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Fixed Costs, Audit Production, and Audit Markets: Theory and Evidence

by

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Abstract

We analyze the role of discretionary joint fixed costs in audit production. Given such costs, the investment decision and production of audit services must be analyzed over a client portfolio. We model this problem, and use monotone comparative statics (Milgrom and Shannon [1994]) to show the implications of variations in client-specific losses and the number of clients for the optimum level of fixed investment and audit assurance. We develop four hypotheses concerning the relations between audit quality and (1) the magnitude of potential client-specific losses; (2) average client losses in a portfolio; (3) the number of clients in a portfolio; and (4) the variability of losses in a portfolio. Using discretionary accruals as the audit quality proxy, we find evidence consistent with these hypotheses. Using PCAOB inspection results, and financial statement restatements as proxies for audit quality, we find weaker evidence consistent with hypotheses 2, 3 and 4.

Keywords: Audit services, client portfolios, production, investments, discretionary common fixed costs

1. Introduction and prior literature

In this paper we analyze the role of discretionary fixed costs in audit production. Such costs can be changed period-to-period by an audit firm's management, but are fixed at a moment in time and are common or joint across a set of the firm's audit clients. Our motivation is to better understand the interaction of the production and supply of audit services and audit market outcomes. Outcomes of interest include audit quality (i.e. audit assurance), the number of hours utilized to service a client, and audit costs. Discretionary fixed costs can be associated with a variety of investments that are made by a public accounting firm to facilitate its audit production, including location specific investments (e.g. the construction of local offices), firm-wide training programs for staff, and investments in audit technology. We conjecture that such investments affect the transformation of audit effort (hours) into assurance, and that these investments (i.e. fixed costs) influence production primarily through their effect on the efficiency of audit effort (i.e. process improvements). Efficiency increasing investments (often referred to as labor enhancing or productivity enhancing) can result in either lower cost audits or higher assurance levels, or a combination of the two outcomes.

The investments and associated costs that we analyze are those that affect the audit of more than a single client. Considered over multiple time periods, such costs are constant for a given period of time, and are joint across the audits (of at least a subset) of clients serviced in that period. We do not consider client-specific set-up costs that may be incurred when performing an audit. A key implication of our focus on these discretionary, fixed, joint or common costs is that the investment decision and the production of audit services cannot be fully analyzed on a client-by-client basis but must consider the auditor's portfolio of clients.

Existing research (e.g. O'Keefe, Simunic, and Stein [1994], Bell, Doogar, and Solomon [2008], Akono and Stein [2014]) models audit production as a simple transformation of variable labor inputs into audit assurance, without explicitly considering how (if at all) the efficiency enhancing investments and the associated fixed costs enter into that transformation. While the paper by Ye and Simunic [2017] also considers efficiency enhancing investments, the investments and associated costs are assumed to be client-specific. In the absence of significant efficiency enhancing common fixed costs, the production of audit services for a specific client is largely separable from the audit production for other clients in the audit firm's client portfolio. This greatly simplifies the audit production problem. When the efficiency enhancing investments and the resulting common fixed costs are an important feature of audit production, individual audits are no longer separable because these investments will improve the efficiency of the production of all audits, or at least a subset of the firm's audits (e.g. clients in certain industries). Audit firms need to aggregate these effects when making investment decisions.

Process improvements can be general for an audit firm's whole pool of clients or limited to a subset of specific clienteles. The modeling strategy we employ in this paper is flexible as it can be extended to cover a multitude of auditing scenarios (e.g. audit firms as a whole, industry specialization, etc.), at least to a first approximation. Our modelling strategy is novel, and we test four hypotheses on the relationship between an audit firm's client portfolio characteristics and audit quality. The analysis does not encompass investments by the auditor that target the demand side of the auditing market such as investments in advertising or customer relations.

We focus on the supply side of the auditing market. Supply conditions are critical to understanding the market for audit services because a large portion of the audit market operates under conditions where audits are mandatory and audit quality is *ex-ante* unobservable. This implies that the demand for varying levels of audit quality is essentially a matter of auditor choice (e.g. Big 4 vs. non-Big 4, or specialist vs. non-specialist), with the chosen supplier determining the details of assurance production. The fact that a well specified and calibrated audit fee model (e.g., Simunic [1980], Hay, Knechel and Wong [2006]) is able to explain 80% or more of the cross-sectional variation in the logarithm of U.S. audit fees (which reflect audit costs) using variables that capture supply-side work scope (e.g., client size and complexity) and the risk imposed by association with a client on the auditor, suggests that supply-side factors are key to understanding observable market outcomes.

Most existing research has treated audit production as simply involving variable labor inputs which are (in some way) transformed into audit assurance, i.e., the probability, as assessed by the auditor and financial statement users, that a client's financial statements are not materially misstated. A significant exception is the paper by Sirois, Marmousez, and Simunic [2016] which applies the endogenous fixed cost (EFC) model developed by Sutton [1991] to the auditing industry. In Sutton's model as applied to auditing, technology plays a central role in determining the level of audit quality and audit fees. Sirois et al further argue that Big 4 auditors make differentially greater technology investments than non-Big 4 auditors and strategically compete on both quality and price through these investments in technology, the level of which is increasing in market size. Ferguson, Pinnuck and Skinner [2016] also apply Sutton's EFC model to explain audit market structure and the emergence of the two-tier audit market (Big 4 vs. non-Big 4) in Australia.

While Sutton's EFC model incorporates technology investments and fixed costs, the application of the EFC model to the analysis of the auditing industry has been largely verbal and *ad hoc*. By contrast, in this paper we formally analyze the audit production problem when fixed investments and the resulting discretionary fixed common costs are important. We first set up the auditor's problem as a simple expected cost minimization problem with client-specific labor hours and the level of fixed investments (that benefit the audits of all clients) as the auditor's choice variables, and audit assurance as an outcome variable. This formulation is equivalent to a profit maximization problem with fixed audit fees. We provide an analytical solution to this cost minimization problem for a case in which specific functional forms of the assurance production function and fixed investments cost function are assumed. We also provide numerical solutions for both the special case and a broader class of reasonable functional forms. Next, the problem is restated as a cost minimization problem, but with the level of fixed investments and the level of assurance as the choice variables and the client-specific audit hours defined implicitly as a function of the choice variables. This formulation facilitates the application of monotone comparative statics (Milgrom and Shannon [1994]) to describe the more general relationship between the characteristics of an auditor's client portfolio and the level of investment and client-specific audit assurance.

These analyses lead to several testable hypotheses regarding audit quality and the characteristics of individual clients and the auditor's portfolios of clients. We test these hypotheses first by using the absolute value of discretionary accruals as the proxy for audit quality and using four definitions of audit markets ranging from the broad U.S. national market (all publicly listed companies) to companies operating in specific U.S. Metropolitan Statistical Areas (MSAs) in specific 2-digit Standard Industrial Classification (SIC) industries. To address the concern that the financial reporting outcomes (e.g., absolute discretionary accruals) may be caused by clients' fundamentals rather than auditor-provided assurance, we employ two other measures that more directly capture the auditors' inputs as the proxies for audit quality. First, we examine the number of audits with deficiencies and the number of specific audit failures in these audits as identified by the Public Company Accounting Oversight Board's (PCAOB) regular inspection of registered audit firms. Then, we use financial statement restatements as another proxy for audit quality in our supplemental analysis. The results of these various empirical tests suggest that the audit investments associated with the discretionary fixed common costs that affect the production of some (or all) of an audit firm's portfolio of clients are an important, hitherto unexamined feature of audit production which can help explain auditor-specific and client-specific systematic variations in audit quality.

The remainder of the paper is organized as follows. In section 2, we set up a basic formulation of the audit production problem where production requires variable labor input(s) but fixed costs are not explicitly considered as a choice variable, either because they do not exist or because technology and other investments associated with fixed costs are given. This formulation is consistent with the way audit production has been conceived and modeled in the existing literature. In section 3, which is the conceptual / theoretical core of our paper, we introduce investments as a choice variable and the associated fixed costs into the analysis. We set up models that describe audit firms and their clients by several exogenous parameters, and study the characteristics of optimal production including the levels of investment, variable labor hours used, and assurance levels provided. We also develop the comparative statics of the auditor's expected cost minimization problem. We conclude this section by developing testable hypotheses that follow from our analyses. In section 4, we develop the empirical design for testing the four hypotheses and report the empirical results. The last section summarizes and concludes the paper.

2. A Basic Model of the Audit Production Problem

2.1 BASIC SET-UP - SINGLE CLIENT OPTIMIZATION

A common assumption for analyzing audit production is that the competition in the market for audits and/or the production of audits given a fixed audit fee motivate auditors to minimize the costs of audit production (e.g., Simunic [1980], Dye [1993]). Formalizing this insight, a rational auditor planning the audit of a single client using audit hours of various types (i.e. a choice among junior, senior, manager, and partner hours) might solve (in concept) the following program:

1) Minimize $c(\mathbf{h}) = \mathbf{w} \cdot \mathbf{h} + L \bullet [1 - q(\mathbf{h}, a)]$

s.t. $q(\mathbf{h}, a) = q^p$,

where, c(•), is the total cost function,

- **h**, is a vector of audit hours of various types (e.g. junior, senior etc.),
- **w**, is a vector of factor costs of various types of audit hours,
- L, is the potential loss an auditor may incur through her association with a client's financial statements
- q(•), is the audit transformation function in which audit hours are transformed into assurance, where assurance is the auditor assessed probability that the post-audit financial statements are free of material misstatement.[1]
- q^p, is the planned level of assurance,
- *a*, is a fixed audit investment (e.g. technology) parameter affecting audit efficiency, and
- (1 - q), is the probability of a post-audit loss.

Imposing appropriate structure to assure a solution and emphasizing that *a* is fixed and not a choice variable, then the auditor's problem is to pick the cost minimizing **h**, i.e.

$$\boldsymbol{h}^* = \underset{\boldsymbol{h}}{\operatorname{argmin}}\, c(a, \boldsymbol{w}, L, q^p, \boldsymbol{h})$$

[1] The assurance production function, q(•), implicitly includes all phases of an audit, i.e. planning, risk assessment, substantive testing, and completion (see Blokdijk, Drieenhuizen, Simunic, and Stein [2006]).

If there is an interior solution to this problem, then it would be characterized by the usual equalities between the ratios of the marginal rates of transformation and the ratios of the factor costs (input prices). This model carries the essence of the auditor's cost structure implicit in most empirical cross-sectional audit fee or audit hour studies involving multiple labor inputs and was used to motivate the empirical analysis of the audit hours utilized by a major public accounting firm in O'Keefe, Simunic, and Stein [1994] and Bell, Doogar, and Solomon [2008].

If we specify an appropriate audit hour transformation function and substitute in parameter values then, in theory, we could write down an audit cost function relative to the parameters as:

2) $\mathrm{c}(h^* | \, a, \boldsymbol{w}, L, q^p)$.

We can view 2) as a foundational model used to motivate archival audit fee studies where ***w*,** the vector of wage rates, is assumed to be exogenous, and *a* represents the fixed investment in technology and other factors utilized by the auditor. *L*, the potential loss, varies across clients and is likely a function of the size, complexity, and other characteristics of the client (e.g. a closely held vs. a listed company) as well as the legal and institutional environment associated with the audit. We expect the potential loss to increase with client size, complexity, etc. and as the legal and institutional regime becomes more onerous to auditors. Because liability is ultimately constrained by the financial resources of the audit firm and / or its professional liability insurance, *L* is finite and bounded from above. To focus on the essential features of audit service production and to simplify our analyses, we assume that auditors are strictly liable for failing to detect material misstatements in financial statements (i.e. there is no "negligence defense" based on adherence to auditing standards) or the combination of auditing standards toughness and vagueness is such that the auditor is motivated to ignore the standards (Ye and Simunic [2013]).

In program 1), q^p is assumed to be fixed either by Generally Accepted Auditing Standards (GAAS) or by audit firm policy. While this is a common assumption in the existing literature.[2] the treatment of the planned level of assurance as a fixed parameter potentially conflicts with cost minimization. If q^p is fixed in advance or predetermined then there is no guarantee that c(h^*| a, $\boldsymbol{w}$, L, q^p) will satisfy the requirement that c(h^*| a, $\boldsymbol{w}$, L, q^p) < c(h, q |a, $\boldsymbol{w}$, L) for all allowable combinations of $\{\boldsymbol{h}, q\}$. If, on the other hand, q is assumed to vary audit by audit then program 1) would need to be changed to reflect optimization over both $\boldsymbol{h}$ and q.

Program 1) is a short-run cost minimization problem where fixed costs are treated as both predetermined and sunk. This is consistent with existing literature in assuming that fixed costs (a) are a predetermined characteristic of the audit firm which are unobservable by the researcher. Empirically, the lack of controls for fixed investment is not necessarily problematic. If fixed costs vary across auditors, then an auditor fixed effect potentially captures the cross-sectional differences. Or if there is no across auditor variation in investment (due, perhaps to competition), then the rental costs of fixed investments are included in the mark-up on cost. This mechanism is consistent with the normal practice in service firms to add mark-up on direct labor costs to bill overhead and earn profits.

