Competition in the Audit Market: Policy Implications*

Joseph Gerakos Chad Syverson

December 16, 2013

Abstract

The audit market's unique combination of features—its role in capital market transparency, mandated demand, and concentrated supply—means it receives considerable attention from policymakers. We explore the effects of two market scenarios that have been the focus of policy discussions: a) further supply concentration due to one of the "Big 4" auditors exiting and b) mandatory audit firm rotation. To do so, we first estimate publicly traded firms' demand for auditing services, allowing services provided by each of the Big 4 to be differentiated products. We then use those estimates to calculate how each scenario would affect client firms' consumer surplus. We estimate that, conservatively, exit by one of the Big 4 would reduce client firms' surplus by $1.2–1.8 billion per year. These estimates reflect only firms' lost options to hire the exiting auditor; they do not include the likely fee increases resulting from less competition among auditors. We calculate that the latter could result in audit fee increases between $0.3–0.5 billion per year. Such losses are substantial; by comparison, total audit fees for public firms were $11 billion in 2010. We find similarly large impacts from mandatory audit firm rotation, estimating consumer surplus losses at approximately $2.4–3.6 billion if rotation was required after ten years and $4.3–5.5 billion if rotation was mandatory after only four years.

*Gerakos: University of Chicago Booth School of Business, 5807 S. Woodlawn Avenue, Chicago, IL 60637, jgerakos@chicagobooth.edu. Syverson: University of Chicago Booth School of Business and NBER, 5807 S. Woodlawn Avenue, Chicago, IL 60637, chad.syverson@chicagobooth.edu. We thank Ray Ball, Mary Barth, J.P. Dubé, David Erkens, Rich Frankel, Ron Goettler, Bobby Gramacy, Günter Hitsch, Ali Hortaçsu, Bill Kinney, Dave Larcker, Christian Leuz, Doug Shackelford, Jesse Shapiro, Doug Skinner, Stephen Taylor, Anne Vanstraelen, Mike Willenborg and workshop participants at Maastricht University, Ohio State University, Stanford University, University of Chicago, University of Connecticut, University of Melbourne, University of North Carolina, University of Southern California, University of Technology, Sydney, Washington University at St. Louis, and the 2012 Illinois Audit Symposium for their comments.

1 Introduction

The market for financial audits exhibits a set of features that distinguish it from other markets for business services (and for that matter, many other goods more broadly). First, it is seen by many to play an important and in some ways unique role in preserving transparency and improving the functioning of capital markets (e.g., Watts and Zimmerman (1983), Black (2001), and Ball (2001)). Relatedly, failures of auditors to catch and report improprieties are often highly—and occasionally spectacularly—visible.

Second, a substantial portion of demand in the market is mandated. Publicly traded firms are compelled to purchase audit services, and there are no services from outside the industry that can legally serve as substitutes.

Third, the market's supply side is highly concentrated. Among publicly traded companies in the U.S., for example, the majority of audit engagements and almost all audit fees involve just four audit firms (the "Big 4": Ernst & Young, Deloitte Touche, KPMG, and PricewaterhouseCoopers). In 2010 the Big 4 handled 67% of audit engagements and collected over 94% of audit fees.[1] As discussed by Velte and Stiglbauer (2012), similar concentration is observed in the audit markets of many other developed economies.

The combination of these features has resulted in the audit industry being subject to frequent policy debates. In this paper, we explore two oft-recurring discussions in this vein. The first regards the effects of further concentration in supply due to one of the Big 4 audit firms exiting the market. The second involves the consequences of imposing a mandatory audit firm rotation policy.

Both of these scenarios have already colored policy toward the industry. There have been several recent cases in which a Big 4 audit firm could arguably have been criminally indicted but the Department of Justice decided to not file charges, probably because of concerns about further

[1] For a breakdown of market shares and fees over the recent decade, see Tables 1 and 2.

increasing concentration.[2] For example, in 2005 KPMG admitted criminal wrongdoing by creating tax shelters that helped clients evade $2.5 billion in taxes. Nevertheless, the Department of Justice did not indict KPMG and instead entered into a deferred prosecution agreement (Johnson (2010)). Moreover, according to the Lehman Brothers bankruptcy examiner's report (Valukas (2010)), Ernst & Young assisted Lehman Brothers in implementing its Repo 105 transactions, which allowed Lehman to temporarily reduce its leverage when preparing its financial statements. Nonetheless, the Department of Justice did not pursue criminal charges against Ernst & Young.[3]

With regard to mandatory auditor rotation, the Public Company Accounting Oversight Board (the "PCAOB") is in active discussions about implementing such a policy for SEC registrants. During the PCAOB's hearings in March 2012 on mandatory audit firm rotation, panelists voiced opposing views about the costs and benefits of mandatory audit firm rotation. For example, the executive director of the AICPA's Center for Audit Quality stated that mandatory audit firm rotation would hinder audit committees in their oversight of external auditors, while former SEC chairman Arthur Levitt supported mandatory rotation because "investors deserve the perspectives of different professionals every so often, particularly when an auditor's independence can be reasonably called into question" (Tysiac (2012)). Moreover, the issue of mandatory audit firm rotation has been addressed by Congress. In June 2013 the House Financial Services Committee unanimously passed a bill to prohibit the PCAOB from mandating audit firm rotation (Cohn (2013)).

We seek to explore how the fruition of these two scenarios—the disappearance of one of the Big 4 and the imposition of mandatory auditor rotation—would affect the audit market, and in particular the consequences for publicly traded firms, its primary customers. Addressing these questions satisfactorily requires, at the very least, measurements of the willingness of firms to substitute among individual auditors and the value firms place (if any) on extended relationships

[2] A criminal conviction prohibits an audit firm from carrying out audits of SEC registrants.

[3] In contrast, the New York attorney general Andrew Cuomo sued Ernst & Young claiming that the audit firm helped Lehman "engage in a massive accounting fraud" (Public Accounting Report (2011)).

with auditors. However, prior research on the structure of the audit market has focused primarily on either correlations between audit fees and firm characteristics or substitutability between the Big 4 and non-Big 4 auditor groups.[4] While this work has offered insights to several questions, its focus has left a gap that we seek to begin to fill with this study.

Our empirical approach treats the audit market much like any other differentiated product market (even the mandatory nature of demand can easily be handled within our framework).[5] We model firms seeking audit services as choosing from among several producers of those services (i.e., the audit firms), with each potential auditor offering varying aspects of service that are potentially valued differentially by each client firm.[6] Each publicly listed firm considers how well the attributes of each auditor's product match its needs (these attributes include price—the audit fees) and hires the auditor offering the best net value.

With this factor demand framework, we can use data on publicly listed firms' choices of auditors to measure via revealed preference how firms view the audit services provided by each of the Big 4 auditors as well as by smaller audit service providers. Importantly, we can quantify a firm's willingness to substitute among auditors. That is, we can compute the dollar transfer that would be necessary to make a client switch to a different auditor. In particular, we are able to calculate the transfer necessary to compensate client firms who lose a potential auditor choice due to exit of a Big 4 auditor, as well as to quantify clients' willingness to pay for longer-term relationships with a particular auditor, and hence what value the client firms would lose if forced to break such relationships because of mandatory auditor rotation. Thus we can address quantitatively some of the key policy questions surrounding the issues of further auditor concentration and mandatory

[4]For examples of studies that examine substitutability between the Big 4 and non-Big 4 groups, see Willenborg (1999), Ettredge, Kwon, and Lim (2009), and Lennox, Francis, and Wang (2012)

[5]Our empirical approach neither assumes nor imposes differentiation. It instead allows for differentiation among the Big 4 audit firms and lets the data speak as to its existence. In this way, it contrasts with prior research that assumes no differentiation among the Big 4 (e.g., Doogar and Easley (1998) and Sirois and Simunic (2013)).

[6]Because audits are inputs into firms' production activities, these are differentiated factor markets, but the economics are essentially the same as in markets for differentiated outputs.

auditor rotation.

Our analyses indicate that the exit of any of the Big 4 auditors would result in substantial losses in client firms' expected consumer surplus (that is, the firms' value of their purchased audit services in excess of the fees they pay for them; the net benefit they derive from the audit services). We estimate that, conservatively, client firms' consumer surplus will fall by between $1.2–1.8 billion per year. This loss in surplus can be interpreted as the total amount of cash transfers client firms would require to compensate them for losing the ability to hire the exiting auditor. These figures reflect only the direct effect of the loss of auditor choice; they do not account for the likely increases in audit fees that would occur due to less competition among the remaining auditors. Using our data to estimate the latter effect, we calculate moving from the Big 4 to the Big 3 could result in audit fee increases between $0.3–0.5 billion per year. These higher fees correspond dollar-for-dollar with lost consumer surplus among client firms, so this supply response effect exacerbates the pure choice effect. Both of these losses are substantial; by comparison, total audit fees for public firms were $11 billion in 2010.

We find similarly large impacts from mandatory audit firm rotation, estimating consumer surplus losses at approximately $2.4–3.6 billion if rotation were required after ten years (with the higher estimated losses reflecting the anticipated fee setting responses of auditors to the new market rules) and $4.3–5.5 billion if rotation were mandatory after only four years.

These estimates carry several caveats. First, the Big 4 audit firms operate worldwide, while our estimates are based only upon their U.S. public clients. Second, due to a lack of data we are also unable to include in our analysis private firms, though they would also suffer losses in surplus. Further, our estimates are limited to audit fees and services and do not take into account non-audit and audit-related fees and services. Nevertheless, these estimates are informative about the costs that could arise from changes in the audit industry's market structure and from the implementation

of mandatory rotation. In addition, they provide some of the first estimates of the value of audit firm-client matches.

Reflecting their status of topics of debate, it is important to point out that there may be benefits from both auditor exit and mandatory auditor rotation as well. For example, the threat of exit due to either market or government response to malfeasance or negligence may discipline auditor moral hazard, and mandatory rotation may resolve rent-seeking behaviors supported by overly cozy relationships between auditors and clients. Quantifying those benefits requires an analytical approach that is beyond the scope of this paper, however. Our estimates here offer a measurement of the costs of additional concentration and mandatory rotation that an optimal policy would balance any benefits against.

The analyses in this paper are obviously relevant to those directly interested in the specific policy-relevant counterfactuals in the audit industry that we examine in this paper. However, we believe more general lessons can also be drawn from the analyses. They offer a framework for investigating sets of demand, supply, and competitive issues in the audit market that extend well beyond the two we investigate here. Indeed, there are entire literatures dedicated to examining these issues, an attention reflecting in part the audit market's special role in helping capital markets function. Our framework, which has been applied in similar forms in other market settings but (to our knowledge) is novel to research on the audit market, lets researchers quantify and isolate demand- and supply-side fundamentals that allow fuller answers to questions about the nature and effects of the market than the previous literature has been able to deliver. Further, the approach here can be applied to address research questions about the markets for business services more broadly (e.g., credit ratings, investment banking, and commercial banking), which are extensive in size and scope.

Our analysis is structured as follows. We first discuss how we model client firms' choices

of auditor. We then describe the estimation of our demand model, including our approaches for dealing with price endogeneity. We also explain how we handle a more atypical situation in demand estimation, the fact that we do not observe prices (fees) for producers (auditors) that a firm does *not* hire. Then, after reporting and discussing our demand estimates, we use these estimates to calculate the expected effects of the two counterfactual scenarios described above: greater audit industry concentration and mandated auditor rotation.

2 Demand Model

Although publicly traded firms are compelled to purchase an audit ("mandated demand"), they can choose among audit firms certified by the Public Company Accounting Oversight Board (the "PCAOB"). We therefore model publicly listed firms' demand for audit services as reflecting a choice among several potential auditors: each of the Big 4 and an amalgam outside good that includes all other audit firms. Every client firm makes its choice based on the expected benefit it would obtain from hiring each of the auditors. This benefit includes the effects of both firm-, auditor-, and match-specific attributes and is net of the fees the auditor charges the client firm for its service.

While the discrete choice demand model we lay out below is in many ways standard in the industrial organization literature, our approach differs from the substantial prior literature on auditor choice in that this work has typically examined the determinants of the simple dichotomous choice between using a Big 4 versus a non-Big 4 auditor. Our analytical structure allows us to characterize much more fully the patterns of substitution among the individual auditors, and just as importantly lets us tie client firms' choices directly to parameters of their factor demands, which is key to quantifying preferences in terms of dollar values.

2.1 Utility Specification

For firms' choice of auditor, we specify the "inside" goods as the Big 4 auditors (Ernst & Young, Deloitte Touche, KPMG, and PricewaterhouseCoopers) and the "outside" good as the aggregation of all other auditors who provide audits to public firms (BDO Seidman, Grant Thornton, etc.). Because we are identifying the preference parameters of publicly listed firms whose demand for audit services is mandated, there is no true outside good in this setting. Thus we can simply define the outside good as any auditor choice not in the Big 4. In fact, mandated demand makes our task easier, as we do not need to be concerned with defining the full breadth of potential demand for the market, a necessary assumption in discrete choice settings where buyers might not purchase any product in the market.

We model each client firm i's utility from choosing auditor j as

$$U_{ij} = \delta_j - \alpha \ln(p_{ij}) + \beta_{ij} x_{ij} + \epsilon_{ij} \tag{1}$$

in which δ_j is an auditor fixed effect that represents the mean utility that all potential clients obtain from choosing auditor j (this variable subsumes brand effects and any other attributes of j's services that all potential clients value equally); p_{ij} is auditor j's price for an audit of firm i (i.e., its audit fees); α parameterizes the marginal willingness to pay for a log-dollar of audit fees; x_{ij} is a vector of observable non-price characteristics of the client-auditor pair; β_{ij} are the utility loadings on these characteristics, and ϵ_{ij} represents an unobserved client-auditor specific component of utility assumed to be independently and identically distributed.[7] In our specification, audit fees enter in logarithmic form. This implies that an additional dollar of audit fees matters less to a large client than a small client. This specification is consistent with clients negotiating with auditors

[7] While we have labeled equation (1) as describing a client firm's utility, it can be interpreted more broadly as any objective function of the client with respect to its audit firm choice.

over percentage changes in audit fees rather than absolute dollar changes.

