, i.e. $e_m = 0$

c. If $x = \frac{(I^U S+\frac{1}{2}\theta)}{Z}$the internal control agent mixes with (γ, 1- γ), where γ indicates $e_m = 1$.

3a. If $x > \frac{(I^U S+\frac{1}{2}\theta)}{Z}$ the internal control agent exerts effort, i.e. $e_m = 1$

The unit decides upon fraud:

- $V(\phi = 1) = \Delta - S$
- $V(\phi = 0) = 0$

→The unit does not commit fraud, contradicts the prerequisite that the internal control agent observes fraud. No equilibrium.

3b. If $x < \frac{(I^U S+\frac{1}{2}\theta)}{Z}$, the internal control agent does not exert effort, i.e. $e_m = 0$.

The unit decides upon fraud:

- $V(\phi = 1) = x(\Delta - S) + (1-x)\Delta$
- $V(\phi = 0) = 0$

i. If $x > \frac{\Delta}{S}$, the unit does not commit fraud, i.e. ϕ = 0. → This would result in p = q = 0. No equilibrium.

ii. If $< \frac{\Delta}{S}$, the unit commits fraud, i.e. ϕ = 1. → This would result in p = 1. Since the participation constraint of the external auditor implies $I^{ex} > \frac{1}{2}c_u$ the condition $p = \frac{c_u}{2I^{ex}}$ cannot hold in equilibrium.

iii. If $= \frac{\Delta}{S}$, the unit mixes with (α, 1- α) where α indicates ϕ = 1. → As in this scenario $p = \frac{c_u}{2I^{ex}}$ and $e_m = 0$ with a chance of 1, must hold, there exists an equilibrium where $\alpha = p = \frac{c_u}{2I^{ex}}$.

➔ **3biii. Equilibrium**

- The external auditor mixes in exerting effort with (x, 1-x) where x indicates $e_A = 1$ and with $x < \frac{(I^U S+\frac{1}{2}\theta)}{Z}$ & $x = \frac{\Delta}{S}$ for belief $p = \frac{c_u}{2I^{ex}}$.

- The internal control agent does not exert effort i.e. $e_m = 0$.
- The unit mixes with (α, 1- α) where α indicates ϕ = 1 and $\alpha = \frac{c_u}{2I^{ex}}$.
- The resulting payoff to the principal is as follows: $W = 1 - \frac{c_u \Delta(S-\Delta)}{2I^{ex}S}$

3c. If $x = \frac{(I^U S + \frac{1}{2}\theta)}{Z}$ *the internal control agent mixes with (γ, 1- γ), where γ indicates* $e_m = 1$.

The unit decides upon fraud:

- $V(\phi = 1) = \gamma(\Delta - S) + (1-\gamma)(x(\Delta - S) + (1-x)\Delta)$
  - For $x = \frac{(I^U S + \frac{1}{2}\theta)}{Z}$ this gives $V(\phi = 1) = \left(\frac{\gamma S\left(I^U S + \frac{1}{2}\theta\right)}{Z} - S\right) - S\left(\frac{\left(I^U S + \frac{1}{2}\theta\right)}{Z}\right) + \Delta$
- $V(\phi = 0) = 0$

i. If $\gamma < \frac{\Delta Z - I^U S^2 - \frac{1}{2}\theta S}{SZ - I^U S^2 - \frac{1}{2}\theta S}$ the unit does commit fraud, i.e. ϕ = 1. → This would result in p = 1. Since the participation constraint of the external auditor implies $I^{ex} > \frac{1}{2}c_u$ the condition $p = \frac{c_u}{2I^{ex}}$ cannot hold in equilibrium.

ii. If $\gamma < \frac{\Delta Z - I^U S^2 - \frac{1}{2}\theta S}{SZ - I^U S^2 - \frac{1}{2}\theta S}$ the unit does not commit fraud, i.e. ϕ = 0. → This would result in p = 0. No equilibrium.

