Risk Sharing Benefits of Mandatory Auditor Rotation

Dae-Hee Yoon
Yonsei University

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Abstract

The old debate about whether mandatory rotation can remedy shortcomings of the audit market has resurfaced after a series of corporate scandals. The main impetus for mandatory rotation is the prospect of greater auditor independence. In this paper, I suggest that mandatory rotation have an additional benefit stemming from risk sharing among auditors. As audit risk is influenced by both detection and client risk, regular rotation of clients enables auditors to intertemporally diversify the risks they face. As client retention offers natural learning benefits, however, there is also a downside to rotation. This downside can be mitigated by information sharing between predecessor and incoming auditors. Information sharing improves the incoming auditor’s information set, and the risk sharing benefit of mandatory rotation is amplified even further.
1 Introduction

The old debate about whether mandatory rotation can remedy shortcomings of the audit market has resurfaced after a series of accounting scandals. Recently, the Public Company Accounting Oversight Board (PCAOB) issued a concept release on auditor independence and audit firm rotation. James Doty, Chairman of PCAOB emphasized the potential of audit firm rotation in addressing the current conflict: "Any serious discussion of these qualities must take into account the fundamental conflict of the audit client paying the auditor. That leads to consideration of firm rotation as a counterweight to that conflict" (Doty 2011). He also has stated that the considerable implementation challenges related to mandatory rotation invite study and consideration regarding potential ways to mitigate those challenges.

This well-known argument in favor of mandatory rotation is rooted in the idea that it can decrease incentives for tacit collusion between an auditor and a manager. That is, with rotation, auditor independence is enhanced because of the decreased economic incentive for collusion between an auditor and a manager. With mandatory rotation, a manager cannot use future engagements as an implicit threat to influence the audit opinion. On the other hand, the main disadvantage is that rotation imposes a higher audit cost because the auditor cannot take advantage of accumulated client-specific knowledge. If an auditor has a client for a long time, the auditor becomes familiar with the client’s business and control system, thereby reducing the audit cost. However, with rotation, the auditor loses this benefit and those who oppose mandatory rotation often argue that this cost would outweigh any benefits of enhanced auditor independence.

Interestingly, existing theory and analysis have shown a focus limited to the effect of mandatory rotation on shareholders and investors. In the analysis, the auditor’s perspective has received little attention; most analyses are quick to point out that auditors would be worse off with rotation because of the higher audit cost. In contrast, this paper focuses on the effect of mandatory rotation on auditors’ welfare and provides new insight regarding the benefit for auditors from mandatory rotation: risk sharing among auditors. That is, rotation enables an auditor to reshuffle the client portfolio regularly, and therefore, the client risk of the portfolio is diversified over time via rotation.

Broadly speaking, audit risk consists of client risk and detection risk; client risk is the likelihood that a firm’s unaudited financial statements have a misstatement, while detection risk is the likelihood that an auditor will not detect such misstatements. An auditor has a portfolio of clients every period, and each client becomes one component of audit risk in the portfolio. An auditor
seeks to reduce his audit risk but can directly control only detection risk, not client risk. This is because client risk is determined by a firm’s nature and business environment, while detection risk is a function of an auditor’s effort. Therefore, diversifying client risk is important for a risk-averse auditor. Mandatory rotation can help ameliorate this dilemma by giving an auditor the opportunity to reshuffle his portfolio every period. Thus, rotation enables the auditor to smooth client risk intertemporally. Such intertemporally smoothed audit risk stands to increase a risk-averse auditor’s welfare without imposing added risk on other parties (i.e., managers and shareholders).

One problem with mandatory rotation is that the effort required for the auditor to maintain the same level of detection risk is presumably higher due to inexperience. Without rotation, the effort required to maintain detection risk will decrease over time as the auditor accumulates client-specific knowledge over time (Beck and Wu 2006). With rotation, in contrast, an auditor is periodically faced with new and unknown clients. Therefore, if the additional audit effort needed with mandatory rotation is too large, an auditor’s welfare will decrease, even if the client risk is diversified under rotation. This paper examines this trade-off and identifies conditions under which mandatory rotation increases the auditor’s welfare even when considering the higher audit cost.

Without rotation, another way of reducing audit costs is to use client-specific knowledge to condition the level of effort on the assessed risk of a client. An auditor can learn about a client’s inherent risk in early audit years and respond to the risk by adjusting his effort level over time, naturally exerting high effort for high-risk companies and low effort for low-risk companies. Such flexibility in choosing the level of effort gives an auditor the opportunity to maintain consistent levels of detection risk with less audit cost. But with rotation, the auditor is unable to respond flexibly to the client risk given the lack of prior knowledge. Instead, the auditor is forced to exert a high level of effort every period to respond to the potential high audit risk. In this case, the benefit of rotation based on risk sharing could be outweighed by either (i) higher audit cost or (ii) the inflexible choice of audit effort.

Next, this paper demonstrates how information sharing affects the auditor’s decision making and his welfare. The results show that the benefit of risk sharing is amplified even further in the presence of information sharing. Interestingly, information sharing increases the attractiveness of mandatory rotation as audit cost increases, while offsetting the disadvantage of lack of prior knowledge. This result may suggest that communication between auditors should be required, not just encouraged, even after the audit contracting process.

The risk sharing benefits of rotation may also accrue in a broader range of settings. Most
notably, one key role of partnerships lies in sharing risks among partners (e.g., Huddart and Liang 2005). The results in this paper focus on the rotation of audit firms rather than partners but they still suggest that the prevalence of partner rotations in the auditing, consulting, and legal professions is no mere coincidence. When risks must be shared among a finite number of audit firms (whose wealth is tied to success with their own clients), rotation can be an effective means of diversifying such risks intertemporally.

There is no literature which directly examines risk sharing among auditors. The auditor’s economic behavior and incentives have become a primary issue after Antle (1982) considered the auditor as an economic agent. After Antle’s work, several studies (e.g., Antle 1984, Fellingham and Newman 1985, and Baiman et al. 1987) followed the framework, considering the auditor as an economic agent. Recently, various attempts have been made to remedy the problem of auditor independence. Among the various alternatives, Dontoh et al. (2004) suggest a financial statement insurance mechanism to improve the alignment of an auditor’s incentives and to achieve better-quality audits. In this mechanism, firms purchase the financial statement insurance to provide insurance coverage to investors against losses due to the misstatement in the financial statements.

Laux and Newman (2010) examine another way to manage audit risk via the client acceptance decision: an auditor evaluates a client’s risk before accepting the audit engagement. Their result shows that the relationship between the strictness of a legal regime and client rejection rate has a U-shape, signifying that the client rejection rate is lower when legal liability is moderate. While client acceptance decisions represent an individual auditor’s audit risk management, the mandatory rotation analyzed in the current paper is a device to manage audit risks as a group by enabling auditors to share client risk over time.

Regarding the effect of mandatory rotation in empirical research, several papers have investigated the association between auditor tenure and quality of financial reporting. Overall, the evidence is mixed. Myers et al. (2005) examine the relationship between the length of auditor-client relationships and misstatements of financial statements. They show that firms tend to make income-increasing misstatements as the audit tenure becomes longer and the audit tenure affects restatement disclosures.

In theoretical research, Lu and Sivaramakrishnan (2009, 2010) examine the real effects of mandatory rotation on firms’ investment decisions. Lu and Sivaramakrishnan (2009) examine how mandatory audit firm rotation affects firms’ investment decisions and auditor choice in a financial market setting. Lu and Sivaramakrishnan (2010) model the dual roles (an information role and an insur-
ance role) of an auditor’s attestation and analyze the impact of various attestation strategies on firms’ investment decisions. The current paper fills an important lacuna in the existing literature: the risk sharing benefit of mandatory rotation from auditors’ perspective.

