Examination of Self-selection Bias and Big N[1] Audit Fee Premiums-Evidence from Norway[2]

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ABSTRACT

Prior study (Firth 1997) examines Big N audit fee premiums by adding a "big auditor" indicator variable in the audit fee determination model. But this dummy variable may be endogenous and cause self-selection bias because clients may not be randomly assigned across Big N and non-Big N auditors (Ireland and Lennox 2002; Chaney et al. 2004). In this paper we first run the ordinary least square (OLS) regression of the audit fee determination model, and Big N audit fee premiums are identified across years. To examine self-selection bias, we employ a Heckman model and a treatment effects model, estimated by both two-step and full maximum likelihood approaches. Results show Big N audit fee premiums across years for Norwegian audit market.

Keywords: *Audit fee premium, Self-selection, Heckman model, Treatment effects model*

Jel Classification: *M42*

ÖZET

Firth (1997) denetçi ücretinin belirlenmesi modeline, "büyük denetçi" belirleyici değişkenini eklemek suretiyle Big N denetçi ücreti primlerini incelemektedir. Ancak bu kukla değişken içsel olabilmekte ve kişisel seçim hatalarına yol açabilmektedir. Çünkü müşteriler Big N ve Big N olmayan denetçiler arasında tesadüfi olarak tahsis edilmiş olmayabilmektedir (Ireland and Lennox 2002; Chaney et al. 2004). Bu çalışmada, öncelikle denetçi ücretinin belirlenmesi modelinde en küçük kareler yöntemi uygulanmaktadır ve Big N denetçi ücret primleri yıllar boyunca tanımlanmaktadır. Kişisel seçim hatalarını incelemek için, Heckman modeli ve düzeltme etkisi modeli uygulanmıştır. Sonuçlar Norveç denetim piyasasında yıllar arasındaki Big N denetçi ücreti primlerini göstermektedir.

Anahtar Kelimeler: *Denetçi ücreti primi, Kişisel seçim, Heckman modeli, Düzeltme etkisi modeli*

Jel Sınıflandırması*: M42*

[1] Big N is a general concept for big audit service providers and refers to Big 8, Big 6, Big 5 or Big 4 in different periods. In this study, the research period covers the change of Big N auditors from 5 to 4. We consistently use Big N to represent either Big 5 or Big 4 before and after the demise of Arthur Andersen in the study.

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1. Introduction

International studies on Big N audit fee premiums have been extensively conducted, and mixed conclusions have been reached for different audit markets and auditee segments. Simunic (1980) for both big and small auditee segments in the U.S. market, Firth (1997) for Norwegian market and Chung and Lindsay (1988) for Canadian market find no audit fee premium. However, studies on small auditee segments observe audit fee premiums. Francis and Stokes (1986) for Australian market and Francis and Simon (1987) for U.S. market have suggested Big N fee premiums for small auditees, but not for large auditees. Palmrose (1986a) for U.S. market also highlight the existence of Big N audit fee premiums.

In the recent studies, the audit fee premiums are captured by a Big N dummy variable which is assumed to be exogenous in regression models. These models are based on the assumption that clients are randomly assigned between Big N and non-Big N auditors. Chaney et al. (2004)[3] use Heckman's self-selection model (Heckman 1979) and data of private firms in the UK to test Big N fee premiums. They suggest that auditees are not randomly assigned between Big N and non-Big N auditors, meaning self-selection exists and the estimates are biased. They find Big N audit fee premiums in the OLS audit fee determination model. However, when they use the two-stage Heckman model to eliminate the selectivity bias, no fee premium is identified. Ireland and Lennox (2002)[4] find Big N audit fee premiums even after taking selectivity bias into account. These two papers bring forward a challenge to studies on Big N auditor fee premiums -- if auditees are not randomly assigned between Big N auditors and non-Big N auditors, the estimates may be biased and conclusions may not hold.

The above two studies motivate us to further examine the Big N auditor fee premiums. With the potential existence of selectivity bias, new accounting evidence for selectivity bias is needed to evaluate the existing literature. The purpose of this paper is to identify the determinants of audit fees in the Norwegian audit market and relate them to prior literature. There are two reasons we select Norwegian audit market. Firstly, empirical evidences are primarily from U.S., U.K. and Australian markets. No evidence on Big N auditor fee premiums exists in Norway. For example, Firth 1997 finds no significant evidence of the Big N auditors charging a premium for their services in the large auditee segment nor in the small auditee segment. Secondly, study of audit fee premiums in Norwegian market is possible only

[3] Chaney et al. (2004) use counterfactual estimation to calculate audit fee premiums. Counterfactual estimation calculates the mean difference between the actual audit fees and the fees that the clients would have paid had they selected the alternative auditors.

[4] Ireland and Lennox (2002) calculate audit fee premiums by looking at the difference of the intercepts between the Big N and non-Big N audit fee equations.

after the law of accounting, "Regnskapsloven[5]", was stipulated in Norway on July 17th, 1998. Prior to "Regnskapsloven", firms disclose total fee only and it is under the requirement from "Regnskapsloven" that firms disclose separately audit fee and other fees.

In addition, Big N audit fee premiums are examined by taking the selectivity bias into account. In this paper, we first use the traditional ordinary least square (OLS) audit fee determination model to identify the determinants of audit fees and Big N audit fee premiums. We then utilize the Heckman model and the treatment effects model to examine Big N auditor fee premiums using both two-step and full maximum likelihood approaches to run the regressions.

The advantage of the treatment effects model over the Heckman model is that the treatment effects model takes both Big N and non-Big N auditees into account in the outcome equation. On the other hand, the advantage of the Heckman model over the treatment effects model is that the Heckman model censors the sample.[6] We observe Big N audit fee premiums in Norway by using the traditional OLS model. Consistent with Ireland and Lennox (2002), after correcting selectivity bias, we continue to observe Big N audit fee premiums in Norway for both the Heckman and the treatment effects models.

The paper makes three contributions to the auditing literature. First, since prior studies mainly characterize regularities from the U.S., U.K. and Australia and very few studies deal with continental European countries (Cobbin 2002), this paper extends the international dimension of the existing audit pricing literature. Second, the study adds new evidence on audit fee premiums after correcting selectivity bias. Third, it uses different models to correct selectivity bias.

The paper is organized as follows. Section II reviews the literature on audit fee premiums. Section III describes the data, and section IV details and evaluates the regression results. Section V concludes the paper.

2. Literature Review

Following the original paper, Simunic (1980), a lot of empirical evidence on Big N audit fee premiums (Francis 1984; Firth 1985; Palmrose 1986a; Francis and Simon 1987; Simon and Francis 1988; Rubin 1988; Chan et al. 1993; Pong and Whittington 1994; Lee

[5] There was a law of accounting, "Regnskapsloven", that was stipulated in Norway on July 17th, 1998 and took into effect at the beginning of 1999. This new law regulates that total fees, audit fees and other fees have to be disclosed separately. Before this new law, there was no regulation on this information. So it is not clear how to split fees between audit fees and other fees, and fees before 1999 were not very precise and reliable in the disclosure.

[6] In the Heckman model, audit fee determination equations are separately run for both Big N and non-Big N clients. The two equations may better fit Big N and non-Big N clients separately. However, when using counterfactual method to calculate audit fee premiums, it may cause extrapolation beyond the scope from which the model is derived, especially when the size difference between Big N and non-Big N clients is large.

1996; Firth 1997; Ferguson and Stokes 2002; Ireland and Lennox 2002; Chaney et al. 2004; etc.) has been published in audit fee studies. These studies mainly focus on several issues such as audit fee determinants, audit market competition, auditor switching effects, concentration of the market and the independence of auditors. The essential problem is the audit pricing issue.

