ERASMUS UNIVERSITEIT ROTTERDAM
ERASMUS SCHOOL OF ECONOMICS
MSc Accounting, Auditing and Control
Accounting and Auditing

The effect of audit market concentration on auditor independence

Policymakers and regulators are concerned about the potential negative effects of the increasing audit market concentration. This research finds a negative association between audit market concentration and auditor independence for small audit markets and a positive association for larger audit markets. Audit market concentration is measured with the Herfindahl-index at metropolitan statistical area level in the United States. Auditor independence is measured using goodwill impairments. The size of the audit market is measured in audit fees and the total assets and revenues of all audit clients. The results of the logistic regression are not robust for different proxies of audit market concentration and audit market size.

JEL-codes: G28, L44, M40, M41, M42

Keywords: Audit market concentration, audit market competition, audit quality, auditor independence.

Author: Matthijs Windhorst
Student number: 471054
Thesis supervisor: Yijun Li
Second assessor: Jingwen Zhang
Ending date: 16 July 2021

Table of Contents

1. Introduction

In the last years, policymakers have expressed their concerns about the potential negative effects of audit market concentration (U.S. Treasury, 2008; The American assembly, 2005; Government Accountability Office, 2003; Oxera, 2006). Since 1989 the audit market concentration has increased. Before 1989 there were eight big accounting firms, but this number has decreased ever since. In 2002 Arthur Anderson, one of the five biggest accounting firms, collapsed due to the Enron scandal. After this event only four big audit firms remained, which lead to the concerns of policymakers. The Government Accountability Office (2003) wrote a report that addressed the impact of audit market concentration on the audit fees, the audit market and the audit quality. More research was needed that could take away or justify their concerns. After research was conducted, including research by the Government Accountability Office (2008), the effect of audit market concentration on the audit quality remained unclear.

An oligopolistic audit market would suggest that the clients have fewer choices in auditors. This strengthens the position of the auditor, which could lead to a less sceptical approach (Government Accountability Office 2003). Other researchers (e.g., DeFond, Francis and Hu, 2011) argue that the stronger market position of auditors could lead to more independency. Market-based institutional incentives, for example the potential reputation loss, could lead to a more sceptical approach. The effect of audit market concentration on the audit quality is therefore ambiguous. This research tries to contribute to this scientific conflict by breaking down and analysing a single component of audit quality, the auditor independence. Prior research focusses on audit quality in general but does not take its many different components into consideration, for example the amount of human capital, auditor independence, resources, time or responsibilities (Deis and Giroux, 1992). This research focusses on auditor independence, a major component of audit quality, by answering the following research question:

Does audit market concentration influence auditor independence?

To answer this question, this research focusses on three different aspects of audit market concentration. Firstly, the effect of audit market concentration on auditor independence in general. Secondly, the effect of audit market concentration within big four accounting firms on auditor independence. Lastly, the interaction effect of audit market concentration with the size of the audit market on auditor independence. To capture audit market concentration, the Herfindahl-index is used, based on the total audit fees and the total audit clients. The Herfindahl-index is calculated for every metropolitan statistical area (MSA) for every year in the United States. To capture auditor independence, goodwill impairments are used. After SFAS 142 was imposed, companies were required to test if goodwill still holds its value and make an impairment if necessary. Because managers have incentives to manipulate this account, it requires an independent auditor to impair goodwill. To make sure a goodwill

impairment is justified, only company-year observations are kept if the book value is higher than the market value of a company. A logistic regression is used to estimate the probability of a goodwill impairment.

This research finds no direct relation between audit market concentration and auditor independence. Audit market concentration within the big four accounting firms does also not influence auditor independence directly. However, the interaction effect of audit market concentration with the size of the audit market is statistically significant. Results show that higher audit market concentration decreases auditor independence in small audit markets and increases auditor independence in relatively large audit markets. These results are not robust to different definitions of audit market size and should therefore be treated with caution. However, this research contributes to existing literature, regarding the effect of audit market concentration on audit quality, by explaining the importance of the interaction of audit market concentration with the size of the audit market. Additional to this, this research tries to get insight into the relation between audit market concentration and a specific component of audit quality, instead of audit quality in general.

The remainder of this study is organised as follows. The next section explains the theoretical framework around the relation between audit market concentration and audit quality and analyses prior literature regarding this topic. Section three outlines the methodology. Section four describes the data that is used for this research. Section five displays all empirical results. Section six concludes. Section seven explains several limitations of this research and contains suggestions for further research.

2. Prior literature

2.1 Prior literature overview

Multiple studies have tried to explain the relation between audit market concentration and audit quality. However, a consensus has not been reached. This section explicates the different approaches of these prior studies and how this has led to mixed findings.

Table 1

Results of prior research regarding the effect of audit market concentration on audit quality

Authors/year	*National or international*	*Dependent Variable (DV)*	*Time period*	*Sign*
Francis, Michas and Seavey (2013)	International	Earnings quality using multiple proxies	1999 - 2007	-
Boone, Khurana and Raman (2012)	National	Meet or beat the earnings expectations with discretionary accruals	2003 - 2009	-
Kallapur, Sankaraguruswamy and Zang (2010)	National	Discretionary accruals	2000 - 2006	+
Huang, Chang and Chiou (2016)	National	Discretionary accruals	2001 - 2011	+/-
Gunn, Kawada and Michas (2019)	International	Discretionary accruals and the probability of reporting a loss	2007 - 2013	-
Bandyopadhyay, Chen and Yu (2014)	National	Discretionary accruals	1999 - 2011	+
Newton, Wang and Wilkins (2004)	National	Restatements		+
Eshleman (2013)	National	Restatements	2000 - 2010	+

Note: The sign represents the sign of the correlation between the dependent variable and audit market concentration.

Table 1 shows the most important prior studies regarding the effects of audit market concentration on audit quality. Most studies use discretionary accruals and restatements as a proxy for audit quality. Table 1 shows the changes in the correlation between audit market concentration and the dependent variable regarding different time periods, it is unable to explain the mixed results.

2.2 The theoretical problem

Theory can explain the potential positive and negative effects of audit market concentration on audit quality or auditor independence. In general, a common view of the structure-conduct-performance paradigm is that the market structure has a big impact on firm performance. More specifically, market concentration drives firm conduct (Weiss, 1979). Suppliers can gain market power through increases in market concentration. This increase in market power has an impact on all market participants. On average, higher market concentration is associated with higher economies of scale, higher profitability, lower product differentiation and a less competitive market (Martin, 1988). However, market competition and market concentration are not interchangeable. Dufwenberg and Gneezy (2000) show that market concentration influences market competition, especially price competition. For the audit market in particular, research has been conducted regarding the effect of audit market concentration on audit fees (Pearson and Trompeter, 1994; Iyer and Iyer, 1996; McMeeking, Peasnell and Pope, 2007; Huang, Chang and Chiou, 2016; Gunn, Kawada and Michas 2019). They all find significant results regarding the correlation between audit market concentration and audit fees. This shows that audit market concentration influences the competition on the audit market. This change in competition is expected to bring about changes in audit quality, or more specifically, auditor scepticism. Auditor scepticism shapes how thorough the auditor will conduct an audit and is mainly determined by auditor independence.

The effect of audit market concentration on audit quality could be negative. Teoh (1992) argues that audit firms take the consequences of displeasing the client into consideration. Giving an opinion different than an unqualified opinion could lead to auditor dismissal. DeAngelo (1981) argues that auditors attract new clients by lowballing, the audit firms will collect the necessary quasi rents in the future. This could have an impact on the independence of the auditor since the auditor is dependent on the future quasi rents to make a profit. To avoid dismissal, the auditor is expected to please the client and reduce independency. Besides this direct effect of audit fees, the change in market competition also affects the costs of displeasing the client. Chaney, Jeter and Shaw (2003) argue that the auditor considers these costs of telling the truth if this displeases the client. A higher audit market concentration leads to lower market competition, this increases the audit fees. Therefore, the costs of telling the truth and displeasing the client are higher when market concentration is high. This suggests that higher audit market concentration leads to a less sceptical approach. The main concern of the Government Accountability Office (2003) is that an oligopolistic audit market suggests that the clients have fewer choices in auditors. This strengthens the position of the auditor, which could lead to a less sceptical approach.

However, the effects of audit market concentration on audit quality could also be positive. According to Boone, Khurana and Raman (2012), a higher audit market concentration leads to lower market competition, this could reduce lowballing and therefore bring about a more sceptical approach. They also argue that in a less concentrated market, i.e., a more competitive market, the probability of clients switching to another auditor after being displeased increases. This suggests that higher audit market concentration leads to a more

sceptical approach. Other researchers (e.g., DeFond, Francis and Hu, 2011) argue that the stronger market position of auditors could lead to more independency. Market-based institutional incentives, for example the potential reputation loss, could lead to a more sceptical approach.

2.3 Positive correlation between audit market concentration and audit quality

Kallapur, Sankaraguruswamy and Zang (2010) use data from the United States to uncover the relation between audit market concentration and audit quality. They use the Herfindahl-index at MSA level as a proxy for audit market concentration and accruals-based earnings quality as a proxy for audit quality. They find a positive correlation, robust to different ways to measure their proxies. This suggests that an increase in audit market concentration will increase audit quality. They also control for the potential endogeneity problem. High quality auditors could attract clients to this particular metropolitan statistical area, thus affecting audit market concentration. They use a two stage least square regression and use exogeneous instrumental variables to proxy for audit market concentration. The results remain unchanged, suggesting that endogeneity is not problematic.

Francis, Michas and Seavey (2013) use data from 42 different countries and find that when the overall market share of the big 4 accounting firms increases, the clients have smaller accruals, are more likely to report losses and account timelier for losses. This suggests that regulators should not have concerns regarding the large share of the big 4 accounting firms since this will increase audit quality.

Bandyopadhyay, Chen and Yu (2014) use data from 273 Chinese companies. They use the Herfindahl-index at province level as a proxy for audit market concentration and use discretionary accruals as a proxy for audit quality. They find that mandatory audit partner rotation only benefits audit quality for clients located in a province with low audit market concentration. They indirectly state that audit quality is higher for concentrated areas because they argue that provinces with low audit market concentration have room for improvement regarding audit quality.

Newton, Wang and Wilkins (2004) use data from the United States. They use the Herfindahl-index at MSA level as a proxy for audit market concentration and the probability of restatement in the financial reporting as a proxy for audit quality. They calculate the Herfindahl-index based on big 4 and non-big 4 accounting firms. They find a positive correlation for audit market concentration and audit quality, with higher correlation coefficients when using the information of non-big 4 accounting firms.

Eshleman (2013) uses data from the United States, he uses the ranked concentration based on MSA data as a proxy for audit market concentration. He uses the probability of a restatement in the financial reporting as a proxy for audit quality. He uses control variables in line with prior research and argues that the size of the audit market should be added as a control variable. Most of prior research does not control for this, but since the economies of scale in larger audit markets have an effect on the audit quality, it should be included. He

finds a positive correlation between audit market concentration and audit quality, only for clients located in relatively large local audit markets.

