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Audit Market Concentration and Audit Quality

Abstract

Policymakers and regulators have been concerned about the impact of audit market concentration resulting from decline in the number of audit firms due to mergers and the demise of Arthur Andersen. In this paper we find a positive association between audit market concentration (Herfindahl index) at the MSA level and audit quality (measured by discretionary accruals and the Dechow-Dichev (2002) measure of accrual quality). We control for fixed year effects, therefore our results are unlikely to be affected by the increase in concentration due to Andersen's demise contemporaneous with an increase in audit quality because of regulatory measures such as SOX. Our results are robust to alternative concentration and audit quality measures, and several sensitivity tests attempting to rule out omitted variables correlated with client firms' MSA location or attributes of clients and auditors. Our results are also robust to controls for endogeneity between audit market concentration and audit quality. Our evidence therefore supports the Government Accountability Office (2003, 2008) conclusions that increased audit market concentration is not currently a cause for concern.

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

Audit Market Concentration and Audit Quality

1 Introduction

Audit market concentration has received much attention in recent times, as the number of big audit firms has decreased from eight to six in 1989 and to five in 1998 due to mergers, and to four in 2002 after the demise of Arthur Andersen. In response, the Sarbanes Oxley Act of 2002 (SOX) mandated that the Government Accountability Office (GAO) study the implications of consolidation on competition, client choice, audit fees, and, the focus of this paper, audit quality. The GAO Report (Government Accountability Office, 2003) concludes that increased concentration had reduced client choice, but did not seem to affect price competition in audit markets. On the relation between concentration and audit quality it concludes that the evidence is sparse, and the limited research evidence that is available is mixed and inconclusive (Government Accountability Office, 2003 pp. 35-42). Reflecting continuing concern over audit market concentration, GAO on its own initiative subsequently conducted another study (Government Accountability Office, 2008) which reiterated the conclusions of the previous study. To provide evidence on the relation between concentration and audit quality, GAO surveyed market participants, most of whom said that audit quality had improved, and attributed it to the SOX. Nevertheless, GAO (2008 p. 32) cautions that high concentration could in principle increase or decrease audit quality. The relation between concentration and audit quality is therefore an important issue that remains unresolved.

In this paper we examine the relationship between audit quality (proxied by absolute discretionary accruals and the Dechow and Dichev (2002) measure of accruals quality, as

explained in Section 2.2) and audit market concentration (Herfindahl index) at the city (MSA or metropolitan statistical area) level. Previous research uses going-concern qualifications (DeFond et al., 2002), restatements (Kinney et al., 2004), or accruals-based earnings quality (Becker et al., 1998; Francis et al., 1999; Frankel et al., 2002; Ashbaugh et al., 2003; Chung and Kallapur, 2003; Myers et al., 2003; Larcker and Richardson, 2004; Srinidhi and Gul, 2007) as proxies for audit quality. Following Myers et al. (2003 p. 782), we use accruals-based earnings quality measures because our interest is in a broad measure, not restricted to extreme occurrences such as going-concern audit opinions or restatements.

Within a single country, variations in audit market concentration can be obtained across city markets, markets segmented by client size, or industry. We calculate our primary concentration measure at the city (MSA) level because a large body of research beginning with Francis et al. (1999), described in Section 2.1, argues that audit markets are indeed local. There is also evidence indicating that audit markets are segmented by client size—small audit firms cannot effectively compete with the Big 5 for large clients (Government Accountability Office, 2008 pp. 37-42)—so we also report the results of supplementary analysis in which we calculate concentration separately for large and small clients within each MSA. Given that each Big 4 audit firm has clients in every industry, we doubt that there is any significant industry segmentation of audit markets and do not pursue an analysis of the relationship between industry-level concentration and audit quality.

We find a positive association between audit quality and concentration, after controlling for the determinants of audit quality identified in previous research. Our

results are robust to alternative measures of audit quality and concentration. The results do not statistically vary between subsamples of the data partitioned by MSA size, client firm size, by whether or not all Big 5 audit firms are present in an MSA or not, and by industry-specialist versus non-specialist auditors. A potential threat to the validity of our finding could be that audit market concentration and audit quality are endogenously determined, i.e., if in a particular MSA some audit firms exogenously provide high quality, clients could migrate towards such audit firms, thereby affecting concentration. To address this issue we use an instrumental variables approach with exogenous instruments for audit market concentration, and we continue to find a positive association between concentration and audit quality.

Previous literature on audit market concentration has documented trends in auditor concentration over time (Eichenseher and Danos, 1981; Danos and Eichenseher, 1986; Hogan and Jeter, 1999; Cairney and Young, 2006) or the effect of concentration on audit fees (Simunic, 1980; Maher et al., 1992; Pearson and Trompeter, 1994; Iyer and Iyer, 1996). Our paper adds to the literature by linking audit market concentration to audit quality, an important public policy issue.

To interpret our findings and relate it to a broader literature, we rely on the idea that concentration proxies for competition. This idea comes from the structure-conduct-performance paradigm in the Industrial Organization Economics literature beginning with Bain (1956), where barriers to entry are thought to result in concentration and thereby to higher profits. Although recent work in industrial organization has questioned whether concentration measures competition, the objections relate to inter-industry studies, particularly where the barriers to entry such as advertising and R&D that determine

concentration are endogenous. Sutton, who is prominently associated with the idea that barriers to entry and therefore concentration are endogenous (Sutton, 1991), nevertheless accepts in his survey article (Sutton, 2007 p. 2307) that concentration is a valid measure of competition across different geographical markets within the same industry. In banking, concentration in different geographical markets is commonly used as a measure of competition in those markets, for example in Petersen and Rajan (1995).

Theoretical results in Chaney et al. (2003) link competition to audit quality; the relationship is ambiguous--they show that competition could a priori either reduce or increase audit quality.[1] This is because an increase in competition reduces the profits that can be earned from a client and hence reduces the cost of telling the truth in respect of a client who would prefer otherwise. Increase in competition however also increases the probability of the client switching after being disappointed by the auditor, and so increases the auditor's cost of telling the truth.

As a check of the concentration-competition link in our sample, we estimate an audit fee model with concentration and control variables from previous literature (Sankaraguruswamy and Whisenant, 2009) as independent variables. Since concentration is lower in large MSAs where wages and hence audit fees tend to be high, we control for median wages of accounting profession in the MSA, MSA area, and MSA rank (by population). We use three measures of concentration: (a) concentration for Big 5 clients only, (b) concentration based on audit fees, and (c) on the number of clients. The relation is positive and significant for two measures, (a) and (c). For (b), based on audit fees, the relation is positive and significant but only at the 10 percent level for a one-tailed test.

[1] Among other reasons to expect concentration to affect audit quality, GAO (2003, pp. 36-37) mentions that concentration could affect auditor tenure and audit firm size, which in turn could affect audit quality.

The result therefore supports, albeit weakly, the idea that concentration is associated with less price competition.

Previous empirical papers in auditing have investigated the link between competition and audit quality by focusing on solicitation or bidding restrictions (Jeter and Shaw, 1995; Hackenbrack et al., 2000), with conflicting results. Hackenbrack et al. (2000) find indirect evidence of higher audit quality (clients engaged larger, more specialized, auditors and were more likely to be recognized for reporting excellence) in a regime with restrictions on bidding (low price competition). Jeter and Shaw (1995), on the other hand, find that in the post-solicitation (more competitive) regime auditors were more likely to qualify opinions, which indicates a positive association between competition and audit quality. Thus empirical findings about the competition-quality relationship in auditing have been ambiguous. Our paper adds to the debate by suggesting that competition might be associated with lower audit quality. However, competition has many aspects (price competition, competition for market share, quality competition, etc.) and there are static and dynamic dimensions to quality; we make no claim that our result definitively resolves the ambiguity in prior literature.

Overall, our results support GAO's (2003, 2008) conclusions that existing levels of concentration do not cause problems with audit quality. Indeed, our results suggest the opposite—that concentrated audit markets are associated with higher audit quality. However, given that our study does not resolve the ambiguity in the previous literature, policy prescriptions based on its results are premature. Our result is based on variation in concentration in the existing system and we cannot predict what will happen if concentration increases beyond existing levels if another audit firm goes out of existence

because of bankruptcy or merger. Moreover, public policy may be justifiably concerned about concentration's effect on the choice of auditors available to clients, or the possibility of regulatory capture by a small number of large auditors—issues not addressed in our study.

2 Proxies for audit market concentration and audit quality

2.1 MSA-level Herfindahl index as a measure of audit market concentration

We measure concentration at the local (MSA, i.e., metropolitan statistical area) level. For each MSA and each year, we measure concentration using the Herfindahl index (*H*), computed as the sum of the squares of the ratios of each audit firm's size to the total size of the audit market:

$$H = \sum_{i=1}^{N} [s_i / S]^2,$$

where, N is the total number of audit firms in the MSA; s_i is the size of audit firm i; and S is the total size of audit market in the MSA. Following GAO (2008) we define size of each audit firm (s_i) based on audit revenues, i.e., the total audit fees earned from audit clients listed in Audit Analytics Auditor file. Similarly, we calculate the total size of audit market (S) as the sum of each audit firm's size. If all audit firms are of equal size then H equals $1/N$ and is higher when N is small. For a given N, H is higher when the audit firms' market shares are unequal, i.e., some firms are larger than others. We also measure concentration using four-firm concentration ratios. Our results are similar to those using H, so we do not report them in the tables.

Our ability to obtain variation in concentration within a sample of U.S. clients relies on the assumption that audit markets are local. Penno and Walther (1996), Wallman

(1996), and Francis et al. (1999) argue that audit markets are indeed local. Choi et al. (2008) show that clients of local auditors (auditors located close to the headquarters of the client firm) report lower discretionary accruals and local Big 4 auditors charge lower fees than do non-local Big 4 auditors, suggesting that the audit market structure is more local than national. Consistent with this, Choi et al. (2008) report that 82 percent of clients are audited by auditors through their practice offices located in the same MSA, and 91 percent of clients are audited by audit offices located within 150 miles.

Even if audit market concentration is local, our ability to detect differences in audit quality across local markets depends on audit quality varying across different offices of the same audit firm. Recent research increasingly suggests that incentives (Wallman, 1996; Reynolds and Francis, 2001), expertise (Francis et al., 1999, 2005), and reputation (Chaney and Philipich, 2002) are indeed local; and that this translates into differences in pricing and quality (Krishnan, 2005; Choi et al., 2008, 2009; Francis and Yu, 2009). Wallman (1996) and Reynolds and Francis (2001) argue that auditor independence is more important at the practice office level rather than at the audit firm (national level). Francis et al. (2005) show that auditors who are industry specialists at both the national and local levels charge a fee premium, suggesting a local component to industry expertise. Chaney and Philipich (2002) find that the disclosure of document shredding by Arthur Andersen affected the stock prices of its Houston office clients more than that of its other clients, suggesting a local component to reputation. Choi et al. (2009) and Francis and Yu (2009) show that large city offices provide better quality audit services compared with smaller city offices of the same audit firm, suggesting that audit quality is audit-office-specific rather than audit-firm-specific.

Following Penno and Walther (1996) and Francis et al. (2005), we define each metropolitan area, identified using the U.S. Census Bureau definition of metropolitan statistical areas (MSA), as a local market.[2] Since the evidence also suggests that non-Big 4 auditors cannot effectively compete for large clients, we also calculate concentration separately for large and small clients within each MSA.

One objection to studying the impact of concentration on audit quality could be that concentration and audit quality are endogenous—if some audit firms in a certain MSA exogenously provide higher quality audits, clients may prefer such firms, increasing concentration and resulting in a positive relation between concentration and audit quality.[3] We control for potential endogeneity by using a 2SLS instrumental variables approach, but do not find statistically significant evidence of endogeneity using the Davidson and MacKinnon (1993) test (see Section 4.104.9 below).