iii. If $\gamma = \frac{\Delta Z - I^U S^2 - \frac{1}{2}\theta S}{SZ - I^U S^2 - \frac{1}{2}\theta S}$), the unit mixes with (α, 1- α) where α indicates ϕ = 1. → As in this scenario $p = \frac{c_u}{2I^{ex}}$ and $e_m = 0$ with a chance of (1- γ) , must hold, there exists an equilibrium where $p = (1-\gamma)\alpha$ i.e. where $\alpha = \frac{p}{1-\gamma}$. This gives $\alpha = \frac{c_u S(Z - I^U S - \frac{1}{2}\theta)}{2I^{ex}Z(S-\Delta)}$.

→ **3ciii. Equilibrium:**

- The external auditor mixes in exerting effort with (x, 1-x) where x indicates $e_A = 1$ and with $x = \frac{(I^U S + \frac{1}{2}\theta)}{Z}$ for belief $p = \frac{c_u}{2I^{ex}}$.
- The the internal control agent mixes with (γ, 1- γ), where γ indicates $e_m = 1$ and with $\gamma = \frac{\Delta Z - I^U S^2 - \frac{1}{2}\theta S}{SZ - I^U S^2 - \frac{1}{2}\theta S}$

- The unit mixes with (α, 1- α) where α indicates ϕ = 1 and $\alpha = \frac{c_u S\left(Z - I^U S - \frac{1}{2}\theta\right)}{2I^{ex} Z(S-\Delta)}$.
- The resulting payoff to the principal is as follows: $W = -\frac{\theta \Lambda (S-\Delta)}{2I^o S}$

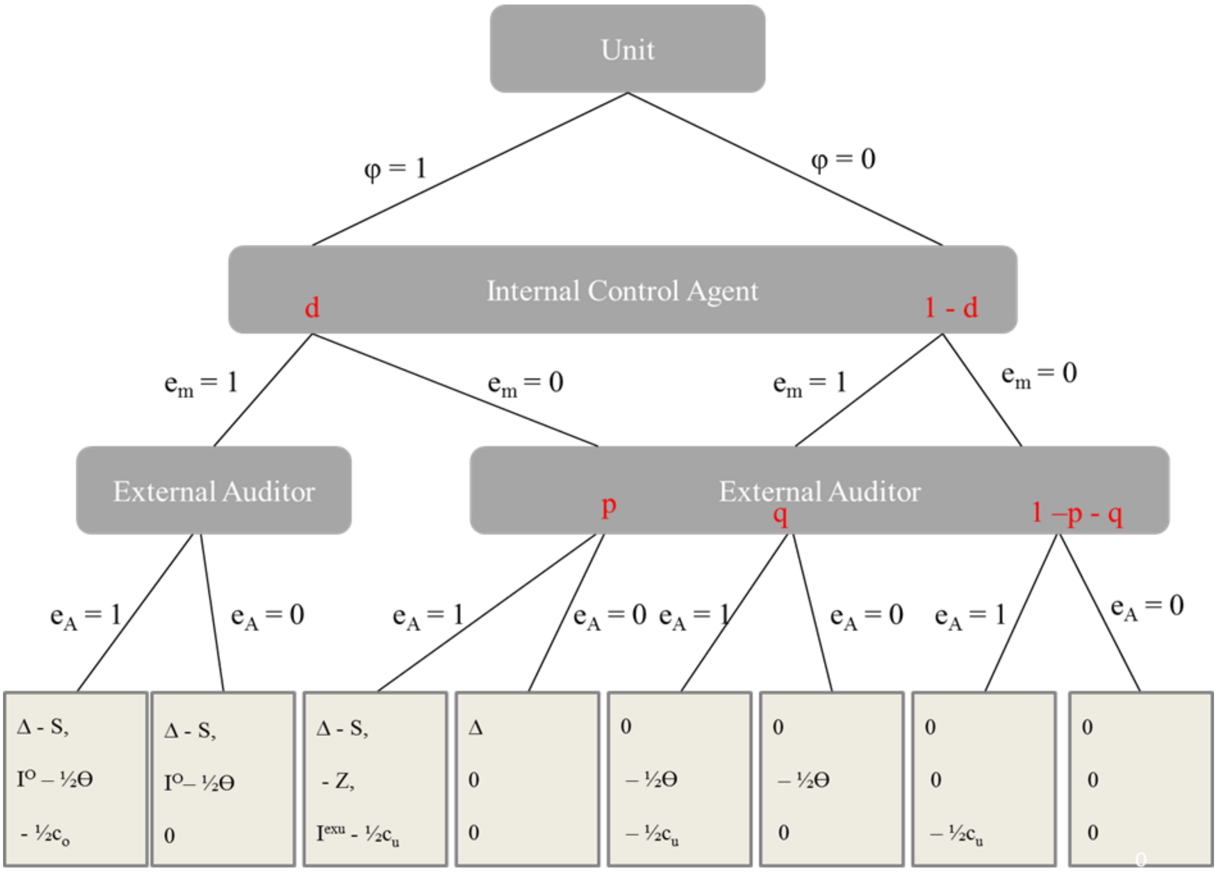
<u>If the internal control agent does not observe fraud:</u>