However, fixed costs can play an important role in audit production. Some investments associated with fixed costs (e.g., the adoption of a more intensive staff training program, or the construction of a more powerful information system) can change the efficiency (marginal product) of the various classes of labor to be transformed to audit assurance. Consequently, the changes in the marginal product of labor will impact the vector of labor hours required to achieve the planned level of assurance, q^p. Given that fixed investments can change the efficiency of audit labor and

[2] For example, audit quality is usually assumed to vary systematically between Big 4 vs. non-Big 4 firms, but audit quality is normally assumed to be the same, or perhaps vary randomly, within these audit firm categories.

that the fixed costs are shared by the auditor's portfolio of clients, fixed costs, audit cost, and audit quality are endogenously determined by the auditors' cost minimization (given fixed audit fees) or profit maximization over its portfolio of clients.

2.2 ANALYSIS WITH MULTIPLE CLIENTS

Before analyzing the role of fixed costs in the auditor's cost minimization problem, we first extend program 1) to incorporate a portfolio of clients, which better captures the reality of audit production. In rewriting program 1), we represent any fixed investments by the parameter a in the assurance transformation function. Higher levels of a imply larger fixed investments. In order to simplify notation and because the mix of labor types is not important to subsequent analyses, we assume a single type of labor going forward. Consequently, *w* and *h* are treated as scalars. Program 1) can be extended to incorporate a portfolio of clients:

3) Minimize w.r.t. h_i: $\sum_{i=1}^{n_t} c_i(h_i) = \mathrm{w} \sum_{i=1}^{n_t} h_i + \sum_{i=1}^{n_t} L_i(1 - q^p)$

s.t. $\mathrm{q}(h_i, a) = q^p$, for all $i \in n_t$,

where n_t is the number of clients in auditor *t*'s set of clients. If audit production is separable in the sense that h_i is independent of any other h_j, then program 3) is a simple adding up of model 1). However, interdependencies might enter the cost functions either through the loss function (see Simunic and Stein [1990]) or through the assurance transformation function, as would occur if learning increased the efficiency of labor. Given the interdependencies of the cost of individual audits in affecting the auditor's total cost, the optimal vectors of h_i's should be jointly determined across the auditor's client portfolio, rather than determined on an audit by audit basis. Further, if an audit firm were to audit to a fixed level of assurance, q^p, across clients, it would make sense for the firm to solve for the optimal q^p at the portfolio level. That is, if there is a fixed level of planned assurance as in 3) then dependencies are also built into the problem.

3. Re- formulating the Audit Production Problem

3.1 AUDIT PRODUCTION WITH INVESTMENTS ASSOCIATED WITH DISCRETIONARY FIXED COSTS

In modeling the role of discretionary fixed costs in audit production, we treat the technology and other investments associated with discretionary fixed costs, i.e., the parameter a, as an input to the auditor's assurance transformation function. We assume that such fixed investments do not directly provide assurance, but rather affect the labor hours needed to produce a given level of assurance. That is, in our model, discretionary fixed costs operate indirectly through the relationship between the usage of hours and the production of assurance. As a consequence of this assumption, fixed investments and costs are inherently efficiency oriented. Investments in technology and other fixed costs reduce the marginal use of labor hours for any target level of assurance.

To formulate the audit production problem in which efficiency enhancing discretionary fixed costs are an auditor's choice variable, we rewrite program 3) which emphasizes that the problem is solved by each auditor at the audit firm level. Importantly, we conjecture and subsequently drop the constraint which characterizes the prior literature that the assurance level produced must equal some planned, target level. If there are t auditors in the market and each auditor has n_t clients, we denote auditor t's choice of investment as a_t. Thus auditors:

4) $$\underset{a_t, h_i}{\text{minimize}} \sum_{i=1}^{n_t} c_i(a_t, h_i) = min\ w \sum_{i=1}^{n_t} h_i + \sum_{i=1}^{n_t} L_i(1 - q_i) + \text{f}(a_t)$$

s.t. q(h_i, a_t) = q_i, for all i ϵ n_t,

where f(a_t) is the fixed rental cost of a_t. We assume df/da > 0 and d^{2}f/da^2 ≥ 0; that is, the fixed costs of investing in technology and other factors increase at a non-decreasing rate. The auditor chooses a parameter value a_t and a vector of client-specific labor hours, h_i, that minimize the total (expected) cost of auditing her portfolio. In program 4), because q(h_i, a_t) = q_i is a function of a_t and h_i, q_i varies across audits (see section 3.2 below) and an audit-firm specific level of assurance is achieved in terms of a portfolio average.

3.2 SOLUTION TO THE COST MINIMIZATION PROBLEM WITH n_t IDENTICAL CLIENTS AND KNOWN FUNCTIONS FOR f(a_t) AND q(h_i, a_t)

To obtain some intuition into the solution of program 4), suppose that an auditor has n_t identical clients and is considering a new fixed investment, say in technology, that improves the efficiency of production for each client. We rewrite program 4) to incorporate the identical client assumption and specify the audit hour transformation function:

5) $$\{h_t^*, a_t^*\} = \underset{a_t,\, h_t}{\text{argmin}}\ c_i(h_t, a_t) = \underset{a_t,\, h_t}{\text{argmin}}\ n_t\, w\, h_t + n_t\, L\, (1 - q_t) + \text{f}(a_t)$$

s.t. $q_t = \beta\, a_t\, h_t^{1/2}\ \forall\ i \in n_t$ and $0 \leq q_t \leq 1$

where β is a positive normalizing constant. To derive an algebraic solution to this problem we also need to specify a functional form for f(•), the cost of the fixed factor a_t. We let

6) $$\text{f}(a_t) = k_t \bullet a_t^3.$$

Importantly, the cost of a_t increases quickly enough to offset the concavity of the assurance transformation function q(•).

Assuming an interior solution and working through the math (not shown), we solve for the optimal values of the choice variables in terms of the parameters:

q_t^*= (L^5 n_t^2 β^5) / (72 k_t^2 w^3), a_t^* = (L^2 n_t β^2) / (6 k_t w), and h_t^* = (L^6 n_t^2 β^6) / (144 k_t^6 w^4)

These results satisfy the second order conditions for cost minimization and have the qualitative attributes: q_t^*, a_t^*, and h_t^*, individually increase in L and n_t and decrease in *w* and k_t.

To get a better sense for these results, we solve the problem numerically for a variety of parameter values. In the table below we set β =.0018, *w* =50 and k_t = 2,000 and then vary both the number of clients and the size of the potential loss of the clients. Optimal outcomes in terms of total portfolio audit cost, fixed investment, audit effort per client, and assurance levels provided are reported in the table below.

n_t	*L*	*Cost*	a*	h*	q*
40	65,000	$2.59924*10^6$	0.9126	1.14007	0.974421
40	60,000	$2.39953*10^6$	0.7776	0.705277	0.653035
35	60,000	$2.09969*10^6$	0.6804	0.539978	0.49998

As a check on these results, we re-specify the model using an asymptotic assurance transformation function. The quadratic assurance function specified in equation (5) can easily hit the 100% assurance upper bound as *a* and *h* increase, so as an alternative we use the following function: q = *a h* / (β + *a h*). This function converges to 100% assurance as *a* and *h* increase to infinity. Using this functional form of q plus modifying equation 6) to f(a_t) = k_t • a_t allow the program to be solved analytically to derive optimal parameterizations of the choice variables (the solutions are ungainly and not included). We then solve the modified model numerically by fixing the following parameter values: β = 10, w =50 and k_t = 2,000 and once again varying both the number of clients and the size of the potential loss of the clients. The results are given in the following table.

n_t	L	*Cost*	a*	h*	q*
40	65,000	140,224.	23.2272	23.2272	0.981802
40	60,000	136,486.	22.6003	22.6003	0.980798
35	60,000	124,825.	20.6629	23.6148	0.979918

In both examples, audit firms are assumed to be endowed with different numbers (n_t) and different types (L_t) of clients, and are solving for the optimum production plan for their specific client portfolio. Summarizing the numerical results presented in the above two tables, we observe that i) the high risk portfolios (large L), *ceteris paribus,* use more labor, make larger fixed cost investments, and provide higher assurance and ii) that auditors with the greater number of clients, *ceteris paribus*, make larger fixed costs investments and provide a higher level of assurance. In the quadratic assurance case the auditor with the greater number of clients uses more labor hours per client, while in the asymptotic assurance case the auditor with the greater number of clients uses fewer labor hours.

In both of the examples if we hold the size of the potential loss constant, then the average cost per client is lower for the portfolio with the larger number of clients. This result, if true in general, suggests that larger auditors could provide higher levels of assurance and undercut the prices of smaller auditors – see footnote 3, below. Specific implications of this observation to audit markets requires equilibrium modeling of audit demand and so lies beyond the scope of our current research, but does raise the question: Is the provision of auditing services a potential natural monopoly? We leave more extensive consideration of this question for future research.

3.3 CLIENT SPECIFIC ASSURANCE AND CLIENT SPECIFIC POTENTIAL LOSSES

In section 3.2, we assumed that each audit firm had n_t identical clients. In this section, we generalize the results by considering the case where each audit firm has two clients that possess different potential losses. We rewrite equation 5) to represent a portfolio with two clients of varying potential losses and assume that $L_1 > L_2$. Substituting in the auditor's assurance transformation function for q_i into the cost equation and assuming an interior solution:

7) $$c(a_t, h_1, h_2) = w \sum_{i=1}^{2} \{ h_i + L_i(1 - q_i(a_t, h_i)) \} + \mathrm{f}(a_t)$$

Taking the first order conditions for 7):

8 i) $$L_1 \; q_{a_t}(a_t, h_1) + L_2 \, q_{a_t}(a_t, h_2)\} = f_{a_t}(a_t)$$

8 ii) $$L_1 \; q_{h_1}(a_t, h_1) = w$$

8 iii) $$L_2 \, q_{h_2}(a_t, h_2) = w$$

Because $L_1 > L_2$ we can see from equations 8 ii) and 8 iii) that $q_{h_1} < q_{h_2}$, this implies that at the optimum $h_1 > h_2$ if we assume that $\frac{\partial q}{\partial h} \geq 0$ and $\frac{\partial^2 q}{\partial h \, \partial h} < 0$. Since we expect that assurance increases with audit effort and that the marginal increase in assurance decreases as effort increases (decreasing marginal returns), these two assumptions (i.e. $\frac{\partial q}{\partial h} \geq 0$ and $\frac{\partial^2 q}{\partial h \, \partial h} < 0$) are readily justified.

The result then is that the client with the larger potential loss is audited to a higher level of assurance than the client with the smaller potential loss. This is in contrast to the usual way audit services are conceptualized (e.g. O'Keefe, Simunic, and Stein [1994]) where a planned level of assurance is delivered for each client (perhaps with random noise). The idea that assurance varies systematically (not randomly) client-by-client around a firm mean is consistent with an economic approach to the auditor's problem in which auditors maximize their profits. In contrast, if the assurance level is set as a constraint to be equaled or bettered, then it is hard to see that strategy as being consistent with profit maximizing. It might be more consistent with the traditional professionalism approach to audit planning, where audit firms are not simply profit maximizing (cost minimizing) but try to maximize some type of social welfare function. But if the professionalism approach violates profit maximization, is it realistic - particularly when audit markets are competitive?

3.4 COMPARATIVE STATICS OF THE AUDITOR'S COST MINIMIZATION PROBLEM

In this section, we drop the known functional forms imposed on the assurance production function, q(h_i, a_t), and the cost of fixed investments, f(a_t), and develop a general approach to the comparative statics of the auditor's cost minimization problem.

Consider an auditor with a portfolio of n_t clients facing the following *ex-ante* single period decision problem:

9) $$\pi(a_t, \boldsymbol{q_i} \mid \boldsymbol{\theta}) = \underset{a_t, \boldsymbol{q_i}}{\text{maximize}} \sum_{i=1}^{n_t} \left[\mathrm{R}(q_i) - w\, H\left(a_t, q_i\right) - L_i(1 - q_i)\right] - \mathrm{f}(a_t)$$

where,

$\boldsymbol{\theta}$ = $\{\boldsymbol{L_t}, w, k\}$, is a set of parameters. Noting $\{\boldsymbol{L_t}\}$ is a vector and $\{w, k\}$ are scalars;

H(a_t, q_i) = $h_i, \forall\, i \in n_t$. H(•) is the auditor's labor function defined implicitly with arguments investment, a, and assurance, q;

R(q_i), is the auditor's fee for audit i; and f(a_t), is the one period rental cost of fixed investment.

In this model, the auditor chooses parameter values $\{a_t, \boldsymbol{q_i})$ – as distinct from $(\boldsymbol{h}_i, a_t)$ in our earlier formulation – to maximize the total (expected) profit of auditing her portfolio. We specialize the profit maximization model by assuming revenues are fixed. Doing so equates profit maximization with cost minimization. This is consistent with our primary interest in audit production. Restricting our attention to the cost minimization component of the model allows us to highlight the supply side of the market without engaging the multiple complications introduced by market demand conditions. We acknowledge this restriction reduces the generality of our results insofar as we are unable to fully characterize the optimal levels of assurance and investment in equilibrium. However, the solution to the auditor's cost minimization problem yields crucial insights from the supply side about the relationships among the auditor's portfolio of client potential losses, the optimal provision of assurance, and the utilization of audit input factors even without a fully specified demand side model.