In sum, this paper investigates the benefit of the audit firm rotation in the audit market outside organizations and discusses risk sharing based on the rotation, which has not been examined in previous studies. This paper consists of six sections. In Section 2, I present the basic model used in the paper, while Section 3 demonstrates how auditors’ risk sharing is achieved over time with mandatory rotation. Section 4 examines extensions: an auditor’s endogenous audit effort, information sharing, voluntary rotation, and generalized audit risk. Section 5 concludes the paper.

2 Model

I consider a two-period model consisting of two audit firms and two client firms: the two audit firms and the two client firms are always matched. The auditor (audit firm)’s preference is captured by a constant absolute risk aversion (CARA) utility function. In particular, the following utility measure is assumed:

\[
U(F, L, a^1, a^2) = \exp(-r(2F - f(L) - a^1 - a^2)),
\]

where \(F\) is an audit fee, \(L\) is the auditor’s liability, and \(f(L) = 2L, L, 0\). \(a^1\) and \(a^2\) are an auditor’s cost of effort in period 1 and in period 2, respectively. There are two effort levels such that \(a^t \in \{a_H, a_L\}\), where \(t = 1, 2\) and an auditor chooses effort level every period. The liability cost \((L)\) is incurred by the auditor only in case of audit failure.\(^1\) In this paper, the liability is separable by year and therefore we can separate the annual expected liability in period 2 from that in period 1. For convenience, I assume that all payments are made at the end of period 2.

The audit risk is the probability of audit failure in each of the two periods and it is defined as follows:

\[
\text{Audit Risk} = \text{Client Risk} \cdot \text{Detection Risk},
\]

where client risk is the likelihood that a firm’s unaudited financial statement has a misstatement; detection risk is the likelihood that the auditor will not detect such misstatements. In the audit risk, client risk is determined by a firm’s nature and business environment.\(^2\)

\(^1\) \(L\) is a pecuniary liability from audit failure and it does not represent any client firm’s type.

\(^2\) According to the audit risk model, \(\text{Audit Risk} = \text{Inherent Risk} \cdot \text{Control Risk} \cdot \text{Detection Risk}\). In this paper, \(\text{Client Risk}\) represents \(\text{Inherent Risk} \cdot \text{Control Risk}\) because both inherent risk and control risk are determined by a client firm.
There exist two types of firms. One is a firm with high client risk \((q_H)\), and the other is a firm with low client risk \((q_L)\). I normalize \(q_L\) to 0 to simplify the model. Formally,

\[
q_j : \text{client risk}, \quad q_j \in \{q_H, q_L\}; \\
0 < q_H < 1, \quad q_L = 0.
\]

On the other hand, the detection risk is affected by the auditor’s effort level: under \(a_L\), the audit risk is the same as the client risk, \(q_j\) but under \(a_H\) the audit risk is \(q_j/p\). That is, \(p\) is a scaling choice of parameters and, without loss of generality, the audit risk decreases by a factor of \(1/p\) if high effort is exerted under the same client risk. Therefore, depending on the effort level, the audit risk is as follows:

\[
\text{Audit Risk} (q_j, a_H) = \frac{q_j}{p}; \\
\text{Audit Risk} (q_j, a_L) = q_j,
\]

where \(p > q_H\). Then, when an auditor is unsure of a client risk, an auditor optimally chooses high effort when the following condition is satisfied:

\[
EU(a_H|H) - EU(a_L|H) \geq EU(a_L|L) - EU(a_H|L),
\]

where

\[
EU(a_H|H) = \frac{q_H}{p}U(F - L - a_H) + (1 - \frac{q_H}{p})U(F - a_H),
\]

\[
EU(a_H|L) = U(F - a_H),
\]

\[
EU(a_L|H) = q_HU(F - L - a_L) + (1 - q_H)U(F - a_L),
\]

\[
EU(a_L|L) = U(F - a_L).
\]

The condition implies that the effect of a high effort \((p)\) is large enough to mitigate the adverse effect of audit liability due to a high client risk. For convenience, \(\frac{q_H}{p}\) is denoted by \(q_h\).

It is assumed that a firm’s client risk is unknown to all parties before auditing and that the probability of audit failure over time is independent as follows:

\[
Pr(\lambda_1, \lambda_2) = Pr(\lambda_1) Pr(\lambda_2),
\]

where \(\lambda_t\) is the audit failure in period \(t\) and \(Pr(\lambda_1)\) is the same as audit risk in period 1. This assumption implies that an audit failure in period 1 does not necessarily mean another audit failure in period 2. Also, for simplicity, the correlation of audit failure across firms in one period is 0 in the sense that the audit failure of one company is not correlated with the failure of another company.
In this setup, the likelihood of audit failure in any period for any firm is independent of the audit regime.

I compare the auditor’s utility level in two regimes: no rotation and mandatory rotation. Without rotation, an auditor audits the same firm for two periods so that he learns a client’s risk type in period 1.\(^3\) On the other hand, with rotation, an auditor is assigned to one of two firms with a probability of 1/2 every period so that the auditor does not have a chance to learn a client’s risk type in the previous period.

### 3 Risk Sharing

In this section, to focus on the risk sharing effect of rotation, the audit effort is exogenously fixed at \(a = a_H\), which is independent of client risk. Because an auditor always exerts high effort, the audit risk is \(q_H = q_h\) when a client firm has a high risk. Then, with rotation, considering the exogenous effort choice \((a = a_H)\), an auditor’s utility is as follows:

\[
U(F, L, a_1^1, a_2^2) = \exp(-r(2F - f(L) - a_H^1 - a_H^2)).
\]  

With rotation, for two periods an auditor faces four cases of client combination as follows: (Low Risk, Low Risk), (Low Risk, High Risk), (High Risk, Low Risk), and (High Risk, High Risk). Table 1 describes the probability structure of audit failures and success.

<table>
<thead>
<tr>
<th></th>
<th>FF</th>
<th>FS</th>
<th>SF</th>
<th>SS</th>
<th>Sub Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>LL</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(\frac{1}{4})</td>
<td>(\frac{1}{4})</td>
</tr>
<tr>
<td>LH</td>
<td>0</td>
<td>0</td>
<td>(\frac{1}{2}q_h)</td>
<td>(\frac{1}{2}(1 - q_h))</td>
<td>(\frac{1}{4})</td>
</tr>
<tr>
<td>HL</td>
<td>0</td>
<td>(\frac{1}{2}q_h)</td>
<td>(\frac{1}{2})</td>
<td>(\frac{1}{2}(1 - q_h))</td>
<td>(\frac{1}{4})</td>
</tr>
<tr>
<td>HH</td>
<td>(\frac{1}{2}q_h)</td>
<td>(\frac{1}{2}q_h)</td>
<td>(\frac{1}{2}(1 - q_h))</td>
<td>(\frac{1}{2}(1 - q_h))</td>
<td>(\frac{1}{4})</td>
</tr>
<tr>
<td>Total</td>
<td>(\frac{1}{4}q_h^2)</td>
<td>(\frac{1}{4}q_h(2 - q_h))</td>
<td>(\frac{1}{4}q_h(2 - q_h))</td>
<td>(\frac{1}{4}(2 - q_h)^2)</td>
<td>1</td>
</tr>
</tbody>
</table>

[Table 1: Probability structure with mandatory rotation]

In the table, \(H\) denotes high-client risk and \(L\) denotes low-client risk. \(F\) denotes audit failure and \(S\) denotes success. For instance, \(HH\) means that the auditor audits a client firm with high risk two

\(^3\)In the main setup, without rotation, an auditor sticks to the same client firm for two periods. Another possibility is that after period 1, an auditor may want to voluntarily resign if he learns of a high client risk. The case that an auditor voluntarily resigns after period 1 will be considered in Section 4.3.
times. In this case, the probability of audit failure for both periods \((FF)\) is \(\frac{1}{2}q_h \cdot \frac{1}{2}q_h = \frac{1}{4}q_h^2\) and the liability is \(2L\). Based on the probability distribution, the expected utility with rotation is:

\[
EU^M = \frac{1}{4} \left[ EU(a^1_H, a^2_H | H, H) + EU(a^1_H, a^2_H | H, L) + EU(a^1_H, a^2_H | L, H) + EU(a^1_H, a^2_H | L, L) \right].
\] (8)

The superscript "\(^M\)" denotes the mandatory rotation regime and

\[
EU(a^1_H, a^2_H | H, H) = q^2_h U_2 + 2q_h (1 - q_h) U_1 + (1 - q_h)^2 U_0;
\] (9)

\[
EU(a^1_H, a^2_H | H, L) = q_h U_1 + (1 - q_h) U_0;
\]

\[
EU(a^1_H, a^2_H | L, H) = q_h U_1 + (1 - q_h) U_0;
\]

\[
EU(a^1_H, a^2_H | L, L) = U_0,
\]

where \(U_2 = U(2F - 2L - 2a_H)\), \(U_1 = U(2F - L - 2a_H)\), and \(U_0 = U(2F - 2a_H)\).