2.4 Negative correlation between audit market concentration and audit quality

Francis, Michas and Seavey (2013) find a positive correlation between big 4 audit share and audit quality using international data. However, they also find that audit market concentration within big 4 accounting firms is negatively correlated with audit quality. They use control variables in line with prior research and country-fixed-effects. They do not control for the audit fees and non-audit fees. These fees are correlated with audit quality (Deis and Giroux, 1992). Therefore, audit fees could explain why some clients that made large accruals, are less likely to report losses and exhibit timely loss recognition.

Boone, Khurana and Raman (2012) use data from the United States at MSA level. They use the Herfindahl-index to proxy for audit market concentration. They proxy for audit quality by looking at the number of discretionary accruals that are used to meet or beat earnings benchmarks. More of these accruals suggest that the auditor uses a lenient and less sceptical approach. Their control variables are in line with prior literature and find that a higher audit market concentration is negatively correlated with audit quality. Their results are robust to different ways to calculate audit market concentration. However, they do not find a significant relation between big 4 audit market share and audit quality, which contradicts the results of Francis, Michas and Seavey (2013).

Huang, Chang and Chiou (2016) use Chinese data to uncover the relation between audit market concentration and audit quality. This is different from the United States data since competition on the audit market is thriving in China, while competition lacks in the United States. Besides this difference in competition, the big 4 dominance is lower in China compared to the United States. They use the Herfindahl-index at city level to proxy for audit market concentration. To proxy for audit quality, they use earnings quality, the need to issue modified audit opinions and the likelihood of auditors and executives being sanctioned. They use a path analysis and find that an increase in audit market concentration leads to higher audit fees, which increases audit quality. However, they find that the direct effect of audit market concentration is positively correlated with the absolute value of discretionary accruals but negatively correlated with the likelihood of auditors and executives being sanctioned. This shows a negative and a positive correlation between the direct effects of audit market concentration on audit quality. The direct effects are smaller than the indirect effects, overall a higher concentration goes in hand with higher audit quality. These results indicate that the increase in audit quality is not caused by the strong institutions in the United States that claim to prevent concentration from deteriorating audit quality.

Gunn, Kawada and Michas (2019) use data from 28 different countries. They find that higher concentration leads to higher audit fees, which increase audit quality. They use accruals and the probability of reporting a profit as proxies for audit quality and find that within big 4 audit firms, market concentration is negatively correlated with audit quality. This research and the corresponding results are in line with the research of Francis, Michas and Seavey (2013). In

addition to their research, Gunn, Kawada and Michas (2019) do control for the effects of audit fees.

2.5 Hypothesis development

In the previous sections the effect of audit market concentration on audit quality remains unclear. The mixed findings of table 1 cannot be explained by simple differences in the methodology. A possible explanation is that audit quality in general is not specific enough to find consistent results. Theory shows that audit market concentration can have an impact on the audit in multiple ways. Economies of scale could improve audit quality but decreasing independence could deteriorate audit quality. Therefore, the specific proxy for audit quality is important. For example, Boone, Khurana and Raman (2012) use discretionary accruals that are used to beat earnings benchmarks as a proxy for audit quality, while Kallapur, Sankaraguruswamy and Zang (2010) use discretionary accruals in general. Besides using a different proxy, some researchers focus on the total effects of audit market concentration on audit quality while others focus on the direct effect only.

Audit market concentration can increase audit fees, which is expected to have a positive effect on audit quality, while the direct effect can be negative. Another explanation for the mixed results is that audit market concentration is defined differently. When the total share of big 4 auditors increases, the audit quality increases (Francis, Michas and Seavey, 2013; Newton, Wang and Wilkins, 2004). This is in line with theory that big 4 auditors provide higher quality audits than non-big 4 auditors (Lawrence, Minutti-Meza and Zhang, 2011). However, when audit market concentration within the big 4 auditors increases, the audit quality decreases according to Francis, Michas and Seavey (2013) and Gunn, Kawada and Michas (2019). The effect of audit market concentration in general remains unclear. Besides these differences in the definition of the dependent variable and the independent variable, there are some minor differences in the control variables that are used. Auditors can only make use of economies of scale to improve their audit, if the audit market is large enough, yet most studies do not control for the size of the audit market.

Theory also does not provide a clear guideline for the expected sign of the correlation between audit quality and audit market concentration. On the one hand, theory suggests that the correlation is positive. Because a higher market concentration reduces lowballing which brings about a more sceptical approach. A higher market concentration also suggests that clients are less likely to switch to another auditor, this makes the auditor more independent. The last reason is that higher market concentration increases market-based institutional incentives to be more independent, for example the potential reputation loss.

On the other hand, theory suggests that the correlation is negative. Because a higher market concentration is expected to increase audit fees, which increases the costs of auditor dismissal. Higher market concentration also strengthens the position of the auditor, which could reduce independency.

This research focusses on the effect of audit market concentration on auditor independence. To proxy for auditor independence, a component of audit quality, I follow the steps of

Carcello, Neal, Reid, and Shipman (2020). They suggest that the use of goodwill impairments can be used as a quantification of auditor independence. Goodwill is an intangible asset that is created during the acquisition of a company by another. Goodwill captures the value of multiple intangible assets that are not separately on the balance sheet, e.g., a good customer base, the brand name or employee relations. This method is possible because of an accounting policy change in the United States in 2001. Before this change, goodwill accounting was straightforward, goodwill was amortized every year by a similar amount. However, accounting policy makers concluded that the value of goodwill does not decline by the same amount every year. Therefore SFAS 142 was imposed in 2001. This new rule required annual impairment testing of goodwill by management. This means that goodwill can hold the same value over multiple years. Managers can use different techniques to measure the value of goodwill to test if an impairment is necessary. Since goodwill captures the value of multiple intangible aspects it is highly sensitive to managements assumptions. The auditor adheres AS 2502, *Auditing fair value measurements and disclosures*, which states that the auditor needs to assess the appropriateness of the impairment testing by the company (PCAOB, 2002). The PCAOB argues that goodwill impairment tests are an audit deficiency (PCAOB, 2017a). Because the auditor needs to assess the assumptions of management which are highly subjective. Besides this, the value of a goodwill impairment is likely to be material and therefore increases audit risk. Prior literature shows that management has incentives to manipulate this account (e.g., Beatty and Weber, 2006; Muller, Neamtiu and Riedl, 2012; Ramanna and Watts, 2012). Therefore, the auditor should remain independent to properly audit this account. Independence increases professional scepticism and auditor judgement, which results in better goodwill accounting. To proxy for auditor independence, making an impairment suggests that the auditor is more independent. Using this proxy for auditor independence, the first hypothesis is created:

H1: ***There exists no relation between audit market concentration and goodwill impairments.***

Since theory could explain both alternatives, the two following hypotheses are tested:
H1a: *There exists a positive relation between audit market concentration and goodwill impairments.*
H1b: *There exists a negative relation between audit market concentration and goodwill impairments.*

Some prior research suggests audit market concentration is positively correlated with audit quality because the market share of the big 4 audit firms is higher in some areas (Francis, Michas and Seavey, 2013). The audit quality provided by big 4 auditors is expected to be higher. Kallapur, Sankaraguruswamy and Zang (2010) argue that the audit market concentration of non-big 4 audit firms could have a weaker correlation with audit quality of larger firms, because smaller audit firms cannot compete with the big 4 audit firms. This noise could result in weaker correlations regarding hypothesis one. To filter out this effect of the

market share of the big 4 auditors, the audit market concentration within the big 4 audit firms is calculated. Therefore, the second hypothesis is:

H2: ***There exists no relation between audit market concentration within the big 4 audit firms and goodwill impairments.***

Since theory could explain both alternatives, the two following hypotheses are tested:
H2a: *There exists a positive relation between audit market concentration within the big 4 audit firms and goodwill impairments.*
H2b: *There exists a negative relation between audit market concentration within the big 4 audit firms and goodwill impairments.*

Newton, Wang and Wilkins (2013) argue that the size of the audit market could influence the effect that audit market concentration has on audit quality. However, they find that the relation is not dependent on the size of the audit market. Eshleman (2013) shows that the size of the audit market influences the effect of audit market concentration on audit quality. He argues that audit firms compete to realize economies of scale, these benefits will be greater in large audit markets. Therefore, the effects of competition are different in larger audit markets, this might have an impact on the amount of goodwill impairments. This results in the third hypothesis:

H3: ***The relation between audit market concentration and goodwill impairments does not depend on the size of the audit market.***

H3a: *The relation between audit market concentration and goodwill impairments depends on the size of the audit market.*

3. Methodology

3.1 Independent variable

To analyse the relation between audit market concentration and auditor independence, a proper quantification of audit market concentration must be made. Following the steps of prior research that focusses on audit market concentration within a country, I calculate the Herfindahl-index at the MSA level in the United States. An MSA is an area in the United States with at least 50.000 inhabitants and a high degree of social and economic integration with the core of the MSA. The United States consist of 384 different MSAs (US Census Bureau, 2020). Prior research (e.g., Chaney and Philipich, 2002; Penno and Walther, 1996; Reynolds and Francis, 2001; Wallman, 1996) suggests that the level of audit market concentration is local. This means that the supply of audit services outside a certain MSA does not influence the market concentration within that MSA. Choi, Kim, Kim and Zang (2010) argue that 82 percent of the clients chose an audit office within the same MSA as their own headquarter. To detect differences in audit quality across different MSAs, audit quality needs to vary across different audit offices of the same audit firm. Reynolds and Francis (2000) argue that the incentives of different audit offices of the same audit firm are different. This results in a difference between independence between local audit offices of the same audit firm. Francis, Reichelt and Wang (2005) argue that the expertise of different audit offices, of the same audit firm, is different. Chaney and Philipich (2002) argue that the reputation of local audit offices is not the same as the reputation of the audit firm. These differences result into different audit quality for local audit offices of the same audit firm (Choi, Kim, Kim and Zang, 2010; Krishnan, 2005; Francis and Yu, 2009). Therefore, looking at the audit market concentration on MSA level is most appropriate. An advantage of analysing the relation between audit market concentration and auditor independence at MSA level in the United States, is that the country specific characteristics are constant for the entire sample. The audit market concentration in an MSA can be calculated with the Herfindahl-index, an index used as quantification of market concentration (Kelly, 1981). Prior research (e.g., Kallapur, Sankaraguruswamy and Zang, 2010) calculates the Herfindahl-index based on different audit firm related variables per MSA per year.

$$HERF = \sum_{i=1}^{n} [s_i/S]^2 \quad (1)$$

N is the number of audit firms, *s* is the size of the local audit practice and *S* is the total size of all the local audit practices in a certain MSA in a certain year. The size can be calculated using different variables that capture the size of a local audit practice. Prior research calculates the Herfindahl-index based on the audit fees per local audit office. For robustness it can also be calculated using book value of assets, the number of clients or the revenue per local audit office. For this research I calculate the Herfindahl-index based on the audit fees and on the number of clients only. The range of the Herfindahl-index is between zero and one, higher values suggest the market concentration is higher. If the Herfindahl-index would be equal to

one, it suggests that only one audit office performed the audit for all the companies in that certain MSA in a certain year.