To model the interactions between non-price characteristics of the client firm and the auditor, we expand $\beta_{ij}x_{ij}$ as follows. First, we interact the auditor fixed effect, δ_j, with the natural logarithm of the client's size, $\ln(TotalAssets_i)$. This interaction allows us to capture audit firm preferences that vary with client firm scale. For example, smaller firms may prefer non-Big 4 auditors, and there could be heterogeneous size-based preferences across each of the Big 4 auditors. Second, we interact the auditor fixed effects with an additional set of client characteristics commonly used in the audit literature: $\ln(Segments_i)$ is the natural logarithm of the number of industrial segments in which the client operates; $Foreign\ Sales_i$ is the ratio of foreign to total sales; $Debt_i$ is the ratio of short plus long-term debt to total assets; ROA_i is the client's return on assets; $Inventory + Receivables_i$ is the ratio of inventory plus accounts receivables to total assets; $Payables_i$ is the ratio of accounts payable to total assets. These interactions allow rich variation in preferences for auditors across client firms with different operating and financial characteristics. Third, we interact the auditor fixed effects with industry indicators (using the Fama-French ten-industry classification system) to control for any systematic preference differences across clients' industries.[8]

While firms in principle choose their auditor every year, the data reveal a strong tendency to rehire the previous year's auditor. For example, in a transition matrix of client firms' auditor choices in consecutive years over the period 2008–2010, the largest elements in the matrix by some distance are its diagonals—the probability of renewing an existing auditor relationship is in the neighborhood of 95%. (See Table 3.) This persistence could reflect the effect of match-specific capital formed during the course of an auditing relationship or reveal the strength of some other match-specific unobservable utility component that makes retention more likely. To parsimoniously incorporate any such effects, we add elements to equation (1) that allow for the possibility that re-

[8]For examples of research on auditor industry specialization, see Craswell, Francis, and Taylor (1995), Hogan and Jeter (1999), and Carson (2009).

choosing the prior year's auditor will deliver additional utility. Specifically, we interact the auditor fixed effects with two additional variables: an indicator that equals one if the client firm did not use the respective auditor in the prior year, $1(Not\ client_{ij})$, and the natural logarithm of the number of consecutive years that the client firm has hired to its current auditor, $\ln(YearsClient_{ij})$.[9]

Given this utility function, a client firm's choice decision is straightforward. Each year client i calculates U_{ij} for each of its five options (the Big 4 firms and the outside good) and then chooses the audit firm j that provides the maximum U_{ij}. This specification is consistent auditor choice in practice—the client's audit committee is required by the Securities and Exchange Commission to evaluate and ratify audit contracts annually.

2.2 Estimation

Equation (1) can be written as $U_{ij} = V_{ij} + \epsilon_{ij}$, in which $V_{ij} \equiv \beta_{ij} x_{ij} - \alpha \ln(p_{ij}) + \delta_j$ is the observable portion of utility, and ϵ_{ij} is the unobserved portion of utility. If we assume that ϵ_{ij} is distributed type 1 extreme value, the predicted probability that client i chooses audit firm j is

$$P_{ij} = \frac{e^{V_{ij}}}{\Sigma_j e^{V_{ij}}}. \tag{2}$$

This specification is the standard conditional logit commonly used in the industrial organization and marketing literatures to estimate demand for discrete differentiated products.[10] The conditional logit is similar to a fixed effect regression in that any characteristic of client i that does not vary across choices (here, auditors) drops out of equation (2). For example, firm size itself drops out of equation (2); only interactions between firm size and the auditor fixed effects remain to influence choice probabilities.

[9] We define this latter variable as zero for Big 4 firms that are not the client firm's current auditor; thus the "not current auditor" indicator coefficient reflects the difference in demand between an auditor with which the client firm does not have a current relationship and an auditor with which the client has been matched for one year.

[10] For a discussion, see Train (2009). For an application, see Petrin (2002).

If $y_{ij} = 1$ represents that client i chooses auditor j and zero otherwise, then the log likelihood corresponding to (2) is:

$$LL(\alpha, \beta, \delta) = \sum_i \sum_j y_{ij} \ln P_{ij} = \sum_i \sum_j y_{ij} \ln \frac{e^{V_{ij}}}{\Sigma_j e^{V_{ij}}} \tag{3}$$

We maximize this log likelihood to obtain estimates of the utility/preference parameters α, β, and δ.

2.3 Prices

The price/fee term of equation (1) raises several estimation issues.

2.3.1 Missing Fees

One issue with equation (1) is that we only observe prices (audit fees) for actual matches between clients and auditors. This is an unusual situation in demand estimation settings; the researcher typically observes the prices of each item of the available choice set. We must therefore estimate what fees a client would have expected to pay had it hired an audit firm other than the one it ended up choosing.

We implement these "what if" prices using a predictive model estimated from the relationships between fees in observed client-auditor matches and client-, auditor-, and match-specific characteristics. We considered several prediction methods including ordinary least squares, lasso regression, ridge regression, partial least squares, and two regression tree approaches (random partitioning and random forest).[11] On an auditor-year basis we use the following set of predictor variables: total assets, the number of industrial segments the firm operates in, foreign sales, debt, return on assets, inventory & receivables, indicators to capture whether and for how long the firm was a

[11] For a discussion of these methods, see Hastie, Tibshirani, and Friedman (2009).

client of the auditor (all of the preceding are characteristics of the client firm), and indicators for the Fama-French ten-industry classification. These are the same variables included in our demand estimation and are commonly used in reduced form regressions of audit fees (Hay, Knechel, and Wong (2006)).

Based on root mean squared error derived from cross-fold validation, we found that regression trees (specifically, random forest) best predict dollar audit fees. The results for the cross-fold validations are presented in Table 4. In Panels A, B, and C we compare the number of times each method provides the lowest RMSE for the auditor-year pair, the mean rank in terms of RMSE of each method for the auditor-year pair, and the median rank. Following Gramacy and Pantaleo (2010), we use distributional characteristics to compare the methods given scale differences across years. Across all auditor-year pairs, random forest has the lowest RMSE the highest number of times and lowest average rank. In terms of the median rank, random forest does as well or better than the other tree based method (random partitioning) for each auditor-year pair. To predict audit fees, we therefore use random forest.

In our demand estimations, we use predicted fees in equation (1) for all auditors, including the actual audit firm chosen by the client. We do so because it is likely that the prices associated with actual choices include a negative price shock that would otherwise bias our estimated price coefficients toward zero. For a discussion of this issue, see Erdem, Keane, and Sun (1999). EXPAND

2.3.2 Price Endogeneity

A major concern in most demand estimation settings is the possibility of price endogeneity (i.e., $cov(p_{ij}, \epsilon_{ij}) \neq 0$). For example, if price is positively correlated with unobserved audit quality—say because client firms have a greater willingness to pay for higher quality audits and/or auditors have higher costs of delivering them—then the coefficient on price will be positively biased (toward zero,

given that theory predicts the coefficient should be negative). The resulting demand estimates would make it appear that firms are less sensitive to audit fees than they really are.

A way to avoid this bias is to identify firms' price sensitivity using fee variation that is driven by supply-side factors that are uncorrelated with demand shifts (ϵ_{ij}). We are fortunate to have in our market setting and data two sets of supply shifters that we can use in our audit fee prediction regressions to aid in this identification. One uses the change in supply structure induced by the sudden and unexpected exit of Arthur Andersen from the market, and the second uses exogenous increases in auditor capacity created by client mergers and acquisitions. We describe each in further detail below.

Disappearance of Arthur Andersen We use the collapse of Arthur Andersen in 2002 due to its post-Enron conviction (later overturned, though too late to revive Arthur Andersen as an auditing firm) as an exogenous shock to supply in the audit market. The collapse of Arthur Andersen reduced competition among auditors, creating an opportunity for the remaining suppliers to increase their audit fees. Prior research on auditor specialization (e.g., Craswell, Francis, and Taylor (1995), Hogan and Jeter (1999), and Casterella, Francis, Lewis, and Walker (2004)) implies this supply shock was industry specific: the supply shift was larger in industries where Andersen had a greater share of the audit market before its collapse (in terms of Andersen's client firms' share of industry assets). This across-industry variation is useful because while one might be concerned that Andersen's collapse might be intertemporally linked with changes in the demand for auditing services (due to the passage of Sarbanes-Oxley, for example), it is unlikely that these demand shifts would be systematically related to Andersen's prior share of the industry market. Thus the cross-industry variation in Andersen's pre-collapse share offers a source of supply-driven price variation that is likely orthogonal to shifts in the demand for auditing services.

To empirically validate the disappearance of Arthur Andersen as relevant to observed changes in audit fees, Table 5 shows the results of regressing the log difference in client firms' audit fees on Andersen's 2001 market share in the firms' respective three-digit SIC industries, $Andersen's\,Share$. If our argument that Andersen's collapse is an inward shift in audit supply is correct, the coefficient on $Andersen's\,Share$ will be positive. That is, publicly traded firms in industries where Andersen was more dominant before its collapse will see a greater increase in fees afterwards, regardless of whether they were Andersen clients themselves.

We estimate these regressions separately for 2008, 2009, and 2010. We focus on this later period in this analysis and in subsequent analyses to better inform current policy. To account for any systematic differences in fee growth tied to the client's auditor, we include as additional controls indicator variables for the firm's auditor in 2001. (For example, the fee growth for Andersen clients may differ from the fee growth for firms that were Ernst & Young clients in 2001.) We also include the change in the client's logged total assets over each period, as the prior literature has found that total assets are the most important predictor of audit fees. We cluster the standard errors by three-digit SIC. Because we require that the data be available over each change interval, the sample size drops monotonically from 2,806 clients for 2001–2008 to 2,399 clients for 2001–2010.

The results, presented in Panel A of Table 5, indicate that the coefficient on the supply shifter $Andersen's\,Share$ is indeed positive at every horizon and statistically significant for all horizons. In other words, industries in which Andersen had a larger market share before its collapse experienced greater growth in audit fees afterwards, and this effect persisted at least through 2010.[12]

An alternative explanation for these results is that Arthur Andersen charged lower prices and provided lower quality audits, thereby leading to greater increases in audit fees for Andersen clients. However, we do not believe that such an effect drives the results presented in Table 5 for two reasons.

[12] We find similar results for the years 2002 through 2007.

First, Cahan, Zhang, and Veenman (2011) find that prior to the Enron scandal, Arthur Andersen provided audits of similar quality to the audits provided by the other major audit firms. Second, as seen in Panel B, we find similar effects if we limit the sample to firms that were not Andersen clients.

It could, however, be the case that industries in which Arthur Andersen had large market shares were perceived post-Enron as riskier in terms of audit quality and future audit fees therefore rose more. If this was the case, then future accounting restatements should be higher in industries in which Andersen had a larger share. We therefore collect all accounting restatements for 2002–2011 from Audit Analytics and examine whether the likelihood of an accounting restatement varies with Andersen's industry shares in 2001. The results for these logistic regressions are presented in Table 6. In column (1) we include only Andersen's 2001 industry share as an independent variable and in column (2) we include the client characteristics as of 2002. In both specifications the coefficient on the Andersen's industry share is positive they are both less than one standard deviation away from zero.

Given the results presented in Table 5, we include *Andersen's Share* in the annual audit fee prediction regressions. This variable offers variation in audit fees due to supply shocks that should be uncorrelated with clients' relative demand for surviving auditors, allowing us to obtain unbiased estimates of the sensitivity to fee changes of client firms' auditor choices.

Client Mergers and Acquisitions Our second source of supply-driven audit fee variation exploits mergers and acquisitions among client firms. Because each firm only needs a single auditor, a merger or acquisition involving firms with different auditors will likely result in one audit firm being dropped.[13] The audit firm that loses a client will find itself with excess capacity that should put

[13]The audit firm that loses the job of auditing the merged client's consolidated financial statements could, however, retain some business with the merged entity, such as tax consulting, information technology consulting, and the auditing of subsidiaries.

downward pressure on audit fees. Supply can also shift even if both pre-merger client firms have the same auditor, because even though the merged firm requires greater auditing, the elasticity of audit fees to total assets is approximately 0.3–0.4; some of the auditor's overhead is duplicative and can be freed for other uses. This creates excess audit capacity for the merged firm's auditor and the resulting price effects. These supply shifts will be orthogonal to audit demand shocks as long as client-level mergers and acquisitions are driven by neither auditor choice nor audit fee considerations, which strike us as quite likely.

To test whether mergers and acquisitions have the expected effects on audit fees, we regress client firms' logged fees on the prior year's ratio of merged to total assets in the firms' respective three-digit SIC industries, *Merged Assets*. We also control for the ratio of receivables to assets, the ratio of inventories to assets, the return on assets, an indicator variable for whether the client experienced a loss, the percent of foreign sales, the natural logarithm of the number of industrial segments, an indicator for whether the firm is an accelerated filer,[14] and firm, industry, and year fixed effects. We cluster standard errors at the client level and estimate the regressions over the sample period 2002–2011.

Columns (1) and (2) of Table 7 present the main results. Consistent with the logic outlined above, the coefficient on *Merged Assets* is negative and statistically significant in both column (1), which includes auditor fixed effects, and in column (2), which does not. Firms in industries that saw more action in mergers and acquisitions paid lower audit fees, all else equal.

As a further check on the validity of the merger measure as a supply shifter, we estimate a specification that, rather than including *Merged Assets* computed for the prior year, instead includes the ex post ratio of merged to total assets observed three years in the future. For these tests, the coefficients on *Merged Assets* in columns (3) and (4) are positive and insignificant. Thus

[14]The Securities and Exchange Commission requires registrants with an aggregate worldwide market value of equity greater than $75 million to file their financial statements earlier than smaller registrants.

merger activity leads price changes and not the reverse, increasing the likelihood that the results reflect the supply-shift story outlined above rather than a spurious connection between fees and merger activity due to other forces.