We have followed GAO (2008) above in using audit fees as the basis to compute concentration. However, audit fees are associated with certain client-specific attributes (e.g., client audit risk, complexity) and auditor-specific attributes (e.g., Big 5 premium), and such associations could impact its validity as a basis for a concentration measure. Therefore as alternative measures of concentration we calculate the Herfindahl index using (a) the total number of clients for each audit firm and (b) aggregated total assets of all clients for each audit firm as the basis.[4]

[2] When multiple offices from the same audit firm exist in certain MSAs, we assume that they share audit resources and that competition among them is minimal, and thus treat them as the same audit firm.
[3] Alternatively if some audit firms exogenously offer poor quality and clients prefer such firms, a negative relation could arise between concentration and quality. This possibility is less of a concern because it is the opposite of the result we find.
[4] That is, for these alternative measures, we define size of each audit firm (s_i) as the number of their audit clients or the sum of total assets of their audit clients and the total size of audit market in the MSA(S) as the sum of all audit firms' size in the MSA for the calculation of the Herfindahl index.

It is possible that the market structure for audit services among large clients is different from that among smaller clients in certain MSAs because large clients may be able to choose only Big 5 auditors when selecting auditors due to their size and geographic diversity. To take into account the possibility of a two-tier audit market, we compute concentration separately for large clients of Big 5 auditors, and for all other clients of both Big 5 and non-Big 5 auditors in each MSA. We use the size (measured as total assets) of the largest non-Big 5 client in each MSA as the cut-off between two size-groups of clients.[5]

We have posited a linear relation above between concentration and audit quality, but the functional form of this relation could be non-linear. Given that the exact form of the relation is unknown, we follow DeFond and Park (1999) and obtain two transformed concentration measures (based on audit fees) by taking the square root of concentration and by ranking MSAs based on concentration.

2.2 Empirical proxies for audit quality

Following previous studies (Becker et al., 1998; Francis et al., 1999; Frankel et al., 2002; Ashbaugh et al., 2003; Chung and Kallapur, 2003; Myers et al., 2003; Larcker and Richardson, 2004; Srinidhi and Gul, 2007) we use accruals-based earnings quality as measures of audit quality. As our main measure, we use discretionary accruals estimated by the Jones (1991) model as modified by Ball and Shivakumar (2006), which allows for a piecewise-linear relation between cash flows and accruals. As additional measures, we

[5] We assume that all non-Big 5 clients and Big 5 clients smaller than the largest non-Big 5 client have a choice between a Big 5 auditor and a non-big 5 auditor when selecting their auditors while all other Big 5 clients greater than the largest non-Big 5 client have a limited choice only within Big 5 auditors. For these two-tier concentration measures, we define size of each audit firm (s_i) for large-sized (small-sized) client market as the total audit fees earned from their large-sized (small-sized) audit clients and the total size of audit market for large-sized (small-sized) clients in the MSA (S) as the sum of all audit firms' size for large-sized (small-sized) clients in the MSA for the calculation of the Herfindahl index.

use performance-adjusted discretionary accruals suggested by Kothari et al. (2005) and accrual quality measures developed by Dechow and Dichev (2002) as modified by McNichols (2002), and further adapted by Srinidhi and Gul (2007) to the auditing context.

Other audit quality measures used in previous studies include the occurrence of restatements, and auditors' propensity to issue going-concern modified audit opinions. Our focus in this study is on audit quality in a broad cross-section of firms, rather than audit quality in specialized situations such as going-concern modifications or restatements; earnings quality measures are therefore more appropriate as Myers et al. (2003 p. 782) point out.

Earnings quality is the joint product of managers and auditors. Kinney and Martin's (1994) conclusions support the use of earnings quality as a measure of audit quality. They review several studies that examine actual audit work papers to determine which earnings issues were identified by auditors and whether they were adjusted or waived, and conclude that auditors have a pervasive effect on pre-audit earnings. More recent evidence in Nelson et al. (2002) continues to indicate that pre-audit earnings are adjusted in a substantial percentage (44 percent) of cases where the auditor identified a potential misstatement. Because earnings quality could be affected by managers' actions as opposed to auditors' actions, we attempt to control for managers' incentives to mis-state earnings using a set of control variables such as the presence of a loss, leverage, and capital-raising. In sensitivity analysis we also control for other variables such as client

firm complexity (presence of foreign subsidiaries and number of business and geographical segments), and litigation risk.[6]

Another limitation of accruals-based measures is that accruals may be high not because of opportunistic earnings management, but because discretion in accruals may be used by managers to communicate their information (Healy and Palepu, 1993, 1995; Subramanyam, 1996). The Dechow and Dichev (2002) measure controls for the informativeness of accruals and we therefore use it as another measure of audit quality.

2.2.1 Our main proxy for audit quality

Ball and Shivakumar (2006) augment the Jones model and control for the role of accounting conservatism on managers' discretion in reporting earnings by including three additional variables, namely CFO_{jt}/TA_{jt-1}, $DCFO_{jt}$, and $(CFO_{jt}/TA_{jt-1})*DCFO_{jt}$, as follows:

$$ACCR_{jt}/TA_{jt-1} = \beta_1[1/TA_{jt-1}] + \beta_2[(\Delta REV_{jt} - \Delta REC)/TA_{jt-1}] + \beta_3[PPE_{jt}/TA_{jt-1}] + \beta_4[CFO_{jt}/TA_{jt-1}] + \beta_5 DCFO_{jt} + \beta_6[(CFO_{jt}/TA_{jt-1}) * DCFO_{jt}] + \varepsilon_{jt}, \quad (1)$$

where, for firm *j* and in year *t* (or *t - 1*),

ACCR	=	total accruals equal to income before extraordinary items minus cash flow from operations (Compustat #123- Compustat #308);
TA	=	total assets (Compustat #6);
ΔREV	=	changes in net sales (Compustat #12);
ΔREC	=	changes in receivables (Compustat #2);
PPE	=	gross property, plant and equipment (Compustat #7);
CFO	=	cash flows from operations (Compustat #308);
DCFO	=	dummy variable equal to 1 if *CFO* is negative and 0 otherwise; and
ε	=	error term.

[6] We do not use these variables in the main regression because the sample size would decrease substantially for lack of data.

Ball and Shivakumar (2006) argue that accounting accruals incorporate economic losses in a timelier manner than they do economic gains; they incorporate this asymmetry by modeling accruals as a piecewise linear function of current-period cash flows from operations. The dependent variable, total accruals (*ACCR*), and all independent variables are deflated by beginning total assets. Eq. (1) is estimated for each two-digit SIC code industry within each year, provided there are at least 10 observations. Our measure of discretionary accruals is the difference between actual total accruals and the fitted values from Eq. (1). We denote this measure by *DA_BS*. Because audit quality is high when absolute *DA_BS* is low, we use absolute *DA_BS* multiplied by -1 as our proxy for audit quality.

2.2.2 Alternative proxies for audit quality

As alternative measures of audit quality, we first estimate performance-adjusted discretionary accruals using the model suggested by Kothari et al. (2005), which is computed as follows. For each two-digit SIC code industry and year with a minimum of 10 observations, we estimate the cross-sectional version of the modified Jones-model in Eq. (2). Residuals from Eq. (2) are *DA* before adjusting for firm performance.

$$ACCR_{jt} / TA_{jt-1} = \alpha_1[1/TA_{jt-1}] + \alpha_2[(\Delta REV_{jt} - \Delta REC_{jt}) / TA_{jt-1}] + \alpha_3[PPE_{jt} / TA_{jt-1}] + \varepsilon_{jt} \quad (2)$$

Kasznik (1999) and Kothari et al. (2005) point out that unadjusted abnormal accruals are significantly correlated with firm performance. Following Kothari et al. (2005), we match each firm-year observation with another from the same two-digit SIC code with the closest return on assets (*ROA*) to control for firm performance. We then compute performance-adjusted discretionary accruals, namely *DA_KLW*, by taking the difference

between *DA* of one firm (before performance-based adjustment) and *DA* of another firm from the same two-digit SIC code industry that has similar *ROA* in the previous year.

Our second alternate metric for audit quality is the accrual quality measure developed by Dechow and Dichev (2002) model and modified by McNichols (2002). Dechow and Dichev (2002) model earnings quality as accruals quality--accruals are of high quality if they map into past, current, and future cash flows effectively. McNichols (2002) suggests that including the original Jones-model variables (i.e., ΔREV and *PPE*) in the model improves performance of the model. Thus, we obtain the second alternative measure by calculating the time series standard deviation of residuals from a cross sectional regression estimated from the following equation:

$$\Delta WCA_{jt} = \alpha_1 + \alpha_2 CFO_{jt-1} + \alpha_3 CFO_{jt} + \alpha_3 CFO_{jt+1} + \alpha_4 \Delta REV_{jt} + \alpha_5 PPE_{jt} + \upsilon_{jt} \quad (3)$$

Where, for firm *j* and in year *t* (or *t - 1*),

ΔWCA = change in working capital, defined as -($\Delta AR + \Delta INV + \Delta AP + \Delta TAX + \Delta OTH$);
ΔAR = change in receivables (Compustat #302);
ΔINV = change in inventory (Compustat #303);
ΔAP = change in payables (Compustat #304);
ΔTAX = change in tax payable (Compustat #305);
ΔOTH = change in other current assets (Compustat #307);
CFO = cash flow from operations (Compustat #308);
ΔREV = change in net sales (Compustat #12);
PPE = gross property, plant and equipment (Compustat #7); and
υ = error term.

All variables above are deflated by average total assets. Eq. (3) is estimated for each two-digit SIC code industry with at least 10 observations in a given year. Then we calculate the standard deviation of residuals υ_t, termed $\sigma(\upsilon)$, for each firm over the years *t*-

4 to *t*. The larger the standard deviation of residuals the greater is the noise in earnings and the lower is the quality of earnings, hence the lower is the audit quality. Our proxy for audit quality is therefore $\sigma(\upsilon)$ multiplied by -1. For this measure we restrict the sample to all firms that have data required to estimate Eq. (3) in each of the five years *t* to *t*-4; this results in a fewer number of observations for tests using this measure as compared to that for tests using other discretionary accruals measures. Given that this measure is subject to a longitudinal data restriction, we also use the absolute value of the residual υ_t from Eq. (3) multiplied by -1 as another proxy for accrual quality as proposed by Dechow and Dichev (2002) and Srinidhi and Gul (2007).

3 Sample selection, research design, and results

3.1 Sample selection

We begin sample selection with all client firms having data about auditor identity, audit engagement office, and audit fee from the Audit Analytics database for the seven-year period from 2000 to 2006. We remove observations where auditors are not located in one of 280 MSAs defined in the U.S. 2000 Census because we calculate concentration measures at the MSA level, as discussed earlier.

We start with 67,167 unique observations located in 179 MSAs. We match these observations with Compustat and remove financial institutions and utility firms (SIC codes 6000-6999 and 4900-4999) because the Jones-model-type abnormal accruals may not be meaningful for these firms. After matching with Compustat for control variables, we are left with 27,756 observations for the tests with our main proxy for audit quality. We use all available observations in the Audit Analytics database to calculate the

Herfindahl index; this ensures that the Herfindahl index calculation is unaffected by observations deleted due to non-matching with Compustat.