Next, we again simplify the representation of the auditor's portfolio to the number of clients and the average size of the clients' potential losses. With these assumptions in place the profit maximization problem 9) is restated as a cost minimization problem:

10) $$c(a_t^*, q_t^* | \boldsymbol{\theta}) = \underset{a_t \in R_+^1 \;\; q_t \;\in[0,1]}{\text{minimize}} \; n_t \, w \, H\big(a_t, q_t\big) + n_t \, L_t(1 - q_t) + \text{f}(\,a_t)$$

Further, we can define the set of optimizers that solves equation 10) (assuming an interior solution exists) as:

11) $$\{a_t^*(\theta), q_t^*(\theta)\} = \underset{q_t \;\in [0,1], \;\; a_t \in \mathbb{R}_+^1}{\arg min} \; c(a_t, q_t | \, \boldsymbol{\theta})$$

Defining audit hours implicitly allows us to rewrite the cost function with investment and assurance as the choice variables. Since we expect audit assurance, q, to be an increasing function of both h_i and a_t, it follows that the implicit hours function, H, would have the following characteristics: $\frac{\partial H}{\partial a} \leq 0$, $\frac{\partial H}{\partial q} \geq 0$, and $\frac{\partial^2 H}{\partial a\, \partial q} \leq 0$. In words, we expect: i) audit effort to decrease in the level of investment, holding assurance constant, ii) audit effort to increase in assurance, holding investment constant, and iii) the rate of increase in audit effort due to an increase in assurance decreases as investment increases. For completeness we also expect that $\frac{\partial^2 H}{\partial q\, \partial q} \geq 0$ and $\frac{\partial^2 H}{\partial a\, \partial a} \geq 0$. Two assurance transformation functions that fit this characterization are the ones we used earlier in our numerical examples: the quadratic assurance function, $q_i = \beta\, a_t h_i^{1/2}$, and the asymptotic assurance function, $q_i = \frac{a_t h_i}{\beta + a_t h_i}$.

A benefit of defining audit effort implicitly is that we can eliminate the requirement that $\{a_t, h_i\}$satisfy the bounds implied by the assurance variable and replace these constraints with the requirement that the domain of q_i is the closed interval $[0,1]$. This is helpful in our later analysis since the domain of the subsequent minimization is a lattice defined on the product space $[0,1] \times \mathbb{R}_+^1$. Below we outline the connections between the cost minimization model and our empirical tests.

The Application of Monotone Comparative Statics to the Auditor's Cost Minimization Model.

We use the above representation of the cost minimization model to generalize our analysis of changes in the parameters, n_t and L_t, on audit production. One way to do this is to apply the techniques of monotone comparative statics (MCS) Milgrom and Shannon [1994]. To see how this approach works, first transform the minimization problem, equation 10), into a maximization problem by multiplying through by -1. Then take the set of optimal solutions to the cost minimization problem given in equation 11),$\{a_t^*(\theta), q_t^*(\theta)\}$, and ask the question: what conditions does the objective function in 10) have to satisfy such that the pair of optimal solutions are jointly (weakly) increasing or decreasing in the scalar parameter θ? The short answer is that if the feasible set is a lattice and the objective function has increasing (decreasing) differences in each of the pairs $\{a, q\}$, $\{a, \theta\}$, and $\{q, \theta\}$, then the required conditions are met for the comparative static result, i.e., the optimal values are jointly increasing (decreasing) in the chosen parameter. The increasing (or decreasing) differences condition does not, in general, require that the objective function to be either differentiable or concave and the MCS results can be obtained by verifying that the increasing differences criterion holds. If one is willing to assume the differentiability of the objective function, an assumption we apply for convenience and to make the verification procedure more transparent to readers not familiar with MCS and Topkis' theorem Topkis [2011], then increasing differences can be checked by demonstrating that the appropriate pairwise cross-partial derivatives are weakly positive on the feasible set, the fore-mentioned lattice.

Demonstration that Assurance and Investment are Non-decreasing (weakly increasing) in Client Potential Loss

We begin by defining a function d(•):

12) $d(a_t, q_t, \boldsymbol{\theta}) \;=\; -(n_t\, w\, H\big(a_t, q_t\big) + n_t\, L_t(1 - q_t) + \mathrm{f}(a_t))$

To show that $\{a_t^*(L), q_t^*(L)\}$ are increasing in L we take the following cross-partial derivatives of equation 12) substituting in L_t for $\boldsymbol{\theta}$ and (assuming the objective function is twice continuously differentiable):

13 i) $d_{a,q}(a_t, q_t, L) = -n_t\, w\, H_{a,q}\big(a_t, q_t\big) \geq 0,$ the condition holds if $\frac{\partial^2 H}{\partial a\, \partial q} \leq 0,$

13 ii) $d_{a,L}(a_t, q_t, L) = 0,$

13 iii) $d_{q,L}(a_t, q_t, L) = n_t \geq 0$

All three of the required conditions (the pair-wise cross-partial derivatives are weakly positive) are easily seen to hold. This verifies that the objective function is characterized by increasing differences in each of the three relevant pairs.

Demonstration that Assurance and Investment are Non-decreasing (weakly increasing) in the Number of Clients in an Audit Firm's Portfolio.

Now to show that $\{a_t^*(n_t), q_t^*(n_t)\}$ are increasing in n_t we take the following cross-partial derivatives of equation 12) substituting in n_t for $\boldsymbol{\theta}$:

14 i) $d_{a,q}(a_t, q_t, n_t) =$ -$n_t\ w\ H_{a,q}\big(a_t, q_t\big) \geq 0$, if $\frac{\partial^2 H}{\partial a\, \partial q} \leq 0$

14 ii) $d_{a,n_t}(a_t, q_t, n_t) =$ -$w\ H_a\big(a_t, q_t\big) \geq 0$, if $\frac{\partial\, H}{\partial a} \leq 0$

14 iii) $d_{q,n_t}(a_t, q_t, n_t) =$ - $w\ H_q\big(a_t, q_t\big) + L_t \geq 0 = 0$

Conditions 14 i) and 14 ii) are met given our assumptions on the hours function H(•). Condition 14 iii) holds since $w\ H_q\big(a_t, q_t\big) + L_t = 0$ is a first order necessary condition for optimality of the cost function (we assume the usual regularity conditions for an interior optimum of the cost function are met).

Increasing Client Loss Variance Decreases Average Assurance and Investment: A Three Client Numerical Model

In order to relax the assumption that L_t is constant within an auditor's portfolio, we take equation 10) and form an auditor portfolio consisting of three clients. Next, we define the auditor's cost function as:

15) $c(a_t, q_1, q_2, q_3 |\, \boldsymbol{\theta}) \; = \; \sum_{i=1}^{3} \{\ w\ H\big(a_t, q_i\big) + \ L_i(1 - q_i)\} + \mathrm{f}(\ a_t)$

where,

$\mathrm{H}(a, q_i) = \frac{q_i}{a(1-q_i)}$, the audit hours function with $H_a(a, q_i) < 0,\ H_q(a, q_i) > 0,$

$H_{aa}(a, q_i) > 0,\ H_{qq}(a, q_i) > 0$ and $H_{aq}(a, q_i) < 0.$

The potential losses for these three clients are defined as: $L_1 = L + \omega,\ L_2 = L$ and $L_3 = L - \omega,$ for $\omega > 0$ which implies that $L_1 > L_2 > L_3$, and we set $\mathrm{f}(k, a_t) = k a_t^2$. The assumption that f(•) is convex in a_t is required for the result. Linear investment costs reverse the numerical results.

We constructed the above potential loss portfolio to be a mean preserving spread. The mean of the client portfolio is increased by increasing L and the variance of the portfolio is increased by increasing ω . We minimize equation 15) numerically to determine optimal values for $\{a_t, q_1, q_2, q_3\}$. The numerical results are suggestive of how the model would extend to auditor portfolios with varying client potential losses. In our numerical calculations we normalized the wage rate to 1 (numeraire good) and set k = 200. The potential loss parameter values are listed along with the q's in each line of the results.

Cost	a*	q_1^*	q_2^*	q_3^*	Ave (q_i^*)
410.857	0.637299	0.967657 L =1,500	0.97199 L =2,000	0.974947 L =2,500	0.971531
409.07	0.635887	0.965219 L =1,300	0.971959 L =2,000	0.975866 L =2,700	0.971015
406.562	0.6339	0.96213 L =1,100	0.971915 L =2,000	0.976677 L =2,900	0.970241

As can be seen in the table above, increasing the variance of client specific losses in an audit firm's portfolio decreases optimal investment, average assurance, and portfolio cost. Interestingly, the assurance level for client 2 also falls as portfolio variance increases even though the potential loss for that client is held constant at L_2 = 2,000.

3.5 TESTABLE EMPIRICAL IMPLICATIONS

Based on the foregoing analyses, we consider four empirical tests. Specifically:

1. For a given audit firm, audit quality is client specific and increases with the size of the potential client specific losses (L_i). This test follows from our assertion in section 3.3 that varying assurance on a client-by-client basis is more consistent with cost minimization than auditing to a static level of assurance when an auditor services heterogeneous clients.
2. In an audit market, the average audit quality produced by an audit firm increases as the average client L_i in the firm's portfolio of clients in that market increases[3] (as average L_i increases, a_t^* increases, and q_i^* increases).
3. In an audit market, average audit quality produced by an audit firm increases as the number of clients (n_t) in the firm's portfolio increases (as n_t increases, a_t^* increases, and q_i^* increases).
4. In an audit market, average audit quality decreases as the variability of client losses (L_i) in the firm's portfolio increases.

We note that these predictions derive solely from production (i.e. supply-side) considerations and do not make any assumptions about the demand for audit quality except that audits are normal goods (i.e. given audit cost, more assurance is preferred to less).

4. Empirical Tests

[3] In addition to increasing assurance levels, the labor enhancing characteristic of audit investment also implies that auditors with larger investments become more efficient in the sense they will require fewer audit hours for a given client and potentially incur lower costs to audit marginal clients than audit firms with lower levels of investment. We conjecture that the resulting market structure will depend upon the interplay of optimal investment scale and market size. For example, a sufficiently large audit market could sustain multiple auditors operating at optimal scale and remain competitive since no audit firm gains a cost advantage due to the equalization of investment. In contrast, audit markets too small to support multiple auditors at scale would tend to become dominated by a single provider.

4.1 KEY INDEPENDENT VARIABLES

The four empirical implications in section 3.5 predict that, in an audit market, the audit quality of a specific client increases with the potential client-specific losses, the audit firm's portfolio average of potential client-specific losses, the number of clients in the audit firm's client portfolio, and audit quality decreases with the variability of the potential client-specific losses. To test H1, we use the natural logarithm of clients' total assets (*Ln(Asset)*) as the proxy for client-specific losses (L_i). Accordingly, for H2, the potential average client losses are proxied by the average value of the natural logarithm of clients' total assets, i.e. the average client size (*AvgClientsize*). The number of clients in the audit firms' client portfolio (*Clientnum*) corresponds to H3. To test H4, the variability of the potential client-specific losses is proxied by the standard deviation of client size (*StdClientsize*).

To construct an audit firm's client portfolio, we define four audit markets: (1) the broad U.S. national market, which includes all publicly listed companies; (2) U.S. public companies operating in specific 2-digit Standard Industrial Classification (SIC) industries; (3) companies operating in specific U.S. Metropolitan Statistical Areas (MSAs); and (4) companies operating in specific U.S. MSAs in specific 2-digit SIC industries. The four audit markets are denoted as M1, M2, M3, and M4, respectively. Note that the market level at which our empirical predictions as developed from the theoretical model should be observable depends on the market level where investments are made by audit firms. For example, the effects of investments in staff training at the national level should be observable in market M1. Or, if audit firms make more local investments that benefit audits of clients in certain industries, the effects should only be observable in the M4 markets.

4.2 PROXIES FOR AUDIT QUALITY

Audit quality is defined as the auditor assessed level of assurance (probability) that the financial statements are free of material misstatements after an audit is completed that results in the issuance of an unqualified (normal) opinion on the financial statements.[4] An ideal proxy for audit quality should (somehow) measure this probability, which, of course, is not directly observable. Note that auditor assurance is developed throughout the audit process that encompasses planning, risk assessment, substantive testing, and completion procedures (such as second partner review). Thus auditor assurance incorporates the auditor's assessment of client managements' contribution to the preparation of accurate financial statements through their personal integrity, quality of accounting systems and controls, etc. We use several variables as the proxies for audit quality: the absolute value of discretionary accruals, the number of audits with deficiencies as well as the number of the audit firms' specific failures as reported in the Public Company Accounting Oversight Board's (PCAOB) inspection reports, and (in a supplementary analysis) financial statement restatements.

Absolute discretionary accruals have been used in a considerable amount of the prior literature as a proxy for audit quality or as the outcome of a high quality audit (e.g. Becker et al. [1998]). This proxy allows us to obtain a client-specific measure of audit quality. This measure is the outcome of the financial reporting process and can be affected by client characteristics. Accordingly, we control for client-specific characteristics in our empirical tests of the four predictions.

---

[4] Audit quality is normally defined as the joint probability that an auditor discovers any material misstatements that exist, and truthfully reports the results of an audit. Since our focus is on audit production, we implicitly assume truthful reporting.