2.3.3 Fit of Predicted Audit Fees

Our random forest prediction specification yields fitted values that are highly correlated with actual audit fees within the sample. The Pearson product moment correlations between actual and predicted fees are as follows: Ernst & Young, 0.977; Deloitte Touche, 0.959; KPMG, 0.971; PricewaterhouseCoopers, 0.970; all other auditors, 0.961. Figure 1 presents plots of actual versus predicted log audit fees for our sample. As shown in the figure, the model does well predicting fees in the mass of the distribution and less in the tails. In untabulated analysis we estimate demand dropping firms in the 1st and 99th percentiles of audit fees. For this sample, we find similar results as for our full sample.

3 Demand Estimation

3.1 Sample

Our sample consists of SEC registrants with available data. We pull audit fee data from Audit Analytics, which provides fee data starting with the mandatory disclosure of audit fees in 2000. We use Compustat to obtain accounting-based financials and the histories of auditor-client matches prior to 2000 (we need this earlier match information to construct our measure of the extent of an existing auditor-client relationship). Finally, we identify client-level mergers and acquisitions using SDC Thomson data.

3.2 Client Firms' Preferences over Auditors

Panel A of Table 8 presents the results from estimating our benchmark demand model. These preference parameters form the basis for our estimates of clients' willingness to pay for audit services and willingness to substitute among audit firms. We estimate the preference functions separately by year over 2008–2010.[15]

To capture restrictions in the client's choice set, we remove audit firms that resigned from auditing the client in the prior three years. We identify such resignations from the Audit Analytics database. Such resignations arise from disagreements over fees, accounting practices, or issuances of going concern opinions. In addition, we estimated a separate set of demand parameters using firms in the top half of the distribution of size to address the possibility that the Big 4 audit firms selectively choose small clients because of litigation risk. Our demand estimates for this restricted sample are similar to those presented in Table 8. Moreover, the Sarbanes-Oxley Act prohibits audit firms from providing certain consulting services to their clients. Unfortunately, we are unable to observe restrictions on clients' choice sets due to such consulting relations with audit firms.

Several patterns emerge across the annual estimates. First, client firms' auditor choices are sensitive to audit fees. The coefficient on $\ln(Audit\ fees_{ij})$ is negative and significant for each year in the sample. We calculate and discuss the elasticities implied by these estimates below.[16]

Second, for each of the Big 4 audit firms, the interactions between the auditor fixed effects and client size are positive and significant each year, implying that larger clients have a stronger preference for the Big 4. Similarly, client firms having a larger share of sales in foreign markets also

[15] We find similar results over the period 2002–2007.

[16] While as noted we focus on the post-2001 period in order to exploit exogenous variation created by the implosion of Arthur Andersen, we found negative and significant coefficients on $\ln(Audit\ fees_{ij})$ in untabulated tests for 2000 and 2001. We also estimated the model using fees predicted without including the Andersen implosion and merger supply-shifters. As theory predicts, the point estimates on predicted fees were on average more positive (that is, smaller in magnitude) than those in Table 8. The size of the differences were modest, however: the 2008 coefficient was essentially unchanged, while the 2009 and 2010 coefficients were -1.75 and -1.78. Thus any price endogeneity due to unobservable demand shifts that existed in the market was relatively minor.

have a preference for using a Big 4 auditor.

Third, having hired an auditor the previous year greatly affects the probability that a client firm rehires the auditor, even after controlling for match-specific observables. The coefficients on the interactions of Big 4 dummies with $1(Not\ client_{ij})$ are negative and significant in every case. Thus the persistence in auditor choice discussed above reflects an unobserved match-specific attribute. On the other hand, the interactions with $\ln(Years\ client_{ij})$ are generally positive but not often significant, implying that while having a current relationship is an important determinant of auditor choice, the duration of the history of this relationship is less important.

Panels B and C of Table 8 present annual mean estimates of client firms' own-price elasticities—the percentage change in the probability of choosing the auditor resulting from a one percent increase in audit fees. In general, as reflected in Panel B, the average estimated elasticities are in the neighborhood of -1.5 to -1.7. An interesting contrast is observed, however, when we look at client firms' elasticities for their auditor in the prior year, as shown in Panel C. These estimates, which incorporate the effect on elasticities of our current-match variables (i.e., the interactions of auditor fixed effects with an indicator for the firm not being a client of the auditor and the number of years that the client firm has been working with its current auditor), reveal that client firms' choices are much less sensitive to changes in the fees of their current auditors. Elasticity estimates for the Big 4 are around -0.05 to -0.1, an order of magnitude smaller than the average elasticities in Panel B. These differences reflect the powerful effect on choices of match-specific utility components within existing client-auditor pairs. As we will see below, the forced destruction of those matches, whether due to the exit of one of the Big 4 auditors or the imposition of mandatory auditor rotation, can destroy a considerable amount of client firms' consumer surplus.

3.3 Fit of the Model

Our demand model fits the data quite well. Table 9 shows the correspondence between the client firms' predicted auditor choices (i.e., the auditor with the largest estimated mean utility for the client, V_{ij}) and their actual choices. Across each of the Big 4 audit firms, the model correctly predicts auditor choice for at least 91% of the clients. Moreover, for clients that chose a non-Big 4 audit firm the model based predictions are correct for over 96% of the clients.

DISCUSS RESULTS FOR PREDICTING CHOICES CONDITIONAL ON SWITCHING.

We also have an interesting opportunity to test the model's predictive abilities by seeing how well it did in predicting which auditor former Andersen clients would choose in 2002, after Andersen's collapse forced them to choose a new auditor. Table 10 lays out the results. Panel A presents three sets of demand estimates for 2002: the first column shows estimates obtained using only clients of Arthur Andersen in 2001; the second column uses all client firms in 2002; the third column uses a sample of all client firms that were not Andersen clients in 2001. We use these parameters to generate predicted probabilities of auditor choice for Andersen clients in 2002. In general, these demand parameters are similar to those presented in Table 8. Importantly, the price coefficient is similar both in sign and magnitude to the baseline estimates. Panel B presents elasticity estimates for Andersen clients based on parameter estimates from the three models. As can be seen, these estimates are similar to those presented in Panel B of Table 8.

We next compare the actual auditor choices of Andersen clients in 2002 to the auditor with the highest predicted choice probability according to the demand estimates in Panel A of Table 10. These results are presented in Table 11. All three models provide better predictions than just chance. With one exception (Arthur Andersen clients in 2001 who hired PricewaterhouseCoopers in 2002, with estimates obtained using only the Andersen clients sample), the auditor that the model predicts as most likely to be hired was in fact the auditor that the client firm actually hired.

Importantly, even parameters estimated using only non-Andersen clients have predictive abilities for former Andersen client firms' choices.

3.4 Alternative Specifications

3.4.1 Nested Logit

An alternative model of audit firm choice is that clients first choose whether to use a non-Big 4 or Big 4 auditor and then, conditional on choosing a Big 4 auditor, choose which of the Big 4 to engage. To explore this possibility, we re-estimated our demand system using a nested logit specification, which incorporates this sequential choice structure explicitly. For these estimates, the substitution parameter between Big 4 and non-Big 4 is approximately 0.85–0.88 and significantly different than the parameters that arise under the conditional logit model.[17] However, the estimated marginal willingness to pay, α, is similar to the baseline estimates presented in Panel A of Table 8 and when we use parameters estimated using nested logit to predict the choices of Andersen clients the predictive accuracy is similar to that of the conditional logit-based predictions presented in Table 11. Further, there is no generally accepted method for generating error terms from a nested logit model (for discussions, see McFadden (1999), Herriges and Kling (1999), and Dagsvik and Karlstrom (2005)), a necessary step for our welfare calculations below. Therefore for the sake of parsimony we use the conditional logit model.

3.4.2 Dollar Fees

In our benchmark specification (1), client firms' choices of auditor are influenced by the logarithm of fees. We base this specification off of the observation that, institutionally, audit fee negotiations typically involve percentage changes in audit fees rather than absolute dollar changes. It also strikes

[17] The nested logit collapses to conditional logit if the substitution parameter equals one.

as intuitive than an additional, say, $100,000 increment to audit fees would foster a much larger response from a small client firm than from a very large one. To examine the sensitivity of the results to the log-linearity assumption, we also estimate a specification where fees enter in levels rather than logs. This specification imposes that a dollar of audit fees is equally important to large and small firms. The non-price preference parameter estimates from this dollar-price specification are similar to those presented in Table 8. The elasticity estimates are, however, about an eighth the magnitude of those based on the benchmark log price specification. This is what one would expect if, in reality, large firms were less sensitive than smaller firms were to a given dollar change in fees, as the model would attempt to explain this relative indifference by fitting a small coefficient to the fee level. The log price specification therefore appears to be better able to handle the heterogeneity in audit fees and client firms' responses to them that are driven by firm size differences.

4 Counterfactuals

Having obtained estimates of client firms' preference parameters, we next use them to address the two aforementioned policy-relevant issues: the effect of increased concentration among audit firms resulting from the exit of one of the Big 4 and the implementation of mandatory audit firm rotation at various tenures.

To estimate these counterfactuals, we use the methodology outlined by McFadden (1999). This involves calculating the expected change in consumer surplus for each audit client firm as the expected dollar transfer required to make that client indifferent between the unrestricted choice set of the status quo and the restricted choice set arising under the counterfactuals. We then sum these estimates of lost surplus across individual clients to find the expected total change in consumer surplus.

For example, suppose that under the status quo client i chooses the auditor j that yields max-

imized utility $\max_j U(Audit\ fees_{ij}, x_{ij,}\epsilon_{ij})$, and under the counterfactual firm i chooses auditor m from a restricted choice set that leads to maximized utility $\max_m U(Audit\ fees_{im}, x_{im,}\epsilon_{im})$. The change in consumer surplus, C_{ijm}, is the dollar transfer (or, equivalently, the reduction in audit fees) that would be required to equate the client's maximum utility under the restricted choice set with what it obtained under the unrestricted choice set:

$$\max_j U(Audit\ fees_{ij}, x_{ij}, \epsilon_{ij}) = \max_m U(Audit\ fees_{im} - C_{ijm}, x_{im}, \epsilon_{im}). \tag{4}$$

The total change in consumer surplus for the counterfactual is the sum of C_{ijm} across client firms.

Mechanically, to estimate C_{ijm}, for each firm i we draw a vector of type 1 extreme value error terms—one for each of the Big 4 auditors and one for the outside good. We then compute the utility client firm i would obtain from each auditor choice using equation (1) by combining the parameter estimates from Panel A of Table 8, the client firm and auditor characteristics observed in the data, and the error term draws. The auditor that delivers the largest utility of the five choices is then client firm i's simulated choice for that error draw. We next restrict the choice set for each client (i.e., depending on the counterfactual being estimated, remove one of the Big 4 auditors or remove the client's prior auditor based on tenure) and calculate the maximum utility that the client would receive under the restricted choice set. Then we solve for the C_{ijm} that equates these two maximized utilities; given that dollar fees enter into utility in log form, C_{ijm} is simply the exponent of the difference in maximized utilities between the unrestricted and restricted choice sets normalized by the estimated marginal willingness to pay. We repeat this procedure 1,000 times for each client firm, each time with new error vector, and then average the lost surplus values of C_{ijm} from each simulation to compute $E[C_{ijm}]$. These values in hand, we aggregate these estimates across client firms to calculate the expected total change in consumer surplus in each counterfactual.

Computing the expected changes in consumer surplus as above using the observed audit fees in the data (or, more precisely, our estimates of audit fees given those observed in existing matches) effectively assumes that there is no supply-side response in the counterfactual scenarios. That is, it estimates the surplus lost by client firms if one of the Big 4 exits or if auditor rotation becomes mandatory while holding the fees charged by the remaining auditors fixed. In this sense, it estimates the pure demand-side effect of the counterfactuals. However, it seems likely that auditors might respond in these counterfactual worlds by changing their fees. (E.g., if one of the Big 4 exits, the resulting reduction in competition is likely to result in the remaining auditors charging higher fees within any given match.) Therefore we estimate two changes in expected surplus for each counterfactual scenario: a pure demand-side effect that holds auditors' price responses fixed, and a second that estimates and takes into account auditors' strategic price responses in the counterfactual scenario.

4.1 Exit of a Big 4 Audit Firm

The first counterfactual involves the exit of a Big 4 audit firm. We estimate the total expected changes in consumer surplus that would be caused by exit of each of the Big 4 auditors (in isolation, of course). We compute separate estimates using the demand parameters from each of the 2008, 2009, and 2010 samples to check the consistency of the results across subsamples.

Table 12, Panel A presents the estimated changes in consumer surplus when audit fees are held constant—that is, without allowing for any strategic price response from the remaining auditors. The estimated total changes in consumer surplus range from an approximately $1.3 billion loss from the exit of Deloitte to up to a $1.8 billion loss for the disappearance of PricewaterhouseCoopers. These losses are substantial; for all of the Big 4, the estimated changes in consumer surplus range from 49% to 63% of each firm's total annual audit fees for our sample. The largest changes relative

to total fees are for KPMG, 53–66%, and the smallest are for PricewaterhouseCoopers, 49–57%.

Panel B presents mean client-level changes in consumer surplus under the counterfactuals along with their correlations with client characteristics. As expected, the expected changes in consumer surplus are significantly larger for clients of an exiting audit firm than for non-clients. For clients the mean expected decrease in consumer surplus ranges from \$1.3 to \$2.1 million, while for non-clients the mean expected change in consumer surplus ranges from \$14,000 to \$30,000. With respect to correlations with firm characteristics, for clients of an exiting audit firm the expected changes in consumer surplus correlate with client size (correlation coefficients between 0.24 and 0.69), audit fees (0.61–0.85), and tenure with the audit firm (0.17–0.31). For non-clients, the expected changes in consumer surplus are basically uncorrelated with client characteristics; that is, they are primarily driven by the error term, ϵ_{ij}.