Next, without rotation, to capture the decreasing audit cost over time, I use a parameter \(k\). In period 2, the cost saving can be obtained because the auditor becomes familiar with a client’s control system and business in period 1. However, with rotation, \(k\) is equal to 0 because the auditor faces a new firm every year. Therefore, with rotation, the auditor should spend the same level of effort to reach the same level of detection risk every period. Thus, by the parameter \(k\), I reflect the fact that mandatory rotation causes a higher audit cost to maintain the same level of detection risk than no rotation. Without rotation, an auditor’s utility is as follows:

\[
U(F, L, a^1, a^2) = -\exp(-r(2F - f(L) - a^1_H - a^2_H + k)).
\] (10)

Without mandatory rotation, an auditor faces two cases over two periods, \((\text{Low Risk, Low Risk})\), \((\text{High Risk, High Risk})\) because he has to stick to one client firm over time. Without rotation, the probability of audit failure is as follows:

<table>
<thead>
<tr>
<th></th>
<th>(FF)</th>
<th>(FS)</th>
<th>(SF)</th>
<th>(SS)</th>
<th>Sub Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(LL)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>(\frac{1}{2})</td>
<td>(\frac{1}{2})</td>
</tr>
<tr>
<td>(HH)</td>
<td>(\frac{1}{2}q_h \cdot q_h)</td>
<td>(\frac{1}{2}q_h \cdot (1 - q_h))</td>
<td>(\frac{1}{2}(1 - q_h) \cdot q_h)</td>
<td>(\frac{1}{2}(1 - q_h) \cdot (1 - q_h))</td>
<td>(\frac{1}{2})</td>
</tr>
<tr>
<td>(Total)</td>
<td>(\frac{1}{2}q_h^2)</td>
<td>(\frac{1}{2}q_h (1 - q_h))</td>
<td>(\frac{1}{2}(1 - q_h) q_h)</td>
<td>(\frac{1}{2} [1 + (1 - q_h)^2])</td>
<td>1</td>
</tr>
</tbody>
</table>

[Table 2: Probability structure without rotation]
Based on the probability, the auditor’s expected utility is:

\[
EU^{N(k)} = \frac{1}{2} EU(a_H^1, a_H^2 | H, H, k) + \frac{1}{2} EU(a_H^1, a_H^2 | L, L, k)
\]

\[
= e^{-rk} \left[ \frac{1}{2} EU(a_H^1, a_H^2 | H, H) + \frac{1}{2} EU(a_H^1, a_H^2 | L, L) \right]
\]

\[
= e^{-rk} EU^N.
\]

The superscript "\(N\)" denotes the no rotation regime. To provide the intuition of risk sharing benefit, start with setting \(k = 0\) and compare the expected utilities under both regimes as follows:

\[
EU^M - EU^{N(k=0)}
\]

\[
= EU^M - EU^N
\]

\[
= \frac{1}{4} \left[ (EU(a_H^1, a_H^2 | H, L) - EU(a_H^1, a_H^2 | H, H) - (EU(a_H^1, a_H^2 | L, L) - EU(a_H^1, a_H^2 | L, H)) \right]
\]

\[
\frac{1}{4} q_h^2 \left[ U_1 - U_2 - (U_0 - U_1) \right]
\]

\[
\frac{1}{4} q_h^2 U(2F - 2a_H)[(\exp(rL) - \exp(2rL)) - (1 - \exp(rL))] > 0.
\]

In (12), "risk sharing gain" reflects the auditor’s utility gain by shifting a high-risk client firm to the other auditor in the second period. That is, even if an auditor has a high-risk client firm in the first period, the rotation allows an auditor to avoid the high-risk client in the second period by \(\frac{1}{4} q_h^2\); the risk sharing with the other auditor is achieved. On the other hand, "risk sharing loss" reflects the auditor’s utility loss from sharing a low-risk firm with the other auditor. That is, even if an auditor has a low-risk client in the first period, the rotation makes an auditor give up the low-risk client in the second period with probability \(\frac{1}{4} q_h^2\). Therefore, there exists a trade-off between the risk sharing gain and the risk sharing loss from the mandatory rotation. Given that the auditor in the model is risk averse (because \(r > 0\) and \(-e(-r(\cdot))\) is concave), "risk sharing gain" always exceeds "risk sharing loss". Therefore, when there is no learning effect \((k = 0)\), \(EU^M\) is always greater than \(EU^N\) and an auditor is always better off with mandatory rotation. Thus, due to risk sharing based on the rotation, the auditor’s utility increases even without a change of expected liability.

In this situation, the learning effect, \(k > 0\), provides a competing force and one cannot posit which regime is better \(a\ priori\) without specifying the value of \(k\): the relative size of risk sharing benefit and the learning effect determine the preference. Hence, considering the two forces,
Proposition 1 follows.

**Proposition 1** Mandatory rotation is preferred if and only if the learning effect on audit costs is small enough (i.e., \( k \leq k^* \)), otherwise no rotation is preferred, where, \( k^* = \frac{1}{r} \ln \left( \frac{EU^N}{EU^M} \right) \).

As shown in Proposition 1, there exists a cutoff, \( k^* \) which equates an auditor’s expected utility with rotation with that without rotation. That is, if the learning effect is larger than \( k^* \), the benefit from the learning effect dominates the effect of risk sharing with rotation. In addition, \( k^* \) is affected by the level of client risk and the amount of liability. An increase in client risk or liability will lead to greater expected liability, and it will make risk sharing more attractive. In addition, the incremental utility \( (\Delta EU = EU^M - EU^N) \) with rotation increases as the auditor’s risk aversion \( (r) \) increases \( (\frac{d\Delta EU}{dr} > 0) \). These results are presented in Corollary 1.

**Corollary 1** (i) As \( k \) increases (saving of audit cost increases), the attractiveness of mandatory rotation decreases.

(ii) Higher client risk increases the attractiveness of mandatory rotation, i.e., \( k^* \) is increasing in \( \Delta q = q_H - q_L \).

(iii) Higher liability increases the attractiveness of mandatory rotation, i.e., \( k^* \) is increasing in \( L \).

(iv) Higher risk aversion increases the attractiveness of mandatory rotation, i.e., \( k^* \) is increasing in \( r \).

4 Extensions

4.1 Endogenous Audit Effort Choice

This section considers an auditor’s endogenous effort choice and examines whether rotation is still beneficial to the auditor even after the auditor’s optimal effort choice. Unlike the previous section, where high effort is exogenous, now effort is endogenous and depends on the relative costs of high and low effort. If the auditor’s effort choice is endogenous, an auditor compares cost saving with increasing the expected liability when low effort is exerted. Without rotation, the auditor can save his audit costs without increasing the expected liability by using the information obtained in period 1. That is, if the auditor learns that the client has low risk in period 1, he exerts low effort in period 2 because low effort does not increase expected liability for a low-risk client firm.
With rotation, however, the auditor cannot save audit costs in the same way because he does not have prior knowledge about the client firm’s risk profile. In this case, the auditor should exert high effort during both time periods, considering the increased expected liability under low effort. Without rotation, the flexibility of action choice enables the auditor to increase his expected utility through cost savings; with rotation, the inflexibility of action choice causes relatively higher audit costs.