In addition to the absolute value of discretionary accruals, we use the number of audits with deficiencies, and the number of the audit firms' specific failures as identified by PCAOB's inspection as two other proxies of audit quality. To enhance the audit quality of public companies, Section 104 of the Sarbanes Oxley Act of 2002 and PCAOB Rule 4003 require the PCAOB to regularly inspect PCAOB-registered accounting firms that provide audit reports for U.S.-listed public companies. The inspections identify matters that the inspection team considered to be audit deficiencies, which include failures by the audit firm to perform, or to perform at a sufficiently high level, certain necessary audit procedures.[5] After an inspection, the PCAOB sends inspection results on engagement-specific audit deficiencies and the identified defects in the audit firms' quality control system to the audit firm inspected. The results on engagement specific audit deficiencies are listed in the inspection reports published on the PCAOB web site. The disclosed information regarding engagement specific audit deficiencies are (1) the number of the inspected audits that contain deficiencies of "such significance that it appeared to the inspection team that the Firm, at the time it issued its audit report, had not obtained sufficient competent evidential matter to support its opinion on the issuer's financial statements"[6], and (2) the specific failures to perform sufficient procedures in supporting its audit opinions. As compared to the absolute

[5] Section 104 of the Sarbanes Oxley Act of 2002 requires the PCAOB to "(1) inspect and review selected audit and review engagements of the firm (which may include audit engagements that are the subject of ongoing litigation or other controversy between the firm and 1 or more third parties), performed at various offices and by various associated persons of the firm, as selected by the Board;(2) evaluate the sufficiency of the quality control system of the firm, and the manner of the documentation and communication of that system by the firm; and (3) perform such other testing of the audit, supervisory, and quality control procedures of the firm as are necessary or appropriate in light of the purpose of the inspection and the responsibilities of the Board." As documented in Auditing Standard No. 3, paragraph 9 and Appendix A to AS No. 3, paragraph A28, an observation that the audit firm did not perform a procedure, obtain evidence, or reach an appropriate conclusion may be based on the absence of such documentation and the absence of persuasive other evidence.

[6] A typical PCAOB inspection report contains this description before describing specific audit failures. An example is available at https://pcaobus.org/Inspections/Reports/Documents/2012_Accell_Audit_Compliance_PA.pdf.

discretionary accruals, these two PCAOB inspection-based proxies better capture auditors' input in providing audit assurance and are less likely to be affected by client characteristics.

Finally, we also use restatements as another proxy for audit quality in our supplemental analysis. Different from discretionary accruals which is the output of the financial reporting process and the audit deficiencies identified by the PCAOB's regular inspection of registered accounting firms, financial statement restatements occur because a material misstatement exists in the audited financial statements. Thus a restatement is more probable as the quality of an audit (assurance) decreases. Misstatements may be discovered either by client management or the auditor after the audit report is issued. More specifically, factors affecting the revelation of an existing material misstatement include the investigation of the company (i.e. the auditor's client) by private parties (e.g. analysts, employees, and lawyers can be the whistleblowers), a Securities and Exchange Commission investigation, and the external legal environment that affects the firm's decision to restate earnings. For instance, as evidenced by Srinivasan, Wahid, and Yu [2014], firms operating in an environment with stronger rule of law are more likely to admit their mistakes in financial reporting, when material misstatements exist. Given the multiple-factors driving a restatement, the absence of a restatement is not necessarily an indicator of high audit quality, although a restatement provides direct evidence of audit failure in the restated year. In contrast, because the PCAOB inspection is on a regular basis and is directly related to the quality of audit production, the inspection results may provide a better audit-quality measure.[7]

4.3 REGRESSION MODELS

[7] The PCAOB Rule 4003 mandates that public accounting firms auditing more than 100 U.S. public companies should be inspected annually and those auditing fewer than 100 U.S. public companies should be inspected at least every three years.

Using the absolute value of discretionary accruals as the proxy for audit quality, we build the following model to test our four empirical predictions.

$$
\begin{aligned}
AbsoluteDAC_{i,t} \\
&= \alpha_0 + \alpha_1 Ln(Asset)_{i,t} + \alpha_2 AvgClientsize_{i,t} + \alpha_3 Clientnum_{i,t} \\
&+ \alpha_4 StdClientsize_{i,t} + \alpha_5 Big4_{i,t} + \alpha_6 OperatingCycle_{i,t} + \alpha_7 ROA_{i,t} \\
&+ \alpha_8 Leverage_{i,t} + \alpha_9 Loss_{i,t} + \alpha_{10} Going\_Concern_{i,t} + \alpha_{11} MB_{i,t} \\
&+ \alpha_{12} Std\_Cfo_{i,t} + \alpha_{13} Std\_Sale_{i,t} + \alpha_{14} Ln(Age)_{i,t} + \alpha_{15} Fsegnum_{i,t} \\
&+ \alpha_{16} Segnum_{i,t} + \alpha_{17} ReportLag_{i,t} + Industry\ fixed\ effect \\
&+ Year\ fixed\ effect + \varepsilon_{i,t} \qquad (16)
\end{aligned}
$$

where the *AbsoluteDAC*$_{i,t}$ is the absolute value of performance adjusted discretionary accruals of client *i* in year *t*. We follow Kothari et al. [2005] in constructing performance controlled discretionary accruals by requiring at least 10 observations in each 2-digit SIC industry to calculate discretionary accruals. *Ln(Asset)* and *AvgClientsize* are proxies for potential client-specific losses, and the average of potential client-specific losses, and these two independent variables are the key variables of interest for testing the first (H1) and the second (H2) empirical predictions. *Clientnum* is the total number of an audit firm's clients in an audit market and *StdClientsize* is the variability of potential client-specific losses in an audit firm's client portfolio in that market. *Clientnum* and *StdClientsize* are the key variables of interest for testing the third (H3) and the fourth (H4) empirical predictions. H1 predicts that the greater the client-specific loss exposure, the higher the assurance level provided by auditors, and the lower the discretionary accruals. Accordingly the coefficient (α_1) on *Ln(Asset)* is predicated to have a negative sign. H2 and H3 predict that the coefficients (α_2 and α_3) on *AvgClientsize* and *Clientnum* also both have a negative sign. H4 predicts that the coefficient (α_4) on *StdClientsize* has a positive sign.

Among the four key independent variables, client size (*Ln(Asset))* is a client-specific variable, and the other three variables are measured using auditors' client portfolios in the audit markets we defined. Corresponding to the four audit markets, for each auditor-year, *AvgClientsize*, *Clientnum*, and *StdClientsize* have four values. We denote the four values with the prefixes M1, M2, M3 and M4, respectively. We test the empirical predictions for the four categories of audit market by applying the key independent variables (i.e. *AvgClientsize*, *Clientnum*, and *StdClientsize*) calculated based on the four categories of audit market in (16).

We draw from the prior literature (e.g., Gu, Lee, and Rosett [2005] and Zang [2011]) and include other control variables in the discretionary accrual regression. The controls include a Big 4 indicator (*Big4*) variable and a battery of other variables that capture the client's business risk which affects the estimation difficulty of accruals: the natural logarithm of the firm's operating cycle (*OperatingCycle*), the ratio of net income to total assets (*ROA*), the leverage ratio (*Leverage*), the loss (*Loss*) indicator variable, the going concern opinion indicator variable (*Going_Concern*), the market to book ratio (*MB*), the standard deviation of cash flows across the previous 7 years (*Std_Cfo*), the standard deviation of the firm's sales across the previous 7 years (*Std_Sale*), and the natural logarithm of the firm's age (*Ln(Age)*). We also add the number of foreign segments (*Fsegnum*), business segments (*Segnum*), and audit report lag (*Reportlag*) to further control for the clients' and auditors' difficulty in estimating accruals.[8] Industry- and year- fixed effects are also controlled.

Using the PCAOB inspection results as the proxy for audit quality, we are only able to test H2, H3, and H4. H1 is not testable using this measure because it requires client-specific loss

[8] Our empirical results are slightly stronger without these three control variables.

exposure. Nevertheless, H1 is more of an assumption rather than an implication of our analysis and is not crucial for the validity of H2- H4. We use the two models below to test H2, H3, and H4.

$$
\begin{aligned}
Num\_Auditswith\_Def_{i,t}& \\
&= \beta_0 + \beta_1 AvgCliensize_{i,t} + \beta_2 Clientnum_{i,t} + \beta_3 StdClientsize_{i,t} \\
&+ \beta_4 Inspection\_Duration_{i,t} + \beta_5 Num\_Inspected_{i,t} + \beta_6 First\_Inspection_{i,t} \\
&+ \beta_7 Num\_Partners_{i,t} + \beta_8 Num\_Staff_{i,t} + \beta_9 Triennially_{i,t} \\
&+ Year\ fixed\ effect + \varepsilon_{i,t} \qquad (17)
\end{aligned}
$$

$$
\begin{aligned}
Num\_Auditfailures_{j,t}& \\
&= \gamma_0 + \gamma_1 AvgClientsize_{j,t} + \gamma_2 Clientnum_{j,t} + \gamma_3 StdClientsize_{j,t} \\
&+ \gamma_4 Inspection\_Duration_{j,t} + \gamma_5 Num\_Inspected_{j,t} + \gamma_6 First\_Inspection_{j,t} \\
&+ \gamma_7 Num\_Partners_{j,t} + \gamma_8 Num\_Staff_{j,t} + \gamma_9 Triennially_{j,t} \\
&+ Year\ fixed\ effect + \varepsilon_{j,t} \qquad (18)
\end{aligned}
$$

where $Num\_Auditwith\_Def_{j,t}$ is the numeric count of audits with deficiencies as identified by the PCAOB inspection of audit firm *j* in the inspection year of *t+1*. Inspection year is the year when the PCAOB starts the inspection of the audit firm. Audit deficiencies identified by an inspection conducted in year *t+1* should have existed in the year when the audit is finished thus should be earlier than year *t+1*. To choose a year close enough to the inspection year, we denote *t* as the year in which the audit deficiencies exist. We use the audit firm's average client size (*AvgClientsize*), number of clients (*Clientnum*), and the standard deviation of client size (*StdClientsize*) in year t as the audit firm characteristics corresponding to $Num\_Auditwith\_Def_{j,t}$ and $Num\_Auditfailures_{j,t}$. Average client size (*AvgClientsize*) and client number (*Clientnum*) are measured at the national audit market. $Num\_Auditfailures_{j,t}$ is the numeric count the audit firm's failures as identified by the PCAOB inspection of audit firm *j* in the inspection year of *t+1*. Because our dependent variables are count values that are always nonnegative, we use an ordered probit regression to estimate models (17) and (18).[9]

The other control variables capture the PCAOB's resource input into the inspection and the audit firms' labor resources. *Inspection_Duration* is the number of days between the inspection start date and the inspection end date. A longer inspection duration indicates greater resource input by the PCAOB, and can be driven by either the greater riskiness of the audits selected for inspection or by the PCAOB-conjectured importance of the inspection. *Num_Inspected* is the number of audits inspected in a specific inspection. *First_Inspection* is an indicator variable set to 1 if the inspection is the first time that the PCAOB inspects the audit firm and 0 otherwise. *Num_Partners* is the number of the audit firm's self-reported partners at the time of the inspection. *Num_Staff* is the number of the audit firm's self-reported personnel, except partners or shareholders and administrative support personnel.[10] *Triennially* is an indicator variable set to 1 if the audit firm is auditing fewer than 100 U.S. public companies and 0 otherwise.[11]

The empirical results for models (16) to (18) are provided in sections 4.3 and 4.4. We apply a probit model for our restatement analysis, following the absolute discretionary accrual model as specified in model (16) in constructing the control variables. Section 4.5 provides empirical results of the probit model that uses restatement as the audit quality proxy.

4.4 DATA AND SAMPLE

[9] Linear regression is not an appropriate estimation technique for count data, as it fails to take into account the limited number of possible values of the response variable. We follow Hausman, Lo, and MacKinlay [1992] in using the ordered probit regression model.

[10] As noted in a typical inspection report, the number of partners and professional staff is an indication of the size of the audit firm, and does not necessarily represent the number of the audit firm's professionals who participate in audits of the public companies.

[11] See footnote 7, above.

Because the data sources of the three audit quality measures (i.e. absolute discretionary accruals, PCAOB identified audit deficiencies, and restatement) differ, the corresponding samples also differ. To construct the sample for the discretionary accrual analysis, we start with the year 2000, the first year for which Audit Analytics provides an expanded set of audit related information, such as the locations of auditors' offices, audit fees, and going concern opinions, none of which are available in Compustat. Our sample ends in 2014. We constrain our sample to U.S.-listed companies headquartered and incorporated in the U.S. to ensure that all audit clients in the sample are subject to the U.S. legal environment. We also require that the audit firms are located in the U.S. so that the auditors are from the same national labor market and are subject to the U.S. legal environment. We remove clients in the financial industry (SIC codes from 6000 to 6999) because financial firms are regulated and auditors' loss exposure associated with these clients can be substantially different from their loss exposure associated with clients in other industries.

We require firms to have auditor choice, auditors' location information, and accounting data necessary to calculate discretionary accruals. Also, we must be able to classify firms into U.S. Metropolitan Statistical Areas, and have other variables in the regression models. As a result of these requirements, our final sample for the absolute discretionary accrual analysis contains 39,518 firm-years. The sample covers 6,291 firms. Accounting data are obtained from Compustat and are winsorized at the 1^{th} percentile and 99^{th} percentile. The absolute values of the discretionary accruals are winsorized at the 99^{th} percentile. Table 1 panel A reports the summary statistics for the variables used in this paper and panel B reports the Pearson correlation matrix for these variables.

The PCAOB inspection data is purchased from Digi Data Mart Ltd.[12] The company extracts data contained in the PCAOB's public inspection reports. As collected by Digi Data Mart Ltd., there are 2,124 unique inspections of U.S. audit firms conducted before 2015 (inclusive) whose inspection reports have been disclosed at the PCAOB website.[13] The first year of inspection is 2003. We use the number of audits with deficiencies (if any) and the number of specific audit failures contained in these inspection reports as two measures of audit-firm level audit quality.