Simunic (1980) establishes a framework for audit pricing by using an ordinary least square (OLS) regression model. In the basic audit pricing models, audit fee determinants have been classified into three categories, i.e., size, complexity, and risk as summarized in Chan et al. (1993). Models with various proxies employed as explanatory or control variables usually explain 50-80 percent of the variations in audit fees. Other explanatory factors such as auditee's profitability, busy season dummy variable[7], and auditor location are included in some studies (Chan et al. 1993; Beattie et al. 2000; Chaney et al. 2004). Market competition for audit service, however, is a perpetual concern. Since the 1980s, there have been several mergers between big auditors, so market shares are in the control of a decreasing number of Big N auditors. With the mergers, more attention is paid to audit fee premiums charged by Big N auditors over non-Big N auditors.

Audit fee premiums may stem from the monopoly power of Big N auditors over an audit market, or from the product differentiation of Big N auditors. From the theoretical points of view, Balachandran and Ramakrishnan (1987) argue that the ability of an audit firm to monitor its members and the ability of the client to write contracts jointly determine audit fees. The client's ability to write contracts depends on the performance of the audit firm with other clients, and large audit firms possess more negotiation power with their clients than small auditors. Alternative explanations are provided to illustrate the existence of audit service differentiation. DeAngelo (1981) first defines the quality of audit service as the market-assessed joint probability that a given auditor will both discover a breach in a client's accounting system and report the breach. Then she argues that because of the start-up costs for an auditor and the switching costs for an auditee, the incumbent auditor will earn client-specific quasi-rents. The quasi-rents are considered as a "collateral" or "bond" for an auditor to provide high quality service. Big N auditors may lose more client-specific quasi-rents if they take a chance of not reporting a found breach because they have more clients and larger market shares. Big auditors thus bear the incentive to report independently and maintain their reputation. It also means that audit service quality is positively related to auditor size. This differential quality of audit service is driven by client-specific quasi-rents passively.

Competing with this theory, Francis and Wilson (1988) argue that, according to the brand name investment model established by Klein et al. (1978), "firms are explicitly motivated to develop and maintain brand name reputations for quality in order to secure and

[7] Most firms' fiscal year ends between December 1 and March 31, so this period is a busy season for auditors.

protect quasi-rents from the brand name". Evidence and assessment support that Big N auditors appear to be brand name higher quality suppliers. This argument is different from DeAngelo (1981) in that the incentive to build brand name is the initiative of auditors themselves. Besides, hiring Big N auditors is helpful in reducing agency costs and the cost of capital.

Earlier studies use a Big N dummy variable in the OLS regression to examine Big N audit fee premiums. The model implicitly relies on two assumptions. The first assumption is that the extra cost of choosing Big N auditors is the same for all firms, meaning that the fee premiums are the same across firms regardless of firm characteristics. The second one assumes that all auditees are randomly allocated among auditors and the dummy variable for Big N auditors is included as an exogenous regressor in the OLS model.

Chaney et al. (2004) employ a Heckman two-stage regression model (Heckman 1979; Lee 1979) to check the validity of these assumptions and find that there is a selection bias between Big N and non-Big N auditors for private firms in the U.K. They conclude that both Big N and non-Big N clients select their auditors cost-efficiently, and the audit fee premiums identified in the OLS regression disappear after taking self-selection bias into account. However, there is an extrapolation[8] issue because the size difference between the size of Big N and non-Big N clients is so big that they may be far beyond the scope from which the models are derived.

In another study by Ireland and Lennox (2002), they calculate audit fee premiums by looking at the difference of the intercepts between the Big N and non-Big N audit fee equations. After taking selectivity bias into consideration, they still find Big N audit fee premiums for firms listed on the U.K. stock exchange. Hamilton et al. (2005) also identify self-selection bias between Big N and non-Big N auditors in Australian market. By using counterfactual effects to calculate audit fee premiums, their results support Ireland and Lennox (2002) that the audit fee premiums still exist after taking the self-selection bias into consideration.

Firth (1997) uses OLS regression to study the audit fee premium for listed firms in Norway and find there is no significant evidence of the Big N auditors charging a premium for their services in the large auditee segment nor in the small auditee segment. However, because of the inherent assumptions associated with the OLS regression model, there is a need to re-examine the results. In this paper, we utilize traditional OLS audit fee determination model, Heckman model and treatment effects model to examine Big N auditor fee premiums in Norway. For both Heckman model and treatment effects model, we use both

[8] Extrapolation means that when predicting audit fees, the values substituted into an estimated model are beyond the scopes from which the model is estimated.

two-step and full maximum likelihood approaches to run the regressions. Our results show that Big N audit fee premiums exist in Norway after correction of self-selection bias.

3. Data And Descriptive Statistics

Sample selection

In this study, we use the database Dun and Bradstreet, Norway to examine audit fee premiums. Enron, WorldCom and Andersen scandals dramatically changed the worldwide audit market. In order to avoid this confounding effect, we select the research period from 1999 through 2003 to concentrate on the post accounting regulation reform "Regnskapsloven". Norwegian firms registered as AS or ASA[9] are required to be audited regardless of firm size. The low registration capital requirement allows even a hairdresser or a restaurant to register as a company. Thus for many small firms, employing an auditor is only to meet the minimum statutory requirements. Therefore, there are more than 250,000 firms in the database, and most of them are small in size. We exclude firms with total assets less than 12 million Norwegian Kroners (about 1.31 million pounds[10]), because small firms could introduce significant noise in the analyses (Chaney et al. 2004). The selection of variables is based on prior studies and the availability of variables in the database. In addition to firm size (total assets), we also include return on assets (ROA), sales to total assets ratio (Aturn), long term debt to total assets ratio (DA), quick ratio (quick), absolute value of exceptional assets to total assets ratio (abs_excep), audit opinion dummy variable (auditopinion), inventory to total assets ratio (invent), and receivables to total assets ratio (receive) in the audit fee determination model. Based on the characteristics of the variables, firms with ROA greater than 10 or less than -10 are eliminated, because these firms are considered to be outliers. Firms with inventory/total assets ratio or receivables/total assets ratio greater than one or less than zero, quick ratio less than zero, sales less than zero, and long-term debt/total assets ratio less than zero are also deleted because such ratios indicate abnormality. After using above sample selection criteria, there are 3973 firms left per year.[11]

[9] AS and ASA are two forms of limited firms in Norway with minimum registered capital of NOK 100,000 and 1000,000 respectively. Firms registered as AS have single or few owners, and can operate in the owners' will. Shares can't be traded unless tradability is written in the charter. Correspondingly, firms registered as ASA have a number of owners/shareholders, and the interest of every investor has to be taken care of. Shares can be traded freely unless it is forbidden by the charter. Firms only registered as ASA can be listed in the Stock Exchange.

[10] The exchange rate is about 9.14 Kroners for one pound on May 4, 2010.

[11] Once the exclusion criteria are met in one year for a firm, it will be deleted in all years. So the sample consists of balanced panel data.