One may wonder how this endogenous action choice is different from the learning effect \((k)\) in the previous section as both reduce an auditor’s cost of effort in the second period. Note that the learning effect can occur regardless of a client’s risk profile: the learning effect is realized from the performed audit experience in the first period. On the other hand, the endogenous action choice is more subtle. After the first period audit, if a client firm turns out to have low risk, the auditor strategically lowers his effort choice in the second period; the endogenous action choice is conditional on the client risk type.

Considering the auditor’s endogenous action choice, the auditor’s endogenous action profile is as follows.

<table>
<thead>
<tr>
<th>a client firm’s risk</th>
<th>(t_1)</th>
<th>(t_2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No rotation</td>
<td>Low, Low (a_H) (a_L)</td>
<td>High, High (a_H) (a_H)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandatory rotation</td>
<td>Low, Low (a_H) (a_H)</td>
<td>Low, High (a_H) (a_H)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High, Low (a_H) (a_H)</td>
<td>High, High (a_H) (a_H)</td>
</tr>
</tbody>
</table>

[Table 3: An auditor’s endogenous action profile]

If the action profile is reflected in the auditor’s utility, without rotation, the expected utility increases as follows:

\[
EU^{N^*} = e^{-rk} \left\{ \frac{q_h^2}{2} U_2 + q_h(1 - q_h) U_1 + \frac{(1 - q_h)^2}{2} U_0 + \frac{1}{2} U_{00} \right\}
\]

\[
= e^{-rk} EU^{N}(\Delta) > e^{-rk} EU^{N},
\]

where \(U_{00} = U(2F - a_H - a_L) = U(2F - 2a_H + \Delta a)\) and \(\Delta a = a_H - a_L\); \(EU^{N^*}\) denotes an auditor’s expected utility in the new action profile. By equating the expected utility with rotation with the new expected utility without rotation, \(k^*\) is obtained. That is, \(k^*\) represents cost saving from the...
learning effect which equates the two regimes under the new action profile. This result is presented in proposition 2.

**Proposition 2** With the endogenous audit effort choice, when $\Delta a \leq \Delta a^*$, mandatory rotation is preferred if and only if the learning effect on audit costs ($k$) is smaller than $k^{**}$, otherwise no rotation is preferred and $k^{**} < k^*$, where $k^{**} = \frac{1}{r} \ln \left( \frac{EU^N(\Delta)}{EU^M} \right)$.

As shown in Proposition 2, when the cost saving based on the learning effect is less than $k^{**}$, the mandatory rotation is still preferred to the no rotation even if the auditor’s action choice is endogenous. However, if the difference between cost of high effort and cost of low effort is very large ($\Delta a > \Delta a^*$), the benefit of the flexible action choice (low effort) without rotation dominates the risk sharing benefit with mandatory rotation and thereby the no rotation is always preferred. Also, note that $k^{**} < k^*$, which means that the relative benefit of mandatory rotation decreases when the endogenous audit effort is considered.

The cutoff, $k^{**}$ is sensitive to $\Delta a$. As $\Delta a$ becomes larger, the advantage of low action choice in period 2 becomes larger without rotation, and $\frac{EU^N(\Delta)}{EU^M}$ becomes smaller: the required learning effect, $k^{**}$ to make the two regimes equal becomes smaller. The lower $k^{**}$ implies that the relative benefit of mandatory rotation becomes smaller. Corollary 2 describes the result.

**Corollary 2** With the endogenous audit effort choice, higher effort cost decreases the attractiveness of mandatory rotation, i.e., $k^{**}$ is decreasing in $\Delta a$.

### 4.2 Information Sharing

This section examines how an auditor’s welfare is affected by information sharing between a previous auditor and an incoming auditor. As a means to overcome the disadvantage incurred with rotation, this section analyzes the dynamics of information sharing between a previous auditor and an incoming auditor. Under information sharing, the previous auditor provides the incoming auditor with information about a client’s risk type which he learned in period 1. Then the incoming auditor’s information structure becomes the same as the previous auditor’s (symmetrical information), and the incoming auditor has flexibility in choosing his effort level depending on the client’s risk profile. Thus, by sharing information, even with rotation, when the client has low risk, the auditor can lower his effort in period 2 without increasing his expected liability.

Under current auditing standards, information sharing is required before audit contracting and
it is encouraged after the audit contract is made. As one may surmise, information sharing can also be made voluntarily between auditors with mandatory rotation because the rotation allows auditors to form a reciprocal relationship which motivates the information sharing. That is, with rotation, an incumbent auditor for a client firm is supposed to be an incoming auditor for a new client firm, which is the other client firm. In this reciprocal relationship, the incumbent auditor cannot ignore a request of information sharing from the incoming auditor because he also would request information for a new client. Thus the voluntary information sharing between auditors is feasible with rotation.

In detail, each auditor has two strategies for information sharing: (Sharing, No Sharing). Without the reciprocal relationship, the auditor is indifferent to Sharing or No Sharing because sharing information with the other auditor does not affect his own payoff and it increases only the other auditor’s payoff by helping him save audit cost. However, the reciprocal relationship created with rotation can motivate an auditor to actively share this information because without receiving the information the other auditor will not share the client information, which the auditor needs. The mutual benefit from the information sharing motivates both auditors’ cooperative action for information sharing, which ultimately leads to the desirable equilibrium, (Sharing, Sharing).

Now a new notation, \( k^{***} \) is used to denote the cost saving from learning effects which equates two regimes under information sharing. Under information sharing, the expected utility with rotation is:

\[
EU^{MI} = \frac{1}{4} \left[ EU(a_H^1, a_H^2 | H, H) + EU(a_H^1, a_L^2 | H, L) + EU(a_H^1, a_H^2 | L, H) + EU(a_H^1, a_L^2 | L, L) \right] \\
= \frac{1}{4} \left[ q_H U_2 + q_h (3 - 2q_h) U_1 + q_h U_{11} + (2 - q_h) (1 - q_h) U_0 + (2 - q_h) U_{00} \right] > EU^M,
\]

where \( U_{11} = U(2F - L - a_H - a_L) = U(2F - L - 2a_H + \Delta a) \) and "MI" denotes information sharing with mandatory rotation. By comparing \( EU^{MI} \) with \( EU^{N*} \), \( k^{***} \) is obtained and this result is presented in Proposition 3.

**Proposition 3** Under information sharing, mandatory rotation is preferred if and only if the learning effect on audit costs \((k)\) is smaller than \( k^{***} \), otherwise no rotation is preferred, and \( k^{**} < k^* < k^{***} \), where \( k^{***} = \frac{1}{7} \ln \left[ \frac{EU^{N*}(\Delta)}{EU^{MI}} \right] \).

\(^4\)Communication between Predecessor and Successor Auditors (AU 315): ...That standard requires a communication with the predecessor prior to acceptance of the engagement....
As shown in Section 4.1, the inflexibility in action choice decreases the desirability of mandatory rotation but, as in Proposition 3, information sharing among auditors increases it again. Due to information sharing, one may expect that the \( k \)-cutoff would be restored to the previous cutoff level, \( k^* \). Interestingly, however, \( k'^* \) is now greater than \( k^* \). That is, under information sharing, the disadvantage of lack of prior knowledge disappears; furthermore, the attractiveness of mandatory rotation exceeds the level of the exogenous audit effort case.