Panel A of Table 1 provides descriptive statistics on our main regression variables. It shows that the median value of absolute discretionary accruals (*DA_BS*) estimated based on Ball and Shivakumar (2006) is 5.3 percent of total assets, and the mean is much larger at 11.8 percent. These statistics are similar to the findings in the prior studies which use the absolute value of discretionary accruals in their analyses (Becker et al., 1998; Choi et al., 2009; Myers et al., 2003; Reynolds and Francis, 2001). Median concentration (the Herfindahl index) is 0.252, and is similar to the value reported in Table 9 of the GAO report (Government Accountability Office, 2008). Because few recent studies have used concentration, we report further descriptive statistics about concentration in Panels B and C of Table 1. Panel B classifies MSAs according to the number of Big 5 audit firms located in them. The distribution of MSAs by the number of Big 5 audit firms is U-shaped (we count the maximum number of Big 5 audit firms present in an MSA during the sample period; therefore Andersen is counted in a particular MSA if it was in that MSA before its demise): there are only five MSAs with three Big 5 firms present, and the number of MSAs having fewer as well as higher number of Big 5 firms is greater. Thirty seven of the 137 MSAs in our sample have no Big 5 firms present, and 40 have all Big 5 firms. These 40 MSAs account for the overwhelming majority of our sample (25,678 of 27,756 client firm year observations). Median concentration in MSAs with zero Big 5 firms is 1, i.e., each of a majority of the 37 MSAs that have zero Big 5 audit firms has only one non-Big-5 audit firm that has clients in the Audit Analytics database. Mean concentration across MSAs decreases monotonically with the number of Big 5 audit

firms: the mean concentration for MSAs with zero Big 5 firms is 0.867 whereas the mean concentration in MSAs with all the Big 5 firms present is only 0.257. For the sub-sample of 40 MSAs with all Big 5 audit firms present (n=25,678), Panel C shows that audit market concentration decreases with MSA population in the U.S. 2000 Census. The mean concentration in low-population MSAs is 0.315, in high-population MSAs it is 0.245.

Table 2 shows the correlation between the variables of interest in our study. In Panel A we find that the Pearson correlations between the four alternative accruals-based proxies for audit quality are high, ranging from about 30 to 60 percent. Similarly, in Panel B we see that the alternative measures of concentration are also very highly correlated though not perfectly. The Pearson correlations range from about 60 to 99 percent. Further, we find that the main measure of concentration based on audit fees is positively correlated with audit quality proxied by (-1)*|*DA_BS*|. This provides univariate evidence supporting that audit quality is higher when concentration is higher. The correlations between the other variables are not high enough to suggest that multicollinearity is a problem in our data.

3.2 Relation between concentration and audit quality

To examine the relation between concentration and audit quality, we estimate the following equation:

$$\begin{aligned} \textit{Audit quality} = {} & \beta_0 + \beta_1\, \textit{Concentration} + \beta_2\, \textit{Size} + \beta_3\, \textit{Short tenure} + \beta_4\, \textit{Sales change} \\ & + \beta_5\, \textit{Book to market} + \beta_6\, \textit{Loss} + \beta_7\, \textit{Leverage} + \beta_8\, \textit{Issue} \\ & + \beta_9\, \textit{Cash from operations} + \beta_{10}\, \textit{Big 5} + \beta_{11}\, \textit{Industry specialist} \\ & + \beta_{12}\, \textit{Firm age} + \beta_{13}\, \textit{Client importance} + \beta_{14}\, \textit{Fee ratio} \\ & + \beta_{15}\, \textit{Lagged accruals} + \Sigma\, \gamma_j \textit{Industry} + \Sigma\, \theta_t \textit{Year} + \omega \end{aligned} \quad (4)$$

Where

Audit quality	=	audit quality, proxied by either (-1)*|*DA_BS*|, (-1)*|*DA_KLW*|, (-1)*$\sigma(\upsilon)$, or (-1)*$\mid \upsilon_t \mid$.
DA_BS	=	discretionary accruals based on Ball and Shivakumar (2006), which is the difference between actual total accruals and the fitted values estimated from Eq. (1). Because high absolute *DA_BS* indicates low audit quality, we multiply it by -1 and use negative absolute value to proxy for audit quality;
DA_KLW	=	performance-adjusted discretionary accruals based on Kothari et al. (2005), which is the difference between unadjusted *DA* of one firm (the residual value estimated from Eq. (2)) and *DA* of another firm from the same two-digit SIC code industry that has similar *ROA* in the previous year. We multiply it by -1 to use negative absolute value of *DA_KLW* as a proxy for audit quality;
υ_t	=	residuals estimated from Eq. (3) based on Dechow and Dichev (2002) as modified by McNichols (2002). We multiply it by -1 to use negative absolute value of υ_t as a proxy for audit quality;
$\sigma(\upsilon)$	=	standard deviation of residuals υ_t estimated from Eq. (3), which is calculated for each firm over the years *t*-4 to *t*. Because high $\sigma(\upsilon)$ indicates low audit quality, we multiply it by -1;
Concentration	=	Concentration of audit market by MSA, measured by the Herfindahl index of audit fees by auditor office, as described in Section 2.1;
Size	=	log of total assets in thousands (Compustat #6);
Short tenure	=	dummy variable equal to 1 if the auditor is in the first or second year of the audit engagement and 0 otherwise;
Sales change	=	Changes in net sales [Compustat #12 – Lag(Compustat #12)] deflated by lagged total assets;
Book to market	=	Ratio of book value (Compustat #60) to market value (Compustat #199 times Compustat #25), winsorized at 0 and 4;
Loss	=	dummy variable equal to 1 if reported net income (Compustat #172) is less than zero, and 0 otherwise;
Leverage	=	Ratio of total liabilities (Compustat #181) to total assets;
Issue	=	dummy variable equal to 1 if the sum of the debt issued (Compustat #111) and equity issued (Compustat #108) during the past 3 years is more than 5% of the total assets, and 0 otherwise;
Cash flow from operations	=	Cash flow from operations (Compustat #308) deflated by lagged total assets;
Big 5	=	dummy variable equal to 1 if the auditor is one of PWC, KPMG, AA, EY, DT, and zero otherwise;
Industry specialist	=	dummy variable equal to 1 if the auditor is an industry specialist both at the national level and at the city (MSA) level, and zero otherwise. Following Reichelt and Wang (2008), an auditor is

		defined as a national (city) industry specialist if it has an annual audit fee market share greater than 40 percent in an industry, based on the two-digit SIC code in the national (city) audit market;
Firm age	=	log of the number of years for which total assets was reported in Compustat since 1974;
Client importance	=	audit fees paid to the auditor divided by total audit fee revenues of the audit office that the auditor belongs to;
Fee ratio	=	ratio of non-audit service fees relative to total fees (i.e., the sum of non-audit fees and audit fees) received from the client firm;
Lagged accruals	=	one-year lagged total accruals; Accruals are defined as income before extraordinary items (Compustat #18) minus cash flow from operations (Compustat #308) deflated by lagged total assets;
Industry	=	Industry dummies based on industry classification by Barth et al. (1998).
Year	=	year dummies from 2001 to 2005. We omit FY 2000, which is therefore captured in the intercept.

We estimate the above OLS model using the pooled sample correcting for clustering by firm and year (Petersen, 2009).[7] The variable of interest in the equation is *Concentration*. A positive relation between *Concentration* and *Audit quality* suggests that audit quality is higher in more concentrated audit markets perhaps due to greater bargaining power resting with the auditor.

We include a set of control variables that are shown by prior literature to affect discretionary accruals. *Size* (log of total assets) is included because larger firms tend to have lower accrual estimation errors and lower discretionary accruals and therefore higher accruals quality (Dechow and Dichev, 2002). A dummy variable indicating short tenure of the auditor (*Short tenure*) is included because Myers et al. (2003) find that firms with short auditor-client relationships have higher magnitude of discretionary accruals (lower audit quality). A dummy variable for loss-reporting firms (*Loss*) is included because such firms have a greater incentive to take a big bath. We include two variables

[7] Alternatively we cluster the standard errors at the MSA level and by year. Our results remain similar.

to proxy for firm growth, *Book to market* and *Sales change*, because McNichols (2000) suggests that firms with higher growth tend to record a greater amount of discretionary accruals (i.e., lower audit quality). We expect *Book to market* (an inverse measure of growth) to be positively related to audit quality, and *Sales change* to be negatively related to audit quality. A dummy variable for equity- or debt-issuance (*Issue*) is included because firms raising capital tend to manage earnings more aggressively (Teoh et al., 1998). We include *Leverage* because Becker et al. (1998) suggest that firms with higher leverage have incentives to manipulate earnings to keep from breaching their debt covenants. Following Ashbaugh et al. (2003) we include *Cash flow from operations* to control for correlation between accruals and cash flow performance. *Firm age* is added because accruals differ with changes in firm life cycle (Anthony and Ramesh, 1992; Myers et al., 2003). *Fee ratio* and *Client importance* are included to control for the possible influences of non-audit fees and quasi-rents specific to clients on the auditor's incentive to compromise independence (Frankel et al., 2002; Chung and Kallapur, 2003). We include *Lagged accruals* to control for variations in the reversal of accruals over time. *Industry* and *year* dummies are included to control for differences across industries and changes over time in discretionary accruals and accruals quality.

Reichelt and Wang (2009) find that auditors who are both national and city-specific industry experts have clients with lower abnormal accruals.[8] Because auditor industry specialization, at least at the city (MSA) level, is determined by the market share of the large auditor, concentrated audit markets are likely to have a greater number of clients audited by industry specialist auditors. To ensure that we do not attribute to audit market

[8] In contrast, they find that abnormal accruals of clients audited by national industry experts alone (without being city-specific industry experts) or by city industry experts alone (without being national industry experts) are not significantly different from those audited by non-industry experts.

concentration the previously documented effect of industry specialist auditors, we control for auditor industry specialization at both nation-level and MSA-level by combining them into one measure (*Industry specialist*) based on Reichelt and Wang (2009).

We present the results of estimating Eq. (4) in Table 3. When audit quality is proxied by negative absolute *DA_BS* (i.e., (-1)*|*DA_BS*|) in the full sample (Column 3) the coefficient on *Concentration* is positive and significant (coefficient = 0.037, t-value = 4.99, p-value = 0.001) suggesting that concentration is associated with high audit quality.[9]

The coefficients on control variables are mostly in line with evidence reported in prior studies. Similar to findings in Myers et al. (2003) and Choi et al. (2009), we find that large firms (*Size*), firms with better cash performance (*Cash from operations*), and higher quality auditors (*Big 5*) have higher audit quality proxied by negative absolute *DA_BS* while firms with higher leverage (*Leverage*) have lower audit quality. Further, consistent with McNichols (2000) we find that firms with higher growth options (low *Book to market* and high *Sales change*) have lower audit quality. The coefficients on *Short tenure* and *Industry specialist* are insignificant at the 0.10 level. Although these results are inconsistent with those of Myers et al. (2003) and Reichelt and Wang (2009) respectively, Francis and Yu (2009) report similar weak effects of these variables using a recent sample over the 2003-2005 period. Although not reported, the coefficients on dummy variables indicating fiscal year 2001-2006 are positive and increasing, and this could be because increased regulatory monitoring arising from the SOX has curtailed earnings management. Given that our results hold after controlling for the fixed year

[9] We drop eight observations with extreme values of the Belsley et al. (1980) DFBETAS statistic. Our results and inferences are all similar if we do not drop these observations.

effects, it is unlikely that our results are attributable to the increase in concentration arising from Arthur Andersen's demise and the contemporaneous increase in audit quality because of regulatory measures such as the SOX.