Descriptive Statistics

Table 1: Descriptive Statistics

	Whole sample		Non-Big N		Big N		tValue
No. of OBS	19865		9186		10679		
variable	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	
audfees	115.30	270.67	68.83	62.87	155.27	357.63	-12.14
logaudfees	4.233	0.881	3.944	0.730	4.481	0.925	-20.40
assets	389543	4729358	67968	184809	666161	6428691	-4.30
logassets	10.916	1.211	10.534	0.838	11.244	1.377	-19.63
quick	1.437	2.054	1.396	1.908	1.473	2.175	-1.39
Aturn	1.701	1.447	1.663	1.418	1.733	1.469	-1.65
DA	0.242	0.249	0.265	0.252	0.222	0.245	4.95
ROA	0.069	0.126	0.079	0.110	0.061	0.137	4.45
abs_excep	0.004	0.043	0.004	0.034	0.004	0.050	0.35
Auditopinion	0.048	0.214	0.052	0.223	0.045	0.206	1.16
invent	0.166	0.188	0.183	0.196	0.152	0.179	5.23
receive	0.191	0.181	0.177	0.167	0.203	0.191	-4.73
sales	250827	2919702	83206	164528	395013	3949307	-3.56
logsales	10.919	1.610	10.523	1.446	11.260	1.665	-15.07

Means and standard deviations are separately reported for the whole sample, the samples of non-Big N and Big N auditees. All means and standard deviations are the averages of yearly means and deviations for each variable from year 1999 through 2003. The t-value is the median of t-statistics across years for the T-tests between non-Big N and Big N samples.

Variable Definitions:

Audfees----------Audit fees a firm pays to its auditor in a year
Logaudfees---------Logarithm of audit fees
Assets----------Total assets of an auditee
Logassets----------Logarithm of total assets
Quick----------Quick ratio, current assets minus inventory divided by current liabilities
Aturn----------Assets turnover, Sales divided by total assets
DA----------Long-term debt/total assets ratio
ROA----------Earnings before interest and taxes divided by total assets
Abs_excep---------The absolute value of exceptional assets/total assets ratio
Auditopinion-------Dummy variable, 1 if the audit report is qualified, 0 otherwise
Invent----------The ratio of inventory to total assets
Receive----------Receivables/total assets ratio
Sales----------Sales of a firm
Logsales----------Logarithm of sales

Table 1 presents simple descriptive statistics of all variables that will be used in the later regressions. The variables are chosen based on data availability, and they are considered to be significant determinants of audit fees by prior studies. The means and standard deviations of all variables are shown for the whole sample, the non-Big N and Big N sub-samples separately. We also test the mean differences of the variables between non-Big N and Big N clients using t-tests, and the medians of the yearly t-values are represented in the last column of Table 1.

Table 2: Pearson Cross-correlations

	logaudfees	BigN	logassets	Aturn	ROA	DA	abs_excep	Audit opinion	invent	receive
BigN	0.297									
logassets	0.619	0.292								
Aturn	0.142	0.024	-0.191							
ROA	-0.064	-0.072	-0.030	0.090						
DA	-0.155	-0.085	0.052	-0.322	-0.134					
abs_excep	0.008	0.003	0.000	-0.009	-0.065	0.015				
Audit Opinion	-0.019	-0.017	-0.050	-0.031	-0.140	0.178	0.026			
invent	0.025	-0.082	-0.186	0.327	0.050	-0.148	-0.021	-0.002		
receive	0.163	0.071	-0.075	0.475	0.031	-0.353	-0.028	-0.029	0.024	
quick	-0.086	0.019	0.093	-0.209	-0.047	0.063	0.021	-0.039	-0.236	-0.132

Variable Definitions:

Logaudfees---------Logarithm of audit fees
BigN----------Equal to 1 if a firm selects one of Big N auditors, and 0 otherwise
Logassets----------Logarithm of total assets
Quick----------Quick ratio, current assets minus inventory divided by current liabilities
Aturn----------Assets turnover, Sales divided by total assets
DA----------Long-term debt/total assets ratio
ROA----------Earnings before interest and taxes divided by total assets
Abs_excep---------The absolute value of exceptional assets/total assets ratio
Auditopinion-------Dummy variable, 1 if the audit report is qualified, 0 otherwise
Invent----------The ratio of inventory to total assets
Receive----------Receivables/total assets ratio

The difference of log audit fees between non-Big N and Big N auditees is highly significant. Compare to the means of audit fees, the standard deviations for both non-Big N and Big N subsamples decrease by logarithm transformation. The statistical properties of total assets also improve by logarithm transformation. Compared to Big N clients, non-Big N clients have higher leverage ratio and earn higher returns based on total assets. Non-Big N clients have higher proportion of inventory and lower fraction of receivables in their total assets than Big N clients. Sales of Big N clients are much higher than those of non-Big N clients.

Table 2 presents the correlations among variables. The correlation between log audit fees and log assets, 62 percent, is the highest in the table. It is consistent with prior studies that auditee size is the most important determinant of audit fees. The correlation between log audit fees and the dummy variable BigN is 30 percent, while the correlations between log audit fees and other variables are less than 20 percent. The correlation between BigN and log assets is 30 percent, meaning that larger firms are more likely to select Big N auditors. Two other notable correlations are the correlation between inventory and asset turnover (32.4 percent) and the correlation between receivables and asset turnover (47.5 percent). These two

correlations are intuitive because high asset turnover needs high inventory to support it, and produces high fraction of receivables. Receivables and debt/assets ratio are negatively correlated with the correlation coefficient at -35.3 percent.

4. Regression Results

OLS Model

For comparison, Table 3 presents the results of the OLS audit fee determination model. The model is as follows,

$$Logaudfees = \beta_0 + \beta_1 \log assets + \beta_2 bigN + \beta_3 Aturn + \beta_4 ROA + \beta_5 DA + \beta_6 quick$$

$$+ \beta_7 abs\_excep + \beta_8 auditopinion + \beta_9 invent + \beta_{10} receive + \varepsilon$$

Where:

Logaudfees---------logarithm of audit fees

Logassets----------Logarithm of total assets

BigN----------Dummy variable, 1 if a firm selects one of Big N as its auditor, and 0 otherwise

Aturn----------Assets turnover, Sales divided by total assets

ROA----------Earnings before interest and taxes divided by total assets

DA----------Long-term debt/total assets ratio

Quick----------Quick ratio, current assets minus inventory divided by current liabilities

Abs_excep----------The absolute value of exceptional assets/total assets ratio

Auditopinion-------Dummy variable, 1 if the audit report is qualified, 0 otherwise

Invent----------The ratio of inventory to total assets

Receive----------Receivables/total assets ratio

There are 3973 observations per year, and we run the regressions separately by years because audit fees have increased over years, and there might be some changes in audit pricing standards in different years. The regression models explain about 50 percent of the variations in audit fees. Consistent with prior studies, auditee size is the most significant explanatory variable of audit fees, and the coefficients, ranging from 0.47 to 0.50, are quite consistent across years. The log transformation makes the coefficient equal to the elasticity of audit fees with respect to total assets. Ceteris paribus, when total assets increase by 1 percent, audit fees will increase by about 0.5 percent. The coefficients for the Big N dummy variable

are positively significant for all years, meaning that Big N auditors charge audit fee premiums over non-Big N auditors.