Also, \( k'^* \) becomes greater as cost saving \( (\Delta a = a_H - a_L) \) increases. That is, if we differentiate \( EU^{MI} \) and \( EU^N(\Delta) \) with regard to \( \Delta a \):

\[
\frac{\partial EU^{MI}}{\partial \Delta a} = \frac{q_h U'_{11}}{4} + \frac{(2 - q_h) U'_0}{4}, \quad \frac{\partial EU^N(\Delta)}{\partial \Delta a} = \frac{U'_0}{2}.
\]  

(15)

If we compare the first derivatives:

\[
\frac{\partial EU^{MI}}{\partial \Delta a} - \frac{\partial EU^N(\Delta)}{\partial \Delta a} = \frac{q_h (U'_{11} - U'_0)}{4} > 0
\]

(16)

since \( U'_{11} > U'_0 \) given the auditor’s risk aversion. Equation (16) shows that both \( EU^{MI} \) and \( EU^N(\Delta) \) increase as \( \Delta a \) increases but the increase of \( EU^{MI} \) is greater because, with rotation, cost saving can be obtained in period 2 even when audit liability from a high risk client firm occurs to an auditor in period 1. Then, the same amount of cost saving \( (\Delta a) \) generates a greater incremental utility with rotation than without rotation because of the auditor’s concave utility function. Therefore, \( k'^* = \frac{1}{2} \ln \left[ \frac{EU^N(\Delta)}{EU^{MI}} \right] \) becomes greater as cost saving \( (\Delta a) \) increases as presented in Corollary 3.

Corollary 3 Under information sharing, higher cost saving \( (\Delta a) \) increases the attractiveness of mandatory rotation, i.e., \( k'^* \) is increasing in \( \Delta a \).

4.3 Voluntary Rotation

The previous analysis assumes that an auditor has the same client firm for two periods without rotation. However, in practice, an auditor can resign in a subsequent period if he learns that the client firm has too high risk: an auditor can voluntarily resign and rotate depending on the client risk profile. Based on the practice, this section considers the auditor’s client acceptance decision and analyzes whether the risk sharing benefit with mandatory rotation can be maintained even after considering voluntary rotation.

With voluntary rotation, when an auditor faces a high risk firm, an auditor makes a decision whether to audit the same client in period 2 or reject it by comparing his payoffs under each case.
If the auditor rejects the client, the auditor has to seek for a new client. But a problem is that the other auditor facing a low risk client would want to keep the same client even in period 2 because retaining the low-risk client is optimal for the auditor. In the case, in the audit market only the rejected high-risk client firm exists unless a new client firm enters the market. Therefore, if the auditor rejects the client, he does not have a client firm in period 2 and its payoff becomes zero in period 2. The following analysis shows the auditor’s client acceptance decision after the first period and specifies under what circumstances an auditor rejects a high risk client firm:

\[ EU(a_H^2|H) \leq U(0) \]  
\[ \iff \frac{q_H}{p}U(F - L - a_H) + \left(1 - \frac{q_H}{p}\right)U(F - a_H) \leq U(0) \]  
\[ \iff q_H \geq q_H^* = p \frac{U(F - a_H) - U(0)}{U(F - a_H) - U(F - L - a_H)}, \]

which implies that an auditor rejects a high risk client firm when its client risk \(q_H\) is too high and the result is summarized in Lemma 1.

**Lemma 1**

(i) An auditor with a low-risk client firm does not rotate in period 2 because there is no benefit from rotation in period 2.

(ii) When \(q_H \leq q_H^* = \min \left[ \frac{p(U(F - a_H) - U(0))}{U(F - a_H) - U(F - L - a_H)}, 1 \right] \), an auditor with a high risk client firm audits the same client firm in period 2 without rotation.

(iii) When \(q_H > q_H^* = \min \left[ \frac{p(U(F - a_H) - U(0))}{U(F - a_H) - U(F - L - a_H)}, 1 \right] \), an auditor with a high risk client firm rejects a client firm in period 2 without rotation.

As shown in Lemma 1, the auditor rejects the client firm only when the risk is greater than the threshold level \(q_H^*\) and, when \(q_H \leq q_H^*\), the same outcome in Proposition 1 is obtained. If the client risk is too high \((q_H > q_H^*)\), an auditor rejects a client and it has no client in period 2. In this case, considering an auditor’s voluntary resignation decision, the two regimes are compared again.

---

5 The situation in which there exists only a high-risk client firm in the audit market after period 1 is due to the model assumption that there are two auditors and two firms in the market. However, even in reality, an auditor would reject a high risk client firm but keep a low risk client firm and therefore, the usual adverse selection problem would arise in the audit market. That is, in the audit market, the client firms seeking a new auditor are more likely to be a high risk firm as in the current model.

6 For simplicity, this section assumes the exogenous audit effort \((a = a_H)\) as in Section 3.
With the auditor’s voluntary rotation, the new probability structure is as follows:

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>S</th>
<th>SS</th>
<th>Sub Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>LL</td>
<td>0</td>
<td>0</td>
<td>1/2</td>
<td>1/2</td>
</tr>
<tr>
<td>HH</td>
<td>1/2q_h</td>
<td>1/2(1 - q_h)</td>
<td>0</td>
<td>1/2</td>
</tr>
<tr>
<td>Total</td>
<td>1/2q_h</td>
<td>1/2(1 - q_h)</td>
<td>1/2</td>
<td>1</td>
</tr>
</tbody>
</table>

[Table 4: Probability structure with voluntary rotation]

Then, the auditor’s expected utility is as follows:

\[
EU^V(k) = \frac{1}{2}[q_hU(F - L - a_H) + (1 - q_h)U(F - a_H)] + \frac{1}{2}[U(2F - a_H - a_H + k)]
\]

\[
= \frac{1}{2}EU(a^1_H | H, 0) + \frac{1}{2}e^{-rk} EU(a^1_H, a^2_H | L, L),
\]

where the superscript "V" denotes the voluntary rotation and "0" denotes a period without a client firm. Comparing an auditor’s expected utilities in each regime yields the following result in Proposition 4.

**Proposition 4**

(i) When \( q_H \leq q^*_H \), the same result in Proposition 1 is obtained.

(ii) When \( q_H > q^*_H \) and \( \Delta a < \Delta a^v \), mandatory rotation is preferred if and only if the learning effect on audit costs (k) is smaller than \( k^*_v \), otherwise voluntary rotation is preferred, where \( k^*_v = \frac{1}{r} \ln \left[ \frac{EU(a^1_H, a^2_H | L, L)}{EU(a^1_H | H, 0)} \right] > 0 \).

As shown in Proposition 4, the k-cutoff for the mandatory rotation exists when \( \Delta a \) is not extremely large. The relative benefit of mandatory rotation still persists even after considering the voluntary rotation derivation.

One may wonder why rotation cannot be voluntarily implemented by auditors if they, in fact, are the beneficiaries of the practice. Though there are ex-ante benefits of rotation rooted in risk sharing, an auditor who learns he has a low-risk client would, ex post, be tempted to renge on any plans to rotate clients because there is no penalty for not rotating: there exists an ex-post commitment problem. Hence, though benefits of rotation do accrue to auditors, such rotation needs to be mandated for such benefits to come to fruition.

To illustrate the conclusions in proposition 1, 2, 3, and 4, consider the following simple example. Suppose \( q_H = 0.5, p = 1.25, q_h = 0.4 \) and set \( a_L = 0 \) without loss of generality. Let audit fee
(F) be 500 and liability (L) be 1,000. The auditor’s degree of risk aversion, \( r \) is 0.001. Figure 1 provides a visual of the \( k \)-cutoffs in each case. In this example, \( k^* \), cost saving which equates the two regimes, is 63.36. As we see in Figure 1, first, \( k^* \) does not vary with \( \Delta a(= a_H - a_L) \) because the audit effort is exogenously set at \( a = a_H \) under both regimes.