To further examine whether the effect of *Concentration* on audit quality differs systematically between clients with income-increasing discretionary accruals and those with income-decreasing discretionary accruals, we split the full sample into two sub-samples with positive and negative discretionary accruals (i.e., $DA\_BS > 0$ and $DA\_BS < 0$). We then estimate Eq. (4) separately for each sub-sample and report the results in Columns 4 and 5 of Table 3.[10] In these columns, the dependent variables is still $(-1)*|DA\_BS|$ so that positive coefficients of variables indicate positive associations with audit quality.[11] We find that the positive association between concentration and audit quality holds for both sub-samples of positive and negative discretionary accruals and so is not driven solely by either income increasing or income decreasing accruals. Specifically, the coefficients on *Concentration* are positive and significant in both columns (0.047 with t-value=4.49, and p-value=0.001 in Column 4 and 0.023 with t-value=2.07 and p-value=0.040 in Column 5) suggesting that concentration is related to higher audit quality for both sub-samples.

[10] Because the dependent variables are truncated at zero in these regressions, we also use truncated regressions instead of regular OLS as a robustness check and our results are qualitatively similar.

[11] Similar to Myers et al. (2003), we consider the more negative discretionary accruals the lower audit quality for clients with income-decreasing accruals as the SEC does not view the use of income-decreasing accruals as appropriate because it creates 'cookie jar reserves' (Levitt, 1998). For example, the SEC took legal steps against Microsoft Corp. for inappropriately using income-decreasing accruals (Wall Street Journal, 2002).

3.3 Relation between concentration and alternative measures of audit quality

Earlier we described alternate proxies for audit quality measured by (a) (-1)*|*DA_KLW*| where *DA_KLW* is performance-adjusted discretionary accruals based on Kothari et al. (2005); (b) (-1)*| υ_t | where υ_t is residuals estimated from Eq. (3) which is developed by Dechow and Dichev (2002) and modified by McNichols (2002); and (c) (-1)*$\sigma(\upsilon)$ where $\sigma(\upsilon)$ is standard deviation of residuals υ_t estimated from Eq. (3), which is calculated for each firm over the years *t*-4 to *t*. We use these alternative accrual-based proxies for audit quality to account for potential errors associated with each measure. We substitute these three alternative proxies for audit quality in estimating Eq. (4) and report the results in Columns 3, 4, and 5 of Table 4.[12] We find that the coefficient on *Concentration* is positive and significant at the 0.01 level in all three cases. When the dependent variable is (a), (b), or (c) above, the coefficients on *Concentration* are 0.038 (t-value=5.11, p-value=0.001), 0.014 (t-value=3.82, p-value=0.001), and 0.015 (t-value=4.35, p-value=0.001) respectively. This suggests that our finding of the positive association between audit market concentration and audit quality is robust to the use of these alternative proxies for audit quality.

Francis, Lafond, Olsson and Schipper (2005) suggest that poor accrual quality can be due to innate features of a firm's business model such as its operating environment and complexity of transactions, or it could be due to discretionary factors such as managerial accounting choices and accruals manipulation. Since the innate factors of | υ_t | and $\sigma(\upsilon)$ in (b) and (c) are mainly driven by a client firm's operating environment, we expect that

[12] For the model where the dependent variable is (-1)*σ(υ) in Column 5, the sample size is much smaller (n = 14,327) because calculating firm-level standard deviation of υ_t requires data for all variables in the Eq. (3) over years *t*-4 to *t*.

audit quality would be better proxied by the discretionary factors of $|\upsilon_t|$ and $\sigma(\upsilon)$, when $(-1)^*|\upsilon_t|$ or $(-1)^*\sigma(\upsilon)$ are used as a measure of audit quality respectively. For this purpose, we decompose both $|\upsilon_t|$ and $\sigma(\upsilon)$ into an innate and a discretionary component each based on the approach outlined in Francis et al. (2005),[13] and substitute (-1) times the discretionary component from $|\upsilon_t|$ or $\sigma(\upsilon)$ [i.e., (-1)*Disc $|\upsilon_t|$ and (-1)*Disc $\sigma(\upsilon)$] into Eq. (4) for audit quality. The results are presented in Columns 6 and 7 of Table 4. Consistent with our expectation, we find that both (-1)* Disc $|\upsilon_t|$ and (-1)* Disc $\sigma(\upsilon)$ are significantly positively related to *Concentration*. The coefficients on *Concentration* when the dependent variables are (-1)* Disc $|\upsilon_t|$ and (-1)* Disc $\sigma(\upsilon)$ are 0.008 (t-value=2.46, p-value=0.007) and 0.008 (t-value=2.73, p-value=0.001) respectively. This suggests that as concentration increases audit quality proxied by negative discretionary component of $|\upsilon|$ or $\sigma(\upsilon)$ also rises

3.4 Relation between alternative measures of concentration and audit quality

As we explained earlier, we calculate the following alternative proxies for concentration: (a) Herfindahl index based on number of client firms, (b) Herfindahl index based on aggregate size of client firms' assets, (c) and (d) separate Herfindahl indexes for subsamples of large and small client firms, where large clients are defined as clients having assets exceeding those of the largest non-Big-5 auditee, (e) square root of the Herfindahl index based on audit fees, and (f) rank transform of Herfindahl index based on audit fees.

[13] Specifically, we regress firm-specific standard deviation of residuals υ_t ($\sigma(\upsilon)$) over the years *t*-4 to *t* (and the absolute value of υ_t) on firm size (the market capitalization), cash flow volatility, sales volatility, operating cycle, and loss proportion following Eq. (8) of Francis et al. (2005). The predicted values from this estimation capture the innate component while unexplained portions (the residuals) capture the discretionary component.

We re-estimate Eq. (4) using these alternative concentration measures, and present the results in Columns 3-8 of Table 5. We find that concentration is significantly positively related with our main measure of audit quality (i.e., (-1)*|*DA_BS*|) for each of these alternative measures of concentration. The coefficient on *Concentration* when it is measured based on the number of audit clients is 0.040 (t-value=4.05, p-value=0.001). The coefficient on *Concentration* when it is measured based on the total assets of audit clients is 0.018 (t-value=2.68, p-value=0.007). We conclude that our results stay qualitatively similar when these alterative metrics are used for the calculation of concentration.

Columns 5 and 6 of Table 5 show that concentration is significantly positively related with audit quality for both big and small clients of Big 5 auditors. The coefficient on *Concentration* when it is measured for only the large client market (Column 5) is 0.023 (t-value=2.60, p-value=0.009). Similarly, the coefficient on *Concentration* when it is measured for the rest small client market (Column 6) is 0.064 (t-value=6.25, p-value=0.001).[14] Results in Columns 7 and 8 of Table 5 show that the positive relation between concentration and audit quality is insensitive to the functional form of concentration. The coefficient on the square root of concentration is 0.049 (t-value=4.88, p-value=0.001) and that on the rank of concentration is 0.00013 (t-value=3.06, p-value=0.002).

[14] Alternatively, when we compute concentration separately for only clients of Big 5 auditors and for only those of non-Big 5 auditors and estimate Eq. (4) separately for the two groups, *Concentration* is significantly positively related to audit quality in each group.

3.5 Relation between concentration and audit quality for different audit markets

As Panels B and C of Table 1 show, audit market concentration depends on the number of Big 5 firms present in an MSA and on the population of the MSA. We perform several analyses to check whether our results differ with MSA size and for certain class of client firms in this section.

First, to examine whether our observed relation between concentration and audit quality differs for large MSAs and small MSAs, we create a dummy variable *Large MSA* which is equal to one for the 15 largest MSAs in terms of audit market size measured by total audit fees earned by all audit firms in the MSA during our sample period, and zero otherwise. We include *Large MSA* and its interaction with *Concentration* in Eq. (4) and re-estimate the equation. Column 3 of Table 6 shows the results of this estimation. The coefficient on *Concentration* now captures the effect of concentration on audit quality for all but the 15 largest MSAs. This coefficient is positive and significant (coefficient = 0.038, t-value=4.84, p-value = 0.001). The coefficient on *Concentration* Large MSA* captures the differential impact of concentration on audit quality for the 15 largest MSAs. This coefficient is positive but insignificant (coefficient=0.004, t-value=0.19, p-value = 0.890). This result suggests that the relation between concentration and audit quality is not significantly different for the 15 largest MSAs, compared to the rest of the MSAs.

Second, it is possible that large MSAs may have a greater number of large client firms. Prior research (Chung and Kallapur, 2003) argues that auditors' incentives to compromise their independence could vary with the size of clients because of the differences in the quasi-rent streams, the probability of detecting audit failure, and the consequences of such detection, between small and large clients. Therefore, in addition to

controlling for firm size in Eq. (4), as a further analysis, we create a dummy variable *Large firm* which takes the value one if the firm size is greater than the median, and zero otherwise. We then interact *Large firm* with *Concentration* and re-estimate Eq. (4). The coefficient on *Concentration* now captures the effect of concentration on audit quality for small firms and the coefficient on the interaction term captures the differential impact of concentration on audit quality for larger firms. As shown Column 4 of Table 6 where we detail the results of this estimation, the coefficient on *Concentration* is 0.047 (t-value=4.40, p-value=0.001) and the coefficient on the interaction term is -0.022 (t-value=-1.04, p-value=0.290). This shows that the impact of concentration on audit quality is not statistically significantly different for large and small clients.

Third, not all MSAs have all the Big 5 auditors' audit offices. This can cause the nature of the audit market to substantially differ between MSAs with all 5 Big 5 auditors and those with fewer Big 5 auditors. For this reason, we create a dummy variable (*Max Big5*) that takes on the value of one if all the Big 5 auditors operate in a particular MSA and zero otherwise. We then interact *Max Big5* with *Concentration* and estimate Eq. (4). The results from this estimation are shown in Column 5 of Table 6. The coefficient on *Concentration* is positive and significant (Coefficient=0.038, t-value=4.28, p-value=0.001) which suggests that the relation between concentration and audit quality is positive for MSAs where not all the Big 5 operate. The coefficient on the interaction term is positive and insignificant (Coefficient=0.022, t-value=0.98, p-value=0.340). This implies that the positive relation between concentration and audit quality is not significantly higher in MSAs where all the Big 5 operate, compared to the remaining MSAs.

Fourth, clients from certain industries may cluster in some MSAs. Moreover, the market share of industry specialist auditors may vary in different industries. As shown in Table 3, *Concentration* is associated with audit quality even after controlling for industry fixed effects and industry specialization of auditors. To further investigate whether the positive association between concentration and audit quality is stronger for clients of industry specialist auditors, we examine the interaction between industry specialization (defined in Eq. (4)) and *Concentration* by estimating Eq. (4) after including such an interaction variable. The results provided in Column 6 of Table 6 show that the relation between concentration and audit quality proxied by negative absolute value of *DA_BS* remains significantly positive for the main effect (for clients of non-specialist auditors) as indicated by the coefficient on *Concentration* (coefficient=0.037, t-value=5.05, p-value=0.001). However, the interaction between *Industry specialist* and *Concentration* is not significantly different from zero (coefficient=0.009, t-value=0.11, p-value = 0.917). This result suggests that the relation between concentration and audit quality is not significantly different for clients of industry specialist auditors compared to clients of non-specialist auditors. Although the effects of omitted correlated variables can never be completely ruled out, our results are robust to some of the obvious possibilities that we examine above.

4 Sensitivity tests

4.1 Weighted regression

Since MSAs differ in the number of client-year observations, we weight the regression with (inverse of) the number of clients. The coefficient on *Concentration* is significantly positive (coefficient=0.040, t-value=41.49, p-value=0.001) when audit

quality is proxied by negative absolute value of *DA_BS*. This sensitivity check suggests that our results are not impacted by different MSAs having different number of clients.