Table 3: OLS audit fee determination model

	1999		2000		2001		2002		2003	
Variable	Coef. Est.	Pr >|t|	Coef. Est.	Pr >|t|	Coef. Est.	Pr >|t|	Coef. Est.	Pr >|t|	Coef. Est.	Pr >|t|
Intercept	-1.405	<.0001	-1.247	<.0001	-1.330	<.0001	-1.391	<.0001	-1.087	<.0001
BigN	0.189	<.0001	0.144	<.0001	0.121	<.0001	0.158	<.0001	0.175	<.0001
logassets	0.481	<.0001	0.473	<.0001	0.480	<.0001	0.487	<.0001	0.500	<.0001
Aturn	0.098	<.0001	0.093	<.0001	0.114	<.0001	0.108	<.0001	0.083	<.0001
ROA	-0.436	<.0001	-0.559	<.0001	-0.590	<.0001	-0.417	<.0001	-0.444	<.0001
DA	-0.313	<.0001	-0.356	<.0001	-0.352	<.0001	-0.358	<.0001	-0.331	<.0001
quick	-0.035	<.0001	-0.038	<.0001	-0.036	<.0001	-0.035	<.0001	-0.031	<.0001
auditopinion	0.031	0.5269	0.098	0.0363	0.089	0.0593	0.033	0.4497	0.198	<.0001
abs_excep	0.120	0.4737	0.150	0.5681	-0.070	0.7705	0.490	0.0374	0.711	0.0047
invent	0.401	<.0001	0.397	<.0001	0.369	<.0001	0.386	<.0001	0.179	0.0037
receive	0.483	<.0001	0.441	<.0001	0.456	<.0001	0.468	<.0001	0.431	<.0001
NO. of OBS	3973		3973		3973		3973		3973	
Adj R2	0.5226		0.5257		0.5161		0.5179		0.4915	

The regression model:

$$Logaudfees = \beta_0 + \beta_1 \log assets + \beta_2 bigN + \beta_3 Aturn + \beta_4 ROA + \beta_5 DA + \beta_6 quick +$$

$$\beta_7 abs\_excep + \beta_8 auditopinion + \beta_9 invent + \beta_{10} receive + \varepsilon$$

where:

Logaudfees---------logarithm of audit fees
Logassets----------Logarithm of total assets
BigN----------Dummy variable, 1 if a firm selects one of Big N as its auditor, and 0 otherwise
Aturn----------Assets turnover, Sales divided by total assets
ROA----------Earnings before interest and taxes divided by total assets
DA----------Long-term debt/total assets ratio
Quick----------Quick ratio, current assets minus inventory divided by current liabilities
Abs_excep----------The absolute value of exceptional assets/total assets ratio
Auditopinion-------Dummy variable, 1 if the audit report is qualified, 0 otherwise
Invent----------The ratio of inventory to total assets
Receive----------Receivables/total assets ratio

As expected, the coefficients of ROA are negative and significant. The coefficients of long-term debt to total assets ratio are negative and significant for all years. Normally higher leverage ratio means higher financial and audit risk, auditors charge higher audit fees accordingly. On the other hand, a higher leverage may lead to stricter monitoring, especially

when debts are mainly concentrated among few lenders, and result in lower audit risk and audit fees. Our result for the leverage ratio is consistent with the latter explanation.[12]

Two Stage Heckman Model

The Heckman model is comprised of two equations. The auditor selection equation (probit model),

$$bigN = \gamma_0 + \gamma_1 \log assets + \gamma_2 Aturn + \gamma_3 ROA + \gamma_4 DA + \gamma_5 quick + \gamma_6 invent + \gamma_7 receive + \varepsilon_i ,$$

and the audit fee determination equation (OLS model),

$$Logaudfees = \beta_0 + \beta_1 \log assets + \beta_2 Aturn + \beta_3 DA + \beta_4 quick + \beta_5 auditopini on + \beta_6 abs\_excep + \beta_7 invent + \beta_8 receive + \beta_\lambda Lambda + v .$$

We use both two-step procedure as well as full maximum likelihood to estimate the Heckman model across years.

To see how well the auditor selection model works, following Chaney et al. (2004), we use a cutoff of 50% to test the prediction accuracy of auditor selection. If the fitted value of the probit model is greater than 0.5 (less than 0.5) given that the auditor is one of the Big N (non-Big N) auditors, we say that the model predicts the auditor selection correctly. Table 4 shows the percentages of correct prediction of auditor selection for the Big N, non-Big N and whole sample in each year.

Table 4: Auditor selection prediction accuracy

	1999	2000	2001	2002	2003
Big N(%)	51	65	69	70	71
Non-Big N(%)	76	62	56	57	58
Whole sample(%)	64	64	63	64	65

From the table we can see that the accuracy for the whole samples across years is about 64% and quite consistent across years. The percentage for Big N prediction in 1999 is only 51%, but it increases to 71 percent in 2003. While for non-Big N clients, the accuracy for year 1999 is the highest, for other years it is about 60 percent. This prediction accuracy is comparable to Chaney et al. (2004).

Table 5 represents the Heckman two-step regression results. In the first step (Table 5, Panel A), logarithm of assets is a positive and significant determinant for firms to choose Big

[12] Since OLS model can't correct self-selection bias and the estimates may be biased, we do not do in-depth analysis. The OLS results presented in Table 3 are mainly for comparison purposes.

N auditors. The coefficients for asset turnover and receivables/total assets ratio are highly significant for most years. These two variables are supposed to reflect the complexity of a firm; so the relationship demonstrates that more complex firms have a higher probability of choosing Big N auditors.

Table 5: The Heckman model, two-step regression

Panel A, Heckman two-step regression results, auditor selection

	Year 1999		Year 2000		Year 2001		Year 2002		Year 2003	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
BigN										
logassets	0.369	0.000	0.381	0.000	0.380	0.000	0.391	0.000	0.395	0.000
aturn	0.046	0.008	0.042	0.018	0.069	0.000	0.064	0.001	0.049	0.006
roa	-0.929	0.000	-0.888	0.000	-0.759	0.000	-0.856	0.000	-0.836	0.000
da	-0.355	0.000	-0.401	0.000	-0.377	0.000	-0.528	0.000	-0.643	0.000
quick	0.004	0.720	-0.003	0.752	0.005	0.673	0.000	0.999	-0.010	0.362
invent	-0.380	0.002	-0.247	0.041	-0.337	0.005	-0.422	0.000	-0.561	0.000
receive	0.441	0.001	0.394	0.004	0.249	0.078	0.260	0.075	0.381	0.008
_cons	-3.980	0.000	-3.980	0.000	-3.964	0.000	-3.997	0.000	-3.986	0.000

The probit regression:

$$bigN = \gamma_0 + \gamma_1 \log assets + \gamma_2 Aturn + \gamma_3 ROA + \gamma_4 DA + \gamma_5 quick + \gamma_6 invent + \gamma_7 receive + \varepsilon_i$$

Panel B, Heckman two-step regression results, for Big N group

	Year 1999		Year 2000		Year 2001		Year 2002		Year 2003	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
logaudfees										
logassets	0.345	0.000	0.333	0.000	0.307	0.000	0.376	0.000	0.372	0.000
aturn	0.085	0.000	0.080	0.000	0.069	0.000	0.087	0.000	0.059	0.000
da	-0.096	0.239	-0.096	0.239	-0.078	0.402	-0.176	0.050	-0.128	0.195
quick	-0.038	0.000	-0.038	0.000	-0.039	0.000	-0.034	0.000	-0.027	0.002
Abs_excep	-0.007	0.971	0.452	0.249	-0.281	0.334	0.201	0.509	0.864	0.011
auditopinion	0.093	0.227	0.122	0.066	0.118	0.092	0.045	0.470	0.226	0.001
invent	0.476	0.000	0.386	0.000	0.497	0.000	0.475	0.000	0.303	0.011
receive	0.293	0.013	0.205	0.061	0.321	0.006	0.325	0.002	0.217	0.049
_cons	0.872	0.124	0.988	0.059	1.357	0.027	0.439	0.384	0.984	0.049
mills										
lambda	-0.772	0.000	-0.798	0.000	-0.968	0.000	-0.671	0.000	-0.733	0.000