- $U^u(e_m = 1) = -\frac{1}{2}\theta$
- $U^u(e_m = 0) = 0$

  → The internal control agent does not exert effort, $e_m = 0$..

➔ This would lead to p = 0, which contradicts $p = \frac{c_u}{2I^{ex}}$. Therefore, there exists no equilibrium where $p = \frac{c_u}{2I^{ex}}$ and the unit commits fraud.

B.2



Perfect Bayesian Equilibriums

Assumption: participation constraint for both the external auditor and the internal control agent holds i.e. $I^{ex} > \frac{1}{2}c_u$ and $I^O > \frac{1}{2}\theta$

- If the external auditor observes a fraud report, he will not exert effort, leading to the SPNE where $e_A = 0$ and the following payoffs for the unit, the internal control agent and the external auditor, respectively: $(\Delta - S, I^o - \frac{1}{2}\theta, 0)$

- If the external auditor observes a good report, his effort exertion depends on his beliefs p, q and 1-p-q.
  - $U^{exu}(e_A = 1) = p\left(I^{ex} - \frac{1}{2}c_u\right) + q\left(-\frac{1}{2}c_u\right) + (1 - p - q)\left(-\frac{1}{2}c_u\right) = pI^{ex} - \frac{1}{2}c_u$
  - $U^{exu}(e_A = 0) = 0$

1. If $p > \frac{c_u}{2I^{ex}}$, the external auditor exerts effort, i.e. $e_A = 1$
2. If $p < \frac{c_u}{2I^{ex}}$, the external auditor does not exert effort, i.e. $e_A = 0$

3. If $p = \frac{c_u}{2I^{ex}}$, the external auditor mixes in exerting effort with x.

1. If $p > \frac{c_u}{2I^{ex}}$, the external auditor exerts effort, i.e. $e_A = 1$

The internal control agent decides upon effort based on his beliefs (d):

- $U^O(e_m = 1) = d\left(I^o - \frac{1}{2}\theta\right) + (1-d)(-\frac{1}{2}\theta)$
- $U^O(e_m = 0) = d(-Z) + (1-d)0 = -Zd$

a. If $d > \frac{\theta}{2(I^O+Z)}$, the internal control agent exerts effort, i.e. $e_m = 1$. In this situation where both e_m and e_A are equal to 1, the unit would not commit fraud, as $\Delta - S < 0$. Then, $d = 0$, contradicting $d > \frac{\theta}{2(I^O+Z)}$ and p = 0, contradicting $p > \frac{c_u}{2I^{ex}}$. Therefore, no equilibrium.

b. If $d < \frac{\theta}{2(I^O+Z)}$, the internal control agent does not exert effort, i.e. $e_m = 0$. In this situation where e_A is equal to 1, the unit would not commit fraud, as $\Delta - S < 0$ Then, p = 0, contradicting $p > \frac{c_u}{2I^{ex}}$. Therefore, no equilibrium.