4.2 Controlling for volatility of sales, cash flows and length of operating cycle

We examine whether our results are robust to inclusion of additional control variables. First, we include controls for the operating cycle and volatility of sales and cash flows in our regression. Dechow and Dichev (2002) show that accruals quality depends on the length of the operating cycle and volatility of sales and cash flows. Hribar and Nichols (2007) suggest that using absolute discretionary accruals as the dependent variable potentially biases the test in favor of rejecting the null hypothesis of no earnings management and that adding volatility of sales and cash flows in the model as additional controls substantially improves test specifications.[15] Thus, we add these additional control variables to our regression model and find that our results are stay qualitatively similar. When the dependent variable is negative absolute value of *DA_BS*, the coefficient on *Concentration* is 0.024 (t-value=2.18, p-value=0.029) with these additional variables controlled.[16]

4.3 Controlling for client complexity

Prior literature on audit fee models has shown that firm complexity is related to audit fees. Since we use audit fees as a basis for calculating the concentration measure, it is necessary to properly control for client complexity to account for their impact on the

[15] We measure the operating cycle by [(sales/360)/(average accounts receivable)+(cost of goods sold/360)/average inventory]], the volatility of sales by standard deviations of cash-based revenues (sales + Δaccounts receivable) (deflated by lagged total assets) for the years *t* - 4 to *t*, and the volatility of cash flows by standard deviations of operating cash flow (deflated by lagged total assets) for the years *t* - 4 to *t*.
[16] We report results in Table 3 excluding these variables because the requirement of these additional variables substantially lowers our sample size. For example, the requirement of cost of goods sold that is necessary for calculation of the operating cycle reduces our sample by 2,939 observations.

concentration measure. We estimate Eq. (4) after including two measures for complexity. The first is a dummy variable that takes on the value one if the client has a foreign subsidiary, and the second is the square root of the number of business and geographic segments disclosed. We find that the coefficient on *Concentration* is 0.039 (t-value=5.19, p-value=0.001) with these variables included in Eq. (4). This shows that controlling for these client complexity variables does not impact the relation between concentration and audit quality even though the basis of measurement of concentration is audit fees.

4.4 Controlling for litigation risk

Auditors' incentives to perform high-quality audits are affected by the fear of being sued. Thus litigation risk against auditors can be an important factor determining audit quality and it is important to control for the auditor litigation risk in estimating Eq. (4). To account for the litigation risk, we include the factor weights documented by Shu (2000), where she describes a litigation model to compute a probability of litigation against auditor for each firm for each year. Since this model has some data restrictions, the number of observations falls by 6,623 observations. We find the coefficient on *Concentration* is 0.024 (t-value=3.34, p-value=0.001) after including a variable for the probability of litigation. The coefficient on the probability of litigation is -0.035 (t-value=-1.57, p-value=0.120). This analysis suggests that our main result is unaffected by the omitted litigation risk.

4.5 Controlling for office size

Recent studies find that individual audit office size has a positive relationship with audit quality (e.g., Choi et al. 2009; Francis and Yu 2009). To ensure that our main results are not merely picking up the effect of audit office size, we also include a control

variable for the size of audit office, measured by the natural log of the total audit fees earned from all the clients audited by that audit office, consistent with Francis and Yu (2009), and re-estimate Eq. (4). The result indicates that the coefficient on *Concentration* remains positive (0.0353) and significant (t-value=4.73, p-value=0.001). Hence our results are robust to controlling for the size of the audit office.

4.6 Controlling for audit and non-audit fees

Although we control for client importance and the non-audit fee ratio (*Fee ratio*) in our main tests, as a sensitivity check we examine whether our results are robust to inclusion of audit and non-audit fee levels deflated by total assets. This test is necessary if auditors trade off audit quality for higher fees or demand a premium for conducting a high quality audit. We remove *Fee ratio* from the equation, and re-estimate Eq. (4). We find that *Concentration* is still positively and significantly (coefficient=0.028, t-value=3.54, p-value=0.001) related to audit quality proxied by (-1)*|*DA_BS*| even after controlling for these two metrics. Alternatively, when we control for logged audit fees and logged non-audit fees in the model, the results stay qualitatively similar.

4.7 Controlling for auditor choice

Prior literature suggests that Big 5 auditors perform higher-quality audits. Thus the impact of concentration on audit quality could be different for clients of Big 5 auditors compared to those of non-Big 5 auditors. For this possibility, we re-estimate Eq. (4) after including the interaction between *Concentration* and *Big 5* in the equation. We find that the main effect of *Concentration*, which measures the impact of concentration on audit quality for non-Big 5 auditors, is positively and significantly related with audit quality (coefficient=0.057, t-value=3.62, p-value=0.001) while the interaction variable is

negative but not significant (coefficient=-0.0283, t-value=-1.38, p-value=0.162). This suggests that the impact of concentration on audit quality is not significantly different between Big 5 audit clients and non-Big 5 audit clients.

4.8 Excluding cash flows from operations and change in sales

The two variables cash flow from operations and change in sales are used to estimate accrual-based audit quality in Eqs. (1)-(3) and thus they could be orthogonal to our audit quality measures. When we drop these two variables from Eq. (4) to check the robustness of our results, we find that *Concentration* is significantly positively related to our measure of audit quality. The coefficient on *Concentration* is 0.045 (t-value=5.40, p-value=0.001) when audit quality is measured by (-1)*|*DA_BS*|.

4.9 Year-by-year analysis of the relation between concentration and audit quality

Instead of a pooled sample analysis, we conduct a year-by-year analysis and calculate a mean t-value using observed yearly coefficients on *Concentration* for our sample period over 2000-2006. We find that the mean coefficient on *Concentration* is 0.033 (t-value=3.15, p-value=0.001) when audit quality is proxied by (-1)*|*DA_BS*|. This suggests that cross-sectional and time-series correlation in the error terms does not impact our results significantly.

4.10 Endogenous relation between concentration and audit quality

Concentration could be endogenous because it is possible that an auditor gains market share by performing a higher-quality audit. We use a two-stage instrumental variables approach to address this concern. Our arguably exogenous instruments for concentration are measures of the costs of operating in that MSA and the attractiveness of

the MSA in terms of market size and growth.[17] For these we use geographic size of MSA area, the number of business establishments at the beginning of the year, and the number of businesses added during the year, for which data is available from the U.S Census Bureau URL: http://www.census.gov/csd/susb/. This data is available for 3 years 2001 to 2003.[18] Hence the number of observations that we use to estimate the 2SLS is smaller than the full sample (n=13,523 and 7,962 when audit quality is proxied by (-1)*|*DA_BS*|.and -$\sigma(\upsilon)$, respectively).

We perform a Davidson and MacKinnon (1993) test of whether endogeneity affects the results and find no evidence that it does. Therefore we do not think our results are affected by endogeneity between audit quality and concentration. Moreover, the positive association between audit quality and concentration continues to hold when we use the fitted value for concentration from the first stage instead of its actual value.

4.11 Potential entry by Big 5 auditors to respond to new demand

When a large client considers requesting audit service from a Big 5 auditor not located in certain MSA, it is not uncommon for the auditor to open a new office to acquire the client. Hence it is not clear which comes first; the local office or the client, and our concentration measure may not take into consideration the potential for new entrants in its computation. To address this issue, we calculate the number of unique audit offices of Big 5 auditors, and the first year they appear in our sample period. Out of 335 unique offices, 309 existed in year 2000, which constitutes 92.2%. When we re-estimate

[17] While firm growth is related to discretionary accruals, we do not see any reason why a client's headquarters location in a growing MSA should be correlated with its discretionary accruals *after controlling* for its *Sales change* and *Book-to-market* ratio.

[18] There is data for total number of business establishments in an MSA for several years before 2001 and after 2003, however, we are interested in the new businesses added and existing businesses which died during the year, for which data is available for only three years 2001 to 2003.

Eq. (4) after restricting the sample to MSAs that existed in year 2000, for the period 2001 onwards, we find that the coefficient on *concentration* is 0.0380 (t-value=5.33, p-value=0.001). This suggests that our results are not driven by new offices being opened in response to a demand for auditing in an MSA.

5 Association between audit fees and concentration

As a separate analysis, we examine whether concentration affects audit pricing. While the GAO report concludes that industry concentration in the audit market does not significantly impact audit fees (GAO, 2003, 2008), Pearson and Trompeter (1994) suggest that audit pricing and concentration could be either positively or negatively related. They argue that monopolistic audit pricing in concentrated audit markets could explain a positive association between concentration and audit fees and that significant economies of scale in concentrated audit markets could explain a negative association between concentration and audit fees.

To obtain insights into this issue, we estimate a standard audit fee model based on the model used by Sankaraguruswamy and Whisenant (2009), which incorporates the findings of the extensive prior literature on audit fee models. We include in this audit fee model *Concentration*, three MSA level variables to control for MSA level differences in audit fees, and *Industry specialist*. The three MSA level variables are, (a) hourly median wage of auditors and accountants obtained from *2007 Metropolitan Area Occupational Employment Statistics* published by the U.S. Bureau of Labor Statistics, (b) size of MSA area, and (c) the rank of MSA size based on the population of MSA. We use three measures of *Concentration*: (a) concentration only within Big 5 auditors based on Big 5 clients, (b) concentration based on audit fees, and (c) concentration based on the number

of clients. The sample used for the audit fee model includes only Big 5 clients to reduce the self-selection problem pointed out by Chaney et al. (2004). The following is the model estimated (the definitions of variables are provided below Table 7):

$$\begin{aligned} Ln(Audit\ fees) = {} & \beta_0 + \beta_1\, Concentration + \beta_2\, Size + \beta_3\, Loss + \beta_4\, Firm\ age + \beta_5\, Bankruptcy + \beta_6\, Xtra + \beta_7 \\ & Sqsegs + \beta_8\, GC + \beta_9\, IC\ audit + \beta_{10}\, IC\ weakness + \beta_{11}\, Sign\ dual + \beta_{12}\, Risk\ Ind + \beta_{13}\, plan \\ & + \beta_{14}\, Foreign + \beta_{15}\, Audit\ lag + \beta_{16}\, New\ finance + \beta_{17}\, Sqemps + \beta_{18}\, Inv\ rec \\ & + \beta_{19}\, Mergers + \beta_{20}\, CFO + \beta_{21}\, Liquidity + \beta_{22}\, Restatement + \beta_{23}\, Resignation \\ & + \beta_{24}\, Re\ Diss + \beta_{25}\, Initial + \beta_{26}\, Median\ wage + \beta_{27}\, Specialist + \beta_{28}\, MSA\ rank \\ & + \beta_{29}\, MSA\ area + \Sigma\, \gamma_j Industry + \Sigma\, \theta_t \mathrm{Year} + \omega \end{aligned} \quad (5)$$

We find mixed results for the relation between audit fees and concentration. When the proxy for concentration is based on (a) audit fees but only for Big 5 audit clients, we find a significant positive relationship (coefficient=0.154, t-value=3.08, p-value=0.002). However, when the proxy for concentration is based on (b) audit fees across both Big 5 and non-Big 5 audit markets, we find a positive but insignificant relationship (coefficient=0.086, t-value=1.55, p-value=0.125). Further, when we measure concentration based on (c) the number of clients across both Big 5 and non-Big 5 audit markets, we find a positive and significant relation between audit fees and concentration (coefficient=0.137, t-value=2.10, p-value=0.036).

Our audit fee tests using (a) and (c) above suggest that as concentration increases audit fees also increase. To the extent high concentration indicates a low level of competition in the audit market, these results support, albeit weakly, the evidence documented in other fields where high competition reduces prices in general, e.g., Weiss (1989).

6 Conclusions

Policymakers have been concerned about the effects of audit market concentration, given the increase in concentration resulting from the decrease in the number of big public accounting firms. One important effect of concentration that has been little examined in prior studies is that on audit quality. In this paper we find that concentration measured by the Herfindahl index at the MSA level is positively associated with our proxies for audit quality.