Because the PCAOB does not disclose the inspected audits and a typical inspection usually inspects more than one audit, there is no way to precisely identify the year for which the identified audit deficiencies (i.e. the audit quality proxy) pertain. However, because an inspection (by construction) targets audits that have been finished, the identified audit deficiencies should capture audit quality for years before the inspection year. We obtain the audit firm's client portfolio characteristics for one year before the inspection year and use this information as the audit firm characteristics corresponding to the identified audit deficiencies. This treatment is consistent with the PCAOB inspection rule (Rule 4003) – noted above. To the extent that the audit quality of audit firms can be expected to maintain a certain level of stability within two years, this treatment matches audit quality with the associated client-portfolio characteristics while avoiding arbitrary selection of the year of client-portfolio characteristics.

By requiring the inspected audit firm to have client information in Audit Analytics in the year before inspection, we are able to manually match 708 audit firm-years between the inspection reports and Audit Analytics.[14] Among these 708 audit firm-years, 666 audit firm-years have non-

[12] See https://auditor-inspection.myshopify.com/.
[13] The audit deficiencies identified by an inspection starting in 2015 corresponds to audit deficiencies existing in 2014.
[14] Because the names of some audit firms change, PCAOB inspection reports and Audit Analytics reports are often not exactly that same, we start with a computerized matching and then manually check and match the audit firms' names in inspection reports with the audit firms' names in Audit Analytics. To ensure the accuracy of the matching, when audit firm's names are not exactly the same in the two sources, we check using a Google search for the phone number, location, and other details of the audit firms.

missing information for the number of audits with deficiencies (or number of audit failures), number of audits inspected, and inspection duration. Table 2 panel A provides details of the sample construction and panel B provides the correlation table for the variables used in equestions (17) and (18).

Restatement information is obtained from Audit Analytics. We include all types of restatements (i.e. restatements caused by accounting errors and those caused by accounting irregularities) in our analysis based on the rationale that a misstatement will not be restated if it is not material and that auditors are responsible for assuring that financial statements are free of any material misstatement, whether caused by fraud or simple error. Our restatement sample starts in 2000, the first year for which Audit Analytics provides comprehensive restatement information, and ends in 2012. Ending in 2012 is consistent with the prior literature (e.g., Czerney, Schmidt, and Thompson [2014], Files, Sharp, and Thompson [2014]) in allowing the company or its auditor at least two years following the audit report year to identify issues that would require a restatement.

4.5 REGRESSION RESULTS

Tables 2 – 5 report the results of the regressions estimated using the four categories of audit market with absolute discretionary accruals as the proxy for audit quality. In all the regressions, the dependent variable *AbsoluteDAC* is client-year specific. In each table, columns (1) – (5) report estimation results for five regressions. Before running the regression as specified in equation (16), we start with a simple regression in column (2) that regresses the first audit quality measure (*AbsoluteDAC*) on our first key variable of interest (*Ln(Asset)*) and the control variables drawn from model (16), while excluding *AvgClientsize*, *Clientnum*, and *StdClientsize* from the regression model. In columns (2) – (4), *Ln(Asset)*is retained as a control variable, and we regress

AbsoluteDAC on *AvgClientsize*, *Clientnum*, and *StdClientsize*, respectively, in each column, while controlling for the battery of control variables drawn from equation (16). Column (5) of each table reports regression results for equation (16), which is specified to test the four empirical implications in one model. The coefficients on all variables in the four tables are standardized for easier comparison.

In Table 2, the audit market is the broad U.S. national market, which includes all publicly listed companies. An audit firm's client portfolio in this market consists of all of the firm's clients that are operated and incorporated in the U.S. *M1(AvgClientsize)*, M1(*Clientnum*), and M1(*StdClientsize*) are the audit firm's average client size, number of clients, and standard deviation of client size in the U.S. national market. The prefix M1 refers to the first category of audit market, i.e. national level market. As reported in column (5), the coefficient on *Ln(Asset)* is significantly negative (*coefficient estimate*=-0.086, *t* = -8.14), suggesting that as client size increases audit quality increases. This evidence is consistent with our first empirical prediction (H1). Consistent with H2, the coefficient on M1(*AvgClientsize*) is -0.112 (*t* =-5.45), suggesting that audit quality increases with the audit firm's average client size in the national market. Furthermore, the coefficients on M1(*Clientnum*) and M1(*StdClientsize*) are 0.041 (*t* = -4.08) and 0.018 (*t* = -1.74). These results suggest that audit quality increases as the number of clients in the audit firm's client portfolio increases and decreases as the variability of client size increases. Additionally, the results in columns (1) – (4) are all consistent with results in column (5). Collectively, the evidence is supportive of the four empirical implications applied to the national audit market.

In Table 3, an audit market covers U.S. public companies operating in specific 2-digit Standard Industrial Classification (SIC) industries. For each client-year in the five regressions, *M2(AvgClientsize)* is calculated as the audit firm's average size of clients operating in the specific client's 2-digit SIC industry. In a similar vein, *M2(Clientnum)* is the number of clients in the specific client's 2-digit SIC industry and *M2(StdClientsize)* is the standard deviation of the size of clients in the specific industry portfolio. Columns (1) to (5) report regression results for the five regressions. The results reported in columns (1) to (5) are consistent with the results in Table 2 and are supportive of our four empirical implications when we apply our analysis to the national client-industry audit market.

In Table 4, the audit market is defined as clients operating in specific U.S. Metropolitan Statistical Areas (MSAs). For each client-year, *M3(AvgClientsize)* is calculated as the audit firm's average size of clients operating in the U.S. Metropolitan Statistical Area where the audit office of the specific client is located. Accordingly, *M2(Clientnum)* is the number of clients operating in the U.S. Metropolitan Statistical Area where the audit office is located. *M3(StdClientsize)* is the standard deviation of the size of clients within the specific MSA. In column (5), where the results of the main regression (i.e. model (1)) are reported, the coefficients on *Ln (Asset)*, *M3(AvgClientsize)*, and *M2(Clientnum)* are all significantly negative, and the coefficient on *M3(StdClientsize)* is significantly positive. These results further support our four empirical predictions.

In Table 5, the audit market consists of companies operating in specific U.S. MSAs in specific 2-digit SIC industries. For each client-year, *M4(AvgClientsize)*is calculated as the average size of clients in the client's specific 2-digit SIC industry in the specific MSA area. *M4(Clientnum)* and *M4(StdClientsize)* are also calculated using the auditor's client portfolio within the specific industry in the MSA where the client's audit office is located. As reported in column (5), the coefficients on all the key variables of interest are consistent with the predicted sign. The coefficients on *Ln(Asset), M4(AvgClientsize), M4(StdClientsize)* are all significant at the 1% level. Even though the coefficient on *M4(Clientnum)* is not statistically significant (*t* = -0.74), the sign of the coefficient is consistent with our empirical prediction. Collectively, the regression results estimated using the four definitions of audit markets provide supportive empirical evidence for our predictions derived from the theory developed in this paper.

4.6. ADDITIONAL RESULTS USING PCAOB INSPECTION FINDINGS AS A PROXY FOR AUDIT QUALITY

To address the concern that absolute discretionary accruals may capture client characteristics that we cannot fully control for, rather than audit quality, we use the PCAOB inspection results as additional proxies.[15] Specifically, we use the number of audits with deficiencies and the number of specific audit failures to measure audit quality. These two proxies may better capture the auditor-provided assurance associated with audit inputs rather than client-specific characteristics. Table 6 reports the results of the regression models in which the number of audits with deficiencies is the dependent variable. To evaluate the effect of these control variables on the robustness of our empirical results, we start with three simple regressions that include *M1(AvgClientsize)*, *M1(Clientnum)*, and *M1(StdClientsize)*, respectively. The control variables in these three simplified models are the inspection duration (*Inspection_Duration*) and the number of audits inspected (*Num_Inspected*). Columns (1) to (3) report regression results for

[15] In unreported analyses, we also control for the firm-fixed effect in our absolute discretionary models (i.e. the models in Tables 2 – 5). We find similar results (although weaker) for national audit market and audit markets as defined by MAS areas. Adding the firm fixed effects better tease out of effect of time-invariant firm characteristics on our dependent variable (i.e. *AbsoluteDAC*). However, if companies tend to choose auditors that have similar attributes (e.g., investment in technology and size), then adding firm fixed effects will also tease out the effect of client portfolio characteristics on *AbsoluteDAC*.

the three simplified models. The model in column (4) includes all of the three key independent variables. In columns (5) to (8), we add other control variables progressively.

The statistical inferences for the three key independent variables as reported in columns (1) to (8) are consistent. Specifically, column (8) reports the regression results for equation (2) as specified in section 4.3. The coefficient on *M1(AvgClientsize)* is -0.1299 (t = -2.96), consistent with H2 that the assurance level increases as the average loss exposure increases. The coefficient on *M1(Clientnum)* is -0.0674 (t = -1.12), the sign of which is consistent with H3 that the assurance level increases as the number of clients in an audit market increases even though it is not statistically significant. The coefficient on *M1(StdClientsize)* is 0.0612 and is marginally significant (t = 1.84), supporting H4 that the assurance level decreases as the variability of the client-specific loss exposure increases in an audit market.

In Table 7, the dependent variable is the number of the audit firm's specific failures as identified by a specific inspection. The three key independent variables and all the control variables are the same as the variables used in Table 6. Similar to the analyses in Table 6, we start with three simplified models that control for *Inspection_Duration* and *Num_Inspected* and then add other controls step by step. The statistical inferences as reported in Table 7 are similar to the ones in Table 6, and are supportive of H2 and H4 without contradicting H3.

4.7. ADDITIONAL RESULTS USING RESTATEMENT AS AN AUDIT QUALITY PROXY

Section 4.6 uses the two count variables of PCAOB-identified audit deficiencies as proxy measures of audit quality. To provide additional evidence, we use the likelihood of restatement as an alternative proxy in this section. In columns (1) to (5) of Table 8, we estimate five probit models that regress the likelihood of restatement by a specific client on its audit firm's client portfolio characteristics in the national market. Column (1) reports results of the model that includes *Ln(Asset)* as the key independent variable, with the control variables the same as the ones in model (16) as specified in section 4.3. In columns (2) to (4), we add *M1(AvgClientsize)*, *M1(Clientnum)*, and *M1(StdClientsize)*, respectively to the model in column (1). Column (5) reports results of the model that regresses the restatement indicator variable on the four key variables of interest: *Ln(Asset), M1(AvgClientsize), M1(Clientnum), and M1(StdClientsize)*. Specifically, in column (5), the coefficient on *M1(Clientnum)* is significantly negative (*coefficient* = -0.2382, *t* = -2.11), suggesting that clients of audit firms with larger number of clients are less likely to restate their financial statement. Consistent with H4, the coefficient on *M1(StdClientsize)* is 0.0797 (*t*= 2.01). Taken together, the results are supportive of H3 and H4,[16] and consistent with the results of the analyses using the absolute discretionary accruals and the PCAOB inspection results as audit quality proxies.

Interestingly, in contrast to the results in Tablet 2, the coefficient on *Ln(Asset)* is significantly positive and the coefficient on *M1(AvgClientsize)* is insignificant. This result is consistent with empirical findings in the prior literature that investigates the determinants of restatements (e.g., Czerney, Schmidt, and Thompson [2014]) and could be driven by the fact that larger firms are more likely to restate earnings given that a material misstatement exists. Note that even though there are a substantial number of studies on restatements, the motivating factors of firms' decision to restate earnings are not well understood. One study that addresses this question is Srinivasan, Wahid, and Yu [2014] which finds that firms operating in environments with a stronger rule of law are more likely to restate earnings conditional on misstatement risk. They find

[16] We include all the years of the restatements associated with a single restatement announcement as restated years. Our results are robust to when we define the restatement year as the first year for which a single restatement announcement is made.

a positive effect of client specific loss exposure on external auditors' and managers' decisions to restate earnings. This effect could bias our tests against finding a negative association between the likelihood of restatement and client' loss exposure (i.e. *Ln (Asset) and M1(AvgClientsize)*).

5. Concluding Comments

In this paper, we analyze audit production when fixed investments associated with fixed costs (e.g., audit technology) are important. A key feature of such investments and associated fixed costs is that they affect the production of audit services for multiple clients. As a result, choosing an optimal level of investment requires the analysis of production over a client portfolio, rather than on a client-by-client basis as has been done in essentially all extant literature in the economics of auditing since Simunic [1980], Dye [1993], and O'Keefe, Simunic and Stein [1994]. Another feature of our analysis is that we assume that these investments influence the production of audit assurance (which exists in the minds of auditors and financial statement users) through their impact on the efficiency of labor (labor enhancing). For instance, technology investments do not produce assurance directly, but make the auditor and her staff more efficient in producing assurance.

Our paper is in the spirit of Sutton's [1991] endogenous / exogenous fixed cost model. However, we build up our analysis from basic elements that reflect our understanding of key features of audit production - a client specific service that is specifically tailored to suit the characteristics (e.g. size, complexity, and riskiness) of each client.

While our focus is almost exclusively on supply-side (not demand side) considerations, we believe that this emphasis is appropriate to understand both audit production and the market for audit services. The fact that supply-side variables measuring the size, complexity, and riskiness of client companies are able to account for 80% of the cross-sectional variation of U.S. listed companies' audit fees implies that the supply-side is critically important, particularly for listed companies where audits are mandatory. As seen in the empirical implications of our analysis discussed in section 3.4, the inclusion of fixed costs as an important feature of audit service production yields a rich set of interesting and novel insights into the audit service market not explored in the extant literature. For instance, Blokdijk, Drieenhuizen, Simunic, and Stein [2006] tried to test whether audit quality was higher for the (then) Big 5 firms compared to non-Big 5 firms by studying total audit hours, and how those hours were utilized (e.g. risk analysis, substantive testing, etc.) for a sample of about 100 Dutch audits. They concluded that any audit quality differences were subtle and associated with the details of how audits were conducted rather than with differences in total audit hours, since the total audit hours of applied by Big 5 firms and non-Big 5 firms were virtually the same, *ceteris paribus*, in their sample. However, if Big 5 firms have higher fixed investments in the Netherlands than non-Big 5 firms, then they would be expected to utilize *fewer* audit hours, *ceteris paribus*. Thus the fact that the total audit hours of the Big 5 and non-Big 5 were the same is consistent with the provision of higher audit quality by the Big 5.