These estimates are subject to several caveats. One factor that could mitigate the size of the estimated losses is the possibility that audit teams from the exiting auditor move en masse with their clients to the remaining auditors. Presumably, some of the match-specific utility would move with the teams even if the audit firm disappears as a legal entity.[18] On the other hand, there are multiple reasons why these estimates might understate the true loss of client firms' consumer surplus. For one, the estimates do not include lost surplus tied to non-audit services (such as consulting and tax services) audit firms might also provide to their clients. Additionally, the estimates exclude any surplus lost by an exiting auditor's domestic private or international clients.

Our estimates are calculated based on the disappearance of a Big 4 audit firm from clients' choice sets for only one year. If the persistence of auditor-client matches is solely due to switching costs, then our single-year estimates should capture most of the present value of the change in consumer surplus, as once the switch is forced by the counterfactual Big 4 exit, no further losses of

[18]Consistent with this possibility, Blouin, Grein, and Rountree (2007) find that some Arthur Andersen clients followed their Andersen audit teams to the remaining Big 4 auditors.

this type would be induced. However, given any persistence in auditor-client matches due instead to unobserved heterogeneity and match-specific capital, the estimates reflect only the first year's loss of the surplus created by these match-specific components; the permanent demise of a Big 4 audit firm may impose similar losses for years into the future.

BASED ON 2001, THE TOTAL CHANGE IN CONSUMER SURPLUS FOR THE DISAPPEARANCE OF ARTHUR ANDERSEN IS $276 MILLION AND THE AVERAGE CHANGE CONDITIONAL ON BEING A CLIENT OF ARTHUR ANDERSEN IS $255 THOUSAND. PART OF THESE LOWER ESTIMATES IS DUE TO THE GROWTH IN FEES. ANDERSEN HAD TOTAL FEES OF $476 MILLION TOTAL FEES IN 2001 WERE $2.8 BILLION COMPARED TO $11 BILLION IN TOTAL FEES IN 2010. MOREOVER, POST SARBANES OXLEY IT COULD BE THE CASE THAT THE IMPORTANCE OF THE AUDITOR-CLIENT MATCH INCREASED.

4.2 Introduction of Mandatory Audit Firm Rotation

The second counterfactual scenario involves the implementation of mandatory audit firm rotation. To estimate the expected change in consumer surplus in this case, we calculate the dollar transfer required to make clients indifferent to the removal of their current auditor from their choice set once the client-auditor match has lasted beyond the statutory maximum allowed. We compute separate estimates for different possible statutory maximum tenures, running from four through ten years. We also again compute estimates using each of the sets of estimated demand parameters from 2008, 2009, and 2010.

Table 13, Panel A presents these expected total changes in consumer surplus. They are significantly larger than expected changes that arise from the disappearance of one of the Big 4, ranging from $2.4–2.8 billion if rotation is mandatory after ten years to $4.3–5.1 billion if rotation is mandatory after four years. (The estimated lost surplus is larger for shorter horizons because a

greater number of matches are affected.) The observed persistence of auditor-client matches results in mandatory audit firm rotation producing larger changes in consumer surplus because the former affects a larger proportion of clients.

Panel B contains mean client-level changes in consumer surplus under the mandatory audit firm rotation counterfactuals and their correlations with client characteristics. Similarly to the aggregate estimates presented in Panel A, the client-level means decrease as the horizon increases, as more client firms are left unaffected by the mandate. If rotation is mandatory after four years, the mean expected change in consumer surplus ranges from $800,000 to $1 million depending upon the year the mandate would have been imposed. If rotation is mandatory after ten years, the mean expected change in consumer surplus ranges from about $450,000 to $550,000. The expected changes in surplus also correlate with client characteristics, with the highest correlations for audit fees (0.50–0.75), followed by tenure with the audit firm (0.34–0.57), and then client size (0.14–0.47).

Note that even though no auditors exit the market in this counterfactual scenario, mandatory auditor rotation implies an increase in market concentration just as the Big 4 exit scenario does. This is because the auditor that is forced out due to rotation is necessarily removed from its formerly matched client firm's choice set. If the remaining eligible auditors recognize they now face less competition when negotiating over audit fees with the client firm, this may lead to higher fees. The lost surplus estimates in Table 13 do not incorporate any such pricing response, focusing only on the demand-side consequences of mandatory rotation. Below, however, as we also do with the Big 4 exit counterfactual, we estimate the expected size of the supply-side audit fee (i.e., pricing) responses of the remaining competing auditors and compute the consequences of this response for client firms' consumer surplus.

An alternative interpretation of these estimates is that they represent what managers (as opposed to shareholders) are willing to pay in order to avoid switching auditors and the estimates

therefore represent agency costs. Under this interpretation, long tenures lead to a loss of auditor independence that managers exploit for their private benefit. Prior literature, however, does not provide support for the idea that auditor independence decreases over longer tenures. In fact, several studies find that audit failures are more likely to occur during the early years of tenure (e.g., Carcello and Nagy (2004) and Geiger and Raghunandan (2002), and others find that audit quality appears to increase over auditor tenure (e.g., Ghosh and Moon (2005), Myers, Myers, and Omer (2003), Chen, Lin, and Lin (2008)). We therefore interpret these estimates as representing a change in consumer surplus. Nevertheless, as we noted above, there may also be social benefits from imposing mandatory rotation. Our estimates serve to quantify the costs such mandates impose on client firms—costs that any social benefits would have to be weighed against in evaluating mandatory rotation policies.

4.3 Supply Side Price Response

As we have discussed, the counterfactual changes in surplus computed above hold audit fees fixed, isolating the surplus changes due to demand-side effects only. In this section, we estimate what the supply-side responses might be under the counterfactual scenarios and quantify their additional impact on client firms' expected surplus.

To estimate the supply response, we first note that both counterfactual scenarios involve reductions in competition. In standard oligopoly models, reductions in competition—resulting from the actual exit of one of the market competitors in one counterfactual and the de facto exit of a client firm's former auditor (at least for that client firm) in the other—lead to higher prices. Our estimate of the counterfactual audit fee changes due to the supply response works off this logic. Specifically, we estimate in our sample how changes in auditor competition for clients within an industry relates to average audit fee changes in that industry.

A typical concern when estimating such relationships is that market structure and prices are both endogenous outcomes, making causal inference difficult. However, we are fortunate in that we have (and indeed have already used for demand estimation purposes above) an exogenous change in competition at the industry level, the collapse of Arthur Andersen. Thus we can identify the causal relationship between competition and fees by estimating the semi-elasticity of audit fees in 2002 with respect to the percent share of industry total assets audited by Arthur Andersen in 2001 based on three-digit SIC. (This regression is presented in Table 14.) We estimate this effect for the period prior to the implementation of mandatory internal control audits under the Sarbanes-Oxley Act. Hence, variation in fees likely represents changes in industry concentration as opposed to changes in demand due to increased regulatory requirements. For a discussion, see Feldman (2006) and Kohlbeck, Mayhew, Murphy, and Wilkins (2008). We estimate this semi-elasticity using ordinary least squares and controlling for the standard audit fee determinants. This semi-elasticity is that audit fees rise 0.15% for each one percentage point of total industry assets that had been audited by Arthur Andersen before its collapse. We view this estimate as a lower bound because it is based solely on inter-industry variation and therefore excludes overall increases in audit fees and increases based on groupings other than our industry classifications.

Panel A of Table 15 presents estimates of the annual increase in total audit fees that would occur if a Big 4 audit firm were to disappear. These estimates range from $335 million for the disappearance of KPMG in 2010 to $533 million for the disappearance of PricewaterhouseCoopers in 2008. Panel B of Table 15 presents estimates of annual increases in total audit fees that would occur under each of the mandatory audit firm rotation horizons. These estimated annual increases range from $772 million for the implementation of ten year rotation in 2010 to $1.34 billion for four year rotation in 2008. The estimated annual increases in fees are over twice as large under this scenario as in the Big 4 exit case, which is to be expected given that mandatory audit firm rotation

would affect a larger number of client firms.

When combined with the estimated demand-side losses in Table 12, and Table 13, the supply response implies estimated initial surplus losses among client firms totaling in the neighborhood of \$1.6–2.3 billion in the case of exit of one of the Big 4 auditors and around \$3.1–3.5 billion (ten-year maximum tenure) or \$5.6–6.4 billion (four-year maximum tenure) in the case of mandatory auditor rotation.

New entry into the market would determine the extent that such annual increases in total audit fees persist into the future. Absent new entry, these increases in annual audit fees could persist indefinitely. The limited entry response subsequent to the collapse of Arthur Andersen, not to mention the revealed reluctance among policymakers to force any further consolidation through legal action, suggests that such increases would likely be quite persistent.

5 Conclusion

Using estimates of publicly listed firms' demand for audit services, we evaluate the consequences for client firms of two important policy-related scenarios: further concentration of the audit industry due to exit of one of the Big 4 audit firms, and the imposition of mandatory auditor rotation.

The estimated parameters of our model, which fit the data quite well, imply that both scenarios would impose substantial costs. The direct impacts on client firms' choice sets alone imply, surplus losses of about \$1.5 billion for exit of one of the Big 4 and \$2.5–5.0 billion for mandatory auditor rotation (shorter mandated maximum tenures create larger losses of surplus). Factoring in the expected supply responses of the remaining auditors—increases in fees due to decreased competition—raises these figure by another 25 percent. Moreover, there are several reasons why these estimated losses are likely to be conservative, including that these figures are for initial one-year surplus losses, while in reality both the loss of choice and increase in fees from less competition

are likely to be persistent.

Of course, these estimates are not comprehensive measures of all possible market consequences of increased concentration or mandatory rotation. Auditor exit and mandatory auditor rotation may yield social benefits as well. Threatened exit due to malfeasance or negligence may discipline auditor moral hazard, and mandatory rotation may reduce problems with rent seeking if auditors and clients become too close. Estimating these effects would certainly be interesting but is beyond the scope of this study. What we have sought to do here is measure as accurately as possible the costs of such changes to a very important set of market participants, the client firms—the consumers in this market. And these costs are precisely what any optimal policy regarding auditor concentration and mandatory rotation would need to balance possible benefits against.

While we have used our framework to address two of the more salient policy questions in the audit industry, we believe our empirical framework can be applied to other sets of economic questions about the industry, and purchased business services more broadly. Furthermore, we see potential gains from analyzing the audit industry in a more explicit economic framework that separates demand from supply effects to better understand the sources and consequences of shifts in the industry's market conditions.

REFERENCES

Ball, R. (2001). Infrastructure Requirements for an Economicallly Efficient System of Public Financial Reporting and Disclsoure. *Brookings-Wharton Papers on Financial Services 1*, 127–169.

Black, B. (2000–2001). The Legal and Institutional Preconditions for Strong Securities Markets. *UCLA Law Review 48*, 781–856.

Blouin, J., B. Grein, and B. Rountree (2007). An analysis of forced auditor change: The case of former Arthur Andersen clients. *The Accounting Review 82*(3), 621–650.

Cahan, S., W. Zhang, and D. Veenman (2011). Did the Waste Management Audit Failures Signal Lower Firm-Wide Audit Quality at Arthur Andersen? *Contemporary Accounting Research 28*(3), 859–891.

Carcello, J. and A. Nagy (2004). Audit Firm Tenure and Fraudualent Financial Reporting. *Auditing: A Journal of Practice and Theory 23*(2), 55–69.

Carson, E. (2009). Industry Specialization by Global Audit Firm Networks. *The Accounting Review 84*(2), 355–382.

Casterella, J., J. Francis, B. Lewis, and P. Walker (2004). Auditor Industry Specialization, Client Bargaining Power, and Audit Pricing. *Auditing: A Journal of Practice and Theory 23*(1), 123–140.

Chen, C., C. Lin, and Y. Lin (2008). Audit Partner Tenure, Audit Firm Tenure, and Discretionary Accruals: Does Long Auditor Tenure Impair Earnings Quality? *Contemporary Accounting Research 25*(2), 415–445.

Cohn, M. (2013, June 20). House Committee Passes Bill Preventing PCAOB from Imposing Audit Firm Rotation. *Accounting Today 1*.

Craswell, A., J. Francis, and S. Taylor (1995). Auditor brand name reputations and industry specializations. *Journal of Accounting and Economics 20*, 297–322.

Dagsvik, J. and A. Karlstrom (2005). Compensating variation and hicksian choice probabilities in random utility models that are nonlinear in income. *Review of Economic Studies 72*(1), 57–76.

Doogar, R. and R. Easley (1998). Concentration without differentiation: A new look at the determinants of audit market concentration. *Journal of Accounting and Economics 25*, 235–253.

Erdem, T., M. Keane, and B. Sun (1999). Missing price and coupon availability data in scanner panels: Correcting for self-selection bias in choice model parameters. *Journal of Econometrics 89*, 177–196.

Ettredge, M., S. Kwon, and C. Lim (2009). Client, Industry, and Country Factors Affecting Choice of Big N Industry Expert Auditors. *Journal of Accounting, Auditing, and Finance 24*, 433–476.

Feldman, E. (2006). A Basic Quantification of the Competitive Implications of the Demise of Arthur Andersen. *Review of Industrial Organization 29*, 193–212.

Geiger, M. and K. Raghunandan (2002). Auditor Tenure and Audit Report Failures. *Auditing: A Journal of Practice and Theory 21*(1), 67–78.

Ghosh, A. and D. Moon (2005). Auditor tenure and perceptions of audit quality. *The Accounting Review 80*(2), 585–612.

Gramacy, R. and E. Pantaleo (2010). Shrinkage Regression for Multivariate Inference with Missing Data, and an Application to Portfolio Balancing. *Bayesian Analysis 5*(2), 237–262.

Hastie, T., R. Tibshirani, and J. Friedman (2009). *The Elements of Statistical Learning* (2nd

ed.). New York, NY: Springer.