c. If $d = \frac{\theta}{2(I^O+Z)}$, the internal control agent mixes in exerting effort with (γ, 1- γ), where γ indicate $e_m = 1$. Since $e_A = 0$, the payoff for the unit when committing fraud will always be $\Delta - S < 0$, since fraud will always be detected. Thus, the unit will never commit fraud. Then, $d = 0$, contradicting $d = \frac{\theta}{2(I^O+Z)}$ and p = 0, contradicting $p > \frac{c_u}{2I^{ex}}$. Therefore, no equilibrium.

2. If $p < \frac{c_u}{2I^{ex}}$ the external auditor does not exert effort, i.e. $e_A = 0$

The internal control agent decides upon effort based on his beliefs:

- $U^O(e_m = 1) = d\left(I^o - \frac{1}{2}\theta\right) + (1-d)(-\frac{1}{2}\theta)$
- $U^O(e_m = 0) = d(0) + (1-d)0 = 0$

a. If $d > \frac{\theta}{2I^O}$, the internal control agent exerts effort, i.e. $e_m = 1$. In this situation where e_m is equal to 1, the unit would not commit fraud, as $\Delta - S < 0$.. Then, $d = 0$, contradicting $d > \frac{\theta}{2I^O}$. Therefore, no equilibrium.

b. If $d < \frac{\theta}{2I^{O}}$, the internal control agent does not exert effort, i.e. $e_m = 0$. In this situation where both e_m and e_A are equal to 0, the unit would commit fraud, as $\Delta > 0$. Then, $d = 1$, contradicting $d > \frac{\theta}{2I^{O}}$, since the participation constraint of the internal control agent requires $I^{O} > \frac{1}{2}\theta$.

c. If $d = \frac{\theta}{2I^{O}}$, the internal control agent mixes in exerting effort with (γ, 1- γ), where γ indicates $e_m = 1$.

The unit then decides whether to commit fraud or not.

- $V(\phi = 1) = \gamma(\Delta - S) + (1-\gamma)\Delta$
- $V(\phi = 0) = 0$

i. If $> \frac{\Delta}{S}$, the unit does not commit fraud. This would lead to $d = 0$, contradicting $d = \frac{\theta}{2I^{O}}$. Therefore, no equilibrium.

ii. If $\gamma < \frac{\Delta}{S}$, the unit commits fraud. This would lead to d = 1, contradicting $d = \frac{\theta}{2I^{O}}$, since the participation constraint of the internal control agent requires $I^{O} > \frac{1}{2}\theta$. Therefore, no equilibrium.

iii. If $\gamma = \frac{\Delta}{S}$, the unit mixes in committing fraud with (α, 1- α), where α indicates ϕ = 1. Since the beliefs $d = \frac{\theta}{2I^{O}}$, needs to hold here, $\alpha = \frac{\theta}{2I^{O}}$.

➔ **Equilibrium 2ciii.**

- The external auditor does not exert effort, i.e. $e_A = 0$ with his beliefs $p < \frac{c_u}{2I^{ex}}$.
- The internal control agent mixes in exerting effort with with (γ, 1- γ), where γ indicates $e_m = 1$ and $\gamma = \frac{\Delta}{S}$, his consistent beliefs is $d = \frac{\theta}{2I^{O}}$.
- The unit mixes with (α, 1- α) where α indicates ϕ = 1 and $\alpha = \frac{\theta}{2I^{\square}}$.