Another example of the importance of recognizing the potential role of fixed investments in the interpretation of evidence on audit hours is the paper by Bell, Doogar, and Solomion [2008] who replicate and extend the empirical tests in O'Keefe, Simunic and Stein [1994]. Bell et al. find that mean audit hours decreased by about 10% for the same Big 4 firm between the sample periods in the two studies (1989 vs. 2002) and attribute the difference to increasing use of the client business risk audit methodology. However, this difference in hours has alternative interpretations if (as is likely) the firm's fixed investments (and related costs) changed between the two sample periods.

As a final example of a deepened perspective derived from our analysis relates to the large literature on auditor-industry specialization that originates with Craswell, Francis and Taylor [1995]. That literature argues that audit firms holding a high market share in a client industry (e.g. banking, manufacturing, etc.) are necessarily associated with the production and sale of differentially higher quality audit services than auditors with lower market shares. Our analysis applies to this setting since, presumably, the development of industry expertise requires fixed investment in either physical or human capital. We (indirectly) show that high market share itself is not sufficient to claim that audit quality is higher than average. A high market share that is based on servicing (perhaps) a relatively small number of large clients is likely to have this effect, since large clients motivate higher fixed investments which are associated with higher assurance levels. However, a market share derived from servicing a large number of small clients, is much less likely to have this effect. Moreover, even the audit firm that services large clients and has large fixed investments will provide an assurance level that is positively correlated with client size. That is, the assurance provided to small clients of a high market share auditor is not expected to be high; the effect is client-specific.

In conclusion, modeling audit production to incorporate both fixed and variable resources and costs yields a different perspective on the market for audit services than exists in the current auditing literature. We believe that further research developing and extending this perspective is likely to be both interesting and highly productive of new insights.

TABLE 1

Panel A Summary Statistics

	N	Mean	STD	P25	Median	P75
AbsoluteDAC	39518	0.15	0.28	0.03	0.07	0.15
Restatement	37376	0.11	0.32	0.00	0.00	1.00
Ln(Asset)	39518	5.48	2.44	3.81	5.53	7.21
M1(AvgClientsize)	39518	5.43	1.78	4.84	5.87	6.71
M2(AvgClientsize)	39518	5.42	1.96	4.54	5.62	6.79
M3(AvgClientsize)	39518	5.43	1.94	4.45	5.74	6.85
M4(AvgClientsize)	39518	5.44	2.23	4.08	5.55	7.02
M1(Clientnum)	39518	454.10	292.40	159.00	503.00	686.00
M2(Clientnum)	39518	32.22	37.25	4.00	16.00	50.00
M3(Clientnum)	39518	21.00	21.62	6.00	13.00	30.00
M4(Clientnum)	39518	3.61	5.21	1.00	2.00	4.00
M1(StdClientsize)	38421	1.87	0.33	1.86	1.91	2.00
M2(StdClientsize)	33960	1.64	0.53	1.37	1.67	1.91
M3(StdClientsize)	37251	1.71	0.54	1.41	1.73	2.02
M4(StdClientsize)	20492	1.47	0.82	0.92	1.44	1.92
Big4	39518	0.71	0.45	0.00	1.00	1.00
LogCycle	39518	4.59	0.83	4.13	4.62	5.08
ROA	39518	-0.21	1.21	-0.10	0.02	0.07
Leverage	39518	0.19	0.25	0.00	0.11	0.29
Loss	39518	0.40	0.49	0.00	0.00	1.00
Going_Concern	39518	0.08	0.27	0.00	0.00	0.00
MB	39518	2.77	7.49	1.10	1.51	2.41
Std_Cfo	39518	0.14	0.30	0.04	0.07	0.13
Std_Sale	39518	0.55	1.14	0.13	0.25	0.52
Ln(Age)	39518	2.77	0.71	2.20	2.71	3.30
ReportLag	39518	4.12	0.37	3.97	4.14	4.33
Num_Auditswith_Def	666	1.65	2.64	0.00	1.00	2.00
Num_Auditfailures	666	3.47	9.13	0.00	1.00	3.00
Inspection_Duration	667	22.96	75.92	4.00	5.00	10.00
Num_Inspected	667	5.34	8.77	2.00	3.00	5.00
First_Inspection	667	0.43	0.50	0.00	0.00	1.00
Num_Partners	633	33.41	89.31	3.00	7.00	19.00
Num_Staff	630	229.54	1006.49	9.00	27.00	96.00
Triennially	667	0.92	0.27	1.00	1.00	1.00

Table 1 panel A presents summary statistics of the main variables used in the empirical analyses. *AbsoluteDAC* is the absolute value of discretionary accruals. *Restatement* is an indicator variable set to 1 if the financial statement of a specific firm-year is subsequently restated and 0 otherwise. *Ln(Asset)* is the natural logarithm of a client's total assets. *M1-M4* refer to four audit markets. *M1(AvgClientsize)* is an audit firm's average client size in the national market. *M2(AvgClientsize)* is an audit firm's average size of clients operating in the specific client's 2-digit SIC industry. *M3(AvgClientsize)* is an audit firm's average size of clients operating in the U.S. Metropolitan Statistical Area where the audit office is located. *M4(AvgClientsize)* is an audit firm's average size of clients in a specific 2-digit SIC industry in a specific MSA area. *M1(Clientnum) - M4(Clientnum)* are an audit firm's numbers of clients in the corresponding four audit markets. *M1(StdClientsize) - M4(StdClientsize)* are an audit firm's standard deviation of the size of clients in the corresponding four audit markets. *Num_Auditswith_Def* is the number of the audits that contain audit failures among the audits inspected by the PCAOB in a specific inspection. *Num_Auditfailures* is the number of specific audit failures of the audits with deficiencies as identified by a specific PCAOB inspection. See Appendix A for more detailed definitions of these variables and for other variable definitions.

TABLE 1(Cont'd)

Panel B Correlation Table of Key Variables in the Absolute Discretionary Accruals and Restatement Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1)AbsoluteDAC	1.00															
(2)Ln(Asset)	-0.37	1.00														
	(0.00)															
(3)M1(AvgClientsize)	-0.34	0.69	1.00													
	(0.00)	(0.00)														
(4)M2(AvgClientsize)	-0.37	0.79	0.86	1.00												
	(0.00)	(0.00)	(0.00)													
(5)M3(AvgClientsize)	-0.34	0.76	0.91	0.85	1.00											
	(0.00)	(0.00)	(0.00)	(0.00)												
(6)M4(AvgClientsize)	-0.37	0.91	0.76	0.87	0.83	1.00										
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)											
(7)M1(Clientnum)	-0.22	0.47	0.67	0.59	0.61	0.51	1.00									
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)										
(8)M2(Clientnum)	-0.07	0.15	0.34	0.17	0.25	0.15	0.54	1.00								
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)									
(9)M3(Clientnum)	-0.07	0.16	0.28	0.19	0.19	0.16	0.50	0.42	1.00							
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)								
(10)M4(Clientnum)	-0.01	0.06	0.16	0.05	0.07	0.05	0.30	0.55	0.69	1.00						
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)							
(11)M1(StdClientsize)	-0.00	0.16	0.18	0.19	0.17	0.17	0.39	0.21	0.20	0.11	1.00					
	(0.42)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)						
(12)M2(StdClientsize)	0.05	0.07	0.13	0.05	0.09	0.05	0.22	0.23	0.13	0.12	0.33	1.00				
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)					
(13)M3(StdClientsize)	0.04	0.06	0.03	0.06	0.04	0.05	0.19	0.11	0.17	0.04	0.55	0.22	1.00			
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)				
(14)M4(StdClientsize)	0.04	0.06	0.03	-0.04	0.02	0.04	0.10	0.11	0.14	0.12	0.21	0.49	0.37	1.00		
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)			
(15)Big4	-0.24	0.58	0.82	0.72	0.75	0.63	0.87	0.46	0.39	0.23	0.42	0.25	0.19	0.10	1.00	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		
(16) *Restatement*	0.01	0.04	0.02	0.02	0.01	0.03	0.07	0.02	0.05	0.02	0.05	-0.00	0.02	0.01	0.05	1.00
	(0.07)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.95)	(0.00)	(0.04)	(0.00)	

Table 1 panel B presents the Pearson correlation matrix for the main variables used in the absolute discretionary accruals and restatement regressions. See Appendix A for detailed variable definitions.

TABLE 1(Cont'd)

Panel C Correlation Table of the PCAOB Inspection Results Regression

	(17)	*(18)*	*(19)*	*(20)*	*(21)*	*(22)*	*(23)*	*(24)*	*(25)*	*(26)*	*(27)*
(17)Num_Auditswith_Def	1.00										
(18)Num_Auditfailures	0.86	1.00									
	(0.00)										
(19)M1(AvgClientsize)	0.35	0.26	1.00								
	(0.00)	(0.00)									
(20)M1(Clientnum)	0.55	0.52	0.51	1.00							
	(0.00)	(0.00)	(0.00)								
(21)M1(StdClientsize)	0.07	0.11	-0.11	0.08	1.00						
	(0.16)	(0.02)	(0.03)	(0.10)							
(22)Inspection_Duration	0.81	0.71	0.47	0.70	0.06	1.00					
	(0.00)	(0.00)	(0.00)	(0.00)	(0.19)						
(23)Num_Inspected	0.83	0.76	0.39	0.62	0.08	0.80	1.00				
	(0.00)	(0.00)	(0.00)	(0.00)	(0.11)	(0.00)					
(24)First_Inspection	-0.15	-0.10	-0.29	-0.21	-0.10	-0.19	-0.16	1.00			
	(0.00)	(0.01)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)				
(25)Num_Partners	0.10	0.11	0.42	0.67	0.05	0.37	0.35	-0.19	1.00		
	(0.01)	(0.01)	(0.00)	(0.00)	(0.32)	(0.00)	(0.00)	(0.00)			
(26)Num_Staff	0.07	0.06	0.36	0.73	0.05	0.48	0.21	-0.15	0.90	1.00	
	(0.07)	(0.12)	(0.00)	(0.00)	(0.34)	(0.00)	(0.00)	(0.00)	(0.00)		
(27)Triennially	-0.70	-0.64	-0.41	-0.62	-0.11	-0.75	-0.72	0.23	-0.40	-0.30	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	

Table 1 panel C presents the Pearson correlation matrix for the main variables used in the PCAOB inspection results regression. See Appendix A for detailed variable definitions.

TABLE 2

Client Portfolio Characteristics in the National Market and the Absolute Value of Discretionary Accruals

	M1_H1	M1_H2	M1_H3	M1_H4	M1_All
	(1)	(2)	(3)	(4)	(5)
Ln(Asset)	-0.111***	-0.102***	-0.108***	-0.105***	-0.086***
	[-10.22]	[-9.93]	[-9.94]	[-9.84]	[-8.14]
M1(AvgClientsize)		-0.108***			-0.112***
		[-5.58]			[-5.45]
M1(Clientnum)			-0.048***		-0.041***
			[-4.79]		[-4.08]
M1(StdClientsize)				0.032***	0.018*
				[3.20]	[1.74]
Big4	-0.045***	0.051***	-0.005	-0.061***	0.062***
	[-7.20]	[3.26]	[-0.60]	[-8.11]	[3.46]
OperatingCycle	-0.034***	-0.022***	-0.035***	-0.029***	-0.030***
	[-3.68]	[-2.71]	[-3.73]	[-3.15]	[-3.29]
ROA	-0.231***	-0.198***	-0.231***	-0.243***	-0.241***
	[-8.31]	[-9.00]	[-8.32]	[-8.56]	[-8.54]
Leverage	0.030***	0.026***	0.029***	0.032***	0.030***
	[3.42]	[3.08]	[3.31]	[3.70]	[3.40]
Loss	0.004	0.028***	0.005	0.002	0.004
	[0.68]	[5.23]	[0.89]	[0.36]	[0.67]
Going_Concern	0.126***	0.113***	0.125***	0.119***	0.110***
	[11.23]	[11.18]	[11.14]	[10.75]	[10.05]
MB	0.043*	0.079***	0.043*	0.048*	0.043*
	[1.70]	[4.02]	[1.69]	[1.84]	[1.66]
Std_Cfo	0.176***	0.146***	0.176***	0.178***	0.172***
	[10.33]	[9.65]	[10.32]	[10.67]	[10.35]
Std_Sale	-0.009	-0.001	-0.009	-0.007	-0.008
	[-0.91]	[-0.10]	[-0.95]	[-0.70]	[-0.81]
LN(Age)	-0.016***	-0.012**	-0.017***	-0.013**	-0.016***
	[-2.64]	[-2.02]	[-2.80]	[-2.27]	[-2.65]
Fsegnum	0.001	0.002	0.001	0.001	0.002
	[0.29]	[0.56]	[0.17]	[0.21]	[0.40]
Segnum	0.006	0.004	0.006	0.006	0.004
	[1.60]	[1.00]	[1.45]	[1.41]	[0.91]
ReportLag	0.014**	-0.001	0.013*	0.011	0.012*
	[2.10]	[-0.12]	[1.92]	[1.60]	[1.88]
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes
N	39519	39519	39519	38422	38422
adj. R-sq	0.3080	0.3104	0.3084	0.3191	0.3214

Table 2 reports regression results for the audit quality model as specified in equation (16), where the dependent variable is the absolute value of discretionary accruals. An audit market is defined as the national audit market, covering all U.S. public companies. *Ln(Asset)*is the natural logarithm of a client's total assets. *M1(AvgClientsize)*is an audit firm's average client size in the national market. *M1(Clientnum)*is an audit firm's number of clients in the national market. *M1(StdClientsize)*is an audit firm's standard deviation of client size in the national market. See Appendix A for more detailed definitions of these variables and for other variable definitions. t-statistics (in parentheses) are computed using heteroskedasticity-consistent standard errors that are corrected for clustering at the firm level. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively, using two-tailed tests.