Hay, R., W. Knechel, and N. Wong (2006). Audit Fees: A Meta-analysis of the Effect of Supply and Demand Attributes. *Contemporary Accounting Research 23*(1), 141–191.

Herriges, J. and C. Kling (1999). Nonlinear Income Effects in Random Utility Models. *Review of Economics and Statistics 81*(1), 62–72.

Hogan, C. and D. Jeter (1999). Industry Specialization by Auditors. *Auditing: A Journal of Practice and Theory 18*(1), 1–17.

Johnson, C. (2010, January 4). Charge Against KPMG Dropped. *Washington Post*.

Kohlbeck, M., B. Mayhew, P. Murphy, and M. Wilkins (2008). Competition for andersen's clients. *Contemporary Accounting Research 25*(4), 1099–1136.

Lennox, C., J. Francis, and Z. Wang (2012). Selection Models in Accounting Research. *The Accounting Review 87*(2), 589–616.

McFadden, D. (1999). Computing willingess to pay in random utility models. *Trade, Theory, and Econometrics: Essays in honour of John S. Chipman 15*, 253–274.

Myers, J., L. Myers, and T. Omer (2003). Exploring the Term of the Auditor-Client Relationship and the Quality of Earnings: A Case for Mandatory Auditor Rotation. *The Accounting Review 78*(3), 799–799.

Petrin, A. (2002). Quantifying the benefits of new products: The case of the minivan. *Journal of Political Economy 119*(4), 705–729.

Public Accounting Report (2011, January 31). E&Y, Deloitte Face New Challenges in Lehman and Bear Stearns Cases.

Sirois, L.-P. and D. Simunic (2013). Auditor Size and Audit Quality Revisited: The Importance of Audit Technology. Unpublished working paper, University of British Columbia.

Train, K. (2009). *Discrete Choice Methods with Simulation*. New York, NY: Cambridge University Press.

Tysiac, K. (2012). PCAOB panelists say mandatory firm rotation could be harmful, helpful. *Journal of Accountancy 213*(4).

Valukas, A. (2010). In re Lehman Bros. Holdings. Technical Report no. 08-13555, ECF No. 7530, Jenner & Block LLP, Bankr. SDNY.

Velte, P. and M. Stiglbauer (2012). Audit Market Concentration and Its Influence on Audit Quality. *International Business Research 5*(11), 146–161.

Watts, R. and J. Zimmerman (1983). Agency Problems, Auditing, and the Theory of the Firm: Some Evidence. *Journal of Law and Economics 26*(3), 613–633.

Willenborg, M. (1999). Empirical analysis of the economic demand for auditing in the initial public offerings market. *Journal of Accounting Research 37*(1), 225–238.

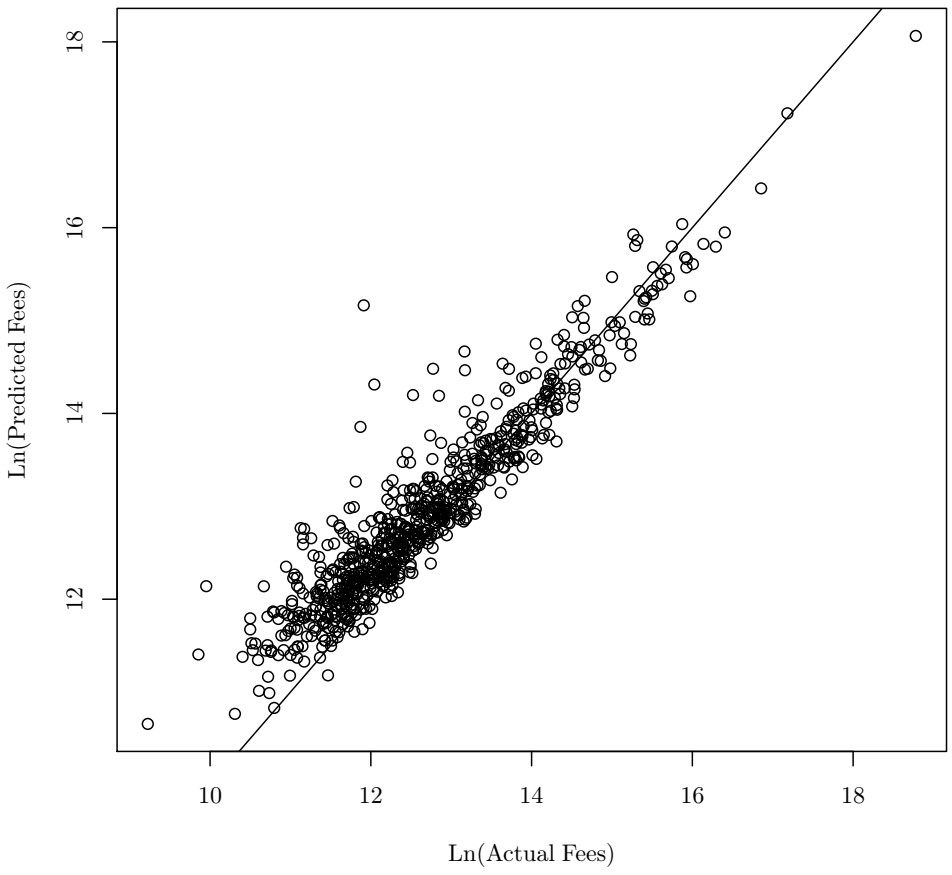

Figure 1: **Actual versus predicted fees.** This figure plots predicted versus actual log audit fees. Predicted fees are generated on an auditor-year basis using random forest with the following predictor variables: total assets, the number of industrial segments the firm operates in, foreign sales, debt, return on assets, inventory & receivables, indicators to capture whether and for how long the firm was a client of the auditor (all of the preceding are characteristics of the client firm), and indicators for the Fama-French ten-industry classification. In addition, we include two supply shifters: Arthur Andersen's share of the client's industry (three-digit SIC) in 2001 and the ratio of total to merged assets in the clients industry (three-digit SIC) in the prior year.

Table 1: Market shares

This table presents annual market shares of SEC registrant audits for the Big 4 and non-Big 4 auditors as well as the mean Herfindahl Index of those shares within three-digit SIC industries. Panel A calculates market shares and Herfindahl Indices based on audit fees and Panel B calculates market shares and Herfindahl Indices based on number of clients. Audit fees and clients are taken from the Audit Analytics database.

Panel A: Market shares based on audit fees

	E&Y	Deloitte	KPMG	PwC	non-Big 4	HHI SIC3
2002	22.50%	18.88%	23.92%	31.55%	3.15%	4,957
2003	23.15%	19.78%	21.71%	32.11%	3.25%	4,955
2004	22.40%	20.71%	21.41%	32.17%	3.31%	5,157
2005	23.64%	21.44%	20.38%	29.93%	4.62%	5,111
2006	24.22%	20.96%	20.19%	29.41%	5.22%	5,133
2007	25.24%	22.17%	19.52%	27.04%	6.04%	4,979
2008	24.21%	22.32%	19.44%	28.16%	5.85%	4,968
2009	25.06%	21.74%	18.71%	28.89%	5.59%	5,070
2010	25.21%	21.35%	18.93%	29.23%	5.28%	5,050

Panel B: Market shares based on number of clients

	E&Y	Deloitte	KPMG	PwC	non-Big 4	HHI SIC3
2002	23.86%	16.71%	19.93%	22.15%	17.35%	3,832
2003	23.16%	16.39%	19.16%	21.65%	19.64%	3,785
2004	21.45%	15.97%	18.32%	20.42%	23.84%	4,034
2005	21.03%	15.59%	16.49%	18.04%	28.86%	4,096
2006	20.85%	14.86%	15.61%	16.64%	32.04%	4,195
2007	20.83%	14.53%	14.51%	15.75%	34.38%	4,114
2008	20.78%	14.44%	14.37%	15.77%	34.63%	4,191
2009	20.82%	14.65%	14.59%	15.58%	34.35%	4,260
2010	20.95%	14.94%	15.16%	16.03%	32.93%	4,262

Table 2: Distribution of audit fees

This table presents annual mean and median audit fees for our sample of SEC registrants. Panel A reports the means and medians for all sample firms, while Panel B reports the annual mean and median fees for a constant subsample of firms that appear in the sample every year. Audit fees are taken from the Audit Analytics database.

Panel A: Full sample

Year	Firms	Mean	Std. Dev.	Q1	Median	Q3
2002	5,775	890,263	3,055,706	115,000	237,000	597,408
2003	5,907	1,076,897	3,097,653	134,011	296,900	757,680
2004	5,856	1,753,816	5,120,930	185,000	545,388	1,420,690
2005	5,877	1,893,852	4,852,954	225,000	640,000	1,608,780
2006	5,799	2,149,814	5,420,347	245,000	712,206	1,783,760
2007	5,727	2,134,638	5,332,254	258,450	740,659	1,800,000
2008	5,414	2,225,593	5,756,625	280,000	752,250	1,804,000
2009	5,071	2,148,250	5,870,241	276,600	735,000	1,674,240
2010	5,008	2,150,459	5,788,977	281,600	735,000	1,713,000

Panel B: Fixed sample

Year	Firms	Mean	Std. Dev.	Q1	Median	Q3
2002	2,567	1,118,127	2,900,624	125,000	283,800	758,230
2003	2,567	1,406,201	3,806,017	159,520	363,000	946,000
2004	2,567	2,299,959	5,445,346	251,000	721,050	1,866,830
2005	2,567	2,532,946	5,984,146	325,398	837,066	2,174,570
2006	2,567	2,816,801	6,402,031	362,750	951,600	2,479,810
2007	2,567	2,871,367	6,224,569	403,500	996,000	2,542,330
2008	2,567	2,960,644	6,813,149	409,000	1,000,000	2,563,860
2009	2,567	2,869,934	7,150,467	400,000	964,960	2,340,940
2010	2,567	2,846,895	7,068,154	390,095	942,000	2,323,790

Table 3: Auditor switches

This table presents the audit firm transition matrix of clients between audit firms over the period 2008–2010.

		Year t+1					
		E&Y	Deloitte	KPMG	PwC	non-Big 4	Total
Year t	E&Y	2,986	18	24	20	36	3,084
		96.8%	*0.6%*	*0.8%*	*0.6%*	*1.2%*	
	Deloitte	25	2,076	12	22	42	2,177
		1.1%	*95.4%*	*0.6%*	*1.0%*	*1.9%*	
	KPMG	25	9	2,086	16	34	2,170
		1.2%	*0.4%*	*96.1%*	*0.7%*	*1.6%*	
	PwC	17	21	13	2,277	23	2,351
		0.7%	*0.9%*	*0.6%*	*96.9%*	*1.0%*	
	non-Big 4	26	17	35	23	4,725	4,826
		0.5%	*0.4%*	*0.7%*	*0.5%*	*97.9%*	
	Total	3,079	2,141	2,170	2,358	4,860	14,608

Table 4: Comparison of RMSEs for the prediction methods

This table presents the results of the comparison of methods to predict audit fees. To evaluate the best method to predict audit fees, we compared six regression methods that are commonly used in forecasting applications: ordinary least squares `ols`, lasso regression `lasso`, ridge regression `ridge`, partial least squares `pls`, recursive partitioning `rpart`, and randomForest `rfor`. For each auditor-year pair, we used the six regression methods to generate RMSEs using 100 repetitions of five-fold cross-validations. As predictors of audit fees, we include the natural logarithm of total assets, the natural logarithm of industrial segments, the percentage of foreign sales, the ratio of debt to total assets, the ratio of inventory and receivables to total assets, the ratios of payables to total assets, the number of years as client of the audit firm, indicator variables for the Fama-French ten industry classification, the ratio of three-digit SIC industry assets audited by Arthur Andersen to total industry assets in 2001, and the ratio of three-digit SIC industry assets merged to total industry assets in the prior year. In Panel A, each cell represents the number of times the regression method has the minimum RMSE for the audit-year pair. Panel B presents the average rank of each regression method's RMSE for each auditor-year pair and Panel C presents the median rank.