![Figure 1: k-cutoffs in varying \( \Delta a = a_H - a_L \)](image)

On the other hand, \( k^{**} \) and \( k^{***} \) vary with \( \Delta a \). As \( \Delta a \) increases, \( k^{**} \) decreases while \( k^{***} \) increases. The increasing rate of \( k^{***} \) is smaller than the decreasing rate of \( k^{**} \) because \( k^{***} \) reflects cost saving under both regimes while \( k^{**} \) captures cost saving from only the no rotation regime. In addition, with voluntary rotation, \( a^v_H \) is 63.47 and \( k^v \) is 36.05 when \( a_H = 50 \) and the \( k \)-cutoff is smaller than \( k^*(63.36) \) but it is shown that there still exists the relative benefit of mandatory rotation even after an audit firm’s option to reject a client. Thus, we can confirm the results in the main setting using the graph in Figure 1.

One may wonder how the relative benefit of mandatory rotation changes in the number of periods (i.e., the number of rotations): the number of periods \( (N) \) is two under the base case. To answer the question, based on the same parameters, I show the following numerical example in Figure 2. First, as shown in the graph, the relative benefit of mandatory rotation \( (\Delta = EU^M - EU^N) \) increases as client risk \( (q_H) \) increases. Second, the relative benefit improves over a greater number of periods \( (N) \) because the auditor can engage in more reshuffling of his client portfolio:
the risk sharing benefit increases as the number of periods (the number of rotation) increases.\(^7\)

![Diagram](image)

**Fig. 2:** The relative benefit of mandatory rotation in varying \(q_H\) and \(N\)

This result is related to a question raised by the recent PCAOB concept release: what would be an appropriate term of engagement with rotation? If the term is too long, the rotation may not enhance auditor independence sufficiently. If the term is too short, audit cost will increase. On the other hand, in the context of risk sharing, as the term of engagement becomes longer, the number of rotations would decrease and, as a result, the benefit of risk sharing would decrease. Therefore, this analysis provides another reason why the short term of engagement can be preferred by showing that the shorter term may actually increase the auditor’s welfare based on the risk sharing benefit.

Note that even if the term of engagement is relatively long, the benefit of risk sharing from mandatory rotation does not necessarily become minimal. In practice, an audit firm has a number of different client firms and then even if the term of engagement becomes longer, the actual number of rotations based on the multiple clients may not become so small that it can create the material benefits of risk sharing.

Concluding this section, I emphasize the fact that in the model, shareholders’ welfare is the same with rotation and without rotation, even though the auditor’s welfare varies between regimes as the audit cost changes. That is, the likelihood of audit failure in any period for any firm

\(^7\)For simplicity, this analysis considers the endogenous action choice without learning effect, \(k\).
is independent of the audit regime. This effect persists in all of the paper’s information sharing scenarios. The constancy of the shareholder’s welfare across regimes makes rotation more attractive because it suggests that Pareto improvements can be achieved through risk sharing among auditors. However, this result can be altered when we consider the generalized audit risk setting, as in the following extension.

### 4.4 Generalized Audit Risk

This section generalizes audit risk and examines whether risk sharing effect is robust to this generalized audit risk. In the main analysis, an auditor is assigned to a high client risk firm or a low client risk firm with equal probability $\frac{1}{2}$, respectively. Instead of the equal probability in the main setup, this section considers $\alpha$ portion of high-risk firms and $(1 - \alpha)$ portion of low-risk firms. Also, let $0 < q_L < q_H$ so that even a low risk client firm has a certain degree of audit risk. For simplicity, assume that $q_L = 0$ under the auditor’s high effort.

This generalization of audit risk may reveal potential implications regarding how the competitive bidding process among auditors affects the risk sharing effect with rotation. This is because the competitive bidding process will affect each auditor’s client-risk profile (i.e., a $\alpha$ probability of having a high-risk firm and a $(1 - \alpha)$ probability of having a low-risk firm).

First, the analysis starts with the exogenous audit effort choice (Section 3) and set $k = 0$ to focus on the effect of the risk profile on the risk sharing effect. If the generalized probability structure ($\alpha$ and $1 - \alpha$) is applied, an auditor’s expected utility without rotation is:

$$EU^N = \alpha q_h^2 U_2 + 2\alpha q_h(1 - q_h)U_1 + [(1 - \alpha) + \alpha(1 - q_h)^2] U_0.$$  \hfill (19)

In the same way, the new expected utility with rotation is:

$$EU^M = (\alpha q_h)^2 U_2 + 2(\alpha q_h)(1 - \alpha q_h)U_1 + (1 - \alpha q_h)^2 U_0.$$  \hfill (20)

Then, the relative benefit of mandatory rotation is:

$$EU^M - EU^N = (1 - \alpha)\alpha q_h^2 (U_1 - U_2 - (U_0 - U_1)) > 0,$$  \hfill (21)

which shows that the risk-sharing benefits always exist for $\alpha \in (0, 1)$. Next, analyze how the portion of high-risk firms ($\alpha$) in the audit market affects the magnitude of risk-sharing benefit. For the analysis, we obtain the portion of high-risk firms which maximizes the relative benefit of mandatory rotation ($EU^M - EU^N$). If we differentiate $EU^M - EU^N$ with regard to $\alpha$, the probability ($\alpha$)
maximizing the benefits is $\alpha = \frac{1}{2}$, which corresponds to the portion of a high-risk firm in the main setup. Therefore, when the audit effort is exogenously set at $a = a_H$, the risk sharing benefits are maximized at the equal portion of high-risk firms and low-risk firms.

Next, consider the auditor’s endogenous audit effort choice as in Section 4.1. Then, the auditor’s expected utilities are:

$$
EU^N = \alpha q_h^2 U_2 + 2\alpha q_h (1 - q_h) U_1 + 2(1 - \alpha) q_L U_{11} + \alpha (1 - q_h)^2 U_0 + (1 - \alpha) (1 - q_L) U_{00};
$$

$$
EU^M = (\alpha q_h)^2 U_2 + 2(\alpha q_h) (1 - \alpha q_h) U_1 + (1 - \alpha q_h)^2 U_0.
$$

Then, the relative benefit of mandatory rotation is:

$$
EU^M - EU^N = (1 - \alpha) (q_L (U_{00} - U_{11}) + \alpha q_h^2 ((U_1 - U_2) - (U_0 - U_1)) - (U_{00} - U_0)).
$$

If we analyze how the low-client risk ($q_L$) affects the relative benefit of mandatory rotation,

$$
d(EU^M - EU^N) = (1 - \alpha) (U_{00} - U_{11}) > 0,
$$

which implies that the attractiveness of mandatory rotation increases as $q_L$ increases. Then, if we get the probability ($\alpha^*$) maximizing the relative benefit ($EU^M - EU^N$):

$$
\alpha^* = \frac{1}{2} - \frac{U_0 - (1 - q_L) U_{00} - q_L U_{11}}{2q_h^2 (U_1 - U_2 - (U_0 - U_1))}.
$$

Unlike the case of the exogenous audit effort, when the audit effort is endogenized, the probability of maximizing the risk sharing benefit is not a constant ($\alpha = \frac{1}{2}$) anymore and $\alpha^*$ depends on a value of $q_L$: $\alpha^*$ can be less (greater) than $\frac{1}{2}$ when $q_L > \frac{U_{00} - U_{11}}{U_0 - U_1}$ ($q_L < \frac{U_{00} - U_{11}}{U_0 - U_1}$). That is, an auditor’s optimal effort choice leads to an "endogenous risk profile ($\alpha^*$)" of $\alpha = \frac{1}{2}$. Also, $\alpha^*$ is determined by the audit market situation because $U$ is affected by audit fee ($F$), liability ($L$), and audit cost ($a$). These results are summarized in Proposition 5.

**Proposition 5**

(i) For exogenous audit effort, risk sharing benefits are maximized at $\alpha = \frac{1}{2}$.