TABLE 3

Client Portfolio Characteristics in the National Industrial Market and the Absolute Value of Discretionary Accruals

	M2_H1	M2_H2	M2_H3	M2_H4	M2_All
	(1)	(2)	(3)	(4)	(5)
Ln(Asset)	-0.111***	-0.078***	-0.110***	-0.089***	-0.073***
	[-10.22]	[-7.78]	[-10.17]	[-7.96]	[-6.68]
M2(AvgClientsize)		-0.109***			-0.081***
		[-5.55]			[-3.47]
M2(Clientnum)			-0.044***		-0.027**
			[-4.63]		[-2.32]
M2(StdClientsize)				0.019**	0.015*
				[2.18]	[1.74]
Big4	-0.045***	0.010	-0.025***	-0.052***	0.004
	[-7.20]	[0.84]	[-3.68]	[-6.87]	[0.26]
OperatingCycle	-0.034***	-0.035***	-0.034***	-0.033***	-0.033***
	[-3.68]	[-3.76]	[-3.69]	[-3.12]	[-3.20]
ROA	-0.231***	-0.226***	-0.231***	-0.267***	-0.265***
	[-8.31]	[-8.12]	[-8.33]	[-8.01]	[-7.97]
Leverage	0.030***	0.028***	0.028***	0.030***	0.029***
	[3.42]	[3.22]	[3.24]	[3.17]	[3.01]
Loss	0.004	0.006	0.006	0.007	0.008
	[0.68]	[1.00]	[1.04]	[0.88]	[1.14]
Going_Concern	0.126***	0.118***	0.125***	0.089***	0.086***
	[11.23]	[10.79]	[11.17]	[7.19]	[6.98]
MB	0.043*	0.035	0.042*	0.040	0.035
	[1.70]	[1.39]	[1.69]	[1.28]	[1.14]
Std_Cfo	0.176***	0.171***	0.176***	0.156***	0.153***
	[10.33]	[9.99]	[10.34]	[7.83]	[7.68]
Std_Sale	-0.009	-0.011	-0.008	0.009	0.009
	[-0.91]	[-1.05]	[-0.83]	[0.84]	[0.80]
LN(Age)	-0.016***	-0.018***	-0.018***	-0.014**	-0.015**
	[-2.64]	[-2.85]	[-2.94]	[-2.19]	[-2.32]
Fsegnum	0.001	0.001	0.001	0.000	0.001
	[0.29]	[0.14]	[0.26]	[0.10]	[0.13]
Segnum	0.006	0.005	0.006	0.003	0.002
	[1.60]	[1.28]	[1.48]	[0.78]	[0.55]
ReportLag	0.014**	0.016**	0.012*	0.019***	0.019***
	[2.10]	[2.41]	[1.88]	[2.58]	[2.59]
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes
N	39518	39518	39518	33960	33960
adj. R-sq	0.3081	0.3099	0.3087	0.2753	0.2765

Table 3 reports regression results for the audit quality model as specified in equation (16), where the dependent variable is the absolute value of discretionary accruals. An audit market is defined as the national industrial audit market, covering U.S. public companies operating in specific 2-digit Standard Industrial Classification (SIC) industries. *Ln(Asset)*is the natural logarithm of a client's total assets. *M2(AvgClientsize)*is an audit firm's average size of clients operating in the specific client's 2-digit SIC industry. *M2(Clientnum)*is an audit firm's number of clients operating in the specific client's 2-digit SIC industry. *M2(StdClientsize)*is an audit firm's standard deviation of the size of clients operating in the specific client's 2-digit SIC industry. See Appendix A for more detailed definitions of these variables and for other variable definitions. t-statistics (in parentheses) are computed using heteroskedasticity-consistent standard errors that are corrected for clustering at the firm level. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively, using two-tailed tests.

TABLE 4

Client Portfolio Characteristics in the MSA Market and the Absolute Value of Discretionary Accruals

	M3_H1	M3_H2	M3_H3	M3_H4	M3_All
	(1)	(2)	(3)	(4)	(5)
Ln(Asset)	-0.111***	-0.091***	-0.111***	-0.105***	-0.087***
	[-10.22]	[-8.41]	[-10.17]	[-9.58]	[-7.86]
M3(AvgClientsize)		-0.061***			-0.059***
		[-4.58]			[-4.58]
M3(Clientnum)			-0.007		-0.013***
			[-1.54]		[-2.80]
M3(StdClientsize)				0.018***	0.017***
				[3.07]	[2.79]
Big4	-0.045***	-0.011	-0.042***	-0.052***	-0.014
	[-7.20]	[-1.16]	[-6.68]	[-8.30]	[-1.45]
OperatingCycle	-0.034***	-0.034***	-0.034***	-0.030***	-0.031***
	[-3.68]	[-3.69]	[-3.69]	[-3.28]	[-3.29]
ROA	-0.231***	-0.230***	-0.231***	-0.245***	-0.244***
	[-8.31]	[-8.30]	[-8.31]	[-8.53]	[-8.53]
Leverage	0.030***	0.030***	0.030***	0.033***	0.033***
	[3.42]	[3.49]	[3.38]	[3.69]	[3.72]
Loss	0.004	0.003	0.005	0.002	0.003
	[0.68]	[0.59]	[0.78]	[0.38]	[0.47]
Going_Concern	0.126***	0.123***	0.126***	0.119***	0.116***
	[11.23]	[10.99]	[11.21]	[10.57]	[10.31]
MB	0.043*	0.040	0.043*	0.050*	0.048*
	[1.70]	[1.58]	[1.70]	[1.92]	[1.82]
Std_Cfo	0.176***	0.173***	0.176***	0.173***	0.171***
	[10.33]	[10.16]	[10.33]	[10.24]	[10.10]
Std_Sale	-0.009	-0.009	-0.009	-0.006	-0.006
	[-0.91]	[-0.94]	[-0.91]	[-0.60]	[-0.63]
LN(Age)	-0.016***	-0.016**	-0.017***	-0.016***	-0.016***
	[-2.64]	[-2.54]	[-2.73]	[-2.62]	[-2.62]
Fsegnum	0.001	0.001	0.001	0.002	0.002
	[0.29]	[0.20]	[0.36]	[0.39]	[0.44]
Segnum	0.006	0.007*	0.006	0.006	0.006
	[1.60]	[1.75]	[1.54]	[1.44]	[1.48]
ReportLag	0.014**	0.015**	0.014**	0.011	0.012*
	[2.10]	[2.28]	[2.08]	[1.62]	[1.78]
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes
N	39518	39518	39518	37251	37251
adj. R-sq	0.3081	0.3089	0.3081	0.3185	0.3194

Table 4 reports regression results for the audit quality model as specified in equation (16), where the dependent variable is the absolute value of discretionary accruals. An audit market is defined as companies operating in the U.S. Metropolitan Statistical Area (MSA) where the audit office is located. *Ln(Asset)*is the natural logarithm of a client's total assets. *M3(AvgClientsize)*is an audit firm's average size of clients operating in the U.S. MSA where the audit office of a specific client is located. *M3(Clientnum)*is an audit firm's number of clients operating in the U.S. MSA where the audit office is located. *M3(StdClientsize)*is an audit firm's standard deviation of the size of clients operating in the U.S. MSA where the audit office is located. See Appendix A for more detailed definitions of these variables and for other variable definitions. t-statistics (in parentheses) are computed using heteroskedasticity-consistent standard errors that are corrected for clustering at the firm level. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively, using two-tailed tests.

TABLE 5

Client Portfolio Characteristics in the MSA Industrial Market and the Absolute Value of Discretionary Accruals

	M4_H1	M4_H2	M4_H3	M4_H4	M4_All
	(1)	(2)	(3)	(4)	(5)
Ln(Asset)	-0.111***	-0.074***	-0.111***	-0.086***	-0.059***
	[-10.22]	[-5.38]	[-10.22]	[-6.05]	[-3.88]
M4(AvgClientsize)		-0.052***			-0.056***
		[-3.76]			[-3.36]
M4(Clientnum)			-0.005		-0.006
			[-0.91]		[-0.74]
M4(StdClientsize)				0.018**	0.019**
				[2.33]	[2.50]
Big4	-0.045***	-0.034***	-0.044***	-0.059***	-0.038***
	[-7.20]	[-5.09]	[-6.98]	[-6.29]	[-3.74]
OperatingCycle	-0.034***	-0.035***	-0.034***	-0.030**	-0.031**
	[-3.68]	[-3.78]	[-3.69]	[-2.38]	[-2.46]
ROA	-0.231***	-0.230***	-0.231***	-0.286***	-0.286***
	[-8.31]	[-8.30]	[-8.31]	[-7.62]	[-7.63]
Leverage	0.030***	0.030***	0.030***	0.033**	0.034***
	[3.42]	[3.45]	[3.40]	[2.53]	[2.59]
Loss	0.004	0.004	0.004	0.003	0.003
	[0.68]	[0.73]	[0.75]	[0.32]	[0.34]
Going_Concern	0.126***	0.125***	0.126***	0.097***	0.096***
	[11.23]	[11.17]	[11.23]	[6.29]	[6.25]
MB	0.043*	0.041	0.043*	0.041	0.038
	[1.70]	[1.63]	[1.70]	[1.05]	[0.99]
Std_Cfo	0.176***	0.175***	0.176***	0.134***	0.132***
	[10.33]	[10.26]	[10.33]	[5.77]	[5.70]
Std_Sale	-0.009	-0.009	-0.009	0.007	0.007
	[-0.91]	[-0.94]	[-0.91]	[0.55]	[0.55]
LN(Age)	-0.016***	-0.016***	-0.017***	-0.023***	-0.023***
	[-2.64]	[-2.64]	[-2.72]	[-2.76]	[-2.81]
Fsegnum	0.001	0.001	0.002	-0.003	-0.001
	[0.29]	[0.30]	[0.38]	[-0.44]	[-0.22]
Segnum	0.006	0.006	0.006	0.005	0.005
	[1.60]	[1.60]	[1.52]	[0.98]	[1.03]
ReportLag	0.014**	0.014**	0.013**	0.018**	0.018**
	[2.10]	[2.13]	[2.05]	[2.03]	[2.03]
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes
N	39518	39518	39518	20492	20492
adj. R-sq	0.3081	0.3084	0.3081	0.2799	0.2806

Table 5 reports regression results for the audit quality model as specified in equation (16), where the dependent variable is the absolute value of discretionary accruals. An audit market is defined as companies operating in a specific 2-digit SIC industry in a specific MSA area. *Ln(Asset)*is the natural logarithm of a client's total assets. *M4(AvgClientsize)*is an audit firm's average size of clients in a specific 2-digit SIC industry in a specific MSA area. *M4(Clientnum)*is an audit firm's number of clients in a specific 2-digit SIC industry in a specific MSA area. *M4(StdClientsize)*is an audit firm's standard deviation of the size of clients in a specific 2-digit SIC industry in a specific MSA area. See Appendix A for more detailed definitions of these variables and for other variable definitions. t-statistics (in parentheses) are computed using heteroskedasticity-consistent standard errors that are corrected for clustering at the firm level. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively, using two-tailed tests.

TABLE 6

Client Portfolio Characteristics in the National Market and the Number of Audits with Deficiencies

	The Dependent Variable is the Number of Audits with Deficiencies (*Num_Auditswith_Def*)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
M1(AvgClientsize)	-0.0836***			-0.0550**	-0.0551**	-0.1286***	-0.1278***	-0.1299***
	[-4.54]			[-2.15]	[-2.15]	[-3.10]	[-2.91]	[-2.96]
M1(Clientnum)		-0.0120		-0.0025	-0.0025	0.0308	-0.0733	-0.0674
		[-0.48]		[-0.09]	[-0.09]	[0.63]	[-1.21]	[-1.12]
M1(StdClientsize)			0.0470***	0.0387**	0.0386**	0.0574*	0.0612*	0.0612*
			[3.09]	[2.45]	[2.44]	[1.88]	[1.84]	[1.84]
Inspection_Duration	0.1255***	0.0955**	0.1210***	0.1538***	0.1537***	0.3155***	0.2495***	0.2738***
	[2.87]	[2.04]	[3.39]	[3.56]	[3.56]	[7.27]	[4.09]	[4.18]
Num_Inspected	0.2628***	0.2596***	0.1946***	0.1987***	0.1987***	0.3010***	0.3056***	0.3090***
	[5.48]	[5.55]	[4.61]	[4.54]	[4.54]	[6.68]	[6.41]	[6.35]
First_Inspection					-0.0011	0.0546	0.0466	0.0445
					[-0.03]	[0.84]	[0.65]	[0.62]
Num_Partners						-0.1302***	-0.3346***	-0.3307***
						[-2.61]	[-2.85]	[-2.79]
Num_Staff							0.2538**	0.2452**
							[2.47]	[2.35]
Triennially								0.0374
								[0.75]
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	666	666	421	421	421	388	385	385
pseudo R-sq	0.1473	0.1389	0.1534	0.1572	0.1572	0.1307	0.1127	0.1131

Table 6 reports the ordered probit model regression results for the audit quality model, where the dependent variable is the number of audits with deficiencies (*Num_Auditswith_Def*). The independent variables are defined in Appendix A. t-statistics (in parentheses) are computed using heteroskedasticity-consistent standard errors**.** *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively, using two-tailed tests.