Panel A: Number of times each method has the lowest RMSE

Auditor	Year	ols	lasso	ridge	pls	rpart	rfor
E&Y	2002	6950	14622	7013	11881	40246	57088
	2003	8606	15464	6828	14194	40949	50759
	2004	9806	19187	5862	13130	35763	41852
	2005	8810	16145	5710	12823	35985	44127
	2006	7768	20323	6096	10464	34195	42054
	2007	7548	19535	6027	11470	32918	41802
	2008	7061	17859	4785	8889	31778	42128
	2009	5355	16343	4652	8371	29905	40974
	2010	5715	16658	4920	8319	29394	39894
	2011	6062	14924	4667	7871	30354	40022
Deloitte	2002	6540	13137	4562	7182	27032	38047
	2003	6001	11442	5411	8354	26141	39451
	2004	6234	10795	5715	10060	23585	37111
	2005	6296	11593	5575	9031	24921	34184
	2006	6438	11617	5103	8552	25034	29456
	2007	7495	13301	4966	8443	23561	25434
	2008	6126	11426	4232	8204	22710	25502
	2009	6347	9854	4835	6559	22915	23790
	2010	5390	9619	4305	6505	24130	24851
	2011	5217	9780	3685	6619	22363	23936
KPMG	2002	6145	8602	5799	9161	26302	59091
	2003	5238	9864	4962	8972	31929	52235
	2004	6102	12859	5631	10092	28531	44085
	2005	7082	10103	6753	9439	24915	38608
	2006	5700	12123	5178	9734	21978	35787
	2007	5342	10891	5058	7701	20713	33395
	2008	5443	8937	4345	6391	20179	32505
	2009	4907	7769	4664	6453	19925	30282
	2010	4968	8648	3845	6227	22157	30055
	2011	5365	7998	3906	6642	20839	32250
PWC	2002	6910	17357	5722	9487	34358	54066
	2003	8931	15761	6316	10174	35686	51032
	2004	9042	15350	7208	12179	32957	42864
	2005	9177	15234	5938	11640	28254	35757
	2006	6880	13206	5472	8348	28374	34220
	2007	5667	12119	4900	8526	26397	32591
	2008	5368	10822	3970	7505	24319	33416
	2009	5068	8575	4128	7920	23739	29570
	2010	4928	8841	4706	8081	25030	28714
	2011	6239	10297	4859	6209	24101	29295
All others	2002	6720	10852	6554	10235	23767	42072
	2003	7078	12717	6210	11469	34562	43964
	2004	12029	18111	9479	17068	32413	50500
	2005	17128	26460	10205	22522	40391	52894
	2006	16949	30819	12408	24171	44751	56702
	2007	17611	29673	12599	28038	49520	59459
	2008	19579	31666	11541	25897	42665	56152
	2009	19058	28916	11138	22339	42637	50112
	2010	16450	28293	11546	21006	41189	46416

Panel B: Average rank of each method

Auditor	Year	ols	lasso	ridge	pls	rpart	rfor
E&Y	2002	4.34	3.83	3.90	4.23	2.52	2.18
	2003	4.25	3.89	3.85	4.08	2.60	2.33
	2004	4.11	3.78	3.79	3.94	2.83	2.54
	2005	4.09	4.04	3.78	3.99	2.73	2.38
	2006	4.17	3.63	3.80	4.12	2.85	2.43
	2007	4.19	3.61	3.81	4.15	2.82	2.43
	2008	4.22	3.61	3.88	4.23	2.73	2.33
	2009	4.34	3.56	3.95	4.24	2.67	2.25
	2010	4.26	3.60	3.87	4.26	2.73	2.28
	2011	4.24	3.68	3.89	4.24	2.68	2.28
Deloitte	2002	4.23	3.67	3.97	4.25	2.63	2.25
	2003	4.15	4.14	3.81	4.05	2.61	2.24
	2004	4.26	3.91	3.84	4.02	2.71	2.26
	2005	4.16	3.94	3.80	4.02	2.76	2.33
	2006	4.10	3.91	3.73	4.04	2.76	2.46
	2007	4.01	3.73	3.71	4.06	2.89	2.59
	2008	4.11	3.72	3.78	4.08	2.82	2.49
	2009	4.10	3.81	3.76	4.13	2.71	2.49
	2010	4.19	3.80	3.81	4.09	2.65	2.47
	2011	4.15	3.77	3.81	4.12	2.73	2.41
KPMG	2002	4.42	3.94	3.88	4.19	2.60	1.97
	2003	4.43	3.92	3.93	4.23	2.46	2.03
	2004	4.29	3.80	3.86	4.17	2.67	2.20
	2005	4.20	3.97	3.75	4.10	2.73	2.24
	2006	4.26	3.74	3.86	4.07	2.85	2.22
	2007	4.27	3.83	3.80	4.08	2.79	2.23
	2008	4.28	3.83	3.81	4.15	2.71	2.22
	2009	4.22	3.91	3.75	4.22	2.66	2.24
	2010	4.31	3.89	3.87	4.14	2.56	2.23
	2011	4.23	3.95	3.83	4.18	2.62	2.20
PWC	2002	4.34	3.63	3.97	4.25	2.65	2.15
	2003	4.31	3.77	3.92	4.16	2.61	2.24
	2004	4.08	4.07	3.71	3.99	2.71	2.44
	2005	4.05	3.92	3.72	3.98	2.81	2.52
	2006	4.15	3.73	3.81	4.14	2.76	2.42
	2007	4.24	3.74	3.82	4.12	2.72	2.35
	2008	4.22	3.78	3.87	4.16	2.68	2.28
	2009	4.24	4.11	3.84	4.02	2.54	2.25
	2010	4.22	4.08	3.79	4.03	2.54	2.35
	2011	4.16	3.83	3.77	4.15	2.68	2.40
All others	2002	4.34	3.75	3.70	4.22	2.72	2.28
	2003	4.45	3.60	3.91	4.23	2.55	2.26
	2004	3.97	3.93	3.60	4.02	3.01	2.47
	2005	3.79	3.85	3.57	3.87	3.18	2.73
	2006	3.76	3.72	3.54	3.69	3.43	2.86
	2007	3.85	4.20	3.55	3.65	3.12	2.63
	2008	3.80	4.07	3.55	3.69	3.24	2.64
	2009	3.70	4.13	3.45	3.88	3.18	2.67
	2010	3.76	4.16	3.50	3.88	3.08	2.63

Panel C: Median rank of each method

Auditor	Year	ols	lasso	ridge	pls	rpart	rfor
E&Y	2002	5	3	4	4	2	2
	2003	5	4	4	4	2	2
	2004	4	4	4	4	2	2
	2005	4	4	4	4	2	2
	2006	5	3	4	4	2	2
	2007	5	3	4	4	2	2
	2008	5	3	4	4	2	2
	2009	5	3	4	4	2	2
	2010	5	3	4	4	2	2
	2011	5	3	4	4	2	2
Deloitte	2002	5	3	4	4	2	2
	2003	4	4	4	4	2	2
	2004	5	4	4	4	2	2
	2005	4	4	4	4	2	2
	2006	4	4	4	4	2	2
	2007	4	4	4	4	2	2
	2008	4	4	4	4	2	2
	2009	4	4	4	4	2	2
	2010	4	4	4	4	2	2
	2011	4	4	4	4	2	2
KPMG	2002	5	4	4	4	2	1
	2003	5	4	4	4	2	2
	2004	5	4	4	4	2	2
	2005	5	4	4	4	2	2
	2006	5	4	4	4	2	2
	2007	5	4	4	4	2	2
	2008	5	4	4	4	2	2
	2009	5	4	4	4	2	2
	2010	5	4	4	4	2	2
	2011	5	4	4	4	2	2
PWC	2002	5	3	4	4	2	2
	2003	5	3	4	4	2	2
	2004	4	4	4	4	2	2
	2005	4	4	4	4	2	2
	2006	4	4	4	4	2	2
	2007	5	4	4	4	2	2
	2008	4	3	4	4	2	2
	2009	5	4	4	4	2	2
	2010	5	4	4	4	2	2
	2011	5	4	4	4	2	2
All others	2002	5	3	4	4	2	2
	2003	5	3	4	4	2	2
	2004	4	4	4	4	2	2
	2005	4	4	4	4	3	2
	2006	4	4	4	4	3	2
	2007	4	5	4	4	3	2
	2008	4	5	4	4	3	2
	2009	4	5	4	4	3	2
	2010	4	5	4	4	3	2

Table 5: Validation of Arthur Andersen supply shifter

This table presents regressions that validate the use of the disappearance of Arthur Andersen as a supply shifter. The dependent variable in all of the regressions is the log growth in audit fees from 2001 to the relevant year. The supply shifter is Arthur Andersen's share of the industry in 2001, with industries based on three-digit SIC codes. We also include indicator variables for the client's auditor in 2001 along with the log growth in the client's total asset from 2001 to the relevant year. Standard errors are in parentheses and clustered at the three-digit SIC level. Panel A presents results for all firms and Panel B presents results for firms that were not clients of Arthur Andersen in 2001.

Panel A: All firms

	2008	2009	2010
Andersen's Industry Share in 2001	0.269*	0.255**	0.228**
	(0.138)	(0.114)	(0.102)
Andersen Client in 2001	0.346***	0.283***	0.260***
	(0.034)	(0.035)	(0.042)
E&Y Client in 2001	0.334***	0.257***	0.234***
	(0.034)	(0.034)	(0.036)
Deloitte Client in 2001	0.288***	0.208***	0.197***
	(0.037)	(0.036)	(0.041)
KPMG Client in 2001	0.293***	0.196***	0.218***
	(0.043)	(0.047)	(0.054)
PwC Client in 2001	0.346***	0.271***	0.255***
	(0.035)	(0.033)	(0.037)
Change in Ln(Assets)	0.386***	0.396***	0.409***
	(0.026)	(0.021)	(0.018)
Constant	0.776***	0.792***	0.767***
	(0.046)	(0.035)	(0.026)
Observations	2,806	2,612	2,399
Adjusted R^2	0.249	0.273	0.298

*** p<0.01, ** p<0.05, * p<0.1

Panel B: Not an Arthur Andersen client in 2001

	2008	2009	2010
Andersen's Industry Share in 2001	0.324**	0.309***	0.275***
	(0.147)	(0.118)	(0.103)
Deloitte Client in 2001	0.287***	0.207***	0.197***
	(0.037)	(0.036)	(0.041)
KPMG Client in 2001	0.293***	0.196***	0.218***
	(0.044)	(0.047)	(0.054)
PwC Client in 2001	0.345***	0.271***	0.254***
	(0.034)	(0.033)	(0.037)
Change in Ln(Assets)	0.389***	0.403***	0.417***
	(0.027)	(0.023)	(0.020)
Constant	0.767***	0.781***	0.756***
	(0.045)	(0.033)	(0.027)
Observations	2,332	2,169	1,987
Adjusted R^2	0.250	0.279	0.303

*** p<0.01, ** p<0.05, * p<0.1

Table 6: Future restatements and Arthur Andersen's industry shares

This table present results from a logistic regression in which the dependent variable is coded as one if the client restates its accounting performance anytime from 2002 through 2011. We identify restatements from the Audit Analytics database. We include Arthur Andersen's share of the industry is based on three-digit SIC as of 2001. All other independent variables are measured as of 2002. Ln(Assets) is the natural logarithm of the client's total assets. Receivables to Assets is the ratio the client's receivables to total assets. Inventory to Assets is the ratio of the client's inventory to total assets. Return on Assets is the client's return on assets measured as net income to total assets. Loss is an indicator for whether the client generated an accounting loss. Percent Foreign Sales is the ratio of the client's foreign sales to total sales. Accelerated Filer is an indicator variable for whether the client is designated as accelerated filer by the Securities and Exchange Commission. Going Concern Opinion is an indicator for whether the client received a going concern opinion from its auditor. Standard errors clustered at the industry level are in parentheses.

	(1)	(2)
Andersen's Industry Share in 2001	0.0034	0.0022
	(0.005)	(0.005)
Ln(Assets)		0.0185
		(0.041)
Receivables to Assets		−0.0328
		(0.406)
Inventory to Assets		0.3094
		(0.658)
Return on Assets		1.2275**
		(0.607)
Loss		0.2608
		(0.248)
Percent Foreign Sales		0.3973**
		(0.202)
Ln(Segments)		0.1033
		(0.093)
Accelerated Filer		0.1909
		(0.249)
Going Concern Opinion		−0.2040
		(0.506)
Constant	−3.7043***	−4.2775***
	(0.127)	(0.328))
Observations	6,184	6,174
p Value	0.499	0.001
Psuedo R-squared	0.001	0.012

*** p<0.01, ** p<0.05, * p<0.1

Table 7: Client mergers as a supply shifter

This table presents regressions that validate the use of client mergers as a supply shifter. The dependent variable in all of the regressions is the natural logarithm of audit fees. The supply shifter is the ratio of merged to total assets in an industry based on the three-digit SIC codes for the prior year. Columns (1) and (2) present regressions in which the shifter is for the prior year. Columns (3) and (4) validate the shifter by setting it forward three years. Ln(Assets) is the natural logarithm of the client's total assets. Receivables to Assets is the ratio the client's receivables to total assets. Inventory to Assets is the ratio of the client's inventory to total assets. Return on Assets is the client's return on assets measured as net income to total assets. Loss is an indicator for whether the client generated an accounting loss. Percent Foreign Sales is the ratio of the client's foreign sales to total sales. Accelerated Filer is an indicator variable for whether the client is designated as accelerated filer by the Securities and Exchange Commission. Going Concern Opinion is an indicator for whether the client received a going concern opinion from its auditor. Standard errors are in parentheses and clustered at the firm-level.

	(1)	(2)	(3)	(4)
Merged to Total Assets	−0.093**	−0.094**		
	(0.039)	(0.039)		
Merged to Total Assets + 2 Years			−0.024	−0.019
			(0.039)	(0.040)
Ln(Assets)	0.405***	0.428***	0.400***	0.424***
	(0.008)	(0.008)	(0.008)	(0.009)
Receivables to Assets	0.251***	0.241***	0.253***	0.242***
	(0.050)	(0.051)	(0.055)	(0.057)
Inventory to Assets	0.344***	0.337***	0.326***	0.321***
	(0.072)	(0.075)	(0.079)	(0.082)
Return on Assets	−0.263***	−0.283***	−0.271***	−0.292***
	(0.019)	(0.019)	(0.020)	(0.021)
Loss	0.036***	0.033***	0.036***	0.033***
	(0.006)	(0.006)	(0.007)	(0.007)
Percent Foreign Sales	0.072***	0.075***	0.070***	0.071***
	(0.016)	(0.017)	(0.018)	(0.019)
Ln(Segments)	0.023***	0.025***	0.020***	0.022***
	(0.006)	(0.007)	(0.007)	(0.007)
Accelerated Filer	−0.049***	−0.054***	−0.057***	−0.064***
	(0.008)	(0.008)	(0.009)	(0.009)
Going Concern Opinion	0.048***	0.057***	0.055***	0.064***
	(0.013)	(0.013)	(0.014)	(0.014)
Constant	9.010***	8.919***	9.158***	9.054***
	(0.429)	(0.439)	(0.328)	(0.332)
Observations	69,280	69,280	59,123	59,123
Adjusted R-squared	0.641	0.628	0.647	0.635
Firm fixed effects	Yes	Yes	Yes	Yes
Auditor fixed effects	Yes	No	Yes	No
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Number of clients	10,525	10,525	10,162	10,162

*** p<0.01, ** p<0.05, * p<0.1

Table 8: Demand estimation

This table presents estimates of demand and price elasticity for SEC registrants over the period 2008–2010. Panel A presents annual estimates of the demand for the Big 4 audit firms. The regressions are estimated using conditional logit with the outside good being the non-Big 4 audit firms. Ln(Predicted Fees) is the natural logarithm of predicted fees for each of the Big 4 audit firms. E&Y, Deloitte, KPMG, and PwC are brand fixed effects for each of the Big 4 audit firms. Ln(Assets) is the natural logarithm of the client's total assets, Ln(Segments) is the natural logarithm of the client's industrial segments, Foreign Sales is the percentage of the clients sales generated outside of the US, Debt is the ratio of short- and long-term debt to total assets for the client, ROA is the client's return on assets, Inventory + Receivables is the client's ratio of inventory and receivables to total assets, and Payables is the ratio of the client's account payables to total assets. Ln(Years Client) is the number of years that the SEC registrant has been a client of the audit firm, and Not Prior Client is an indicator variable for whether the SEC registrant was not a client of the audit firm in the prior three years. Not tabulated are interactions between the brand fixed effects and indicators for the Fama-French ten industries. Data on client characteristics are taken from Compustat. Panel B presents annual mean price elasticity estimates by audit firm for all clients. Panel C presents annual mean price elasticity estimates by audit firm conditional on being a client of the audit firm in the prior year.