The second-step for Big N group:

$$Logaudfees = \beta_0 + \beta_1 \log assets + \beta_2 Aturn + \beta_3 DA + \beta_4 quick + \beta_5 auditopini on + \beta_6 abs\_excep + \beta_7 invent + \beta_8 receive + \beta_\lambda Lambda + v$$

Panel C, Heckman two-step regression results, for non-Big N group

	Year 1999		Year 2000		Year 2001		Year 2002		Year 2003	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
logaudfees										
logassets	0.355	0.000	0.242	0.000	0.342	0.000	0.348	0.000	0.369	0.000
aturn	0.076	0.000	0.059	0.000	0.100	0.000	0.085	0.000	0.067	0.000
da	-0.245	0.001	-0.191	0.035	-0.244	0.006	-0.169	0.068	-0.046	0.679
quick	-0.031	0.000	-0.034	0.000	-0.038	0.000	-0.034	0.000	-0.027	0.001
Abs_excep	0.902	0.026	-0.175	0.628	1.684	0.012	1.072	0.002	0.617	0.074
auditopinion	-0.013	0.838	0.082	0.207	0.102	0.115	0.045	0.464	0.184	0.003
invent	0.605	0.000	0.647	0.000	0.543	0.000	0.594	0.000	0.458	0.000
receive	0.370	0.001	0.378	0.004	0.429	0.000	0.522	0.000	0.503	0.000
_cons	-0.439	0.337	0.466	0.389	-0.383	0.491	-0.341	0.476	-0.195	0.694
mills										
lambda	-0.455	0.044	-0.833	0.001	-0.542	0.043	-0.410	0.071	-0.428	0.075

The second-step for non-Big N group:

$$Logaudfees = \beta_0 + \beta_1 \log assets + \beta_2 Aturn + \beta_3 DA + \beta_4 quick + \beta_5 auditopini on$$

$$+ \beta_6 abs\_excep + \beta_7 invent + \beta_8 receive + \beta_\lambda Lambda + v .$$

Where:

BigN----------Dummy variable, 1 if a firm selects one of Big N as its auditor, and 0 otherwise
Logassets----------Logarithm of total assets
Aturn----------Assets turnover, Sales divided by total assets
ROA----------Earnings before interest and taxes divided by total assets
DA----------Long-term debt/total assets ratio
Quick----------Quick ratio, current assets minus inventory divided by current liabilities
Invent----------The ratio of inventory to total assets
Receive----------Receivables/total assets ratio
Logaudfees---------logarithm of audit fees
Abs_excep----------The absolute value of exceptional assets/total assets ratio
Auditopinion-------Dummy variable, 1 if the audit report is qualified, 0 otherwise
Invent----------The ratio of inventory to total assets
Receive----------Receivables/total assets ratio
Lambda----------Selectivity term, it is the inverse mills ratio calculated from the first step of the probit regression

The coefficient of ROA is negatively significant, indicating that firms with higher ROA are less likely to select Big N auditors. Firms with low profitability may need better service from the more reputable Big N auditors. The coefficient for inventory/total assets ratio is negatively significant for all years, which is counter-intuitive. Quick ratio is not a significant determinant for firms to choose Big N auditors.

In the second step of the Heckman model for Big N group (Table 5, Panel B), as expected, log audit fees are positively correlated with firm size, asset turnover, inventory/total assets ratio and receivables/total assets ratio, and negatively related to quick ratio. The coefficient of lambda is negatively and highly significant for all years, meaning that selection

between Big N and non-Big N auditors is not random. The sign of the coefficients is the same as that in Chaney et al. (2004) for the Big N group.

In Panel C of Table 5, the regression results for non-Big N auditors after correcting selectivity bias are presented. As for Big N auditors, auditee size, asset turnover, inventory/total assets ratio and receivables/total assets ratio are still significant determinants of audit fees for the non-Big N group. The selectivity term is significant at 10 percent level for all years and significant at 5 % level for year 1999, 2000 and 2001. Different from Chaney et al. (2004), the coefficients of the selectivity term for the non-Big N group are negative across years.

Heckman Model with FML Estimation

Table 6 demonstrates the regression results using full maximum likelihood (FML) method. Comparing to the two-step method in Table 5, the magnitude and significance of the coefficients are quite similar in the auditor selection model for client size, asset turnover, debt/assets ratio and receivables to total assets ratio. For the audit fee determinants, there are no big differences for the coefficients and the significance levels of log assets, asset turnover, quick ratio, inventory and receivables to total assets ratios between the two regression methods. Consistent with two-step method, the coefficients of the selectivity term are negative and highly significant. Thus we can conclude that the results are not sensitive to the choice of estimation methods.

Table 6: Heckman model, FML

	Year 1999		Year 2000		Year 2001		Year 2002		Year 2003	
	Coef.	TValue	Coef.	TValue	Coef.	TValue	Coef.	TValue	Coef.	TValue
logaudfees										
logassets	0.360	25.09	0.344	26.11	0.347	26.12	0.363	26.64	0.379	26.57
aturn	0.087	6.09	0.084	6.29	0.078	5.85	0.089	6.40	0.057	4.09
da	-0.087	-1.24	-0.093	-1.37	-0.121	-1.65	-0.135	-1.83	-0.126	-1.66
quick	-0.038	-4.75	-0.035	-4.88	-0.037	-4.58	-0.032	-4.11	-0.027	-3.19
Abs_excep	0.114	0.54	0.363	0.92	-0.422	-1.65	0.140	0.47	0.780	2.36
auditopinion	0.112	1.49	0.160	2.51	0.117	1.83	0.064	1.10	0.239	3.58
invent	0.409	4.13	0.304	3.24	0.394	4.15	0.434	4.47	0.252	2.48
receive	0.327	3.16	0.217	2.23	0.368	3.69	0.342	3.31	0.228	2.20
_cons	0.636	3.53	0.803	4.93	0.761	4.64	0.612	3.65	0.886	4.95
BigN										
logassets	0.366	18.69	0.368	19.06	0.369	19.18	0.378	19.20	0.392	19.30
aturn	0.046	2.56	0.049	2.74	0.075	3.85	0.075	3.88	0.041	2.32
roa	-0.964	-7.01	-1.053	-8.45	-1.072	-8.83	-1.005	-7.77	-0.941	-6.89
da	-0.281	-3.30	-0.347	-4.05	-0.382	-4.18	-0.464	-5.15	-0.599	-6.58
quick	0.006	0.60	0.008	0.81	0.008	0.75	0.007	0.67	-0.012	-1.11
invent	-0.464	-3.87	-0.376	-3.17	-0.468	-3.92	-0.543	-4.56	-0.635	-5.32
receive	0.494	3.62	0.394	2.94	0.290	2.10	0.354	2.48	0.397	2.81
_cons	-3.966	-17.61	-3.852	-17.39	-3.836	-17.23	-3.900	-17.21	-3.936	-16.94
lambda	-0.691	-22.66	-0.726	-29.00	-0.740	-30.06	-0.737	-27.19	-0.690	-20.09

The model specification is the same as in table 5 for the two-step Heckman model.
The definitions of the variables are the same as in Table 5.

Two Stage Treatment Effects Model

In this study, we also employ the treatment effects model to check the selection bias by using two-step and full maximum likelihood methods to estimate the model as well. The first step of the two-step treatment effects model is identical to the selection model in the Heckman two-step method, so it is skipped here. The difference between the treatment effects model and the Heckman model is that treatment effects model uses all observations to run the second step regression whereas the Heckman model only runs regression for one type of auditors. In the treatment effects model, the BigN dummy is included as a regressor after correcting selectivity bias in the second step to catch the difference of the constants between BigN and non-BigN. Table 7 represents the regression results of the treatment effects model using the two-step method.