The Herfindahl-index also received some criticism. Kwoka (1981) found that the choice of the concentration measure matters. Results might change when using a different concentration measure. However, the Herfindahl-index has the best theoretical foundation (Kwoka, 1985). It is important to analyse the market of interest and the theoretical problem before choosing a concentration measure. For example, the CR4 index does not take smaller firms into account while the Herfindahl-index takes all firms into account. Prior literature regarding audit market concentration argues that the Herfindahl-index is adequate for analysing the concentration on this specific market. Another main concern is that market concentration fails to capture the degree of market competition. Prior literature shows that audit market concentration is significantly correlated with (price) competition (Pearson and Trompeter, 1994; Iyer and Iyer, 1996; McMeeking, Peasnell and Pope, 2007; Huang, Chang and Chiou, 2016; Gunn, Kawada and Michas, 2019). This could be different for other market, but the Herfindahl-index seems appropriate for this research.

3.2 Dependent variable

Prior literature is focused on audit quality in general and uses different proxies to capture this. To understand the real effect of audit market concentration on audit quality, it is more appropriate to focus on the different components of audit quality. For this research I focus on auditor independence, a major and relevant component of audit quality. The theory behind the effect of audit market concentration on audit quality can predict a more or a less sceptical approach of the auditor. Auditor independence determines how sceptical the auditor will conduct an audit (Tepalagul and Lin, 2015). This research uses goodwill impairments as a proxy for auditor independence. Because the auditor should remain independent to properly audit this account. Independence increases professional scepticism and auditor judgement, which results in better goodwill accounting.

However, making a goodwill impairment does not necessarily mean that the auditor made the right choice based on his independency. I only use the data of companies where an impairment is expected, an impairment would therefore be justified. Carcello et al., (2020) argue that if the book to market value of a company exceeds unity, it indicates an impairment in goodwill. However, not all companies have a material amount of goodwill on their balance sheet. The auditor will only properly audit goodwill and its respective impairment if potential adjustments could be material. To account for this, only company-years that include goodwill with a value higher than one percent of the companies' assets are kept for analysis. For robustness the results are also recalculated using different thresholds for materiality of goodwill. These thresholds are a value of goodwill that is higher than a half, two or three percent of the companies' assets. This threshold decision does not quantitatively change the results.

3.3 Logistic regression analysis

To analyse the effect of audit market concentration on the likelihood of a goodwill impairment, the following logistic regression model is used:

$$IMP_{it} = \beta_0 + \beta_1 HERF + \beta_x CONTROLS_{it} + YEAR\_FE + \varepsilon_{it} \quad (2)$$

In this regression model, *i* denotes the firm, *t* denotes the year, IMP is a dummy variable that is equal to one if an impairment was made and zero otherwise. *HERF* is the value of the Herfindahl-index that measures audit market concentration. *HERF* can be calculated using all audit fees and audit clients for hypothesis one or based on the big 4 audit fees and big 4 audit clients for hypothesis two. *CONTROLS* stands for a vector of different control variables. *YEAR_FE* stands for year fixed effects. This regression model is used for hypotheses one and two. Carcello et al., (2020) use industry fixed effects because they argue that it is unknown whether goodwill impairments depend on industry specific information. However, there is no literature or theory that argues that goodwill impairment decisions are industry specific. Therefore, the results are displayed without industry fixed effects. However, for robustness the results are recalculated with industry fixed effects. Industry fixed effects are not significant and do not change the results, these results are reported in Appendix 8, 9 and 10. Kallapur, Sankaraguruswamy and Zang (2010) argue that endogeneity could exist. If audit quality in a certain MSA is high, companies can move toward that MSA. Thus, audit quality can affect audit market concentration. They use a two stage least square regression analysis to test whether endogeneity exists. They find that endogeneity does not exist or alter the results when controlled for.

3.4 Control variables

The audit of impairment testing remains an audit deficiency, auditors do not enforce as many goodwill impairments as they should. Therefore, regulatory bodies have tried to improve goodwill accounting and its respective audit. The PCAOB imposed new auditing standards (PCAOB, 2017b). This new standard could strengthen the audit of all accounting estimates. An important new auditing standard is the Sarbanes-Oxley Act from 2002, which improved audit quality (DeFond and Lennox, 2011). To account for all the changes in accounting rules and auditing standards that are expected to improve the audit of goodwill, year fixed effects are included. The control variables that are used in the logistic regression model are based on prior literature. Table 1 gives an overview of the papers that include control variables that are used in this research. All variables that are used in the regression models are explained in Appendix 1.

The first set of control variables consists of company related variables. *LN_AUDITFEES* is the natural logarithm of the total audit fees in thousands. Pearson and Trompeter (1994), Iyer and Iyer (1996), McMeeking, Peasnell and Pope (2007) find that the audit fees are affected by the audit market concentration, but the audit fees also influence the audit quality. Since higher audit fees increase the number of recourses that are available to the auditor to

conduct an audit, it is expected to increase the audit quality in general. However, a higher audit fee also means that the client is more important to the auditor. Higher audit fees could therefore decrease auditor independence. The sign can thus not be predicted. *NONAUDITFEES* are the non-audit fees divided by the total audit fees. Carcello et al., (2020) find that non-audit fees negatively affect auditor independence. Because the client can put pressure on the auditor by threatening to decrease the non-audit fees in the future. Therefore, the expected sign is negative. *LN_ASSETS* is the natural logarithm of the total assets of the company in thousands. This controls for the size of the company, since larger companies are more likely to impair goodwill (Carcello et al., 2020). *LOSS* is a dummy variable that is equal to one if the company made a loss and zero otherwise. This variable is included because Jordan and Clark (2004) find that companies that make a loss are more likely to take a big bath. During a big bath, companies record more expenses, like a goodwill impairment. However, Hayn and Hughes (2006) find that losses are an indication that goodwill needs to be impaired. Therefore, the expected sign of this dummy variable is unknown. *LEVERAGE* is the total short-term and long-term debt divided by the shareholders equity before impairments. Becker et al., (1998) argues that companies with a high leverage are more likely to manipulate earnings to avoid breaking debt covenants. Companies with a high leverage are less likely to impair goodwill. Therefore, the expected sign is negative. To control for the relative amount of goodwill, I include the variable *GOODWILL*. It is goodwill divided by the pre-impairment level of assets. A relatively high amount of goodwill makes it more important for the auditor. If more time is taken to audit this account, better goodwill accounting is expected. *SP500* is a dummy variable that is equal to one if the company is listed in the Standards and Poor 500 (S&P500) index and zero otherwise. Companies that are listed in this index are covered by more and better analysts (Brown, 1997). Analysts publish company specific information, including indications of a goodwill impairment. Therefore, the expected sign is positive. *CEO_CHANGE, CFO_CHANGE* are dummy variables that are equal to one if there is a change in the CEO or CFO respectively and zero otherwise. Beatty and Zajac (1987) show that a new CEO improves firm performance because he has more incentives to do so. Geiger and North (2006) find that a new CFO is less likely to manipulate earnings. A new CFO increases the likelihood of appropriate goodwill accounting. The expected signs are positive.

The second set of control variables consists of auditor and market related variables. *AUDITMARKET_FEES* is the size of the audit market, measured by the natural logarithm of the total audit fees in thousands in an MSA in a year that is matched with the respective companies. This variable is included because Eshleman (2013) finds that the effect of audit market concentration on audit quality is different for bigger audit markets. In bigger audit markets, an auditor could benefit from economies of scale if audit market concentration is high. The expected sign is therefore positive. *BIG_AUDITOR* is a dummy variable that is equal to one if the company is audited by a big 4 auditor and zero otherwise. Before Arthur Anderson collapsed in 2002, five big accounting firms existed, the big 5. The dummy variable *BIG_AUDITOR* is also equal to one if a company was audited by one of the big 5 auditors in 2002 or audited by one of the big 4 auditors after 2002. Francis (2009) argues that the big 5

accounting firms are able to provide a higher audit quality. The expected sign is therefore positive. The variable *IMP_PCT* is the percentage that a company's market value is below the book value of the company. Beatty and Weber (2006) argue that this variable captures the markets expectations of a goodwill impairment. If the difference between market value and book value increases, the likelihood of a goodwill impairment increases. Therefore, the expected sign is positive. *AUDIT_CHANGE* is a dummy variable that is equal to one if there is a change in the auditor of the company and zero otherwise. Kim, Lee and Lee (2015) argue that audit firm rotation has a positive impact on audit quality. The expected sign is therefore positive.

3.5 Adjustments for hypothesis two

The independent variable, the Herfindahl-index, can be calculated using the total audit fees and the total audit clients. However, hypothesis two focusses on the audit market concentration within the big 4 accounting firms. Kallapur, Sankaraguruswamy and Zang (2010) argue that the audit market concentration of non-big 4 audit firms could have a weaker correlation with audit quality of larger firms, because smaller audit firms cannot compete with the big 4 audit firms. This noise could result in weaker correlations regarding hypothesis one. Since the theoretical relation between audit market concentration and audit quality is based on the different effects of competition, I exclude smaller audit firms in the calculation of the Herfindahl-index. This results in the Herfindahl-index based on the audit market concentration within the big 4 audit firms that will be used for hypothesis two. In contrary to the data used by Kallapur, Sankaraguruswamy and Zang (2010), the data that is used in this research also includes audit fees paid to Arthur Anderson, a big 5 auditor. Therefore, the calculation of the Herfindahl-index includes the information of all audit fees or all audit clients of the big 5 accounting firms for the year 2002 and data of only the big 4 accounting firms after 2002. For writing purposes, I refer only to the big 4 companies in this research, but I do include data of Arthur Anderson for the year 2002 in the calculations. Because smaller audit firms are excluded from the calculation of audit market concentration, the companies that are audited by non-big 4 audit firms, are excluded from the dataset too. In the regression model regarding hypothesis one, I control for the higher quality audits provided by the big 4 auditors. But since hypothesis two only uses data from these auditors, the control variable *BIG_AUDITOR* will be excluded.