  Since $p = \alpha(1-\gamma)$ needs to hold, $p = \frac{\theta(S-\Delta)}{2I^{O}}$. Due to the consistent beliefs that $p < \frac{c_u}{2I^{ex}}$, $\frac{\theta(S-\Delta)}{2I^{O}} < \frac{c_u}{2I^{ex}}$ needs to hold.
- The resulting payoff to the principal is as follows: $W = -\frac{\lambda\theta(S-\Delta)}{2I^{O}S}$

3. ***If*** $\boldsymbol{p = \frac{c_u}{2I^{ex}}}$***, the external auditor mixes in exerting effort with x, where x indicates*** $\boldsymbol{e_A = 1}$**.**

The internal control agent decides upon effort based on his beliefs:

- $U^O(e_m = 1) = d\left(I^o - \frac{1}{2}\theta\right) + (1-d)(-\frac{1}{2}\theta)$
- $U^O(e_m = 0) = d(x(-Z) + (1-x)0) + (1-d)0$

a. If $d > \frac{\theta}{2(I^O+Zx)}$, the internal control agent exerts effort. Then, p = 0, contradicting $p = \frac{c_u}{2I^{ex}}$, therefore no equilibrium exists.

b. If $d < \frac{\theta}{2(I^O+Zx)}$, the internal control agent does not exert effort. The unit then decides whether to commit fraud or not.

- $V(\phi = 1) = x(\Delta - S) + (1-x)\Delta$
- $V(\phi = 0) = 0$

i. If $x > \frac{\Delta}{S}$, the unit does not commit fraud. This gives p = 0, contradicting $p = \frac{c_o}{2I^{ex}}$. Therefore, no equilibrium.

ii. If $x < \frac{\Delta}{S}$, the unit commits fraud. Then, this would give p = 1. However, the participation constraint of the external auditor requires $I^{ex} > \frac{1}{2}c_u$, and thus p can never be equal to 1 when $p = \frac{c_o}{2I^{ex}}$. Therefore, no equilibrium.

iii. If $x = \frac{\Delta}{S}$, the unit mixes in committing fraud with (α, 1- α), where α indicates ϕ = 1. Since $p = \frac{c_o}{2I^{ex}}$ and $e_m = 0$, $\alpha = \frac{c_o}{2I^{ex}}$ must hold. This gives $d = \frac{c_o}{2I^{ex}}$ as well.

➔ **Equilibrium 3biii**

- The external auditor mixes in exerting effort with x, where x indicates $e_A = 1$ with $x = \frac{\Delta}{S}$, for beliefs $p = \frac{c_o}{2I^{ex}}$.
- The internal control agent does not exert effort, i.e. $e_m = 0$,. His consistent beliefs is $d = \frac{c_o}{2I^{ex}}$ and since $d < \frac{\theta}{2(I^O+Zx)}$ must hold, $\frac{c_o}{2I^{ex}} < \frac{\theta}{2(I^O+Z(\frac{\Delta}{S}))}$ in equilibrium.
- The unit mixes with (α, 1- α) where α indicates ϕ = 1 and $\alpha = \frac{c_o}{2I^{ex}}$.
- The resulting payoff to the principal is as follows: $W = -\frac{\Lambda c_O(S-\Delta)}{2I^{ex}S}$

c. If $d = \frac{\theta}{2(I^O+Zx)}$, the internal control agent mixes in exerting effort with (γ, 1- γ), where γ indicates $e_m = 1$. The unit then decides whether to commit fraud or not.

- $V(\phi = 1) = \gamma(\Delta - S) + (1-\gamma)(x(\Delta - S) + (1-x)\Delta)$
- $V(\phi = 0) = 0$

i. If $\gamma < \frac{xS-\Delta}{xS-S}$, the unit commits fraud. Then, $d = 1$, contradicting $d = \frac{\theta}{2(I^O+Zx)}$, since the participation constraint of the internal control agent requires $I^O > \frac{1}{2}\theta$. Therefore, no equilibrium.

ii. If $\gamma > \frac{xS-\Delta}{xS-S}$, the unit does not commit fraud. Then, this would give $d = 1$, contradicting $d = \frac{\theta}{2(I^O+Zx)}$, since the participation constraint of the internal control agent requires $I^O > \frac{1}{2}\theta$. Therefore, no equilibrium.

iii. If $\gamma = \frac{xS-\Delta}{xS-S}$, the unit mixes in committing fraud with (α, 1- α), where α indicates ϕ = 1. Since $d = \frac{\theta}{2(I^O+Zx)}$, $\alpha = \frac{\theta}{2(I^O+Zx)}$.