Table 7:Treatment effects model, two-step

	Year 1999		Year 2000		Year 2001		Year 2002		Year 2003	
	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|	Coef.	P>|z|
logaudfees										
logassets	0.373	0.000	0.356	0.000	0.352	0.000	0.415	0.000	0.408	0.000
aturn	0.081	0.000	0.075	0.000	0.085	0.000	0.093	0.000	0.067	0.000
da	-0.186	0.001	-0.196	0.001	-0.186	0.004	-0.230	0.000	-0.143	0.039
quick	-0.035	0.000	-0.036	0.000	-0.037	0.000	-0.034	0.000	-0.028	0.000
Abs_excep	0.146	0.373	0.183	0.492	-0.032	0.898	0.536	0.022	0.734	0.003
auditopinion	0.039	0.422	0.111	0.018	0.118	0.013	0.055	0.216	0.219	0.000
invent	0.532	0.000	0.487	0.000	0.511	0.000	0.483	0.000	0.338	0.000
receive	0.357	0.000	0.333	0.000	0.385	0.000	0.432	0.000	0.349	0.000
BigN	1.075	0.000	1.102	0.000	1.199	0.000	0.755	0.000	0.932	0.000
_cons	-0.686	0.003	-0.532	0.010	-0.563	0.011	-0.980	0.000	-0.561	0.003
Hazard										
lambda	-0.543	0.000	-0.587	0.000	-0.662	0.000	-0.365	0.002	-0.462	0.000

The second-step of the treatment effects model:

$$Logaudfees = \beta_0 + \beta_1 \log assets + \beta_2 Aturn + \beta_3 DA + \beta_4 quick + \beta_5 auditopini on$$

$$+ \beta_6 abs\_excep + \beta_7 invent + \beta_8 receive + \beta_9 bigN + \beta_\lambda Lambda + v .$$

The definitions of the variables are the same as in Table 5.

Compared to the results of the Heckman model, the main difference is that debt/asset ratio is negative and significant for all years. The significance of other control variables is quite similar as in the Heckman model. The intercepts are negative and significant for all years. The coefficient of lambda is negatively significant for all years, so selectivity bias is

detected using the treatment effects model. The coefficient of BigN is positively significant for all years.

Treatment Effects Model with FML Estimation

Table 8 represents the regression results of the treatment effects model using FML. The coefficients of Big N determinants and their significance levels are quite similar to those in Heckman FML for logassets, ROA, DA and receivables across years. There are some differences for the significance levels of asset turnover and inventory, but the coefficient signs are identical. The magnitudes and significance levels of the coefficients of the important audit fee determinants, such as logassets, asset turnover and receivables/total assets ratio, are quite similar to those in the Heckman FML model. The selectivity term is negatively significant, indicating the existence of selectivity bias.

Table 8: Treatment effects model, FML

	Year 1999		Year 2000		Year 2001		Year 2002		Year 2003	
	Coef.	Tvalue	Coef.	Tvalue	Coef.	Tvalue	Coef.	Tvalue	Coef.	Tvalue
logaudfees										
logassets	0.397	32.31	0.370	33.19	0.373	33.02	0.384	33.15	0.397	31.60
aturn	0.085	9.09	0.077	7.99	0.089	8.65	0.087	8.44	0.065	6.30
da	-0.207	-4.36	-0.211	-4.24	-0.209	-3.85	-0.184	-3.47	-0.123	-2.22
quick	-0.035	-6.26	-0.036	-6.76	-0.037	-5.90	-0.034	-5.87	-0.027	-4.29
Abs_excep	0.180	1.03	0.114	0.44	-0.046	-0.18	0.540	2.24	0.703	2.91
auditopinion	0.042	0.87	0.108	2.34	0.121	2.61	0.054	1.24	0.221	4.80
invent	0.503	7.80	0.474	7.12	0.489	7.03	0.524	7.64	0.358	4.93
receive	0.388	5.40	0.348	4.75	0.400	5.18	0.410	5.22	0.338	4.16
BigN	0.877	13.81	0.989	21.44	1.026	23.51	1.011	20.18	1.024	16.97
_cons	-0.861	-7.02	-0.622	-5.26	-0.696	-5.71	-0.785	-6.46	-0.494	-3.86
BigN										
logassets	0.363	18.27	0.362	18.65	0.363	18.71	0.368	18.66	0.382	18.95
aturn	0.032	1.87	0.026	1.56	0.069	3.66	0.056	2.99	0.032	1.86
roa	-1.060	-6.82	-1.181	-8.45	-1.064	-8.21	-0.986	-7.08	-0.964	-6.90
da	-0.325	-3.76	-0.401	-4.62	-0.414	-4.53	-0.506	-5.58	-0.615	-6.77
quick	0.005	0.42	0.002	0.16	0.008	0.71	0.004	0.36	-0.013	-1.23
invent	-0.337	-2.83	-0.197	-1.66	-0.308	-2.58	-0.399	-3.36	-0.538	-4.52
receive	0.529	3.88	0.524	3.89	0.325	2.35	0.381	2.67	0.458	3.26
_cons	-3.905	-17.10	-3.760	-16.86	-3.767	-16.82	-3.769	-16.59	-3.827	-16.56
lambda	-0.423	-11.14	-0.522	-19.35	-0.560	-22.14	-0.527	-18.04	-0.522	-14.73

The model specification of the auditor selection equation is the same as in the Heckman model. The Definitions of variables are the same as in table 5.

Audit Fee Premiums

To identify Big N audit fee premiums, we calculate the counterfactual effects for both Big N clients and non-Big N clients, i.e., predict log audit fees (alternative audit fees) for Big N clients using the estimated equation for non-Big N clients and do the corresponding calculation for non-Big N firms. The mean differences between actual audit fees and the alternative audit fees reflect whether a type of clients (Big N or non-Big N) select auditors cost-efficiently. Table 9, Panel A represents the mean differences between actual fees and counterfactual fees for Big N and non-Big N clients in the Heckman two-step model. The mean differences between the actual fees and the alternative fees are significantly positive for the Big N auditees for all years.

For the non-Big N group, the mean differences between actual fees and the alternative audit fees had they chosen Big N auditors are significantly negative for all years, meaning that non-Big N clients would have had to spend more audit fees if they had selected Big N auditors. Chaney et al. (2004) find that the mean differences between actual fees and the alternative fees are all negative for both Big N and non-Big N clients. This implies that both Big N and non-Big N clients select their auditors cost-efficiently, and there is no Big N fee premium. In contrast, we find that Big N clients pay more than if they had chosen non-Big N auditors, namely, Big N auditors charge audit premiums over non-Big N auditors.

For the treatment effects model, we can see that the mean difference in expected audit fees between Big N and non-Big N firms is not only decided by the coefficient of the Big N dummy variable, but also the selectivity term. The alternative fees are predicted using the estimated model had Big N (non-Big N) clients chosen non-Big N (Big N) auditors. The mean differences between actual fees and alternative fees are calculated for both Big N and non-Big N clients across years. Panel B and C of Table 9 present the counterfactual effects for treatment effects model using two-step and FML estimation respectively. From both estimation approaches, we can see that the Big N clients pay more audit fees than had they chosen non-Big N auditors, and non-Big N clients pay less audit fees than had they chosen Big N auditors. It costs more (less) for Big N (non-Big N) clients than had they chosen non-Big N (Big N) auditors for all years. The two estimation methods give quite consistent results for every year. Namely, the mean differences between actual fees and the alternative fees are similar for Big N and non-Big N clients using both estimation methods in the same year.