(ii) For endogenous audit effort, risk sharing benefits are maximized at $\alpha = \alpha^* = \frac{1}{2} - \frac{U_0 - (1 - q_L) U_{00} - q_L U_{11}}{2q_h^2 (U_1 - U_2 - (U_0 - U_1))}$.

One may expect that a symmetric structure ($\alpha = \frac{1}{2}$) of the audit market would maximize the benefit of rotation because the risk sharing is done via the exchange of a high risk firm with a low risk firm among auditors. This intuition is correct when the audit effort is exogenous. When

---

8This section assumes that $\Delta a = a_H - a_L$ is large enough that an auditor exerts low effort for a low-risk client firm as in Section 4.1.
high efforts are always exerted under both regimes, the audit risk is best diversified with equal portions of high-risk firms and low-risk firms. If $\alpha$ is greater or less than $\frac{1}{2}$, the risk sharing benefit decreases. As $\alpha$ decreases below $\frac{1}{2}$, the demand for the risk sharing would decrease because the auditor’s concern about having a high risk client firm becomes less. Also, as $\alpha$ increases beyond $\frac{1}{2}$, the risk sharing benefit decreases because it is more likely that an auditor can rotate from a high-risk client firm to another high-risk client firm. Thus, the risk sharing benefit is maximized $\alpha = \frac{1}{2}$.

However, with the endogenous audit effort, this intuition changes. Without rotation, since an auditor rationally exerts low effort for a low risk client in period 2, additional audit failures may occur when $q_L > 0$ despite cost saving. Therefore, as $q_L$ increases, the demand for rotation increases even if $\alpha$ is smaller than $\frac{1}{2}$ unlike the exogenous audit effort case: $\alpha^*$ can be less than $\frac{1}{2}$ if $q_L > \frac{U_{00} - U_1}{U_{01} - U_{11}}$. On the other hand, $\alpha^*$ can be greater than $\frac{1}{2}$ if $q_L < \frac{U_{00} - U_1}{U_{01} - U_{11}}$.

Furthermore, we compare shareholders’ welfare under each regime based on the generalized risk. In the main analysis, where $q_L$ was normalized to zero, shareholders’ welfare was the same under both regimes. However, when $q_L > 0$, without rotation, an auditor exerts low effort for a low client to save audit cost in period 2 and the low effort can cause the additional audit failure by $(1 - \alpha)q_L$: the additional audit failure decreases shareholders’ welfare. This result implies that the shareholders can benefit from the auditor’s high effort with rotation even if the high effort is costly for the auditor. This result is summarized in Proposition 6.

**Proposition 6** With the endogenous audit effort choice, the shareholders’ welfare is higher with mandatory rotation than without rotation when the audit risk is generalized.

## 5 Conclusion

The mandatory rotation has been examined in many previous studies; however, the risk sharing benefit for auditors has not been discussed. This paper revisits the benefits of mandatory rotation from an auditor’s perspective and shows that mandatory rotation enables auditors to share their client risk over time and thereby enhancing the auditor welfare.

One may think that most audit firms have many audit clients so are able to diversify client risks in the cross-section and then do not need to do so intertemporally as shown in this paper. However, as we have observed, audit firms have been consistently merging and market concentration has increased and such increasing merger and market concentration may imply that they are seeking
ways to diversify risks (Forbes.com, February 4, 2013). Rotation could be more cost-efficient in that it reduces the need to diversify risks via mergers.

Also, audit firms have increased in size such that one would presume their size allows risk-diversification. But, incentive concerns have led to individual partners taking on individual risks in their compensation arrangements. In other words, an audit firm’s risk diversification is imperfect due to contracting with partners, which may affect the riskiness of the client portfolio, client acceptance decisions, auditor effort choices, and audit quality (Francis 2011; Knechel et al. 2013). This means that intertemporal sharing of risks can be pertinent. In fact, the results in the current paper may provide some evidence on the benefits and costs of partner rotation as well as audit firm rotation.

The analyses in the current paper implicitly assume that an auditor can reveal a client’s type perfectly during auditing process. But, in practice, a client type may not be perfectly revealed during the audit process and an auditor may not be sure of a client’s audit risk even after the auditing process. This uncertain client type can decrease the advantage of the no rotation, which is a flexible effort choice in period 2 based on the client information obtained in period 1. That is, with the imperfect information about a client risk, an auditor may not effectively match his effort to the client type in period 2 and an additional audit failure may occur. Thus, if we consider the imperfect information, the relative benefit of mandatory rotation clearly increases.

On the other hand, if we consider the information sharing between auditors, this imperfect information affects both the no rotation and the mandatory rotation. The information sharing between auditors cannot be perfect and the benefit of mandatory rotation can be reduced as well. The unreported analysis shows that the qualitatively same result as shown in this paper is obtained even when the information is imperfect and the relative benefit of mandatory rotation increases as the precision of a signal from auditing process improves.\textsuperscript{9}

Admittedly, the risk sharing benefit of mandatory rotation was shown in a model which excludes several important factors affecting the relative benefit of mandatory rotation including strategic interaction between an auditor and management, risk-adjusted audit fee, market competition and an auditor’s more transparent communication with shareholders. In practice, without rotation, the auditor’s tenure may reduce its objectivity and willingness to resist pressure from management. If management anticipates the auditor’s accommodating behavior, they will have greater incentive to manage earnings; as a result, client risk will increase and the benefit of mandatory rotation may

\textsuperscript{9}The analysis and proof are available upon request.
increase. In addition, in the current model, the audit fee is fixed over time. In reality, without rotation, with the auditor learning the client risk, the audit fee can increase or decrease by reflecting the client risk. The risk-adjusted audit fee can decrease or increase the relative benefit of mandatory rotation but its effect was not analyzed in the current work. Also, mandatory rotation enables an auditor to communicate more transparent information about a client because the communication does not affect the audit contract in the next period. It can be another important benefit of the rotation but this effect was not considered in this paper. Finally, even among audit firms, there has been the debate whether this mandatory rotation increases or decreases competition in the audit market.10 This may be another empirical or analytical research question to be explored. Future work could layer in the factors to better analyze the benefits of mandatory rotation.

10 For instance, Ernst & Young (2011) raised a concern that mandatory rotation may increase competition and thereby the audit fee and audit quality can be lower. On the other hand, PwC (2012) made a comment that the shortcoming of the mandatory rotation is to reduce the competition.
6 Appendix

Proof of Proposition 1

Let $EU_N^N(k)$ and $EU_N^M$ be defined by (11). It follows that $EU_N^N(k) = \exp(-rk)EU_N^N$. Since $0 > EU_M^M > EU_N^N$ and $EU_N^N(k)$ is increasing in $k$, there exists $k^* > 0$ such that $EU_M^M = \exp(-rk^*)EU_N^N = EU_N^N(k)$. The Proposition follows, with

$$k^* = \frac{1}{r} \ln \left[ \frac{EU_N^N}{EU_M^M} \right].$$ \hfill (A-1)

Proof of Corollary 1

(ii) As shown in (12), $EU_M^M - EU_N^N$ increases as $q_H$ increases. Since $q_H$ increases in $q_L$, the result implies that $k^* = \frac{1}{r} \ln \left[ \frac{EU_N^N}{EU_M^M} \right]$ increases in the client risk, $\Delta q = q_H - q_L$.

(iii) The first derivative of $(EU_M^M - EU_N^N)$ in (12) with regard to $L$ is

$$\frac{q_H^2}{4} e^{-r(2F-2a_H)} e^{rL} (e^{rL} - 1) r > 0.$$ \hfill (A-2)

The result implies that $k^*$ increases in the liability $L$. \hfill □

Proof of Proposition 2

$$EU_{N*} = \frac{1}{2} EU(a_H^1, a_H^2, k|H, H) + \frac{1}{2} EU(a_L^1, a_L^2, k|L, L)$$

$$= e^{-rk} EU_N^{N(\Delta)} > e^{-rk} EU_N^N,$$

where $EU_N^{N(\Delta)} = \frac{1}{2} EU(a_H^1, a_H^2|H, H) + \frac{1}{2} EU(a_L^1, a_L^2|L, L)$. If $a_H = a_L (\leftrightarrow \Delta a = a_H - a_L = 0), EU_M^M - EU_N^{N(\Delta)} = EU_M^M - EU_N^N > 0$. As $\Delta a$ increases, $EU_M^M - EU_N^{N(\Delta)}$ decreases and then, there exists $\Delta a^*$, at which $EU_M^M = EU_N^{N(\Delta)}$.