Panel A: Demand estimates

	2008	2009	2010
Ln(Predicted Fees)	−2.052***	−1.935***	−1.941***
	(0.138)	(0.147)	(0.152)
E&Y	2.498***	1.738***	2.913***
	(0.602)	(0.661)	(0.752)
Deloitte	1.797***	2.894***	1.829***
	(0.695)	(0.724)	(0.703)
KPMG	1.163*	1.990***	2.478***
	(0.689)	(0.704)	(0.777)
PwC	2.084***	0.555	2.686***
	(0.768)	(0.745)	(0.889)
E&Y * Ln(Assets)	0.498***	0.570***	0.536***
	(0.062)	(0.073)	(0.071)
Deloitte * Ln(Assets)	0.495***	0.428***	0.484***
	(0.069)	(0.071)	(0.070)
KPMG * Ln(Assets)	0.551***	0.392***	0.416***
	(0.071)	(0.075)	(0.074)
PwC * Ln(Assets)	0.504***	0.559***	0.572***
	(0.076)	(0.078)	(0.076)
E&Y * Ln(Segments)	−0.259**	−0.179	−0.076
	(0.128)	(0.149)	(0.159)
Deloitte * Ln(Segments)	0.132	−0.308**	−0.058
	(0.144)	(0.149)	(0.161)
KPMG * Ln(Segments)	−0.092	−0.184	0.261
	(0.152)	(0.166)	(0.164)
PwC * Ln(Segments)	−0.076	0.198	−0.259
	(0.154)	(0.154)	(0.169)
E&Y * Foreign Sales	0.578**	0.538**	0.554**
	(0.238)	(0.274)	(0.256)
Deloitte * Foreign Sales	0.035	0.637**	0.995***
	(0.298)	(0.299)	(0.274)
KPMG * Foreign Sales	0.730**	0.801***	0.847***
	(0.287)	(0.304)	(0.263)
PwC * Foreign Sales	0.697**	0.228	0.664**
	(0.307)	(0.308)	(0.289)
E&Y * Debt	−0.272	−0.264	−0.808
	(0.343)	(0.455)	(0.503)
Deloitte * Debt	−0.441	0.086	−0.667
	(0.407)	(0.475)	(0.474)
KPMG * Debt	−0.282	−0.195	−0.198
	(0.473)	(0.538)	(0.507)
PwC * Debt	0.218	−0.501	−0.827
	(0.461)	(0.507)	(0.508)
E&Y * ROA	−1.022***	0.739	−1.062**
	(0.382)	(0.561)	(0.513)
Deloitte * ROA	−0.092	0.838	−0.983*
	(0.528)	(0.637)	(0.595)
KPMG * ROA	−0.857*	0.251	−0.690
	(0.501)	(0.663)	(0.637)
PwC * ROA	−0.596	−0.859	−0.432
	(0.543)	(0.605)	(0.713)
E&Y * Inventory + Receivables	−1.345**	−1.930**	−1.762**
	(0.598)	(0.755)	(0.725)
Deloitte * Inventory + Receivables	−0.438	−1.373*	−0.958
	(0.691)	(0.733)	(0.721)
KPMG * Inventory + Receivables	−0.846	−1.814**	−1.381*
	(0.666)	(0.774)	(0.708)
PwC * Inventory + Receivables	−1.297*	−1.034	−2.403***
	(0.779)	(0.808)	(0.822)
E&Y * Payables	−1.559*	0.162	−0.810
	(0.845)	(0.993)	(0.977)
Deloitte * Payables	−1.603*	−1.468	−1.942**
	(0.964)	(0.910)	(0.837)
KPMG * Payables	−1.787**	−1.115	−1.136
	(0.820)	(0.848)	(0.794)
PwC * Payables	0.142	0.107	−0.699
	(1.144)	(1.064)	(1.098)
E&Y * Ln(Years Client)	−0.111	−0.025	−0.028
	(0.197)	(0.209)	(0.264)
Deloitte * Ln(Years Client)	0.093	0.321	0.799***
	(0.207)	(0.219)	(0.258)
KPMG * Ln(Years Client)	0.397*	0.483**	0.374
	(0.219)	(0.202)	(0.297)
PwC * Ln(Years Client)	0.157	0.335	0.464
	(0.241)	(0.233)	(0.320)
E&Y * Not Prior Client	−5.873***	−6.233***	−6.167***
	(0.432)	(0.470)	(0.599)
Deloitte * Not Prior Client	−5.947***	−5.565***	−4.867***
	(0.446)	(0.479)	(0.509)
KPMG * Not Prior Client	−5.292***	−5.495***	−5.884***
	(0.444)	(0.422)	(0.608)
PwC * Not Prior Client	−6.191***	−5.496***	−5.849***
	(0.551)	(0.526)	(0.695)
Industry Interactions with Brand Fixed Effects	YES	YES	YES
Observations	27,034	25,333	25,024

*** p<0.01, ** p<0.05, * p<0.1

Panel B: Mean price elasticities for all clients

	2008	2009	2010
E&Y	−1.625	−1.532	−1.535
Deloitte	−1.754	−1.651	−1.651
KPMG	−1.757	−1.652	−1.647
PwC	−1.728	−1.633	−1.630
Other	−1.341	−1.270	−1.302

Panel C: Mean price elasticities conditional on being a client of the audit firm in the prior year

	2008	2009	2010
E&Y	−0.074	−0.066	−0.038
Deloitte	−0.101	−0.094	−0.060
KPMG	−0.086	−0.089	−0.043
PwC	−0.055	−0.066	−0.034
Other	−0.201	−0.192	−0.250

Table 9: Model fit

This table compares actual auditor choices with the predicted choices based on the estimated parameters from our the demand models. The predicted choice is the auditor with the highest predicted probability for the client and the matrix pools actual and predicted choices over 2008–2010. Panel A presents the matrix for all clients. Panel B presents the matrix conditional on the client making a switch between audit firms. Panels A and B base the predicted probabilities of audit firm choice on the estimated parameters presented in Table 8. Panel C uses predicted probabilities estimated in a demand model that does not control for the history of the auditor-client match.

Panel A: All clients

		Highest predicted probability					
		E&Y	Deloitte	KPMG	PwC	non-Big 4	Total
Actual choice	E&Y	2,983	28	23	22	174	3,230
		92.4%	*0.9%*	*0.7%*	*0.7%*	*5.4%*	
	Deloitte	22	2,077	14	23	136	2,272
		1.0%	*91.4%*	*0.6%*	*1.0%*	*6.0%*	
	KPMG	26	19	2,073	9	150	2,277
		1.1%	*0.8%*	*91.0%*	*0.4%*	*6.6%*	
	PwC	21	24	18	2,258	126	2,447
		0.9%	*1.0%*	*0.7%*	*92.3%*	*5.1%*	
	non-Big 4	56	48	36	38	5,088	5,266
		1.1%	*0.9%*	*0.7%*	*0.7%*	*96.6%*	
	Total	3,108	2,196	2,164	2,350	5,674	15,492

Panel B: Conditional on a switch

		Highest predicted probability					
		E&Y	Deloitte	KPMG	PwC	non-Big 4	Total
Actual choice	E&Y	16	28	23	22	174	263
		6.1%	*10.7%*	*8.8%*	*8.4%*	*66.2%*	
	Deloitte	22	26	14	23	131	216
		10.2%	*12.0%*	*6.5%*	*10.7%*	*60.7%*	
	KPMG	26	19	12	9	150	216
		12.0%	*8.8%*	*5.6%*	*4.2%*	*69.4%*	
	PwC	21	24	18	12	123	198
		10.6%	*12.1%*	*9.1%*	*6.1%*	*62.1%*	
	non-Big 4	33	38	30	20	466	587
		5.6%	*6.5%*	*5.1%*	*3.4%*	*79.4%*	
	Total	118	135	97	86	1,045	1,481

Panel C: Conditional on a switch with demand estimated without controlling for history of auditor-client match

		Highest predicted probability					
		E&Y	Deloitte	KPMG	PwC	non-Big 4	Total
Actual choice	E&Y	145	21	14	37	46	263
		55.1%	*8.0%*	*5.3%*	*14.1%*	*17.5%*	
	Deloitte	56	76	18	24	42	216
		25.9%	*35.2%*	*8.3%*	*11.1%*	*19.4%*	
	KPMG	47	15	72	23	59	216
		21.8%	*6.9%*	*33.3%*	*10.7%*	*27.3%*	
	PwC	46	15	10	87	40	198
		23.2%	*7.6%*	*5.1%*	*43.9%*	*20.2%*	
	non-Big 4	48	13	9	10	507	587
		8.2%	*2.2%*	*1.5%*	*1.7%*	*86.4%*	
	Total	342	140	123	181	695	1,481

Table 10: Demand and price elasticity estimates for Arthur Andersen clients

This table presents demand estimates and price elasticity estimates for former Arthur Andersen clients in 2002. Panel A presents demand estimates: column (1) presents estimates of audit firm choice in 2002 for firms that were clients of Arthur Andersen in 2001; column (2) presents estimates of audit firm choice in 2002 for all firms; column 3 presents estimates of audit firm choice in 2002 for firms that were not clients of Arthur Andersen in 2001. For all three regressions, the outside good consists of the non-Big 4 audit firms. Ln(Predicted Fees) is the natural logarithm of predicted fees for each of the Big 4 audit firms. E&Y, Deloitte, KPMG, and PwC are brand fixed effects for each of the Big 4 audit firms. Ln(Assets) is the natural logarithm of the client's total assets, Ln(Segments) is the natural logarithm of the client's industrial segments, Foreign Sales is the percentage of the clients sales generated outside of the US, Debt is the ratio of short- and long-term debt to total assets for the client, ROA is the client's return on assets, Inventory + Receivables is the client's ratio of inventory and receivables to total assets, and Payables is the ratio of the client's account payables to total assets. Not tabulated are interactions between the brand fixed effects and indicators for the Fama-French ten industries. Panel B presents price elasticity estimates for former Arthur Andersen clients based on the parameter estimates from the three regressions presented in Panel A.

Panel A: Demand estimates for former Arthur Andersen clients in 2002

	Andersen clients	All clients	non-Andersen clients
Ln(Predicted Fees)	−2.283***	−2.058***	−2.009***
	(0.197)	(0.069)	(0.074)
E&Y	−1.034	−1.053***	−1.088***
	(0.961)	(0.257)	(0.271)
Deloitte	−2.277 * *	−1.690***	−1.656***
	(1.007)	(0.269)	(0.283)
KPMG	−1.403	−1.426***	−1.456***
	(0.965)	(0.256)	(0.269)
PwC	−1.264	−1.661***	−1.677***
	(1.015)	(0.263)	(0.274)
E&Y * Ln(Assets)	0.849***	0.662***	0.655***
	(0.166)	(0.038)	(0.039)
Deloitte * Ln(Assets)	0.981***	0.650***	0.624***
	(0.171)	(0.039)	(0.040)
KPMG * Ln(Assets)	0.858***	0.646***	0.631***
	(0.167)	(0.038)	(0.040)
PwC * Ln(Assets)	0.871***	0.760***	0.752***
	(0.171)	(0.039)	(0.040)
E&Y * Ln(Segments)	−0.079	−0.049	−0.097
	(0.251)	(0.072)	(0.076)
Deloitte * Ln(Segments)	−0.158	−0.025	−0.048
	(0.260)	(0.075)	(0.079)
KPMG * Ln(Segments)	−0.606 * *	−0.158 * *	−0.130*
	(0.254)	(0.074)	(0.079)
PwC * Ln(Segments)	−0.567 * *	−0.215***	−0.207***
	(0.267)	(0.074)	(0.077)
E&Y * Foreign Sales	−0.347	0.391***	0.437***
	(0.551)	(0.148)	(0.155)
Deloitte * Foreign Sales	−0.284	0.340 * *	0.388 * *
	(0.576)	(0.158)	(0.165)
KPMG * Foreign Sales	0.214	0.780***	0.839***
	(0.548)	(0.154)	(0.163)
PwC * Foreign Sales	0.257	0.957***	0.974***
	(0.575)	(0.151)	(0.157)
E&Y * Debt	−1.719 * *	−0.804***	−0.796***
	(0.760)	(0.214)	(0.228)
Deloitte * Debt	−1.553*	−0.259	−0.215
	(0.819)	(0.234)	(0.248)
KPMG * Debt	−0.854	0.123	0.187
	(0.785)	(0.225)	(0.239)
PwC * Debt	−2.237***	−0.714***	−0.592 * *
	(0.837)	(0.223)	(0.232)
E&Y * ROA	0.725	−1.141***	−1.360***
	(0.759)	(0.247)	(0.265)
Deloitte * ROA	1.466*	−0.127	−0.287
	(0.865)	(0.282)	(0.301)
KPMG * ROA	0.264	−0.920***	−1.002***
	(0.757)	(0.259)	(0.281)
PwC * ROA	1.290	−0.716***	−0.896***
	(0.845)	(0.261)	(0.278)
E&Y * Inventory + Receivables	0.900	−0.948***	−0.932***
	(1.167)	(0.282)	(0.294)
Deloitte * Inventory + Receivables	1.009	−0.496	−0.471
	(1.246)	(0.304)	(0.317)
KPMG * Inventory + Receivables	1.692	−0.553*	−0.643 * *
	(1.166)	(0.286)	(0.301)
PwC * Inventory + Receivables	2.325*	−0.761***	−0.897***
	(1.237)	(0.294)	(0.305)
E&Y * Payables	−2.890 * *	−2.987***	−3.128***
	(1.330)	(0.355)	(0.376)
Deloitte * Payables	−3.846***	−2.703***	−2.641***
	(1.431)	(0.366)	(0.383)
KPMG * Payables	−2.956 * *	−2.577***	−2.544***
	(1.261)	(0.328)	(0.347)
PwC * Payables	−3.994***	−3.656***	−3.730***
	(1.396)	(0.372)	(0.392)
Observations	3,784	28,854	25,070
Industry Interactions	Yes	Yes	Yes

*** p<0.01, ** p<0.05, * p<0.1

Panel B: Mean price elasticity estimates for former Arthur Andersen clients in 2002

	Demand parameters estimated using		
	Andersen clients	All clients	non-Andersen clients
E&Y	−1.622	−1.567	−1.539
Deloitte	−1.806	−1.714	−1.681
KPMG	−1.649	−1.647	−1.628
PwC	−1.918	−1.602	−1.541
Other	−2.135	−1.701	−1.646

Table 11: Actual choices of Arthur Andersen clients compared to model predictions

This table compares predicted with actual auditor choices in 2002 for firms that were clients of Arthur Andersen in 2001. Panel A uses the highest predicted probability from the model estimated on all clients presented in column (1) of Table 10. Panel B uses the highest predicted probability based on the model estimated only on Arthur Andersen clients presented in column (2) of Table 10. Panel C uses the highest predicted probability from the model estimated on firms that were not Arthur Andersen clients presented in column (3) of Table 10.