To compare audit fee premiums obtained from OLS, the Heckman and the treatment effects models, we list the percentages of Big N audit fee premiums in Table 10. From the table we can see that consistently across years, the Heckman model presents the highest audit fee premiums among the three models, and the treatment effects model presents the lowest audit fee premiums.

Table 9
Counterfactual effects

Panel A, Counterfactual effects for Heckman two-step

	Year 1999		Year 2000		Year 2001		Year 2002		Year 2003	
	Mean Diff.	Tvalue	Mean Diff.	Tvalue	Mean Diff.	Tvalue	Mean Diff.	Tvalue	Mean Diff.	Tvalue
E(logfees-Alt.fees) for Big N	0.270	11.84	0.421	21.09	0.323	15.42	0.351	16.14	0.372	16.62
E(logfees-Alt.fees) for non-Big N	-0.355	-20.84	-0.185	-10.73	-0.111	-6.16	-0.149	-8.27	-0.182	-9.70

Panel B, Counterfactual effects for treatment two-step

	Year 1999		Year 2000		Year 2001		Year 2002		Year 2003	
	Mean Diff.	Tvalue	Mean Diff.	Tvalue	Mean Diff.	Tvalue	Mean Diff.	Tvalue	Mean Diff.	Tvalue
E(logfees-Alt.fees) for Big N	0.173	12.01	0.119	8.93	0.089	6.55	0.139	10.01	0.149	10.15
E(logfees-Alt.fees) for non-Big N	-0.188	-14.89	-0.144	-11.19	-0.120	-8.96	-0.157	-11.78	-0.174	-11.68

Panel C, Counterfactual effects for treatment FML

	Year 1999		Year 2000		Year 2001		Year 2002		Year 2003	
	Mean Diff.	Tvalue	Mean Diff.	Tvalue	Mean Diff.	Tvalue	Mean Diff.	Tvalue	Mean Diff.	Tvalue
E(logfees-Alt.fees) for Big N	0.177	12.25	0.120	9.03	0.091	6.70	0.127	9.12	0.145	9.85
E(logfees-Alt.fees) for non-Big N	-0.190	-15.03	-0.147	-11.42	-0.123	-9.18	-0.160	-11.94	-0.177	-11.90

Here logfees are the log audit fees (actual fees) Alt. fees are the audit fees Big N (non-Big N) clients would have paid had they selected non-Big N (Big N) auditors. The Alt. fees for Big N (non-Big N) clients are calculated by substituting the variables of the Big N (non-Big N) clients into the equation of non-Big N (Big N) clients.

Table 10: Percentages of audit fee premiums for the three models

	year 1999	year 2000	year 2001	year 2002	year 2003
OLS	0.208	0.155	0.129	0.171	0.191
Heckman 2S	0.310	0.524	0.382	0.420	0.451
Treatment 2S	0.189	0.127	0.093	0.150	0.161

From the statistical point of view, OLS model does not correct the selectivity bias, so it can't be proved to be reliable. Besides, the method to calculate audit fee premiums is different from the Heckman model and the treatment effects model, so the results are lack of comparability. The difference between the Heckman model and the treatment effects model might be caused by two reasons. First, the Heckman model truncates the sample to separately run regressions for both Big N and non-Big N auditees, while the treatment effects model pools all observations together to form one regression equation. It causes different regression coefficients and different predicted values. Second, the Heckman model might cause extrapolation problems, namely, when we substitute the values of Big N (non-Big N) variables into the audit fee determination equation of non-Big N (Big N), the values might be beyond the scope from which the equation is estimated, and unreasonable results might be produced.

So comparing the three models, OLS model is the simplest one although it does not hold if there is self-selection bias. The Heckman model separately fits the Big N and non-Big N subsamples, so from the goodness of fit, it will be superior to the OLS model and the treatment effects model. But when using counterfactual estimation to calculate audit fee premiums, it might cause extrapolation problem. The treatment effects model uses one equation to fit all observations in the sample as the OLS model, so it might be a tradeoff to fit the data. But comparing to OLS, it corrects the self-selection bias, and comparing to the Heckman model, it won't cause extrapolation problem when using counterfactual estimation. Therefore, all three models have their own advantages, and choice of a model will be based on the specific characteristics of data.

5. Conclusions

This study examines audit fee premiums charged by Big N auditors over non-Big N auditors in the Norwegian market. Study of audit fee premiums is possible only after the new law of accounting, "Regnskapsloven", was stipulated in Norway on July 17th, 1998.

For comparison, we first employ the traditional OLS audit pricing model to identify audit fee premiums. Contradictory to Firth (1997), the results show that there are audit fee premiums of Big N auditors consistently across years. Because the auditor selection dummy variable used in the OLS model is potentially endogenous and selectivity bias exists between Big N and non-Big N auditors, we use both the Heckman model and the treatment effects

model to correct the selectivity bias. The two models, each estimated by Two-step and Full Maximum Likelihood estimation methods, consistently show the existence of selectivity bias in two estimation methods. We also use counterfactual estimation to calculate the mean differences between the actual fees and the audit fees firms would have paid had they selected alternative type of auditors. Results show audit fee premiums after correcting selectivity bias. In all three models, the Heckman model shows the highest audit fee premiums.

There are two limitations about these results. First, the audit fee determination model is parsimonious because of data availability. Second, because of the research scope limitation, this study can't tell whether the audit fee premiums originate from the product differentiation or market power of Big N auditors. Nevertheless, this study represents one of the few studies using samples from continental European countries and the finding of audit fee premiums in Norway is a breakthrough from Firth (1997).

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Appendix MODEL SPECIFICATIONS

1. Ordinary Least Square (OLS) Regression Model

The traditional method uses a dummy variable of auditor selection in the OLS regression to examine Big N audit fee premiums. Most prior studies used the following regression model:

$$LogAudfees = \beta_0 + \beta_1 X + \gamma bigN + \varepsilon .$$

where LogAudfees is the logarithm of audit fees a firm pays to its auditor, and BigN is a dummy variable that takes value of one if a firm's auditor is one of the Big N auditors, and zero otherwise. X is a set of other explanatory variables that capture the effects of firm and auditor characteristics on audit fees. A positively significant coefficient of BigN indicates Big N auditor fee premiums.

2. Heckman Two-Stage Regression Model (Heckman 1979; Lee 1979)

Audit fee regression equations: $y_{0i} = x_{0i}\beta_0 + v_{0i}$ if $AUD_i^* \le 0$

$$y_{1i} = x_{1i}\beta_1 + v_{1i} \quad \text{if } AUD_i^* > 0$$

Sample selection equation:

$$AUD_i^* = z_i\gamma + \varepsilon_i ,$$

where AUD_i^* is the benefit to hire a Big N auditor, and BigN=1 if $AUD_i^* > 0$; BigN=0 if $AUD^*{}_i \le 0$. Z is the set of auditor selection determinants.