Following previous studies, we use various accruals-based earnings quality measures as proxies for audit quality. This assumes that high quality audits constrain the extreme accrual choices that managers would like to make for financial reporting —the assumption is supported by evidence from studies of actual audit working papers reviewed in Kinney and Martin (1994) and by evidence reported in Nelson et al. (2002). However, reported earnings are a joint product of managers and auditors, so we control for managers incentives to manage earnings using variables such as loss, leverage, and capital-raising.

Besides other controls for earnings quality identified in previous studies, we also control for fixed year effects; therefore our results are unlikely to be affected by the increase in concentration due to Andersen's demise contemporaneous with an increase in audit quality because of regulatory measures such as SOX.

Our results are robust to the use of alternative concentration measures, namely, Herfindahl index based on number of clients and total client assets, separate Herfindahl indexes for large and small clients in each MSA, and transformed functional forms of the Herfindahl index. We perform several sensitivity tests in an attempt to rule out omitted

variables associated with clients' MSA location or characteristics of auditors and clients. We also find our results unchanged after controlling for endogeneity between audit quality and concentration.

Concentration's effect on audit quality is likely to arise from its relation to competition (Chaney et al. 2003). Therefore we examine whether concentration is associated with prices, i.e., audit fees. After controlling for audit wages in the MSA, MSA size and population, we find some evidence indicating a positive association between concentration and audit fees. The results show that the coefficient on concentration is statistically significant in two of the three specifications, it is marginally significant at the 0.10 level with one-tailed test in the third—we interpret this as weak evidence in favor of a concentration-price competition link.

Our evidence overall supports GAO's (2003, 2008) conclusions that existing levels of concentration do not cause problems with audit quality. Indeed, our results suggest the opposite—that concentrated audit markets are associated with higher audit quality. However, we make no assertions from our study as to whether further concentration in the audit market will be more effective in enhancing audit quality. Given that our result is based on the variation in concentration in the existing system, we cannot predict what will happen if concentration increases beyond existing levels if another audit firm goes out of existence because of bankruptcy or merger. Moreover, public policy may be justifiably concerned about concentration's effect on the choice of auditors available to clients, or the possibility of regulatory capture by a small number of large auditors—issues not addressed in our study.

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Table 1
Descriptive statistics of variables of interest

Panel A: Variables used in regression analyses (n=27,756)

Variable	Mean	SD	Q1	Median	Q3
Audit Quality [*(-1)*|DA_BS|*]	-0.118	0.190	-0.130	-0.053	-0.021
Concentration	0.281	0.115	0.23	0.252	0.293
Size	12.231	2.253	10.645	12.216	13.762
Short tenure	0.285	0.452	0.000	0.000	1.000
Sales change	0.108	0.381	-0.024	0.059	0.198
Book To market	0.580	0.665	0.189	0.408	0.724
Loss	0.415	0.493	0.000	0.000	1.000
Leverage	0.580	0.647	0.286	0.495	0.697
Issue	0.455	0.498	0.000	0.000	1.000
Cash from operations	0.003	0.325	-0.024	0.068	0.136
Big 5	0.772	0.419	1.000	1.000	1.000
Industry Specialist	0.019	0.138	0.000	0.000	0.000
Firm age	2.51	0.668	2.079	2.485	3.091
Client importance	0.109	0.202	0.010	0.030	0.101
Fee ratio	0.715	2.580	0.106	0.316	0.776
Lagged accrual	0.167	0.654	0.039	0.078	0.150

Panel B: MSA-level audit market concentration by the number of Big 5 firms with office in that MSA

			Concentration				
Number of Big 5 firms with offices in an MSA	Number of MSAs	Number of client firm-year observations	Mean	SD	Q1	Median	Q3
0	37	153	0.867	0.199	0.705	1.000	1.000
1	29	250	0.863	0.180	0.758	0.961	1.000
2	12	421	0.599	0.180	0.488	0.531	0.719
3	5	277	0.551	0.139	0.466	0.553	0.642
4	14	977	0.436	0.152	0.320	0.392	0.504
5	40	25,678	0.257	0.054	0.226	0.245	0.277
	137	27,756					

Note: The sample spans the demise of Arthur Andersen. We count an auditor office in an MSA if it existed during any sample year.

Panel C: Audit market concentration for MSAs with all Big 5 audit firms, by MSA population

		Concentration				
MSA population	Number of client firm-year observations	mean	SD	Q1	Median	Q3
high	17,574	0.245	0.040	0.220	0.241	0.257
middle	5533	0.271	0.051	0.229	0.255	0.315
low	2571	0.315	0.084	0.271	0.308	0.362
	25,678					

Audit Quality [(-1)*|*DA_BS*|] = (-1)* absolute value of residuals from regression Eq. (1) below;

$$ACCR_{jt} / TA_{jt-1} = \beta_1[1/TA_{jt-1}] + \beta_2[(\Delta REV_{jt} - \Delta REC)/TA_{jt-1}] + \beta_3[PPE_{jt}/TA_{jt-1}]$$

$$+\beta_4[CFO_{jt}/TA_{jt-1}] + \beta_5 DCFO_{jt} + \beta_6[(CFO_{j_t}/TA_{jt-1}) * DCFO_{jt}] + \varepsilon_{jt},$$

This equation is estimated for each two-digit, SIC-code industry within each year, provided there are at least 10 observations.

Concentration = Concentration of audit market by MSA, measured by the Herfindahl index of audit fees by auditor office, as described in Section 2.1;

Size = log of total assets in thousands (Compustat #6);

Short tenure = dummy variable equal to 1 if the auditor is in the first or second year of the audit engagement and 0 otherwise;

Sales change = Changes in net sales [Compustat #12 – Lag(Compustat #12)] deflated by lagged total assets;

Book to market = Ratio of book value (Compustat #60) to market value (Compustat #199 times Compustat #25), winsorized at 0 and 4;

Loss = dummy variable equal to 1 if reported net income (Compustat #172) is less than zero, and 0 otherwise;

Leverage = Ratio of total liabilities (Compustat #181) to total assets;

Issue = dummy variable equal to 1 if the sum of the debt issued (Compustat #111) and equity issued (Compustat #108) during the past 3 years is more than 5% of the total assets, and 0 otherwise;

Cash flow from operations = Cash flow from operations (Compustat #308) deflated by lagged total assets;

Big 5 = dummy variable equal to 1 if the auditor is one of PWC, KPMG, AA, EY, DT, and zero otherwise;

Industry specialist = dummy variable equal to 1 if the auditor is an industry specialist both at the national level and at the city (MSA) level, and zero otherwise. Following Reichelt and Wang (2008), an auditor is defined as a national (city) industry specialist if it has an annual audit fee market share greater than 40 percent in an industry, based on the two-digit SIC code in the national (city) audit market;

Firm age = log of the number of years for which total assets was reported in Compustat since 1974;

Client importance = audit fees paid to the auditor divided by total audit fee revenues of the audit office that the auditor belongs to;

Fee ratio = ratio of non-audit service fees relative to total fees (i.e., the sum of non-audit fees and audit fees) received from the client firm;

Lagged accruals = one-year lagged total accruals; Accruals are defined as income before extraordinary items (Compustat #18) minus cash flow from operations (Compustat #308) deflated by lagged total assets.

Table 2

Panel A: Pearson correlations between different measures of audit quality

Variable	1	2	3	4
1. *(-1)*|DA_BS|*	1.000			
2. *(-1)*|DA_KLW|*	0.584	1.000		
3. *(-1)*σ(υ)*	0.411	0.338	1.000	
4. *(-1)*| υ_t |.*	0.388	0.294	0.592	1.000

Panel A: Pearson correlations between different measures of concentration

Variable	5	6	7	8	9
5. Concentration based on audit fees	1.000				
6. Concentration based on number of clients	0.785	1.000			
7. Concentration based on total assets	0.748	0.615	1.000		
8. Square root of Concentration based on audit fees	0.990	0.761	0.735	1.000	
9. Rank of Concentration based on audit fees	0.763	0.620	0.638	0.775	1.000

Panel C: Pearson correlations between independent variables

Variable	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
10. (-1)|DA_BS|*	1.00															
11. Concentration	0.07	1.00														
12. Size	0.34	0.05	1.00													
13. Short tenure	-0.08	0.01	-0.17	1.00												
14. Sales change	-0.08	-0.01	0.05	0.01	1.00											
15. Book to market	0.08	0.03	-0.07	-0.01	-0.15	1.00										
16. Loss	-0.24	-0.09	-0.37	0.08	-0.20	0.08	1.00									
17. Leverage	-0.20	0.02	-0.12	0.05	-0.09	-0.17	0.14	1.00								
18. Issue	-0.11	0.00	0.00	0.03	0.11	-0.13	0.11	0.11	1.00							
19. Cash from operations	0.39	0.07	0.35	-0.07	0.08	0.06	-0.44	-0.16	-0.20	1.00						
20. Big 5	0.22	0.01	0.54	-0.27	-0.01	-0.02	-0.15	-0.14	-0.02	0.16	1.00					
21. Industry specialist	0.03	-0.02	0.07	-0.03	-0.01	-0.03	-0.03	-0.02	0.00	0.01	0.08	1.00				
22. Firm Age	0.17	0.09	0.25	-0.10	-0.11	0.04	-0.26	0.02	-0.11	0.19	0.00	0.01	1.00			
23. Client importance	-0.03	0.28	-0.05	0.06	0.00	0.04	-0.01	0.08	0.00	0.01	-0.36	-0.04	0.10	1.00		
24. Fee ratio	0.00	-0.01	0.10	-0.04	0.02	0.00	-0.02	-0.02	0.02	0.02	0.08	0.01	-0.03	-0.02	1.00	
25. Lagged accruals	-0.18	-0.03	-0.11	0.04	0.03	-0.03	0.12	0.11	0.04	-0.14	-0.07	-0.01	-0.12	0.00	0.01	1.00

n = 27,756 for all variables except correlations involving different audit quality measures (i.e., Panel A), for which n = 14,327. All correlations in Panels A and B are statistically significant at the 1 percent level. Given a sample size of 27,756, correlations exceeding 0.012 are statistically significant at the 5 percent level, and those exceeding 0.015 are significant at the 1 percent level.

DA_KLW = performance-adjusted discretionary accruals based on Kothari et al. (2005), which is the difference between unadjusted *DA* of one firm (the residual value estimated from Eq. (2)) and *DA* of another firm from the same two-digit SIC code industry that has similar *ROA* in the previous year. We multiply it by -1 to use negative absolute value of *DA_KLW* as a proxy for audit quality.

υ_t = residuals estimated from Eq. (3) which is developed by Dechow and Dichev (2002) and modified by McNichols (2002). We multiply it by -1 to use negative absolute value of υ_t as a proxy for audit quality.

$\sigma(\upsilon)$ = standard deviation of residuals υ_t estimated from Eq. (3), which is calculated for each firm over the years *t*-4 to *t*. Because high $\sigma(\upsilon)$ indicates low audit quality, we multiply it by -1.

See Table 1 for other variable definitions.