When $\Delta a \leq \Delta a^*$, there exist $k^{**}$, which equates $EU_M^M$ with $EU_{N*}$ since $0 > EU_M^M > EU_N^{N(\Delta)}$ and $EU_{N*} = e^{-rk} EU_N^{N(\Delta)}$ is increasing in $k$. The Proposition follows with

$$k^{**} = \frac{1}{r} \ln \left[ \frac{EU_N^{N(\Delta)}}{EU_M^M} \right].$$ \hfill (A-3)

Next, if we compare $k^{**}$ with $k^*, EU_N^{N(\Delta)} > EU_N^N$ so that

$$k^{**} = \frac{1}{r} \ln \left[ \frac{EU_N^{N(\Delta)}}{EU_M^M} \right] < \frac{1}{r} \ln \left[ \frac{EU_N^N}{EU_M^M} \right] = k^*.$$ \hfill (A-4)

Note that $EU(\cdot)$ is negative as defined in the model. If we apply $U(\cdot) = -\exp(-r(\cdot))$,

$$\Delta a^* = \frac{1}{r} \ln \left[ \frac{2}{2 - (exp(rL) - 1)^2 q_H^2} \right] \quad \text{and}$$

$$k^{**} = \frac{1}{r} \ln \left[ \frac{2(q_H^2 e^{r2L} + 2q_H(1 - q_H)e^{rL} + q_H e^{-r(a_H - a_L)})}{(q_H(e^{rL} - 1) + 2)^2} \right].$$ \hfill (A-5)

Note that $EU(\cdot)$ is negative as defined in the model. If we apply $U(\cdot) = -\exp(-r(\cdot))$,
Proof of Proposition 3

\[ E_{U}^{N*} = e^{-rk} E_{U}^{N(\Delta)} ; \]  
\[ E_{U}^{MI} = \frac{1}{4} \left[ E_{U}(a_{H}^{1}, a_{H}^{2}|H, H) + E_{U}(a_{H}^{1}, a_{L}^{2}|H, L) + E_{U}(a_{H}^{1}, a_{H}^{2}|L, H) + E_{U}(a_{H}^{1}, a_{L}^{2}|L, L) \right] . \]

When \( k = 0 \), \( E_{U}^{MI} > E_{U}^{N(\Delta)} \) since

\[ \Delta E_{U}^{I} = E_{U}^{MI} - E_{U}^{N(\Delta)} \]
\[ = \frac{1}{4} \left( E_{U}(a_{H}^{1}, a_{H}^{2}|H, H) - E_{U}(a_{H}^{1}, a_{H}^{2}|H, L) - [E_{U}(a_{H}^{1}, a_{L}^{2}|L, L) - E_{U}(a_{H}^{1}, a_{L}^{2}|L, H)] \right) \]
\[ = \frac{1}{4} \left( q_{H} \left[ (U_{1} - U_{2}) - (U_{0} - U_{1}) \right] + q_{H} \left[ (U_{0} - U_{1}) - (U_{00} - U_{11}) \right] \right) > 0 \]

Since \( 0 > E_{U}^{MI} > E_{U}^{N(\Delta)} \) and \( E_{U}^{N*} = e^{-rk} E_{U}^{N(\Delta)} \) is increasing in \( k \), there exists \( k^{**} \), which equates \( E_{U}^{MI} \) with \( E_{U}^{N*} \). The Proposition follows with

\[ k^{**} = \frac{1}{r} \ln \left( \frac{E_{U}^{N(\Delta)}}{E_{U}^{MI}} \right) \]  
(A-9)

In Proposition 1,

\[ \Delta E_{U} = E_{U}^{M} - E_{U}^{N} \]
\[ = \frac{1}{4} \left( E_{U}(a_{H}^{1}, a_{H}^{2}|H, H) - E_{U}(a_{H}^{1}, a_{H}^{2}|H, L) - [E_{U}(a_{H}^{1}, a_{L}^{2}|L, L) - E_{U}(a_{H}^{1}, a_{L}^{2}|L, H)] \right) . \]

Then,

\[ \Delta E_{U}^{I} - \Delta E_{U} = \frac{1}{4} \left( E_{U}(a_{H}^{1}, a_{H}^{2}|H, L) - E_{U}(a_{H}^{1}, a_{L}^{2}|H, L) - [E_{U}(a_{H}^{1}, a_{L}^{2}|L, L) - E_{U}(a_{H}^{1}, a_{L}^{2}|L, H)] \right) > 0 . \]

(A-11)

Therefore, \( k^{**} = \frac{1}{r} \ln \left( \frac{E_{U}^{N(\Delta)}}{E_{U}^{MI}} \right) > k^{*} = \frac{1}{r} \ln \left( \frac{E_{U}^{N}}{E_{U}^{M}} \right) \) and \( k^{**} < k^{*} < k^{* * *} \).

Proof of Corollary 3

\( \frac{E_{U}^{N(\Delta)}}{E_{U}^{MI}} \) decreases as \( \Delta a = a_{H} - a_{L} \) increases since \( \frac{\partial E_{U}^{MI}}{\partial \Delta a} > \frac{\partial E_{U}^{N(\Delta)}}{\partial \Delta a} \) as in (16). Therefore, \( k^{**} \) increases as \( \Delta a \) increases.

Proof of Proposition 4

As defined in (18),

\[ E_{U}^{V(k)} = \frac{1}{2} E_{U}(a_{H}^{1}, H, 0) + \frac{1}{2} e^{-rk} E_{U}(a_{H}^{1}, a_{H}^{2}|L, L) \]
\[ \geq \frac{1}{2} E_{U}(a_{H}^{1}, H, 0) + \frac{1}{2} E_{U}(a_{H}^{1}, a_{H}^{2}|L, L) = E_{U}^{V(k=0)} . \]
When \( k = 0 \) and \( a_H < a_H^* \), \( EU^M - EU^V(k=0) = EU^M - EU(a_H^1|H,0) - EU(a_H^2|H,L,L) > 0 \), where \( a_H^* \) solves \( EU^M = EU(a_H^1|H,0) + EU(a_H^2|H,L,L) \). When \( a_H < a_H^* \), there exists \( k_v^* > 0 \) such that \( EU^M = EU^V(k) \) since \( 0 > EU^M > EU^V(k=0) \) and \( EU^V(k) \) is increasing in \( k \). The Proposition follows with

\[
    k_v^* = \frac{1}{r} \ln \left[ \frac{EU(a_H^1,a_H^2|L,L)}{EU^M - EU(a_H^1|H,0)} \right].
\]  

(A-13)

If we apply \( U(\cdot) = -\exp(-r(\cdot)) \),

\[
    a_H^v = \frac{1}{r} \ln \left[ \frac{2e^{rF}(1 + (e^{rL} - 1)q_h)}{2 + (e^{rL} - 1)q_h(4 + (e^{rL} - 1)q_h)} \right] \quad \text{and} \quad \text{(A-14)}
\]

\[
    k_v^{**} = \frac{1}{r} \ln \left[ \frac{2}{e^{-r(2F-a_H^v)}((2 - q_h)^2e^{rF} - 2q_h(2 - q_h)e^r - 2q_h^2e^{r(F+L)} + 2q_h(2 - q_h)e^{r(L+a_H^v)} + q_h^2e^{r(2L+a_H^v)})} - (2F - 2a_H^v) \right].
\]
References