3.6 Adjustments for hypothesis three

To test if the size of the audit market has an impact on the effect of audit market concentration on goodwill impairments, the interaction effect is added to the logistic regression analysis (2). This results in the logistic regression analysis (3).

$$IMP_{it} = \beta_0 + \beta_1 HERF + \beta_2 AUDITMARKET + \beta_3 HERF * AUDITMARKET + \beta_x CONTROLS_{it} + YEAR\_FE + \varepsilon_{it} \quad (3)$$

In this regression model, *i* denotes the firm, *t* denotes the year, IMP is a dummy variable that is equal to one if an impairment was made and zero otherwise. *HERF* is the value of the Herfindahl-index that measures audit market concentration. *HERF* can be calculated using all audit fees or audit clients. *CONTROLS* is a vector of different control variables. *YEAR_FE* stands for year fixed effects. The control variables are equal to the control variables of model (2), but the variable *AUDITMARKETS* is removed from the control variables and is a variable of interest in model (3). *AUDITMARKET* is the size of the audit market, calculated by the natural logarithm of the total audit fees, assets or revenues of all audit clients per thousand in a year in an MSA. The most common proxy for the audit market size, is the total audit fees. However, the Herfindahl-index based on audit fees also uses this information. To make sure that this will not cause any problems I also calculate the size of the audit market based on the proxies of Eshleman (2013). The size of the audit clients, measured by assets or revenues, also give an indication of the size of the audit market.

4. Data

4.1 Data collection

The company related data is obtained from COMPUSTAT for the fiscal years 2002 until 2019. SFAS 142 went into effect at the end of 2001. Since I match the Herfindahl-index of a certain MSA with the company data, the company must be headquartered in an MSA. Not all companies are located in an MSA, these observations will be lost. The data is merged with Audit Analytics data to obtain the audit fee related information. Two restrictions apply for the data that is left. Firstly, the company must have a material level of goodwill. Lastly, the company's book value must be higher than the market value of the company. Table 2 outlines the sample selection process.

Table 2

Sample selection

	Observations
Observations with all required COMPUSTAT data (fiscal year 2002-2019)	146,604
Less:	
Observations without MSA data	(33,193)
Observations without fee data in Audit Analytics	(34,649)
Observations without a material level of goodwill	(41,265)
Observations without a book value that is higher than the market value	(33,538)
Total observations for hypotheses 1 and 3:	**3,959**
Less:	
Observations that are audited by a non-big 4 auditor	(1,711)
Total observations for hypothesis 2:	**2,248**

Note: Goodwill with a value higher than one percent of the company's assets is considered a material level of goodwill.

4.2 Descriptive statistics

Table 3 shows the descriptive statistics of the 3959 firm-year observations. 22.5% of the observations have a goodwill impairment. The Herfindahl-index based on fees or clients shows different results. This is plausible because the Herfindahl-index based on clients does not take the size of the audit into account. However, this does show that the definition of audit market concentration is important. The Herfindahl-index based on the number of clients is lower than the index based on fees in every column of table 3, they follow a similar distribution. For this study, all continuous variables are winsorized at the 1st and 99th percentile.

Multicollinearity does not exist between the variables. Table 4 shows the correlation between all variables that are used in various regression analysis. The correlations between all variables are relatively low, except for the correlations between variables that are used to

measure the same concept. That is the correlation between *herf_fees* and *herf_clients* (correlation = 0.798) and the correlations between the different proxies for the size of the audit market. This indicates that the different proxies for the same concept are valid for further analysis. The VIF scores are below the threshold of 10. According to Hair, Anderson, Tatham and Black (1995), a VIF score below 10 suggests multicollinearity does not influence the results. VIF scores are found in Appendix 4

Table 3

Descriptive statistics

Variable	N	Mean	Sd	Min	P25	Median	P75	Max
Imp	3959	0.225	0.418	0.000	0.000	0.000	0.000	1.000
herf_fees	3959	0.308	0.150	0.137	0.231	0.255	0.322	1.000
herf_clients	3959	0.154	0.145	0.022	0.085	0.116	0.180	1.000
ln_auditfees	3959	4.040	1.294	0.914	3.086	4.029	5.014	7.054
nonauditfees	3959	0.313	0.529	0.000	0.035	0.152	0.353	3.597
ln_assets	3959	5.956	2.038	1.780	4.453	5.968	7.327	11.191
loss	3959	0.186	0.389	0.000	0.000	0.000	0.000	1.000
leverage	3959	2.368	3.282	-24.114	0.544	1.139	2.569	64.242
goodwill	3959	0.159	0.159	0.009	0.037	0.097	0.237	0.958
imp_pct	3959	0.273	0.207	0.000	0.102	0.227	0.404	0.998
big_auditor	3959	0.568	0.495	0.000	0.000	1.000	1.000	1.000
sp500	3959	0.153	0.360	0.000	0.000	0.000	0.000	1.000
auditmarket_fees	3959	18.391	1.994	11.997	17.350	18.785	19.780	21.170
auditmarket_assets	3959	19.613	2.553	11.028	18.438	20.096	21.178	23.182
auditmarket_revenue	3959	18.494	2.360	10.019	17.615	19.180	20.114	21.199
auditor_change	3959	0.105	0.307	0.000	0.000	0.000	0.000	1.000
ceo_change	3959	0.049	0.215	0.000	0.000	0.000	0.000	1.000
cfo_change	3959	0.004	0.059	0.000	0.000	0.000	0.000	1.000

Note: This table presents the descriptive statistics for the full sample. Variable definitions are displayed in Appendix 1.

Table 4

Variable correlation matrix

Variable	*herf_clients*	*herf_fees*	*ln_auditfees*	*nonauditfees*	*ln_assets*	*loss*	*leverage*	*goodwill*	*imp_pct*
herf_clients	1.000								
herf_fees	0.798 ***	1.000							
ln_auditfees	-0.080	-0.071	1.000						
nonauditfees	0.062	0.065	-0.238*	1.000					
ln_assets	0.068	0.081	0.769***	-0.010	1.000				
loss	-0.064	-0.099	-0.207**	0.009	-0.334***	1.000			
leverage	0.194	0.194**	0.046	0.006	0.375*	-0.080	1.000		
goodwill	-0.078	-0.096	0.000	0.007	-0.148	0.073	-0.233**	1.000	
imp_pct	-0.029	-0.012	-0.151**	0.004	-0.175**	0.133	0.053	-0.031	1.000
big_auditor	0.016	-0.013	0.504***	0.089	0.467***	-0.127*	-0.028	-0.030	-0.156*
sp500	-0.002	0.011	0.384***	-0.035	0.427***	-0.148**	0.025	-0.026	-0.148**
auditmarket_fees	-0.596***	-0.662***	0.186	-0.107	-0.005	0.070	-0.197**	0.094	-0.029
auditmarket_assets	-0.549***	-0.618***	0.158	-0.080	0.010	0.061	-0.152**	0.074	-0.034
auditmarket_revenue	-0.609***	-0.663***	0.164	-0.079	-0.011	0.054	-0.213**	0.092	-0.021
auditor_change	-0.010	-0.016	-0.198**	0.035	-0.141	0.066	-0.024	0.063	0.046
ceo_change	-0.025	-0.019	0.199	-0.013	0.170	-0.034	-0.009	0.006	-0.035
cfo_change	-0.009	0.000	0.059	-0.014	0.048	-0.007	-0.008	0.006	0.034
fyear	-0.034	0.002	0.315**	-0.256**	0.263*	-0.080	0.044	-0.045	-0.091

Table 4

Variable correlation matrix, continued

Variable	*big_auditor*	*sp500*	*auditmarket_ fees*	*auditmarket_ assets*	*auditmarket_ revenue*	*auditor_ change*	*ceo_ change*	*cfo_ change*	*fyear*
big_auditor	1.000								
sp500	0.300	1.000							
auditmarket_fees	0.029	0.060	1.000						
auditmarket_assets	0.045	0.060	0.968***	1.000					
auditmarket_revenue	0.053	0.064	0.968***	0.952***	1.000				
auditor_change	-0.067	-0.068	-0.001	0.006	0.003	1.000			
ceo_change	0.143	0.181	0.045	0.041	0.049	-0.040	1.000		
cfo_change	0.052	0.010	-0.004	-0.005	-0.002	-0.007	0.065	1.000	
fyear	-0.113	0.155	0.136	0.115	0.091	-0.128	0.057	-0.034	1.000

Note: Variable definitions are displayed in Appendix 1. *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels respectively for a two tailed test.

Table 5 shows the mean of all variables for the company data divided into two groups, company years in which a goodwill impairment was made and company years in which no goodwill impairment was made. The comparison of the means of the Herfindahl-indices based on audit fees and on audit clients are significantly different. The Herfindahl-index is between 0.02 and 0.025 lower when a goodwill impairment is made. This suggests that lower audit market concentration is associated with higher auditor independence. Higher audit fees, assets, losses, book to market ratios, audit markets, CEO changes and CFO changes are associated with more goodwill impairments. The group of companies that have made a goodwill impairment, are more likely to be audited by a big 4 auditor and included in the S&P500 index. Companies that did not make a goodwill impairment have higher non-audit fees on average.

Table 5

Mean comparison

	Imp = 0		***Imp = 1***				
Variable	**N**	**Mean**	**N**	**Mean**	**Diff**	***t*-statistic**	***p*-value**
herf_fees	3068	0.312	891	0.292	0.020	4.002	0.000***
herf_clients	3068	0.160	891	0.134	0.025	5.538	0.000***
ln_auditfees	3068	3.891	891	4.554	-0.663	-14.133	0.000***
nonauditfees	3068	0.332	891	0.248	0.085	4.589	0.000***
ln_assets	3068	5.858	891	6.295	-0.438	-5.711	0.000***
loss	3068	0.175	891	0.224	-0.049	-3.152	0.002***
leverage	3068	2.409	891	2.229	0.180	1.447	0.148
goodwill	3068	0.158	891	0.162	-0.004	-0.716	0.474
imp_pct	3068	0.261	891	0.314	-0.053	-6.323	0.000***
big_auditor	3068	0.548	891	0.635	-0.087	-4.711	0.000***
sp500	3068	0.144	891	0.181	-0.036	-2.525	0.012**
auditmarket_fees	3068	18.284	891	18.762	-0.478	-7.075	0.000***
auditmarket_assets	3068	19.509	891	19.968	-0.458	-5.153	0.000***
auditmarket_revenue	3068	18.379	891	18.888	-0.510	-6.511	0.000***
auditor_change	3068	0.107	891	0.098	0.010	0.841	0.401
ceo_change	3068	0.037	891	0.088	-0.050	-4.968	0.000***
cfo_change	3068	0.002	891	0.010	-0.008	-2.470	0.014**

Note: This table presents the comparison between the means of the group when *imp = 0*, which indicates that no goodwill impairment was made and for the group when *imp = 1*, which indicates that a goodwill impairment was made. This table presents the descriptive statistics for the full sample. Variable definitions are displayed in Appendix 1. *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels respectively for a two tailed test.

5. Results

5.1 Hypothesis one

Table 6 shows the output of the logistic regression analysis. Column (1) shows the effect of the Herfindahl-index based on the audit fees on goodwill impairments. *herf_fees* is not significant. Column (2) shows the effect of the Herfindahl-index based on the audit clients on goodwill impairments. *herf_clients* is not significant. This suggests that audit market concentration does not influence auditor independence.