Table 3

Relationship between audit quality (using its main proxy, i.e., *(-1)*|DA_BS|*) and audit market concentration. *DA_BS* is calculated based on the Ball and Sivakumar (2006) methodology. Concentration is measured by the Herfindahl index of audit fees by auditor office in each MSA, as described in Section 2.1. Coefficient estimates and t-statistics of estimating the regression equation:

$$\begin{aligned} \textit{Audit quality} = {} & \beta_0 + \beta_1 \textit{ Concentration} + \beta_2 \textit{ Size} + \beta_3 \textit{ Short tenure} + \beta_4 \textit{ Sales change} \\ & + \beta_5 \textit{ Book to market} + \beta_6 \textit{ Loss} + \beta_7 \textit{ Leverage} + \beta_8 \textit{ Issue} \\ & + \beta_9 \textit{ Cash from operations} + \beta_{10} \textit{ Big 5} + \beta_{11} \textit{ Industry specialist} \\ & + \beta_{12} \textit{ Firm age} + \beta_{13} \textit{ Client importance} + \beta_{14} \textit{ Fee ratio} \\ & + \beta_{15} \textit{ Lagged accruals} + \Sigma\, \gamma_j \textit{Industry} + \Sigma\, \theta_t \text{Year} + \omega \end{aligned} \quad (4)$$

	Predicted sign	Column 3 *Audit quality (-1)*|DA_BS|*	Column 4 *Audit quality DA_BS>0*	Column 5 *Audit quality DA_BS<0*
		Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)
Concentration	+	**0.037 (4.99)*****	**0.047 (4.49)*****	**0.023 (2.07)****
Size	+	0.013 (7.92)***	0.018 (10.18)***	0.009 (4.75)***
Short tenure	+	-0.002 (-0.54)	-0.002 (-0.50)	-0.003 (-0.51)
Sales change	-	-0.060 (-7.95)***	-0.055 (-9.13)***	-0.060 (-4.18)***
Book to market	+	0.008 (3.39)***	0.004 (1.15)	0.012 (4.67)***
Loss	-	-0.006 (-1.31)	0.062 (9.29)***	-0.062 (-8.52)***
Leverage	-	-0.040 (-10.18)***	-0.025 (-4.64)***	-0.048 (-10.66)***
Issue	-	-0.004 (-1.78)*	-0.005 (-1.55)	-0.004 (-1.17)
Cash from operations	+	0.152 (10.74)***	0.184 (17.80)***	0.141 (7.86)***
Big5	+	0.028 (5.16)***	0.033 (6.67)***	0.019 (2.34)**
Industry specialist	+	-0.003 (-0.41)	-0.002 (-0.18)	-0.007 (-0.81)
Firm age	+	0.006 (2.14)**	-0.002 (-0.54)	0.016 (2.69)***
Client importance	?	-0.003 (-0.46)	-0.016 (-2.04)**	0.010 (0.81)
Fee ratio	?	-0.001 (-1.22)	0.000 (-0.40)	-0.006 (-13.83)***
Lagged accruals	-	-0.024 (-2.00)**	-0.011 (-1.29)	-0.036 (-2.93)***
Industry &Year	?	Included	Included	Included
Intercept	?	-0.365 (-13.27)***	-0.455 (-12.26)***	-0.251 (-9.11)***
n		27,756	14,836	12,920
Adjusted R-Square		0.271	0.287	0.310
Goodness of fit		156.85***	95.78***	82.84***

*, **, *** refer to two tailed significance at the 10%, 5%, and 1% respectively.
See Table 1 for other variable definitions. Industry and year dummy variables included in the regression, but not reported.

Table 4

Alternative audit quality measures regressed on audit market concentration and control variables. Concentration is measured by the Herfindahl index of audit fees by auditor office in each MSA, as described in Section 2.1. Coefficient estimates and t-statistics of estimating the regression equation (4):

	Predicted sign	Column 3 *Audit quality (-1)*|DA_KLW|*	Column 4 *Audit quality (-1)*| υ_t |*	Column 5 *Audit quality (-1)*$\sigma(\upsilon)$*	Column 6 *Audit quality (-1)*Disc [| υ_t |]*	Column 7 *Audit quality (-1)*Disc [$\sigma(\upsilon)$]*
		Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)
Concentration	+	**0.038 (5.11)*****	**0.014 (3.82)*****	**0.015 (4.35)*****	**0.008 (2.46)****	**0.008 (2.73)*****
Size	+	0.017 (10.80)***	0.008 (23.16)***	0.007 (20.07)***	0.000 (-1.21)	0.000 (-0.33)
Short tenure	+	-0.001 (-0.24)	0.000 (-0.24)	0.000 (-0.15)	0.000 (0.36)	0.003 (1.81)*
Sales change	-	-0.064 (-6.83)***	-0.004 (-2.40)**	-0.008 (-4.00)***	0.001 (0.41)	-0.004 (-1.32)
Book to market	+	0.011 (5.57)***	0.006 (5.92)***	0.004 (6.79)***	0.001 (1.43)	0.000 (-0.12)
Loss	-	0.004 (0.57)	-0.003 (-4.05)***	-0.002 (-2.55)**	0.004 (2.71)***	0.003 (0.73)
Leverage	-	-0.041 (-11.05)***	-0.012 (-4.76)***	-0.020 (-9.43)***	-0.016 (-3.05)***	-0.036 (-2.58)***
Issue	-	-0.005 (-1.11)	-0.001 (-0.92)	0.000 (-0.44)	0.000 (0.02)	0.001 (0.32)
CFO	+	0.213 (36.36)***	0.018 (6.22)***	0.017 (7.29)***	-0.016 (-3.27)***	-0.015 (-1.40)
Big5	+	0.031 (5.81)***	0.002 (1.29)	0.005 (1.77)*	0.003 (1.46)	0.004 (1.69)*
Industry specialist	+	0.000 (-0.01)	0.000 (-0.05)	-0.004 (-1.68)*	0.001 (0.54)	-0.001 (-0.52)
Firm age	+	0.008 (3.83)***	0.005 (4.13)***	0.002 (2.16)**	0.001 (0.93)	-0.001 (-0.55)
Client importance	?	-0.013 (-1.55)	-0.002 (-0.92)	-0.002 (-0.74)	-0.003 (-1.28)	0.001 (0.25)
Fee ratio	?	-0.001 (-1.91)*	0.000 (0.76)	0.000 (-0.46)	0.000 (0.99)	0.000 (-0.60)
Lagged accruals	-	-0.018 (-1.83)*	-0.025 (-4.57)***	-0.003 (-1.42)	-0.028 (-2.61)***	-0.012 (-0.98)
Industry & Year	?	Included	Included	Included	Included	Included
Intercept	?	-0.468 (-16.95)***	-0.174 (-24.32)***	-0.139 (-22.67)***	0.002 (0.18)	0.007 (0.38)
n		27,756	19,764	14,327	11,903	11,896
Adj. R-Square		0.243	0.377	0.213	0.084	0.099
Goodness of fit		149.71***	179.27***	105.14***	6.75***	13.25***

*, **, *** refer to two tailed significance at the 10%, 5%, and 1% respectively

See Table 1 for other variable definitions. Industry and year dummy variables included in the regression, but not reported.

Table 5

Alternative audit market concentration measures as independent variables in a regression of audit quality (= *(-1)*|DA_BS|*) on concentration and control variables. Coefficient estimates and t-statistics of estimating the regression equation (4).

	Predict. sign	Column 3 Based on number of clients	Column 4 Based on total assets of clients	Column 5 Based on audit fees, for large clients of Big 5 auditors only	Column 6 Based on audit fees, for non-Big 5 and small Big 5 clients only	Column 7 Square root of concentration based on audit fees	Column 8 Rank of concentration based on audit fees
		Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)
Concentration	+	**0.040 (4.05)*****	**0.018 (2.68)*****	**0.023 (2.60)*****	**0.064 (6.25)*****	**0.049 (4.88)*****	**0.000 (3.06)*****
Size	+	0.013 (7.87)***	0.013 (7.98)***	0.004 (1.71)*	0.020 (10.01)***	0.013 (7.92)***	0.013 (7.91)***
Short tenure	+	-0.002 (-0.53)	-0.002 (-0.51)	-0.012 (-1.64)	-0.002 (-0.43)	-0.002 (-0.55)	-0.002 (-0.54)
Sales change	-	-0.060 (-7.94)***	-0.060 (-7.99)***	-0.075 (-3.60)***	-0.056 (-10.00)***	-0.060 (-7.96)***	-0.060 (-7.99)***
Book to market	+	0.008 (3.53)***	0.008 (3.47)***	0.006 (1.83)*	0.008 (3.59)***	0.008 (3.36)***	0.008 (3.36)***
Loss	-	-0.006 (-1.31)	-0.007 (-1.35)	-0.039 (-5.70)***	0.003 (0.64)	-0.006 (-1.30)	-0.006 (-1.34)
Leverage	-	-0.039 (-10.01)***	-0.040 (-10.11)***	-0.007 (-0.28)	-0.039 (-10.97)***	-0.040 (-10.19)***	-0.040 (-10.12)***
Issue	-	-0.004 (-1.71)*	-0.004 (-1.75)*	0.003 (0.78)	-0.008 (-3.27)***	-0.004 (-1.78)*	-0.004 (-1.77)*
CFO	+	0.152 (10.73)***	0.152 (10.71)***	0.139 (3.05)***	0.149 (11.84)***	0.152 (10.75)***	0.152 (10.75)***
Big5	+	0.028 (5.55)***	0.029 (5.34)***	NA	0.022 (3.86)***	0.028 (5.13)***	0.029 (5.18)***
Industry specialist	+	-0.004 (-0.49)	-0.003 (-0.40)	0.003 (0.50)	NA	-0.003 (-0.41)	-0.003 (-0.35)
Firm age	+	0.006 (2.20)**	0.006 (2.19)**	0.009 (2.68)***	0.007 (2.22)**	0.006 (2.12)**	0.006 (2.19)**
Client importance	?	-0.003 (-0.32)	0.000 (-0.01)	0.004 (0.44)	0.000 (0.03)	-0.003 (-0.47)	0.000 (-0.05)
Fee ratio	?	-0.001 (-1.22)	-0.001 (-1.21)	0.000 (-0.21)	-0.004 (-3.41)***	-0.001 (-1.22)	-0.001 (-1.22)
Lagged accruals	-	-0.024 (-2.00)**	-0.024 (-2.00)**	-0.042 (-2.24)**	-0.021 (-1.90)*	-0.024 (-2.00)**	-0.024 (-1.99)**
Industry & Year	?	Included	Included	Included	Included	Included	Included
Intercept	?	-0.362 (-12.80)***	-0.363 (-13.40)***	-0.197 (-12.61)***	-0.443 (-13.46)***	-0.380 (-14.14)***	-0.336 (-10.55)***
n		27,756	27,756	6,908	20,848	27,756	27,756
Adj. R-Square		0.271	0.271	0.219	0.269	0.271	0.271
Goodness of fit		156.94***	156.82***	30.94***	111.03***	156.83***	156.88***

*, **, *** refer to two tailed significance at the 10%, 5%, and 1% respectively

See Table 1 for other variable definitions. Industry and year dummy variables included in the regression, but not reported.