TABLE 7

Client Portfolio Characteristics in the National Market and the Number of the Audit Firm's Failures

	The Dependent Variable is the Number of the Audit Firm's Failures (*Num_Auditfailures*)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
M1(AvgClientsize)	-0.0259***			-0.0169**	-0.0166**	-0.0656***	-0.0939***	-0.0950***
	[-4.82]			[-2.34]	[-2.29]	[-3.15]	[-3.15]	[-3.18]
M1(Clientnum)		-0.0075		-0.0029	-0.0024	0.0234	-0.0054	-0.0022
		[-1.09]		[-0.40]	[-0.33]	[1.03]	[-0.13]	[-0.05]
M1(StdClientsize)			0.0122***	0.0097**	0.0100**	0.0236*	0.0341*	0.0340*
			[2.99]	[2.28]	[2.36]	[1.70]	[1.65]	[1.66]
Inspection_Duration	0.0505***	0.0437***	0.0442***	0.0560***	0.0562***	0.1533***	0.1525***	0.1665***
	[5.03]	[4.56]	[5.11]	[5.78]	[5.76]	[6.06]	[3.26]	[3.29]
Num_Inspected	0.0698***	0.0700***	0.0515***	0.0529***	0.0530***	0.0944***	0.1241***	0.1258***
	[6.11]	[6.35]	[5.50]	[5.27]	[5.25]	[5.21]	[4.50]	[4.49]
First_Inspection					0.0092	0.0564	0.0807	0.0795
					[0.80]	[1.51]	[1.45]	[1.42]
Num_Partners						-0.0415*	-0.1225*	-0.1199*
						[-1.96]	[-1.71]	[-1.67]
Num_Staff							0.0837	0.0786
							[1.33]	[1.24]
Triennially								0.0212
								[0.81]
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	666	666	421	421	421	388	385	385
pseudo R-sq	0.1263	0.1184	0.1344	0.1387	0.1391	0.0974	0.0795	0.0798

Table 7 reports the ordered probit model regression results for the audit quality model, where the dependent variable is the number of the audit firm's failures (*Num_Auditfailures*). The independent variables are defined in Appendix A. t-statistics (in parentheses) are computed using heteroskedasticity-consistent standard errors**.** *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively, using two-tailed tests.

TABLE 8

Client Portfolio Characteristics in the National Market and Likelihood of Restatement

	M1_H1	M1_H2	M1_H3	M1_H4	M1_All
	(1)	(2)	(3)	(4)	(5)
Ln(Asset)	0.0557***	0.0563***	0.0574***	0.0559***	0.0567***
	[5.80]	[5.70]	[5.95]	[5.71]	[5.66]
M1(AvgClientsize)		-0.0058			0.0091
		[-0.31]			[0.42]
M1(Clientnum)			-0.2416**		-0.2382**
			[-2.19]		[-2.11]
M1(StdClientsize)				0.0754**	0.0797**
				[1.97]	[2.01]
Big4	0.0324	0.0492	0.1674**	0.0179	0.1214
	[0.83]	[0.74]	[2.27]	[0.42]	[1.29]
OperatingCycle	0.0364**	0.0363*	0.0362*	0.0385**	0.0384**
	[1.96]	[1.96]	[1.95]	[2.02]	[2.01]
ROA	-0.0085	-0.0083	-0.0086	0.0006	0.0002
	[-0.67]	[-0.65]	[-0.68]	[0.04]	[0.01]
Leverage	0.0928*	0.0921*	0.0887*	0.0887*	0.0854
	[1.76]	[1.75]	[1.68]	[1.65]	[1.58]
Loss	0.0685**	0.0687***	0.0718***	0.0721***	0.0750***
	[2.57]	[2.58]	[2.69]	[2.66]	[2.77]
Going_Concern	-0.1519***	-0.1547***	-0.1584***	-0.1559***	-0.1584***
	[-3.26]	[-3.32]	[-3.40]	[-3.24]	[-3.29]
MB	0.0022	0.0021	0.0021	0.0026	0.0026
	[1.20]	[1.13]	[1.15]	[1.25]	[1.23]
Std_Cfo	0.0960**	0.0940**	0.0959**	0.1053**	0.1083**
	[2.04]	[1.98]	[2.03]	[2.01]	[2.04]
Std_Sale	0.0089	0.0088	0.0086	0.0073	0.0070
	[0.95]	[0.95]	[0.93]	[0.76]	[0.73]
LN(Age)	-0.0764***	-0.0765***	-0.0785***	-0.0755***	-0.0774***
	[-3.37]	[-3.38]	[-3.47]	[-3.27]	[-3.36]
Fsegnum	0.0072**	0.0072**	0.0070**	0.0070*	0.0068*
	[2.03]	[2.02]	[1.98]	[1.93]	[1.89]
Segnum	0.0087***	0.0087***	0.0086***	0.0089***	0.0087***
	[2.84]	[2.84]	[2.79]	[2.89]	[2.83]
ReportLag	0.2309***	0.2315***	0.2252***	0.2341***	0.2272***
	[6.86]	[6.89]	[6.71]	[6.81]	[6.63]
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes
N	37376	37376	37376	36271	36271
adj. R-sq	0.0518	0.0518	0.0522	0.0529	0.0533

Table 8 reports regression results for the probit model on the effect of client portfolio characteristics in the national market on the likelihood of client restatement. *Ln(Asset)*is the natural logarithm of a client's total assets. *M1(AvgClientsize)*is an audit firm's average client size in the national market. *M1(Clientnum)*is an audit firm's number of clients in the national market. M1(StdClientsize)is an audit firm's standard deviation of client size in the national market. See Appendix A for more detailed definitions of these variables and for other variable definitions. t-statistics (in parentheses) are computed using heteroskedasticity-consistent standard errors that are corrected for clustering at the industry level. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively, using two-tailed tests.

APPENDIX A

VARIABLES	DEFINITIONS
Dependent variables	
AbsoluteDCA	The absolute value of discretionary accruals. The discretionary accrual model follows the modified Jones (1991) model, as implemented by Dechow, Sloan, and Sweeney (1995) and modified by Kothari, Leone, and Wasley (2005). The abnormal discretionary accruals for firm *i* (which is in industry *j*) in year t are the difference between the total accruals (TAC) and predicted accruals estimated using the model specified as $\frac{TAC_{i,j,t}}{AT_{i,j,t-1}} = \alpha_{0,j,t} + \alpha_{1,j,t}\frac{1}{AT_{i,j,t-1}} + \alpha_{2,j,t}\left(\frac{\Delta SALE_{i,j,t} - \Delta RECT_{i,j,t}}{AT_{i,j,t-1}}\right) + \alpha_{2,j,t}\left(\frac{PPEGT_{i,j,t}}{AT_{i,j,t-1}}\right) + \alpha_{3,j,t}\left(\frac{NI_{i,j,t-1}}{AT_{i,j,t-1}}\right) + \varepsilon_{i,j,t}$. TAC=IBC-OANCF. All the variables in the discretionary accrual model are winsorized at the 1st and 99th percentiles before estimation. The estimated absolute value of abnormal discretionary accrual is winsorized at 99th percentile. Source: Compustat.
Num_Auditswith_Def	The number of the audits that contain audit failures among the audits inspected by the PCAOB, as disclosed by the inspection reports. Source: The PCAOB's inspection reports as summarized by the data vendor Digi Data Mart Ltd.
Num_Auditfailures	The number of the specific audit failures contained in the audits with deficiencies as identified by a specific PCAOB inspection. A typical inspection report of the PCAOB will list the specific audit failures. The count of the specific audit failures is obtained as this variable. Source: The PCAOB's inspection reports as summarized by the data vendor Digi Data Mart Ltd.
Restatement	An indicator variable set to 1 if the financial statement of a specific firm-year is subsequently restated and 0 otherwise.
Independent variables	
Ln(Asset)	The natural logarithm of a client's total assets (AT). Source: Compustat.
M1(AvgClientsize)	An audit firm's average client size in the national market. Client size is measured by the natural logarithm of a client's total assets (AT).
M1(Clientnum)	An audit firm's number of clients in the national market. Source: Audit Analytics
M1(StdClientsize)	An audit firm's standard deviation of client size in the national market. Source: Audit Analytics and Compustat
M2(AvgClientsize)	An audit firm's average size of clients operating in the specific client's 2-digit SIC industry. Source: Audit Analytics and Compustat
M2(Clientnum)	An audit firm's number of clients operating in the specific client's 2-digit SIC industry. Source: Audit Analytics
M2(StdClientsize)	An audit firm's standard deviation of the size of clients operating in the specific client's 2-digit SIC industry. Source: Audit Analytics and Compustat
M3(AvgClientsize)	An audit firm's average size of clients operating in the U.S. Metropolitan Statistical Area where the audit office of a specific client is located. Source: Audit Analytics and Compustat
M3(Clientnum)	An audit firm's number of clients operating in the U.S. Metropolitan Statistical Area where the audit office of a specific client is located. Source: Audit Analytics
M3(StdClientsize)	An audit firm's standard deviation of the size of clients operating in the U.S. Metropolitan Statistical Area where the audit office of a specific client is located. Source: Audit Analytics and Compustat
M4(AvgClientsize)	An audit firm's average size of clients in a specific 2-digit SIC industry in a specific MSA area of a specific client. Source: Audit Analytics and Compustat
M4(Clientnum)	An audit firm's number of clients in a specific 2-digit SIC industry in a specific MSA area of a specific client. Source: Audit Analytics
M4(StdClientsize)	An audit firm's standard deviation of the size of clients in a specific 2-digit SIC industry in a specific MSA area of a specific client.
Big4	An indicator variable set to 1 when a firm uses one of the Big 4 auditors (Arthur Andersen, PricewaterhouseCoopers, Ernst & Young, Deloitte & Touche, or KPMG) and 0 otherwise. Source: Audit Analytics

Independent variables(cont'd)	
LogCycle	The natural logarithm of firms' operating cycle (360*(INVT+lag(INVT))/(2*COGS) + 360*(AP+lag(AP))/(2*COGS)). Lag(INVT) and lag(AP) are firms' lagged inventory and accounts payable. Source: Compustat.
ROA	Net income (NI) over total assets (AT). Source: Compustat.
Leverage	The ratio of year-end total liabilities (DLTT) to total assets (AT). Source: Compustat.
Loss	An indicator variable that is set to 1 when income before extraordinary items (IB) is less than zero and 0 otherwise. Source: Compustat.
Going_Concern	An indicator variable that is set to 1 if the auditor opinion for the fiscal year includes a going concern qualification and 0 otherwise. Source: Compustat.
MB	The ratio of the market value of total assets to the book value of total assets (AT+CSHO*PRCC_F-CEQ- TXDB)/AT). Source: Compustat.
Std_Cfo	Firm-specific standard deviation of the cash flow from operations deflated by average total assets from years *t*-7 to *t*-1 (cash flow = 2*OANCF/ (AT+LAG(AT)). We require at least three years of data available for standard variation calculation. Source: Compustat.
Std_Sale	Firm-specific standard deviation of the sales deflated by average total assets from years *t*-7 to *t*-1 (sales = 2*SALE/ (AT+LAG(AT)). We require at least three years of data available for standard variation calculation. Source: Compustat.
Ln(Age)	The natural logarithm of firm-specific age. Age is calculated as the difference between the current year and the first year the firm appears in Compustat. Source: Compustat.
Fsegnum	The total number of foreign segments; this is coded as 0 when this information is missing in the segment file. Source: Compustat.
Segnum	The total number of business segments; this is coded as 1 when this information is missing in the segment file. Source: Compustat.
ReportLag	The natural logarithm of the lag between the auditor's signature date and the date of the fiscal year-end. Source: Audit Analytics.
Inspection_Duration	The number of days between the inspection start date and the inspection end date. Source: The PCAOB's inspection reports as summarized by the data vendor Digi Data Mart Ltd.
Num_Inpsected	The number of audits inspected in a specific inspection. Source: The PCAOB's inspection reports as summarized by the data vendor Digi Data Mart Ltd.
First_Inspection	An indicator variable set to 1 if the inspection is the first time that the PCAOB inspects the audit firm and 0 otherwise. Source: The PCAOB's inspection reports as summarized by the data vendor Digi Data Mart Ltd.
Num_Partners	The number of the audit firm's self-reported partners at the time of the inspection. Source: The PCAOB's inspection reports as summarized by the data vendor Digi Data Mart Ltd.
Num_Staff	The number of the audit firm's self-reported personnel of the audit firm, except partners or shareholders and administrative support personnel. Source: The PCAOB's inspection reports as summarized by the data vendor Digi Data Mart Ltd.
Triennially	An indicator variable set to 1 if the audit firm is auditing fewer than 100 U.S. public companies and 0 otherwise. Source: The PCAOB's inspection reports as summarized by the data vendor Digi Data Mart Ltd.

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