Not all the signs of the coefficients match the expected sign. The coefficient of *nonauditfees* is positive and marginally significant (coefficient = 0.199, z-score = 1.919 and coefficient = 0.200, z-score = 1.929). An increase in the relative amount of non-audit fees increases the probability of a goodwill impairment, which contradicts the findings of Carcello et al., (2020). The coefficient of *ln_assets* is negative and highly significant (coefficient = -0.191, z-score = -4.381 and coefficient = -0.208, z-score = -4.690). This suggests that smaller companies are more likely to impair goodwill, which also contradicts Carcello et al., (2020). The coefficient of *loss* is positive and highly significant (coefficient = 0.396, z-score = 3.654 and coefficient = 0.389, z-score 3.590). Companies that record a loss are more likely to impair goodwill, this is not in line with the expectation that companies that make a loss will take a big bath (Jordan and Clark, 2004) but confirms the findings of Hayn and Hughes (2006). They find that losses indicate a goodwill impairment.

The coefficients of most other significant control variables are in line with the findings of prior research and the expectations. The coefficient of *ln_auditfees* is positive and highly significant (coefficient = 0.638, z-score = 9.555 and coefficient = 0.664, z -score = 9.801). An increase in the audit fees, increases the probability of a goodwill impairment, which matches the expectations. The variable *imp_pct* is positive and highly significant (coefficient = 1.302, z-score = 6.404 and coefficient = 1.297, z-score = 6.369). When the percentage that a company's market value is below the book value of the company increases, the likelihood of a goodwill impairment increases too. The variable *auditmarket_fees* is positive and marginally significant only in column (1). Goodwill impairments are slightly more likely to occur in large audit markets. The dummy variables that indicate a change in the auditor, CEO or CFO are positive and significant in both columns. A change in the auditor, CEO or CFO increases the probability of a goodwill impairment, which matches the expectations. The pseudo-R-squared for this logistic regression model is above 0.1, this suggests the model is doing relatively well in explaining goodwill impairment decisions. A pseudo-R-squared between 0.2 and 0.4 suggests an excellent fit (McFadden, 2021). For robustness, the audit market size is also calculated with the total assets or total revenues of all the audit clients. The results do not change when using the different definitions of audit market size but are not reported for brevity.

Table 6

Logistic regression model, full sample

		(1)		(2)	
Variable	**Expected sign**	**Coef**	**z-score**	**Coef**	**z-score**
herf_fees	**?**	**0.112**	**0.279**		
herf_clients	**?**			**-0.486**	**-1.170**
ln_auditfees	+	0.638	9.555***	0.664	9.801***
nonauditfees	-	0.199	1.919*	0.200	1.929*
ln_assets	?	-0.191	-4.381***	-0.208	-4.690***
loss	?	0.396	3.654***	0.389	3.590***
leverage	-	0.004	0.224	0.007	0.444
goodwill	+	-0.150	-0.561	-0.167	-0.622
imp_pct	+	1.302	6.404***	1.297	6.369***
big_auditor	+	0.023	0.214	0.019	0.170
sp500	+	-0.115	-0.941	-0.104	-0.854
auditmarket_fees	+	0.058	1.949*	0.036	1.338
auditor_change	+	0.301	2.159**	0.314	2.243**
ceo_change	+	0.572	3.421***	0.567	3.391***
cfo_change	+	1.201	1.955*	1.216	1.976**
intercept		-1.874	-2.550**	-1.404	-2.140**
Year fixed effects		Included		Included	
Observations		3959		3959	
Pseudo R^2		0.105		0.107	
Adj pseudo R^2		0.089		0.091	
Area under ROC		0.720		0.721	

Note: This table presents the results of the logistic regression analysis for hypothesis one. Appendix 1 shows variable definitions. The dependent variable is *imp.* Year fixed effects are not reported for brevity. The variable of interest is indicated with bold text. *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels respectively for a two tailed test. The R-squared for this logistic regression model is based on the McFadden's (2021) pseudo-R-squared and the adjusted pseudo-R-squared.

5.2 Hypothesis two

Table 7 shows the output of the regression analysis regarding the logistic regression model to test hypothesis two. The data only includes companies that are audited by a big 4 accounting firm, since the Herfindahl-index that is used in this model, represents the audit market concentration within the big 4 accounting firms. The results are similar to the results of table 6. *Herf_fees* and *herf_clients* are not significant. This suggests that audit market concentration within the big 4 accounting firms does not influence auditor independence. The variable *loss* is not significant in table 7, table 6 shows highly significant results for the variable *loss*. This suggests that big 4 accounting firms do not use the same information regarding losses when considering whether a goodwill impairment needs to be made compared to non-big 4 accounting firms. The coefficient *auditor_change* also changed from significant in table 6, to

not significant in table 7. This suggests that switching from a big 4 accounting firm to another big 4 accounting firm does not improve auditor independence. For robustness, the audit market size is also calculated with the total assets or total revenues of all the audit clients. The results do not change when using the different definitions of audit market size but are not reported for brevity.

Table 7
Logistic regression model, reduced sample

		(1)		(2)	
Variable	**Expected sign**	**Coef**	**z-score**	**Coef**	**z-score**
herf_fees	**?**	**0.318**	**0.586**		
herf_clients	**?**			**0.143**	**0.255**
ln_auditfees	+	0.597	6.598***	0.600	6.628***
nonauditfees	-	0.209	1.647*	0.20651	1.636
ln_assets	?	-0.243	-4.170***	-0.243	-4.177***
loss	?	0.250	1.594	0.247	1.579
leverage	-	0.016	0.742	0.016	0.745
goodwill	+	-0.510	-1.344	-0.509	-1.337
imp_pct	+	1.588	5.682***	1.592	5.695***
sp500	+	0.017	0.124	0.018	0.135
auditmarket_fees	+	0.122	2.478**	0.110	2.380**
auditor_change	+	0.326	1.585	0.326	1.587
ceo_change	+	0.710	3.918***	0.711	3.923***
cfo_change	+	1.176	1.868*	1.186	1.880*
intercept		-3.048	-2.664***	-2.748	-2.570**
Year fixed effects		Included		Included	
Observations		2248		2248	
Pseudo R^2		0.121		0.121	
Adj pseudo R^2		0.096		0.096	
Area under ROC		0.733		0.733	

Note: This table presents the results of the logistic regression analysis for hypothesis two. Appendix 1 shows variable definitions. The dependent variable is *imp.* Year fixed effects are not reported for brevity. The variable of interest is indicated with bold text. *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels respectively for a two tailed test. The R-squared for this logistic regression model is based on the McFadden's (2021) pseudo-R-squared and the adjusted pseudo-R-squared.

5.3 Hypothesis three

Table 8 presents the results of the logistic regression model using equation (3). The results regarding the control variables are similar to the results of table 6. Interestingly, the results of variables of interest changed when the interaction effect with the size of the audit market is included. Column (1) shows significant results for the variable *herf_fees* (z-score = -2.148). The coefficient of -5.301 indicates that an increase in the audit market concentration, will

decrease auditor independence if the size of the audit market would be zero. However, the interaction term *herf_fees * auditmarket_fees* is positive and significant (coefficient = 0.346, z-score = 2.244). This suggests that an increase in the size of the audit market, auditor independence will go up if the audit market concentration stays constant. The size of the audit market could influence multiple aspects of competition. For example, the economies of scale, institutional incentives or the potential auditor changes are influenced by the combination of audit market concentration and the audit market size. Therefore, the effect of audit market concentration depends on the size of the audit market.

Table 8

Logistic regression model, including the interaction effect with audit market size based on fees

		(1)		(2)	
Variable	**Expected sign**	**Coef**	**z-score**	**Coef**	**z-score**
*herf_fees * auditmarket_fees*	**?**	**0.346**	**2.244****		
herf_fees	**?**	**-5.301**	**-2.148****		
*herf_clients * auditmarket_fees*	**?**			**0.129**	**0.901**
herf_clients	**?**			**-2.412**	**-1.099**
auditmarket_fees	**+**	**-0.042**	**-0.789**	**0.018**	**0.544**
ln_auditfees	+	0.661	9.743***	0.663	9.783***
nonauditfees	-	0.197	1.893*	0.202	1.950*
ln_assets	?	-0.207	-4.677***	-0.207	-4.674***
loss	?	0.395	3.640***	0.389	3.589***
leverage	-	0.006	0.384	0.007	0.437
goodwill	+	-0.197	-0.731	-0.179	-0.666
imp_pct	+	1.308	6.417***	1.303	6.392***
Big-auditor	+	0.012	0.109	0.013	0.118
sp500	+	-0.115	-0.941	-0.108	-0.884
auditor_change	+	0.320	2.284**	0.032	2.260**
ceo_change	+	0.565	3.378***	0.568	3.398***
cfo_change	+	1.211	1.958*	1.208	1.958*
intercept		-0.316	-0.312	-1.136	-1.575
Year fixed effects		Included		Included	
Observations		3959		3959	
Pseudo R^2		0.107		0.107	
Adj pseudo R^2		0.091		0.091	
Area under ROC		0.721		0.721	

Note: This table presents the results of the logistic regression analysis for hypothesis three. Appendix 1 shows variable definitions. The dependent variable is *imp.* Year fixed effects are not reported for brevity. The variable of interest is indicated with bold text. *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels respectively for a two tailed test. The R-squared for this logistic regression model is based on the McFadden's (2021) pseudo-R-squared and the adjusted pseudo-R-squared.

Table 9 shows the marginal effect of audit market concentration on auditor independence, given a certain audit market size. The different slopes of the log odds when the audit market size increases. The effect is significant for larger audit markets (*auditmarket_fees* = 19, z-score = 1.974).

Table 9

Average marginal effects of herf_fees conditional on auditmarket_fees

Variable	auditmarket_fees	AME	SE	z-score	lower	upper
herf_fees	11	-1.494	0.843	-1.771*	-3.146	0.159
herf_fees	12	-1.147	0.713	-1.610	-2.544	0.249
herf_fees	13	-0.801	0.593	-1.350	-1.965	0.362
herf_fees	14	-0.455	0.494	-0.921	-1.424	0.513
herf_fees	15	-0.109	0.428	-0.255	-0.949	0.731
herf_fees	16	0.237	0.413	0.574	-0.573	1.047
herf_fees	17	0.583	0.453	1.287	-0.305	1.471
herf_fees	18	0.929	0.536	1.733*	-0.122	1.980
herf_fees	19	1.275	0.646	1.974**	0.009	2.542
herf_fees	20	1.621	0.771	2.102**	0.110	3.133
herf_fees	21	1.968	0.906	2.173**	0.193	3.742
herf_fees	22	2.314	1.045	2.213**	0.265	4.362
herf_fees	23	2.660	1.189	2.238**	0.330	4.989

Note: The results are based on the logistic regression corresponding with column one of table 8. AME denotes the average marginal effect and is displayed as log odds. SE denotes the standard error. *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels respectively for a two tailed test.