Table 6

Testing for differences in the relationship between audit quality and audit market concentration for different sub-groups of the sample, namely, large and small MSAs, large and small client firms, MSAs with and without the presence of all Big 5 audit firms, and clients of industry specialist and non-industry-specialist auditors. Indicator variables denoting sub-samples are interacted with concentration and introduced as additional independent variables in Eq. (4). Coefficient estimates and t-statistics of estimating the regression equation (4), the dependent variable is *(-1)*|DA_BS|*, and concentration is measured by the Herfindahl index of audit fees by auditor office in each MSA, as described in Section 2.1:

	Predicted sign	Column 3 Indicator: *Large MSA*	Column 4 Indicator: *Large Firm*	Column 5 Indicator: *Max big5*	Column 6 Indicator: *Industry specialist*
		Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)	Coeff. (t-value)
Concentration	**+**	**0.038 (4.84)*****	**0.047 (4.40)*****	**0.038 (4.28)*****	**0.037 (5.05)*****
Concentration * Indicator	**?**	**0.004 (0.19)**	**-0.023 (-1.04)**	**0.022 (0.98)**	**0.009 (0.11)**
Indicator Variable	?	0.000 (-0.03)	-0.009 (-0.97)	-0.003 (-0.33)	NA
Size	+	0.013 (8.07)***	0.016 (6.15)***	0.013 (7.93)***	0.013 (7.92)***
Short tenure	+	-0.002 (-0.54)	-0.003 (-0.61)	-0.002 (-0.55)	-0.002 (-0.54)
Sales change	-	-0.060 (-7.95)***	-0.060 (-8.20)***	-0.060 (-7.99)***	-0.060 (-7.94)***
Book to market	+	0.008 (3.36)***	0.008 (3.41)***	0.008 (3.33)***	0.008 (3.39)***
Loss	-	-0.006 (-1.33)	-0.007 (-1.50)	-0.006 (-1.30)	-0.006 (-1.30)
Leverage	-	-0.040 (-10.17)***	-0.038 (-9.78)***	-0.040 (-10.22)***	-0.040 (-10.18)***
Issue	-	-0.004 (-1.76)*	-0.004 (-1.61)	-0.004 (-1.77)*	-0.004 (-1.78)*
Cash from operations	+	0.152 (10.76)***	0.151 (10.47)***	0.152 (10.77)***	0.152 (10.75)***
Big5	+	0.029 (4.99)***	0.029 (5.40)***	0.028 (5.15)***	0.028 (5.18)***
Industry specialist	+	-0.003 (-0.42)	-0.003 (-0.41)	-0.003 (-0.41)	-0.006 (-0.23)
Firm age	+	0.006 (2.13)**	0.006 (2.14)**	0.006 (2.13)**	0.006 (2.14)**
Client importance	?	-0.003 (-0.42)	-0.004 (-0.49)	-0.003 (-0.43)	-0.003 (-0.46)
Fee ratio	?	-0.001 (-1.22)	-0.001 (-1.19)	-0.001 (-1.23)	-0.001 (-1.22)
Lagged accruals	-	-0.024 (-2.00)**	-0.024 (-2.00)**	-0.024 (-2.00)**	-0.024 (-2.00)**
Industry &Year	?	Included	Included	Included	Included
Intercept	?	-0.365 (-12.66)***	-0.395 (-10.80)***	-0.367 (-11.65)***	-0.365 (-13.25)***
n		27,756	27,756	27,756	27,756
Adjusted R-Square		0.271	0.272	0.271	0.271
Goodness of fit		148.53***	149.14***	148.00***	152.23***

*, **, *** refer to two tailed significance at the 10%, 5%, and 1% respectively

See Table 1 for other variable definitions. Industry and year dummy variables included in the regression, but not reported.

Table 7

Relationship between audit fees and audit market concentration. Concentration is measured by the Herfindahl index of audit fees by auditor office in each MSA, as described in Section 2.1. Coefficient estimates and t-statistics of estimating the following regression equation:

$$Ln(Audit\ fees) = \beta_0 + \beta_1\ Concentration + \beta_2\ Size + \beta_3\ Loss + \beta_4\ Firm\ age + \beta_5\ Bankruptcy + \beta_6\ Xtra + \beta_7\ Sqsegs + \beta_8\ GC + \beta_9\ IC\ audit + \beta_{10}\ IC\ weakness + \beta_{11}\ Sign\ dual + \beta_{12}\ Risk\ Ind + \beta_{13}\ plan + \beta_{14}\ Foreign + \beta_{15}\ Audit\ lag + \beta_{16}\ New\ finance + \beta_{17}\ Sqemps + \beta_{18}\ Inv\ rec + \beta_{19}\ Mergers + \beta_{20}\ CFO + \beta_{21}\ Liquidity + \beta_{22}\ Restatement + \beta_{23}\ Resignation + \beta_{24}\ Re\ Diss + \beta_{25}\ Initial + \beta_{26}\ Median\ wage + \beta_{27}\ Specialist + \beta_{28}\ MSA\ rank + \beta_{29}\ MSA\ area + \Sigma\ \gamma_j Industry + \Sigma\ \theta_t Year + \omega \quad (5)$$

	Predict. sign	Column 3 Concentration for only large Big 5 Clients	Column 4 Concentration based on audit fees	Column 5 Concentration based on number of clients
		Coeff.: (t-value)	Coeff.: (t-value)	Coeff.: (t-value)
Concentration	**?**	**0.154 (3.08)*****	**0.086 (1.55)**	**0.137 (2.10)****
Size	+	0.400 (91.11)***	0.400 (91.10)***	0.399 (90.84)***
Loss	+	0.133 (13.82)***	0.132 (13.80)***	0.132 (13.76)***
Firm Age	+	0.002 (4.53)***	0.002 (4.59)***	0.002 (4.65)***
Bankruptcy	+	0.195 (8.12)***	0.196 (8.14)***	0.196 (8.17)***
Xtra	+	0.158 (11.47)***	0.158 (11.45)***	0.158 (11.48)***
Sqsegs	+	0.060 (11.56)***	0.059 (11.51)***	0.059 (11.50)***
GC	+	0.114 (5.16)***	0.114 (5.16)***	0.113 (5.13)***
IC audit	+	0.580 (31.25)***	0.579 (31.22)***	0.579 (31.22)***
IC weakness	+	0.303 (9.15)***	0.303 (9.12)***	0.302 (9.08)***
Sign dual	+	0.126 (3.70)***	0.127 (3.71)***	0.127 (3.72)***
Risk Ind	+	0.044 (3.18)***	0.043 (3.09)***	0.040 (2.92)***
Plan	+	0.187 (15.51)***	0.186 (15.43)***	0.186 (15.43)***
Foreign	+	0.209 (18.53)***	0.209 (18.55)***	0.209 (18.53)***
Audit lag	+	0.002 (9.27)***	0.002 (9.29)***	0.002 (9.31)***
New finance	+	0.022 (2.68)***	0.022 (2.69)***	0.023 (2.73)***
Sqemps	+	0.057 (13.44)***	0.057 (13.45)***	0.057 (13.51)***
Inv rec	+	0.425 (14.98)***	0.425 (14.98)***	0.426 (15.00)***
Mergers	+	0.111 (10.43)***	0.111 (10.41)***	0.112 (10.45)***
CFO	-	-0.173 (-10.33)***	-0.173 (-10.31)***	-0.172 (-10.30)***
Liquidity	-	-0.009 (-2.58)***	-0.009 (-2.58)***	-0.009 (-2.57)**
Restatement	+	-0.009 (-0.63)	-0.009 (-0.63)	-0.009 (-0.64)
Resignation	+	0.228 (2.62)***	0.228 (2.61)***	0.228 (2.61)***
Re Diss	+	0.329 (3.57)***	0.329 (3.57)***	0.330 (3.57)***
Initial	-	-0.250 (-8.24)***	-0.250 (-8.24)***	-0.249 (-8.23)***
Median wage	+	0.000 (16.09)***	0.000 (16.15)***	0.000 (15.91)***
Specialist	+	0.050 (1.75)*	0.050 (1.75)*	0.047 (1.63)
MSA Rank	?	-0.003 (-9.49)***	-0.003 (-8.57)***	-0.003 (-8.74)***
MSA Area	+	0.000 (0.99)	0.000 (1.05)	0.000 (1.15)
Industry and Year	?	Included	Included	Included
Intercept	?	5.729 (53.86)***	5.739 (54.01)***	5.745 (54.04)***
n		15,952	15,952	15,952
Adjusted R-Square		0.827	0.827	0.827
Goodness of Fit		1,664***	1,662***	1,661***

*, **, ***, refer to two tailed significance at the 10%, 5%, and 1% respectively

Industry and year dummy variables included in the regression, but not reported.

Below are the definitions of variables in Eq. (5):

Ln(*Audit fees*)	=	log of current fiscal year reported audit fees. The source of audit fee data is Audit Analytics;
Size	=	natural logarithm of total assets (TA) (Compustat #6) after measured in $ thousands;
Loss	=	an indicator variable equal to one if the audit client reported a loss in the current or previous fiscal year (Compustat #172); zero otherwise;
Firm Age	=	number of fiscal years since the company's initial public offering use IPO data in Compustat, and manually obtained if missing;
Bankruptcy	=	probability of bankruptcy score based on Zmijewski (1984);
Xtra	=	an indicator variable equal to one if the audit client reported extraordinary items or discontinued operations if the absolute value exceeds $10,000; zero otherwise. Data are obtained from Compustat #48;
Sqsegs	=	the square root of the number of segments, where number of segments are obtained from Compustat (Business Information - Segment Item Value File, Segment Identifier);
GC	=	an indicator variable equal to one if the audit opinion includes a going concern modification; zero otherwise. The source of audit opinion data is Audit Analytics;
IC audit	=	an indicator variable equal to one if the annual report includes an opinion on management's assessment of internal control in accordance with Section 404 of the SOX; zero otherwise;
IC weakness	=	an indicator variable equal to one if the annual report includes an opinion on management's assessment reported ineffective internal control (i.e, adverse); zero otherwise;
Sign dual	=	is an indicator variable equal to one if the audit opinion is dual-dated (or more) for events occurring after completion of field work for audit procedures; zero otherwise;
Risk Ind	=	dichotomous variable equal to one if primary SIC is defined as a Arisky industry@; zero otherwise.
Plan	=	an indicator variable equal to one if the company has a pension or post-retirement plan, where existence is defined as either current year plan assets or cost > $1 million; zero otherwise. Data are obtained from Compustat Xpressfeed North America Dataset (aco_pnfnda);
Foreign	=	an indicator variable equal to one if the audit client has foreign operations as indicated by foreign currency adjustments to income (Compustat #150); zero otherwise. A firm is considered to have foreign operations if the absolute value of the Foreign Currency Adjustment Account exceeds $10,000;
Audit lag	=	is the number of days between audit opinion signature date and fiscal year end. If the audit opinion is dual-dated (or more), the initial date is used as that date represents the last day of field work for audit procedures and the last day for the auditor's responsibility for review of events that occur after the balance sheet date. Dual-dating (or more) suggests additional work and disclosures *only* for the new event occurring after completion of field work.
New finance	=	indicator variable for material new equity issue or debt (Compustat #108 and #111) is greater $50,000 ($ actuals);
Sqemps	=	the square root of the number of employees (Compustat #29 and Compact Disclosure-SEC, measured in thousands) disclosed in Form 10-K filings;
Inv rec	=	inventory plus accounts receivable (Compustat #3 + #2) deflated by total assets TA_{t-1}.
Mergers	=	indicator variable equal to one for mergers and acquisitions (AFTN #1 = 'AA', 'AB', 'AR', 'AS', 'FA', 'FB', 'FC', 'FD', 'FE', 'FF', 'FW'), and zero otherwise;
CFO	=	Cash flow from operations (Compustat # 308) deflated by assets TA_{t-1};
Liquidity	=	Ratio of current assets less inventory divided by current liabilities;
Restatement	=	an indicator variable equal to one if client announced a restatement in the previous financial year, zero otherwise;
Resignation	=	an indicator variable equal to one if the predecessor audit firm resigned from the audit engagement; zero otherwise;
Re Diss	=	an indicator variable equal to one if the predecessor audit firm had a disagreement or reportable event with the client; zero otherwise;

Initial	=	an indicator variable equal to one if there is an auditor change in that fiscal year; zero otherwise. All auditor changes are to and from Big 5 auditors;
Median wage	=	hourly median wage of auditors and accountants obtained from *2007 Metropolitan Area Occupational Employment Statistics* published by the U.S. Bureau of Labor Statistics;
Specialist	=	dummy variable equal to 1 if the auditor is an industry specialist both at the national level and at the city (MSA) level, and zero otherwise. Following Reichelt and Wang (2008), an auditor is defined as a national (city) industry specialist if it has an annual audit fee market share greater than 40 percent in an industry, based on the two-digit SIC code in the national (city) audit market;
MSA rank	=	rank of the MSAsize based on the population of the MSA given in 2000 U.S. Census; and
MSA area	=	the total area of the MSA given in 2000 U.S. Census.