➔ **Equilibrium 3ciii**

- The external auditor mixes in exerting effort with x, where x indicates $e_A = 1$ for beliefs $p = \frac{c_o}{2I^{ex}}$ and with $x = \frac{I^{ex}\theta(1-\gamma)-c_o I^o}{Zc_o}$.
- The internal control agent mixes in exerting effort with (γ, 1- γ), where γ indicates $e_m = 1$ and $\gamma = \frac{xS-\Delta}{xS-S}$. As $p = \alpha(1-\gamma)$, using the specified values for α and p, this gives another expression for γ: $\gamma = 1 - \frac{c_o(I^o+Zx)}{\Theta I^{ex}}$. His consistent beliefs is $d = \frac{\theta}{2(I^O+Zx)}$.
- The unit mixes with (α, 1- α) where α indicates ϕ = 1 and $\alpha = d = \frac{\theta}{2(I^O+Zx)}$.
- The resulting payoff to the principal is as follows: $W = -\frac{\Lambda\theta(S-\Delta)(1-x)}{2(I^o+Zx)(S-xS)}$

- Note that since both $\gamma = 1 - \frac{c_o(I^o + Zx)}{\Theta I^{ex}}$ and $\gamma = \frac{xS - \Delta}{xS - S}$ need to hold in this equilibrium, x needs to be the solution of one of the following expressions:

$$x = \frac{c_o S(Z - I^O) + \sqrt{(c_o S(Z - I^O))^2 - 4SZc_o(\theta I^O S - I^O c_o S - \theta I^{ex}\Delta)}}{2SZc_o}$$

$$x = \frac{c_o S(Z - I^O) - \sqrt{(c_o S(Z - I^O))^2 - 4SZc_o(\theta I^O S - I^O c_o S - \theta I^{ex}\Delta)}}{2SZc_o}$$

In order for a solution to exist, the term under square roots needs to be positive, $(c_o S(Z - I^O))^2 - 4SZc_o(\theta I^O S - I^O c_o S - \theta I^{ex}\Delta) > 0$.This is certainly the case when: $\theta I^O S < I^O c_o S + \theta I^{ex}\Delta$

Expressed in only exogenous parameters, the resulting payoff to the principal for this equilibrium is one of the following:

$$-\frac{\beta\theta(S - \Delta)\left(1 - \frac{c_o S(Z - I^O) + \sqrt{(c_o S(Z - I^O))^2 - 4SZc_o(\theta I^O S - I^O c_o S - \theta I^{ex}\Delta)}}{2SZc_o}\right)}{2\left(I^o + Z\frac{c_o S(Z - I^O) + \sqrt{(c_o S(Z - I^O))^2 - 4SZc_o(\theta I^O S - I^O c_o S - \theta I^{ex}\Delta)}}{2SZc_o}\right)\left(S - \frac{c_o S(Z - I^O) + \sqrt{(c_o S(Z - I^O))^2 - 4SZc_o(\theta I^O S - I^O c_o S - \theta I^{ex}\Delta)}}{2SZc_o}S\right)}$$

$$-\frac{\beta\theta(S - \Delta)\left(1 - \frac{c_o S(Z - I^O) - \sqrt{(c_o S(Z - I^O))^2 - 4SZc_o(\theta I^O S - I^O c_o S - \theta I^{ex}\Delta)}}{2SZc_o}\right)}{2\left(I^o + Z\frac{c_o S(Z - I^O) - \sqrt{(c_o S(Z - I^O))^2 - 4SZc_o(\theta I^O S - I^O c_o S - \theta I^{ex}\Delta)}}{2SZc_o}\right)\left(S - \frac{c_o S(Z - I^O) - \sqrt{(c_o S(Z - I^O))^2 - 4SZc_o(\theta I^O S - I^O c_o S - \theta I^{ex}\Delta)}}{2SZc_o}S\right)}$$

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