These results should be treated with caution. The formula of the Herfindahl-index (1) based on the audit fees includes the total audit fees. The size of the audit market is also based on the total audit fees. This could bias the results, but given a certain audit market size, the Herfindahl-index could still range from zero to one. Appendix 5 and Appendix 6 show the regression results with a different proxy for the size of the audit market, the total assets of all audit clients and the total revenues of all audit clients respectively. When the total assets of all audit clients are used as a proxy for the size of the audit market, the significance of the interaction term *herf_fees * auditmarket_assets* and the variable *herf_fees,* stays marginally above the ten percent significance cut-off level. However, when the total revenues of all audit clients are used as a proxy for the size of the audit market, the significance of the interaction term *herf_fees * auditmarket_revenue* and the variable *herf_fees,* stay below the ten percent significance cut-off level. The variables of interest regarding the model that includes *herf_clients* are not significant. This shows that the results are not robust for different definitions of audit market concentration and the size of the audit market. However, the coefficients are similar in size and sign.

6. Conclusion

In the last years policymakers have expressed their concerns for the potential negative effects of audit market concentration (U.S. Treasury, 2008; The American Assembly, 2005; Government Accountability Office, 2003; Oxera, 2006). Prior research has not reached a consensus on this topic. Audit market concentration influences the audit market competition. A higher audit market concentration could lead to a stronger position of the auditor because lowballing decreases and institutional incentives, like reputation loss, increase. This could lead to a more sceptical approach of the auditor. However, a higher audit market concentration could also compromise auditor independence. Since the costs of potential client loss increase when lowballing decreases and the clients are less likely to switch to another auditor.

To test whether audit market concentration influences auditor independence, a component of audit quality, I use a logistic regression analysis. The Herfindahl-index is used to calculate audit market concentration on MSA level in the United States. To proxy for auditor independence, I follow the steps of Carcello et al., (2020). After SFAS 142 was imposed, companies were required to test if goodwill still holds its value and make an impairment if necessary. Because managers have incentives to manipulate this account, it requires an independent auditor to impair goodwill. To make sure a goodwill impairment is justified, only company-year observations are kept if the book value is higher than the market value of a company. The logistic regression model includes control variables based on prior literature and year fixed effects to control for regulation changes that improve goodwill accounting over the years.

The logistic regression analysis shows that audit market concentration does not compromise nor improve auditor independence, independent of the definition of audit market concentration. Audit market concentration within the big 4 accounting firms also does not influence auditor independence. However, when including the interaction effect of audit market concentration with the size of the audit market, it shows significant results when audit market concentration is based on the audit fees and audit market size is calculated using total audit fees or total revenues of all audit clients. However, these results should be treated with caution because the results are no longer significant when market concentration is calculated with the number of audit clients or when audit market size is calculated using the value of assets of all audit clients.

The interaction effect of audit market concentration based on the audit fees with the size of the audit market, measured by the natural logarithm of the total audit fees, is positive. While the coefficient of the Herfindahl index is negative. This suggests that in the smallest audit markets, an increase in audit market concentration will bring about less auditor independence. But an increase in audit market concentration will increase auditor independence in larger audit markets. This could explain the mixed findings of prior literature. Theory explains that higher audit market concentration has a positive effect on auditor independence in several ways (reputation loss, clients switches, lowballing). These effects increase if the size of the audit market increases. Theory can also explain why an increasing

audit market concentration will decrease auditor independence. The stronger position of the auditor might bring about a less sceptical approach. This effect might only exist in small audit markets.

7. Limitations and suggestions for further research

This research has certain limitations. Firstly, the Herfindahl-index is calculated for existing levels of audit market concentration. Thus, the results only apply for existing levels of audit market concentration. Secondly, the results of this research are not robust for different definitions of audit market concentration or the size of the audit market. This makes it difficult to make decisions based on the findings of this research. Thirdly, this research does not differentiate for the potential effects of audit market concentration. Theory suggests that audit market concentration influences lowballing, institutional incentives, audit fees and client switches. This research only focusses on the direct effect of audit market concentration on auditor independence.

However, this research contributes to the literature in multiple ways. It shows that the interaction of audit market concentration with the size of the audit market should be considered. Future research can use this interaction term to recalculate prior findings. Future research can go further by analysing different components of audit quality that have not been considered. For example, what is the effect of audit market concentration on the economies of scale for auditors? Future research could also go further by analysing the indirect effects of audit market concentration on different components of audit quality.

Literature

Bandyopadhyay, S. P., Chen, C., and Yu, Y. (2014). Mandatory audit partner rotation, audit market concentration, and audit quality: Evidence from China. *Advances in Accounting*, *30*(1), 18-31.

Beatty, A., and Weber, J. (2006). Accounting discretion in fair value estimates: An examination of SFAS 142 goodwill impairments. *Journal of Accounting Research*, *44*(2), 257-288.

Beatty, R. P., and Zajac, E. J. (1987). CEO change and firm performance in large corporations: Succession effects and manager effects. *Strategic Management Journal*, *8*(4), 305-317.

Becker, C. L., DeFond, M. L., Jiambalvo, J., and Subramanyam, K. R. (1998). The effect of audit quality on earnings management. *Contemporary Accounting Research*, *15*(1), 1-24.

Boone, J. P., Khurana, I. K., and Raman, K. K. (2012). Audit market concentration and auditor tolerance for earnings management. *Contemporary Accounting Research*, *29*(4), 1171-1203.

Brown, L. D. (1997). Analyst forecasting errors: Additional evidence. *Financial Analysts Journal*, *53*(6), 81-88.

Brown, K., and Dugan, I. J. (2002). Arthur Andersen's Fall From Grace Is a Sad Tale of Greed and Miscues. *Wall Street Journal.* https://www.wsj.com/articles/SB1023409436545200

Carcello, J. V., Neal, T. L., Reid, L. C., and Shipman, J. E. (2020). Auditor independence and fair value accounting: An examination of nonaudit fees and goodwill impairments. *Contemporary Accounting Research*, *37*(1), 189-217.

Chaney, P. K., and K. Philipich. (2002). Shredded reputation: The cost of audit failure. *Journal of Accounting Research*, *40*(4), 1221–45.

Chaney, P. K., Jeter, D. C., and Shaw, P. E. (2003). The impact on the market for audit services of aggressive competition by auditors. *Journal of Accounting and Public Policy*, *22*(6), 487-516.

Choi, J. H., Kim, C., Kim, J. B., and Zang, Y. (2010). Audit office size, audit quality, and audit pricing. *Auditing: A Journal of Practice and Theory*, *29*(1), 73-97.

DeAngelo, L. E. (1981). Auditor independence,'low balling', and disclosure regulation. *Journal of Accounting and Economics*, *3*(2), 113-127.

Deis Jr, D. R., and Giroux, G. A. (1992). Determinants of audit quality in the public sector. *Accounting Review*, 462-479.

DeFond, M. L., Francis, J. R., and Hu, X. (2011). The geography of SEC enforcement and auditor reporting for financially distressed clients. *Available at SSRN*.

Fox, R. G., III. (2008). Remarks before the 2008 AICPA National Conference on Current SEC and PCAOB Developments, https://www.sec.gov/news/speech/2008/spch120808rgf.htm

DeFond, M. L., and Lennox, C. S. (2011). The effect of SOX on small auditor exits and audit quality. *Journal of Accounting and Economics*, *52*(1), 21-40.

Deis Jr, D. R., and Giroux, G. A. (1992). Determinants of audit quality in the public sector. *Accounting Review*, 462-479.

Dufwenberg, M., and Gneezy, U. (2000). Price competition and market concentration: an experimental study. *International Journal of Industrial Organization*, *18*(1), 7-22.

Eshleman, J. D. (2013). The effect of audit market concentration on audit pricing and audit quality: The role of the size of the audit market. *LSU Doctoral Dissertations,* 1317.

Francis, J.R., K. Reichelt, and D. Wang. (2005). The pricing of national and city-specific reputations for industry expertise in the US audit market. *The Accounting Review 80*(1), 113-136.

Francis, J. R., Michas, P. N., and Seavey, S. E. (2013). Does audit market concentration harm the quality of audited earnings? Evidence from audit markets in 42 countries. *Contemporary Accounting Research*, *30*(1), 325-355.

Francis, J. R., and Yu, M. D. (2009). Big 4 office size and audit quality. *The Accounting Review*, *84*(5), 1521-1552.

Geiger, M. A., and North, D. S. (2006). Does hiring a new CFO change things? An investigation of changes in discretionary accruals. *The Accounting Review*, *81*(4), 781-809.

Government Accountability Office. (2003). Public Accounting Firms: Mandated Study on Consolidation and Competition. *Washington, DC: Government Printing Office*.

Gunn, J. L., Kawada, B. S., and Michas, P. N. (2019). Audit market concentration, audit fees, and audit quality: A cross-country analysis of complex audit clients. *Journal of Accounting and Public Policy*, *38*(6), 106693.

Hair, J. F. Jr., Anderson, R. E., Tatham, R. L., and Black, W. C. (1995). Multivariate Data Analysis (3rd ed). New York: Macmillan.

Harrington, J., C. Nunes, and G. Roland. (2012). In Goodwill Impairment Study, edited by D. Phelps. Morristown, NJ: Financial Executives Research Foundation, https://www.duffandphelps.com/insights/publications/goodwill-impairment/2012-goodwill-impairment-study

Hoitash, R., Markelevich, A., and Barragato, C. A. (2007). Auditor fees and audit quality. *Managerial Auditing Journal. 22*(8), 761-786.

Huang, T. C., Chang, H., and Chiou, J. R. (2016). Audit market concentration, audit fees, and audit quality: Evidence from China. *Auditing: A Journal of Practice and Theory*, *35*(2), 121-145.

Hayn, C., and Hughes, P. J. (2006). Leading indicators of goodwill impairment. *Journal of Accounting, Auditing and Finance*, *21*(3), 223-265.

Iyer, V. M., and Iyer, G. S. (1996). Effect of Big 8 mergers on audit fees: Evidence from the United Kingdom. *Auditing*, *15*(2), 123.

Jordan, C. E., and Clark, S. J. (2004). Big bath earnings management: the case of goodwill impairment under SFAS No. 142. *Journal of Applied Business Research (JABR)*, *20*(2).

Kallapur, S., Sankaraguruswamy, S., and Zang, Y. (2010). Audit market concentration and audit quality. *Available at SSRN 1546356*.

Kelly, W. A. (1981). A generalized interpretation of the Herfindahl index. *Southern Economic Journal*, 50-57.

Kim, H., Lee, H., and Lee, J. E. (2015). Mandatory audit firm rotation and audit quality. *Journal of Applied Business Research (JABR)*, *31*(3), 1089-1106.

Krishnan, J. (2005). Audit committee quality and internal control: An empirical analysis. *The Accounting Review*, *80*(2), 649-675.