To show the selectivity bias, we take the expectation of y_{1i} given X and the fact that BigN is one, and the expectation of y_{0i} given X and the fact that BigN is zero,

$$E(y_{1i} \mid x_i, z_i, bigN_i = 1) = E(y_{1i} \mid x_i, z_i, \varepsilon_i > -z_i\gamma) = x_{1i}\beta_1 + E(v_{1i} \mid \varepsilon_i > -z_i\gamma) \quad (1)$$

$$E(y_{0i} \mid x_i, z_i, bigN_i = 0) = E(y_{0i} \mid x_i, z_i, \varepsilon_i \le -z_i\gamma) = x_{0i}\beta_0 + E(v_{0i} \mid \varepsilon_i \le -z_i\gamma) \quad (2)$$

Now take equation (1) as an example and assume that v_1 and ε are jointly distributed with distribution function $f(v_1, \varepsilon)$. Then according to Bayes rules, we can write

$$E(v_1 \mid \varepsilon > -z\gamma) = \frac{\int_{-\infty}^{\infty}\int_{-z\gamma}^{\infty} v_1 f(v_1, \varepsilon)\, d\varepsilon\, dv_1}{\int_{-\infty}^{\infty}\int_{-z\gamma}^{\infty} f(v_1, \varepsilon)\, d\varepsilon\, dv_1} = \mu(z\gamma), \quad (3)$$

where $\mu(z\gamma)$ is a function of $z\gamma$. So the conditional expectation of y_{1i} given X, z and BigN=1 is biased if $\mu(z\gamma)$ is not equal to zero.

Empirically, the residuals of the outcome equation and the residuals of the auditor selection equation are assumed to be bivariate normally distributed. Thus the selection equation becomes a Probit model. This is the Heckman selection model.

There are two ways to estimate the model: two-step and full maximum likelihood. The Heckman model first assume the following trivariate joint normal distribution for v_0, v_1 and ε,

$$\begin{pmatrix} v_0 \\ v_1 \\ \varepsilon \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_0^2 & \sigma_{01} & \rho_0\sigma_0 \\ \sigma_{01} & \sigma_1^2 & \rho_1\sigma_1 \\ \rho_0\sigma_0 & \rho_1\sigma_1 & 1 \end{pmatrix} \right]$$

where ρ_0 and ρ_1 are the correlations between v_0 and ε and between v_1 and ε respectively. The variance of the disturbance in the Probit equation is normalized to one without loss of generality [Johnson and Kotz (1970)]. Then equation (1) becomes

$$E(y_{1i} \mid x_i, z_i, bigN_i = 1) = x_{1i}\beta_1 + \rho_1\sigma_1 \frac{\phi(-z_i\gamma)}{1-\Phi(-z_i\gamma)}$$

$$= x_{1i}\beta_1 + \rho_1\sigma_1 \frac{\phi(z_i\gamma)}{\Phi(z_i\gamma)} \qquad (4)$$

where $\phi(\bullet)$ and $\Phi(\bullet)$ are normal probability density function and distribution function respectively. $\frac{\phi(z_i\gamma)}{\Phi(z_i\gamma)}$ is called Inverse Mill Ratio (IMR). Since IMR is always positive, the regression line for y on x will be biased upward when ρ_1 is positive and downward when ρ_1 is negative. Using similar logic, equation (2) for non-Big N auditees becomes

$$E(y_{0i} \mid x_i, z_i, bigN = 0) = x_{0i}\beta_0 + E(v_{0i} \mid \varepsilon_i \le -z_i\gamma) = x_{0i}\beta_0 - \rho_0\sigma_0 \frac{\phi(-z_i\gamma)}{\Phi(-z_i\gamma)}$$

$$= x_{0i}\beta_0 - \rho_0\sigma_0 \frac{\phi(z_i\gamma)}{1-\Phi(z_i\gamma)} \qquad (5)$$

Equation (4) and (5) suggest a way to estimate the self-selection model. First we obtain the estimates of γ, $\hat{\gamma}$ by running the Probit regression of the auditor selection model, and then we substitute $\hat{\gamma}$ into equations (4) and (5) and run OLS regressions for both Big N and non-Big N auditees. So the unbiased estimates of parameters β can be obtained from the second step OLS regressions after correcting the selectivity bias.

3. Counterfactual Estimation [Maddala (1983, P260, 261)]

The self-selection model is easy to identify selectivity bias, but it is deficient to evaluate the effect of self-selection. Specifically, in this study it is hard to evaluate the effects of selecting Big N auditors on audit fees. Maddala (1983, P260, 261) uses counterfactual estimation to assess the effects of self-selection. In our case, the method is as follows. To see whether there is any audit fee premium of Big N auditors, we will assess the mean difference between the actual fees Big N clients paid to their auditors and the audit fees they would have paid had they chosen non-Big N auditors, and assess the mean difference between the actual fees non-Big N clients paid to their auditors and the audit fees they would have paid had they selected Big N auditors. For a Big N auditee if it had chosen a non-Big N auditor, the conditional expected audit fees are

$$E(y_{0i} \mid bigN_i = 1) = x_i\beta_0 + E(v_{0i} \mid \varepsilon_i > -z_i\gamma) = x_i\beta_0 + \rho_0\sigma_0 \frac{\phi(z_i\gamma)}{\Phi(z_i\gamma)} \qquad (6)$$

The expected conditional audit fees for a non-Big N auditee had it chosen a Big N auditor are

$$E(y_{1i} \mid bigN_i = 0) = x_i\beta_1 + E(v_{1i} \mid \varepsilon_i \le -z_i\gamma) = x_i\beta_1 - \rho_1\sigma_1 \frac{\phi(z_i\gamma)}{1-\Phi(z_i\gamma)} \qquad (7)$$

4. Treatment Effects Model

The treatment effects model is also used in this study to deal with the selectivity problem (Green 2003). It starts from the traditional model for testing Big N fee effects using a BigN dummy variable in the OLS regression model

$$y_i = x_i\beta + \delta bigN_i + v_i$$

and the auditor selection model

$$AUD_i^* = z_i\gamma + \varepsilon_i$$

where AUD_i^* is the gain/benefit to hiring a Big N auditor. $BigN_i$=1 if AUD_i^*>0, and 0 otherwise.

Here v_i and ε_i are assumed to be normally distributed. Combining the two equations, we will find that

$$E[y_i \mid bigN_i = 1, x_i, z_i] = x_i\beta + \delta + \rho\sigma_v \frac{\phi(z_i\gamma)}{\Phi(z_i\gamma)} \qquad (8)$$

and for the non-Big 5 group,

$$E[y_i \mid bigN_i = 0, x_i, z_i] = x_i\beta + \rho\sigma_v \frac{-\phi(z_i\gamma)}{1-\Phi(z_i\gamma)}. \qquad (9)$$

So the mean difference in expected audit fees between Big N and non-Big N firms is,

$$E[y_i \mid bigN_i = 1, x_i, z_i] - E[y_i \mid bigN_i = 0, x_i, z_i] = \delta + \rho\sigma_v \frac{\phi(z_i\gamma)}{\Phi(z_i\gamma)(1-\Phi(z_i\gamma))} \qquad (10)$$

5. Comparison of Heckman model, Treatment Effects Model and Counterfactual Estimation

The difference between the Heckman model and the treatment effects model exists in two ways. First the Heckman model truncates the sample and only keeps observations of one type of auditor selection in the second step regression while the treatment effects model uses the whole sample in the second step regression. Second, the Heckman model uses two sets of coefficients to fit Big N and non-Big N auditees separately, and the treatment effects model uses one set of coefficients to fit both types of auditees. So the Heckman model may separately fit both Big N and non-Big N auditees better than the treatment effects model. But when using counterfactual estimation to calculate audit fee premiums, if there are significant differences between the coefficients of Big N and non-Big N audit fee determination equations, there might be extrapolation problem. Although the treatment effects model might not perfectly fit both Big N and non-Big N auditees, it makes a trade-off for the extrapolation problem.

From equation (4), (5), (8) and (9) we can see that if the error term ε in the auditor selection equation is independent of the error term in the audit fee determination equation, then the estimated β and δ will be unbiased. But if they are correlated, then there will be selectivity bias, the traditional method to examine Big N audit fee premiums doesn't hold and we need to use self-selection models to correct it.