Panel A: Conditional logit estimated on Arthur Andersen clients

		Highest predicted probability					
		E&Y	Deloitte	KPMG	PwC	non-Big 4	Total
Acutal choice	E&Y	138	24	48	3	6	219
		63.0%	*11.0%*	*21.9%*	*1.4%*	*2.7%*	
	Deloitte	39	75	31	11	2	158
		24.7%	*47.5%*	*19.6%*	*7.0%*	*1.3%*	
	KPMG	53	19	127	7	4	210
		25.2%	*9.1%*	*60.5%*	*3.3%*	*1.9%*	
	PwC	33	18	40	28	2	121
		27.3%	*14.9%*	*33.1%*	*23.1%*	*1.7%*	
	non-Big 4	17	5	9	1	17	49
		34.7%	*10.2%*	*18.4%*	*2.0%*	*34.7%*	
	Total	280	141	255	50	31	757

Panel B: Conditional logit estimated on all clients

		Highest predicted probability					
		E&Y	Deloitte	KPMG	PwC	non-Big 4	Total
Acutal choice	E&Y	132	12	17	41	17	219
		60.3%	*5.5%*	*7.8%*	*18.7%*	*7.8%*	
	Deloitte	37	66	14	34	7	158
		23.4%	*41.8%*	*8.9%*	*21.5%*	*4.4%*	
	KPMG	44	10	90	42	24	210
		21.0%	*4.8%*	*42.9%*	*20.0%*	*11.4%*	
	PwC	26	9	22	58	6	121
		21.5%	*7.4%*	*18.2%*	*47.9%*	*5.0%*	
	non-Big 4	18	3	1	1	26	49
		36.7%	*6.1%*	*2.0%*	*2.0%*	*53.1%*	
	Total	257	100	144	176	80	757

Panel C: Conditional logit estimated on non-Arthur Andersen clients

		Highest predicted probability					
		E&Y	Deloitte	KPMG	PwC	non-Big 4	Total
Actual choice	E&Y	119	10	17	53	20	219
		54.3%	*4.6%*	*7.8%*	*24.2%*	*9.1%*	
	Deloitte	34	63	12	42	7	158
		21.5%	*39.9%*	*7.6%*	*26.6%*	*4.4%*	
	KPMG	41	4	87	52	26	210
		19.5%	*1.9%*	*41.4%*	*24.8%*	*12.4%*	
	PwC	27	9	16	62	7	121
		22.3%	*7.4%*	*13.2%*	*51.2%*	*5.8%*	
	non-Big 4	18	1	1	2	27	49
		36.7%	*2.0%*	*2.0%*	*4.1%*	*55.1%*	
	Total	239	87	133	211	87	757

Table 12: Disappearance of a Big 4 audit firm with no supply response

The table presents expected changes in consumer surplus if one of the Big 4 audit firms disappeared. Estimates are based on Table 8 coefficient estimates for 2008, 2009, and 2010. For the disappearance of each of the Big 4 audit firms, we estimate the expected change in consumer surplus, C_{ijm}, for each firm i. To do so, we draw vectors of type 1 extreme value error terms—one for each of the Big 4 auditors and one for the outside good. For each vector draw, we combine in equation (1) the parameter estimates from the demand estimation along with the the firm-auditor characteristics and the error term draw to calculate the utility that client would receive from choosing each of the Big 4 auditors and the outside good. We then pick the audit firm that leads to maximum utility under this unrestricted choice set. We next restrict the choice set for each client (i.e., remove one of the Big 4 auditors) and calculate the maximum utility that the client would have received under the restricted choice set. Then, we solve for the change in consumer surplus C_{ijm} that equates the maximum utilities. For each client, we repeat this procedure 1,000 times and take the average of the required dollar transfer to create $E[C_{ijm}]$. Panel A presents the estimates of the expected total change in consumer surplus if each of the Big 4 disappears. Panel B presents the firm-level mean change in consumer surplus and correlations of the firm-level change in consumer surplus with firm size, audit fees, and tenure with auditor.

Panel A: Total expected changes in consumer surplus if one of the Big 4 audit firms disappears (US$ in billions)

	2008	2009	2010
E&Y	1.548	1.517	1.646
Deloitte	1.334	1.247	1.386
KPMG	1.234	1.192	1.278
PwC	1.657	1.540	1.794

Panel B: Firm-level expected changes in consumer surplus if one of the Big 4 audit firms disappears (US$ dollars)

		2008				2009				2010			
			Correlations with				*Correlations with*				*Correlations with*		
		Mean	Size	Fees	Tenure	Mean	Size	Fees	Tenure	Mean	Size	Fees	Tenure
E&Y	Client	1,297,902	0.47	0.77	0.22	1,378,301	0.52	0.78	0.19	1,507,432	0.69	0.85	0.17
	Not a client	20,427	0.02	0.08	0.03	15,422	0.11	0.18	0.02	16,362	0.10	0.11	-0.02
Deloitte	Client	1,601,992	0.24	0.61	0.22	1,592,570	0.32	0.69	0.29	1,762,295	0.40	0.74	0.28
	Not a client	17,520	0.02	0.08	0.02	14,705	0.05	0.12	0.00	16,030	0.03	0.08	-0.02
KPMG	Client	1,503,839	0.34	0.67	0.17	1,528,908	0.36	0.66	0.18	1,597,928	0.56	0.75	0.18
	Not a client	13,780	0.06	0.15	0.02	14,018	0.03	0.16	0.01	15,326	0.03	0.05	-0.01
PwC	Client	1,867,005	0.33	0.72	0.31	1,863,480	0.34	0.66	0.31	2,140,601	0.51	0.78	0.27
	Not a client	13,687	0.02	0.08	0.05	15,850	0.04	0.12	0.00	17,945	0.05	0.14	-0.01

Table 13: Mandatory audit firm rotation with no supply response

The table presents expected changes in consumer surplus if mandatory audit firm rotation were to be implemented after four through ten years. Estimates are based on Table 8 coefficient estimates for 2008, 209, and 2010, and are denominated in billions of US dollars. For the implementation of mandatory audit firm rotation at various tenures, we remove an auditor from the client's choice set if the length of the auditor-client relationship was equal to or greater than the specified number of years that require mandatory rotation and then estimate the expected change in consumer surplus, C_{ijm}, for each firm i. To do so, we draw vectors of type 1 extreme value error terms—one for each of the Big 4 auditors and one for the outside good. For each vector draw, we combine in equation (1) the parameter estimates from the demand estimation along with the the firm-auditor characteristics and the error term draw to calculate the utility that client would receive from choosing each of the Big 4 auditors and the outside good. We then pick the audit firm that leads to maximum utility under this unrestricted choice set. We next restrict the choice set for each client based on mandatory audit firm rotation and calculate the maximum utility that the client would have received under the restricted choice set. Then, we solve for the change in consumer surplus C_{ijm} that equates the maximum utilities. For each client, we repeat this procedure 1,000 times and take the average of the required dollar transfer to create $E[C_{ijm}]$. Panel A presents the estimates of the expected total change in consumer surplus for mandatory audit firm rotation. Panel B presents the firm-level mean change in consumer surplus and correlations of the firm-level change in consumer surplus with firm size, audit fees, and tenure with auditor.

Panel A: Changes in consumer surplus if mandatory audit firm rotation is implemented (US$ in billions)

	2008	2009	2010
Four years	4.298	4.260	5.039
Five years	4.067	4.018	4.425
Six years	3.156	3.828	4.191
Seven years	2.918	3.010	3.997
Eight years	2.733	2.776	3.191
Nine years	2.547	2.586	2.966
Ten years	2.363	2.419	2.761

Panel B: Firm-level expected changes in consumer surplus if one of the Big 4 audit firms disappears (US$ dollars)

	2008				2009				2010			
		Correlations with				*Correlations with*				*Correlations with*		
	Mean	Size	Fees	Tenure	Mean	Size	Fees	Tenure	Mean	Size	Fees	Tenure
4 years	793,904	0.19	0.60	0.42	840,007	0.21	0.61	0.39	1,006,208	0.47	0.75	0.34
5 years	751,262	0.19	0.60	0.43	792,313	0.21	0.60	0.41	883,578	0.25	0.64	0.39
6 years	582,848	0.20	0.57	0.50	754,852	0.21	0.60	0.42	836,925	0.25	0.63	0.46
7 years	538,920	0.20	0.56	0.52	593,655	0.21	0.57	0.48	798,163	0.25	0.63	0.41
8 years	504,810	0.17	0.54	0.54	547,444	0.21	0.55	0.50	637,171	0.24	0.60	0.45
9 years	470,465	0.15	0.51	0.56	509,884	0.18	0.52	0.52	592,267	0.24	0.58	0.47
10 years	436,394	0.14	0.50	0.57	477,066	0.17	0.52	0.53	551,274	0.20	0.55	0.49

Table 14: Semi-elasticity of audit fees to changes in three-digit SIC audit firm market share

This table presents ordinary least squares estimates of the semi-elasticity of audit fees in 2002 to Andersen's share of three-digit SIC industry assets in 2001. The dependent variable is the natural logarithm of audit fees in 2002. Andersen's industry share is measured as of 2001, while the remaining independent variables are measured contemporaneously with audit fees. Ln(Assets) is the natural logarithm of the client's total assets. Receivables to Assets is the ratio the client's receivables to total assets. Inventory to Assets is the ratio of the client's inventory to total assets. Return on Assets is the client's return on assets measured as net income to total assets. Loss is an indicator for whether the client generated an accounting loss. Percent Foreign Sales is the ratio of the client's foreign sales to total sales. Accelerated Filer is an indicator variable for whether the client is designated as accelerated filer by the Securities and Exchange Commission. Going Concern Opinion is an indicator for whether the client received a going concern opinion from its auditor.

Andersen's Industry Share in 2001	0.0015**
	(0.001)
Ln(Assets)	0.4733***
	(0.006)
Receivables to Assets	−0.4083***
	(0.051)
Inventory to Assets	0.7668***
	(0.071)
Return on Assets	−0.3357***
	(0.053)
Loss	0.1780***
	(0.025)
Percent Foreign Sales	0.5504***
	(0.022)
Ln(Segments)	0.2156***
	(0.011)
Accelerated Filer	−0.1614***
	(0.025)
Going Concern Opinion	0.1978***
	(0.048)
Constant	9.3935***
	(0.044)
Observations	6,174
Adjusted R^2	0.707
Auditor fixed effects	Yes

*** p<0.01, ** p<0.05, * p<0.1

Table 15: Supply responses for counterfactuals

This table presents estimates of the increase in total annual audit fees under the two counterfactuals. To calculate the expected supply side responses, we estimate the semi-elasticity of audit fees in 2002 with respect to the percent share of industry total assets audited by Arthur Andersen in 2001 based on three-digit SIC. These estimates are presented in Table 14. The estimated semi-elasticity is a 0.15% increase in audit fees for each one percentage point of total industry assets audited by Arthur Andersen. For each counterfactual, we calculate by three-digit SIC the percentage of total assets either audited by the disappearing Big 4 audit firm or subject to mandatory audit firm rotation. For each client, we then calculate the expected increase in annual audit fees based on the client's actual audit fees times the semi-elasticity times the percentage of industry assets audited by the disappearing firm. The columns present sums by year denominated in billions of US$. Panel A presents the supply response if one of the Big 4 audit firms disappears. Panel B presents the supply response for the implementation of mandatory audit firm rotation.

Panel A. Supply response for the disappearance of a Big 4 audit firm

	2008	2009	2010
E&Y	0.456	0.426	0.415
Deloitte	0.408	0.369	0.362
KPMG	0.397	0.346	0.335
PwC	0.533	0.486	0.497

Panel B: Supply response for the implementation of mandatory audit firm rotation

	2008	2009	2010
Four years	1.337	1.227	1.336
Five years	1.302	1.178	1.160
Six years	1.065	1.145	1.119
Seven years	1.004	0.931	1.090
Eight years	0.915	0.878	0.893
Nine years	0.839	0.801	0.848
Ten years	0.786	0.755	0.772