Kwoka, J. E. (1981). Does the choice on concentration measure really matter?. *The Journal of Industrial Economics*, 445-453.

Kwoka Jr, J. E. (1985). The Herfindahl index in theory and practice. *Antitrust Bull.*, *30*, 915.

Lawrence, A., Minutti-Meza, M., and Zhang, P. (2011). Can Big 4 versus non-Big 4 differences in audit-quality proxies be attributed to client characteristics?. *The Accounting Review*, *86*(1), 259-286.

Martin, S. (1988). Market power and/or efficiency?. *The review of Economics and Statistics*, 331-335.

McFadden, D. (2021). *Quantitative methods for analysing travel behaviour of individuals: some recent developments* (pp. 279-318). Routledge.

McMeeking, K. P., Peasnell, K. V., and Pope, P. F. (2007). The effect of large audit firm mergers on audit pricing in the UK. *Accounting and Business Research*, *37*(4), 301-319.

Muller, K. A., Neamtiu, M., and Riedl, E. (2012). Do managers benefit from delayed goodwill impairments?. *Available at SSRN 1429615*.

Newton, N. J., Wang, D., and Wilkins, M. S. (2013). Does a lack of choice lead to lower quality? Evidence from auditor competition and client restatements. *Auditing: A Journal of Practice and Theory*, *32*(3), 31-67.

Oxera. (2006). *Competition and Choice in the U.K. Audit Market: Prepared for the Department of Trade and Industry and Financial Reporting Council*. Oxford, U.K.: Oxera Consulting.

PCAOB. (2002). AS 2502: *Auditing Fair Value Measurements and Disclosures*.

PCAOB. (2017a). Staff inspection brief: Information about 2017 inspections. Vol. 2017/3. August 2017.

PCAOB. (2017b). Proposed auditing standard: Auditing accounting estimates, including fair value measure-ments and proposed amendments to PCAOB auditing standards. PCAOB Release No. 2017-002. Rulemaking Docket Matter No. 43. June 1, 2017

Pearson, T., and Trompeter, G. (1994). Competition in the market for audit services: The effect of supplier concentration on audit fees. *Contemporary Accounting Research*, *11*(1), 115-135.

Penno, M., and B. Walther. (1996). The concentration of local markets: A study of accounting, advertising and law. *Accounting Horizons*, *10*(2),88–99.

PricewaterhouseCoopers. (2017). *History and milestones*. https://www.pwc.com/us/en/about-us/pwc-corporate-history.html

Ramanna, K., and Watts, R. L. (2012). Evidence on the use of unverifiable estimates in required goodwill impairment. *Review of Accounting Studies*, *17*(4), 749-780.

Reynolds, J. K., and Francis, J. R. (2000). Does size matter? The influence of large clients on office-level auditor reporting decisions. *Journal of Accounting and Economics*, *30*(3), 375-400.

Teoh, S. H. (1992). Auditor independence, dismissal threats, and the market reaction to auditor switches. *Journal of Accounting Research*, *30*(1), 1-23.

Tepalagul, N., and Lin, L. (2015). Auditor independence and audit quality: A literature review. *Journal of Accounting, Auditing and Finance*, *30*(1), 101-121.

Tergesen, A. (2002). How much is the goodwill worth? Business Week, September 2002.

The American Assembly. (2005). The future of the accounting profession: Auditor concentration. NewYork: The American Assembly.

United States Department of Labor. (2014). *SIC Manual | Occupational Safety and Health Administration*. https://www.osha.gov/data/sic-manual

US Census Bureau. (2020). *About*. The United States Census Bureau. https://www.census.gov/programs-surveys/metro-micro/about.html

U.S. Treasury. (2008). Advisory committee on the auditing profession: final report. *October 6*, 2008.

Velte, P., and Stiglbauer, M. (2012). Audit market concentration and its influence on audit quality. *International Business Research*, *5*(11), 146.

Wallman, S. M. (1996). The future of accounting, part III: Reliability and auditor independence. *Accounting Horizons*, *10*(4), 76.

Weiss, L. W. (1979). The structure-conduct-performance paradigm and antitrust. *University of Pennsylvania Law Review*, *127*(4), 1104-1140.

Appendix

Appendix 1

Variable names and definitions

Variable	Variable definition
HERF	The value of the Herfindahl-index, calculated based on audit fees or audit clients. (AUDIT_FEES and ZIP)
IMP	A dummy variable that is equal to one if the company made a goodwill impairment and zero otherwise. (GDWLIP)
LN_AUDITFEES	The natural logarithm of the total audit fees in thousands. (AUDIT_FEES)
NONAUDITFEES	The non-audit fees divided by the total audit fees. (NON_AUDIT_FEES)
LN_ASSETS	The natural logarithm of the total assets of the company in thousands. (AT)
LOSS	A dummy variable that is equal to one if the company made a loss and zero otherwise. (GP)
AUDITMARKET_FEES	The size of the audit market, measured by the natural logarithm of the total audit fees in thousands in an MSA in a year. (AUDIT_FEES)
AUDITMARKET_ASSETS	The size of the audit market, measured by the natural logarithm of the total assets of all audit clients in thousands in an MSA in a year. (MATCHFY_BALSH_ASSETS)
AUDITMARKET_REVENUE	The size of the audit market, measured by the natural logarithm of the total revenues of all audit clients in thousands in an MSA in a year. (matchqu_incmst_rev_ttm)
LEVERAGE	The total short-term and long-term debt divided by the shareholders equity before impairments. (LT and TEQ)
BIG_AUDITOR	A dummy variable that is equal to one if the company is audited by a big 5 auditor and zero otherwise. (AUDITOR_FKEY)
GOODWILL	Goodwill divided by the pre-impairment level of assets. (GDWL)
IMP_PCT	The percentage that a company's market value is below the book value of the company. (BKVLPS and CSHO and MKVALT)
SP500	A dummy variable that is equal to one if the company is listed in the S&P 500 index and zero otherwise. (IS_IN_SP500)
CEO_CHANGE	A dummy variable that is equal to one if the company changed its CEO in the financial year and zero otherwise. (PCEO)
CFO_CHANGE	A dummy variable that is equal to one if the company changed its CFO in the financial year and zero otherwise. (PCFO)
AUDIT_CHANGE	A dummy variable that is equal to one if there is a change in the auditor of the company and zero otherwise. (AUDITOR_FKEY)

Note: Text between the parentheses represents the original variable name in the source before adjustments.

Appendix 2

Descriptive statistics of the reduced sample for hypothesis two

Variable	N	Mean	Sd	Min	P25	Median	P75	Max
imp	2248	0.252	0.434	0.000	0.000	0.000	1.000	1.000
herf_fees_big	2248	0.358	0.158	0.246	0.275	0.295	0.367	1.000
herf_clients_big	2248	0.335	0.146	0.229	0.262	0.283	0.342	1.000
ln_auditfees	2248	4.614	1.202	0.914	3.932	4.710	5.413	7.054
nonauditfees	2248	0.354	0.585	0.000	0.047	0.155	0.392	3.597
ln_assets	2248	6.780	1.850	1.780	5.524	6.702	7.949	11.191
loss	2248	0.144	0.351	0.000	0.000	0.000	0.000	1.000
leverage	2248	2.266	3.080	0.015	0.609	1.202	2.527	64.242
goodwill	2248	0.155	0.147	0.009	0.041	0.097	0.238	0.752
imp_pct	2248	0.245	0.194	0.000	0.091	0.197	0.357	0.998
sp500	2248	0.247	0.431	0.000	0.000	0.000	0.000	1.000
auditmarket_fees	2248	18.442	1.839	11.997	17.457	18.851	19.718	21.170
auditmarket_assets	2248	19.601	2.369	11.028	18.343	20.100	21.117	23.182
auditmarket_revenue	2248	18.442	2.172	10.019	17.589	19.211	20.089	21.199
auditor_change	2248	0.088	0.283	0.000	0.000	0.000	0.000	1.000
ceo_change	2248	0.076	0.264	0.000	0.000	0.000	0.000	1.000
cfo_change	2248	0.006	0.079	0.000	0.000	0.000	0.000	1.000

Note: Variable definitions are displayed in Appendix 1.

Appendix 3

Mean comparison of the reduced sample for hypothesis two

	Imp = 0		Imp = 1				
Variable	**N**	**Mean**	**N**	**Mean**	**Diff**	***t*-statistic**	***p*-value**
herf_fees_big	1682	0.363	566	0.344	0.019	2.636	0.009***
herf_clients_big	1682	0.339	566	0.323	0.016	2.498	0.013**
ln_auditfees	1682	4.470	566	5.041	-0.570	-10.796	0.000***
nonauditfees	1682	0.383	566	0.266	0.117	4.679	0.000***
ln_assets	1682	6.698	566	7.023	-0.325	-3.791	0.000***
loss	1682	0.136	566	0.168	-0.032	-1.780	0.075*
leverage	1682	2.251	566	2.311	-0.060	-0.390	0.697
goodwill	1682	0.156	566	0.155	0.001	0.157	0.875
imp_pct	1682	0.229	566	0.291	-0.062	-6.222	0.000***
sp500	1682	0.238	566	0.272	-0.034	-1.573	0.116
auditmarket_fees	1682	18.297	566	18.871	-0.575	-7.200	0.000***
auditmarket_assets	1682	19.512	566	20.074	-0.562	-7.219	0.000***
auditmarket_revenue	1682	18.380	566	18.979	-0.599	-7.308	0.000***
auditor_change	1682	0.092	566	0.074	0.018	1.371	0.171
ceo_change	1682	0.058	566	0.127	-0.069	-4.555	0.000***
cfo_change	1682	0.003	566	0.016	-0.013	-2.382	0.018**
ln_nonauditfees	1682	0.445	566	0.616	-0.171	-2.592	0.010**

Note: This table presents the comparison between the means of the group when *imp = 0*, which indicates that no goodwill impairment was made and for the group when *imp = 1*, which indicates that a goodwill impairment was made. Variable definitions are displayed in Appendix 1. *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels respectively for a two tailed test.

Appendix 4

VIF scores

Variable	**VIF-score**
herf_fees	1.732
ln_auditfees	4.344
nonauditfees	1.214
ln_assets	4.832
loss	1.191
leverage	1.445
goodwill	1.073
imp_pct	1.157
sp500	1.321
auditmarket	1.828
auditor_change	1.069
ceo_change	1.067
cfo_change	1.015

Note: Variable definitions are displayed in Appendix 1. VIF scores are calculated using the regression model belonging to table 5. A VIF score of 10 or higher is considered problematic.

Appendix 5

Logistic regression model, including the interaction effect with audit market size based on assets

		(1)		(2)	
Variable	**Expected sign**	**Coef**	**z-score**	**Coef**	**z-score**
*herf_fees * auditmarket_assets*	**?**	**0.178**	**1.581**		
herf_fees	**?**	**-3.068**	**-1.621**		
*herf_clients * auditmarket_assets*	**?**			**0.178**	**1.581**
herf_clients	**?**			**-3.068**	**-1.621**
auditmarket_assets	**+**	**-0.031**	**-0.775**	**-0.031**	**-0.775**
ln_auditfees	+	0.677	10.029***	0.677	10.029***
nonauditfees	-	0.203	1.948*	0.203	1.948**
ln_assets	?	-0.214	-4.837***	-0.214	-4.837***
loss	?	0.393	3.622***	0.393	3.622***
leverage	-	0.005	0.294	0.005	0.294
goodwill	+	-0.187	-0.695	-0.187	-0.695
imp_pct	+	1.306	6.416***	1.306	6.416***
Big-auditor	+	0.006	0.059	0.006	0.059
sp500	+	-0.108	-0.880	-0.108	-0.880
auditor_change	+	0.324	2.319**	0.324	2.319**
ceo_change	+	0.569	3.401***	0.569	3.401***
cfo_change	+	1.200	1.943*	1.200	1.943**
intercept		-3.384	-4.250***	-3.384	-4.250***
Year fixed effects		Included		Included	
Observations		3959		3959	
Pseudo R^2		0.106		0.109	
Adj pseudo R^2		0.090		0.092	
Area under ROC		0.720		0.723	

Note: This table presents the results of the logistic regression analysis for hypothesis three. Appendix 1 shows variable definitions. The dependent variable is *imp.* Year fixed effects are not reported for brevity. The variables of interest are indicated with bold text. *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels respectively for a two tailed test. The R-squared for this logistic regression model is based on the McFadden's (2021) pseudo-R-squared and the adjusted pseudo-R-squared.

Appendix 6

Logistic regression model, including the interaction effect with audit market size based on revenues

		(1)		(2)	
Variable	**Expected sign**	**Coef**	**z-score**	**Coef**	**z-score**
*herf_fees * auditmarket_revenue*	**?**	**0.217**	**1.849***		
herf_fees	**?**	**-3.314**	**-1.749***		
*herf_clients * auditmarket_revenue*	**?**			**0.120**	**1.035**
herf_clients	**?**			**-2.261**	**-1.269**
auditmarket_revenue	**+**	**-0.020**	**-0.447**	**0.012**	**0.405**
ln_auditfees	+	0.667	9.868***	0.666	9.855***
nonauditfees	-	0.200	1.927*	0.204	1.966*
ln_assets	?	-0.210	-4.741***	-0.209	-4.718***
loss	?	0.397	3.661***	0.391	3.614***
leverage	-	0.007	0.442	0.008	0.476
goodwill	+	-0.195	-0.726	-0.181	-0.675
imp_pct	+	1.305	6.409***	1.301	6.384***
Big-auditor	+	0.009	0.080	0.011	0.099
sp500	+	-0.116	-0.950	-0.110	-0.898
auditor_change	+	0.322	2.304**	0.318	2.276**
ceo_change	+	0.565	3.377***	0.566	3.388***
cfo_change	+	1.203	1.948*	1.202	1.949*
intercept		-3.691	-4.292***	-4.098	-6.740***
Year fixed effects		Included		Included	
Observations		3959		3959	
Pseudo R^2		0.107		0.107	
Adj pseudo R^2		0.091		0.091	
Area under ROC		0.721		0.721	

Note: This table presents the results of the logistic regression analysis for hypothesis three. Appendix 1 shows variable definitions. The dependent variable is *imp.* Year fixed effects are not reported for brevity. The variable of interest is indicated with bold text. *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels respectively for a two tailed test. The R-squared for this logistic regression model is based on the McFadden's (2021) pseudo-R-squared and the adjusted pseudo-R-squared.

Appendix 7

Logistic regression model with industry fixed effects, full sample

		(1)		(2)	
Variable	**Expected sign**	**Coef**	**z-score**	**Coef**	**z-score**
herf_fees	**?**	**0.128**	**0.314**		
herf_clients	**?**			**-0.504**	**-1.195**
ln_auditfees	+	0.587	7.921***	0.618	8.130***
nonauditfees	-	0.000	-0.193	0.180	1.742*
ln_assets	?	-0.146	-2.984***	-0.168	-3.352***
loss	?	0.456	4.141***	0.448	4.071***
leverage	-	0.037	2.152**	0.039	2.291**
goodwill	+	-0.674	-2.326**	-0.677	-2.335**
imp_pct	+	1.254	6.084***	1.245	6.034***
big_auditor	+	0.029	0.259	0.026	0.234
sp500	+	-0.060	-0.483	-0.047	-0.378
auditmarket_fees	+	0.052	1.705*	0.028	1.010
auditor_change	+	0.302	2.140**	0.312	2.207**
ceo_change	+	0.603	3.548***	0.601	3.542***
cfo_change	+	1.301	2.139**	1.317	2.162**
intercept		-4.441	-4.894***	-4.019	-4.782***
Industry					
Construction		-0.818	0.671	-0.834	-1.246
Finance		-1.138	-1.840*	-1.115	-1.809*
Manufacturing		-0.472	-0.791	-0.481	-0.807
Mining		-0.205	-0.321	-0.188	-0.296
Non-classifiable		0.475	0.702	0.476	0.706
Retail		-0.520	-0.846	-0.531	-0.866
Services		-0.089	-0.149	-0.101	-0.171
Transportation		0.107	0.175	0.125	0.206
Wholesale		-0.402	-0.649	-0.402	-0.651
Year fixed effects		Included		Included	
Observations		3959		3959	
Pseudo R^2		0.120		0.121	
Adj pseudo R^2		0.100		0.101	
Area under ROC		0.735		0.736	

Note: This table presents the results of the logistic regression analysis for hypothesis one. Appendix 1 shows variable definitions. The dependent variable is *imp.* Year fixed effects are not reported for brevity. The variable of interest is indicated with bold text. *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels respectively for a two tailed test. The R-squared for this logistic regression model is based on the McFadden's (2021) pseudo-R-squared and the adjusted pseudo-R-squared. Industry fixed effects are based on the industry classification of the United States Department of Labor (2014).

Appendix 8

Logistic regression model with industry fixed effects, restricted sample

		(1)		(2)	
Variable	**Expected sign**	**Coef**	**z-score**	**Coef**	**z-score**
herf_fees	**?**	**0.464**	**0.844**		
herf_clients	**?**			**0.303**	**0.537**
ln_auditfees	+	0.539	5.467***	0.541	5.493***
nonauditfees	-	0.178	1.396	0.176	1.385
ln_assets	?	-0.181	-2.768***	-0.181	-2.769***
loss	?	0.304	1.913*	0.301	1.894*
leverage	-	0.047	2.115**	0.046	2.107**
goodwill	+	-1.105	-2.684***	-1.104	-2.677***
imp_pct	+	1.644	5.802***	1.648	5.815***
big_auditor	+	0.051	0.374	0.053	0.384
auditmarket_fees	+	0.138	2.737***	0.125	2.655***
auditor_change	+	0.332	1.599	0.333	1.605
ceo_change	+	0.705	3.822***	0.706	3.827***
cfo_change	+	1.241	2.005**	1.249	2.014**
intercept		-6.397	-4.645***	-6.098	-4.634***
Industry					
Construction		-0.438	-0.471	-0.450	-0.482
Finance		-0.682	-0.777	-0.677	-0.771
Manufacturing		0.083	0.096	0.086	0.100
Mining		0.148	0.164	0.144	0.159
Non-classifiable		0.309	0.305	0.308	0.303
Retail		-0.089	-0.101	-0.082	-0.093
Services		0.414	0.480	0.414	0.480
Transportation		0.340	0.389	0.343	0.392
Wholesale		-0.098	-0.111	-0.103	-0.116
Year fixed effects		Included		Included	
Observations		2248		2248	
Pseudo R^2		0.132		0.132	
Adj pseudo R^2		0.100		0.100	
Area under ROC		0.744		0.744	

Note: This table presents the results of the logistic regression analysis for hypothesis two. Appendix 1 shows variable definitions. The dependent variable is *imp.* Year fixed effects are not reported for brevity. The variable of interest is indicated with bold text. *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels respectively for a two tailed test. The R-squared for this logistic regression model is based on the McFadden's (2021) pseudo-R-squared and the adjusted pseudo-R-squared. Industry fixed effects are based on the industry classification of the United States Department of Labor (2014).

Appendix 10

Logistic regression model with industry fixed effects, full sample

		(1)		(2)	
Variable	**Expected sign**	**Coef**	**z-score**	**Coef**	**z-score**
*herf_fees * auditmarket_fees*	**?**	**0.366**	**2.319****		
herf_fees	**?**	**-5.602**	**-2.216****		
*Herf_clients * auditmarket_fees*	**?**			**0.119**	**0.825**
herf_clients	**?**			**-2.297**	**-1.029**
auditmarket_fees	**+**	**-0.056**	**-0.445**	**-0.050**	**-0.397**
ln_auditfees	+	-0.055	-1.012	0.011	0.315
nonauditfees	-	0.617	8.120***	0.618	8.133***
ln_assets	?	0.180	1.736*	0.183	1.770*
loss	?	-0.171	-3.404***	-0.169	-3.364***
leverage	-	0.454	4.115***	0.448	4.070***
goodwill	+	0.039	2.241**	0.039	2.284**
imp_pct	+	-0.704	-2.430**	-0.686	-2.367**
big_auditor	+	1.254	6.078***	1.250	6.055***
sp500	+	0.019	0.171	0.020	0.183
auditor_change	+	0.319	2.255**	0.314	2.224**
ceo_change	+	0.602	3.539***	0.602	3.546***
cfo_change	+	1.319	2.153**	1.312	2.149**
intercept		-2.869	-2.474**	-3.762	-4.186***
Industry					
Construction		-0.757	-1.121	-0.817	-1.218
Finance		-1.080	-1.734*	-1.106	-1.789*
Manufacturing		-0.458	-0.762	-0.478	-0.800
Mining		-0.099	-0.155	-0.168	-0.263
Non-classifiable		0.530	0.778	0.487	0.719
Retail		-0.493	-0.796	-0.518	-0.843
Services		-0.071	-0.117	-0.095	-0.160
Transportation		0.153	0.249	0.129	0.212
Wholesale		-0.389	-0.623	-0.400	-0.645
Year fixed effects		Included		Included	
Observations		3959		3959	
Pseudo R^2		0.122		0.121	
Adj pseudo R^2		0.102		0.101	
Area under ROC		0.736		0.736	

Note: This table presents the results of the logistic regression analysis for hypothesis three. Appendix 1 shows variable definitions. The dependent variable is *imp.* Year fixed effects are not reported for brevity. The variable

of interest is indicated with bold text. *, **, and *** indicate significance at the 0.10, 0.05 and 0.01 levels respectively for a two tailed test. The R-squared for this logistic regression model is based on the McFadden's (2021) pseudo-R-squared and the adjusted pseudo-R-squared. Industry fixed effects are based on the industry classification of the United States Department of Labor (2014).