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Common auditor and supplier's performance

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COMMON AUDITOR AND SUPPLIER'S PERFORMANCE

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MPHIL

LINGNAN UNIVERSITY

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COMMON AUDITOR AND SUPPLIER'S PERFORMANCE

by
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ABSTRACT

Common Auditor and Supplier's Performance

by

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Master of Philosophy

I examine the effect of a common auditor in supply chain on supplier's performance. A common auditor in supply chain is defined as the same audit firm that provides auditing services to both the supplier and the customer. As the common third party, the common auditor could transfer information between supplier and customer, which might benefit the performance of the supplier. I find that a common auditor can increase supplier's ROA and this effect is driven by the reduction of supplier's production cost. I also find that a common auditor can reduce supplier's receivables conversion periods. This finding gives evidence that supplier gains more bargaining power in supply chain through the presence of common auditor, which might contribute to the positive effect of common auditor on supplier's ROA. The common auditor effect of improving supplier's performance is found to be more pronounced when there is high information asymmetry in supply chain, when the supplier and customer use the same audit office, and before the enactment of the Sarbanes-Oxley Act, which gives evidence that common auditor plays an information intermediary role in improving supplier's performance. As for the information content transferred by common auditor, I find that common auditor can reduce supplier's bullwhip effect. This finding indicates that common auditor might transfer customer's demand information to supplier so that the supplier could make better capacity planning and thus reduce production cost. Overall, the results show that supplier can benefit from the presence of common auditor, and the results are robust to alternative measure of common auditor, and potential endogeneity concerns.

Key words: Common Auditor, Supply Chain, Supplier's Performance

DECLARATION

I declare that this is an original work based primarily on my own research, and I warrant that all citations of previous research, published or unpublished, have been duly acknowledged.

SIGNED

(ZHUANG Lei)

Date: 17/09/2021

CERTIFICATE OF APPROVAL OF THESIS

COMMON AUDITOR AND SUPPLIER'S PERFORMANCE

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1. Introduction

I examine whether and how a supplier will benefit from sharing an auditor with its customers. I hypothesize that common auditor can foster information transfer between supplier and its customers, which can improve the supplier's financial performance and give supplier more bargaining power. I also predict that the common auditor effect will be more pronounced when increased information transfer is more important and significant.

Auditors have been shown to play an information intermediary role among their clients. For example, auditors can gather and spread information about tax savings strategies within their network ties (Bianchi et al. 2014; Lim et al. 2018). In mergers and acquisitions, the auditor who audits both the acquirer and target companies could improve the acquirer's acquisition quality by transferring more information of the target to the acquirer (Dhaliwal et al. 2016; Cai et al. 2016). And in supply chain, the auditor who audits both the supplier firm and the customer firm can improve relationship specific investments by reducing information asymmetry and mitigate hold-up problems (Dhaliwal et al. 2017).

Common auditor in supply chain could foster information transfer between suppliers and customers through three channels. First, common auditor can increase accounting comparability between suppliers and customers (Dhaliwal et al. 2017). High accounting comparability facilitates the supply chain partners to learn about each other through better interpretation and understanding of each other's accounting information. Second, common auditor can improve accounting quality of supply chain partners (Johnstone et al. 2014; Chen et al. 2012; Huang et al. 2014). High accounting quality can increase the reliability of the accounting information and reduce managers' myopic

and opportunistic behavior, which can improve firms' information environment to their supply chain partners. Third, common auditor could transfer information through discussions with the managers of supply chain partners. Common auditor has access to general information and senior executives of both the supplier and the customer in the conduct of its audits. So common auditor has opportunity to transfer information through discussions with firm managers of both supplier and customer, whether intentional or otherwise.

The information asymmetry reduction by common auditor between the supplier and the customer could influence supply chain partners' operating performance. As far as I know, there is no extant study examining the effect of common auditor on corporate operating performance, this study is going to investigate this association by examining the impact of common auditor on supply chain partners' operating performance. As listed firms are only required to report their major customers but not their major suppliers, in this study, I investigate the impact of common auditor on supplier's performance.

The information transfer by common auditor could have positive effect on supplier's performance, as information sharing plays an important role in supply chain management (Zhou and Benton 2007). More information sharing between the supplier and its customers can increase supplier's sales (Schloetzer 2012). And the information sharing in supply chain has positive effect on supply chain partners' coordination and collaboration (Inderfurth et al. 2013), which can increase supply chain efficiency and reduce cost. Thus common auditor in supply chain could foster information transfer between suppliers and customers and increase supplier's performance. So I conduction empirical tests to examine whether common can improve supplier's performance.

In my empirical testes, I collected the supply chain relationship data from the Compustat Segments-Customer database. The firms' financial information and audit firm data is from Compustat Fundamental Files and the audit office data is from Audit Analytics database. My final sample includes 68,887 supplier-customer-year observations which stands for 40,399 supplier-year observations for the period from 1977 to 2016. To test the impact of common auditor on supplier's performance, I use the supplier-year observations as my testing sample. The characteristics of supplier's customer base is measured by using the sales-weighted average method. I use ROA as the main measure of supplier's operating performance.

In my regression models, the primary explanatory variable is *Pct_Common_Auditor* which is the percentage of the supplier's sales accounted for by the customers who use the same auditor as their supplier. I also measure the common auditor presence by suing an alternative variable *Dum_Common_Auditor* that is an indicator variable equal to 1 if at least one of the supplier's customers uses the same auditor as the supplier, and 0 otherwise. The regression result shows that there's a positive and significant association between common auditor and supplier's ROA, which means that common auditor can improve supplier's performance.

To understand how common auditor improves supplier's performance, I investigate which aspects of supplier's performance can be influenced by common auditor. To test this, I employ DuPont Profitability Analysis to decompose supplier's ROA. By taking the different components as dependent variables, I run regressions to see what impact common auditor has on each of the components. Based on the results, I find that the positive impact of common auditor on supplier's performance is mainly driven by the increase of supplier's gross margin. As I did not find a significant association between

common auditor and supplier's sales, the gross margin increase is supposed to come from the reduction of cost of goods sold. This indicates that common auditor improves supplier's performance mainly by reducing supplier's production cost. Besides, I find that common auditor has no significant effect on supplier's transaction cost (SG&A expenses).

To further explore whether the reduction of supplier's production cost is because that common auditor could transfer customers' demand information to the supplier, I examine the impact of common auditor on supplier's bullwhip effect which is measured by the ratio of supplier's production variability to its customers' demand variability. The empirical finding shows that there a negative association between common auditor's presence and supplier's bullwhip effect, which further proves that common auditor can reduce supplier's production cost and also gives evidence that common auditor might transfer customers' demand information to the supplier.

The information transfer by common auditor could also influence supplier's bargaining power, which might contribute to the common auditor's positive effect on supplier's performance. As the supplier's major customers should be the more powerful party in the supply chain relationships, the major customers could ask the supplier to share more information to them and thus they will face less information asymmetry of the supplier. Then the information transfer by common auditor could be more important to the supplier to reduce its information asymmetry of its major customers, and thus might give the supplier more bargaining power. If the supplier gets more bargaining power, it might pressure the customers to provide more concessions such as carrying less inventory, increasing prices, and reducing trade credit (Porter 1974). As there is no data of supplier's price, I use supplier's receivables conversion

period and inventory conversion period as the proxies for supplier's bargaining power. I find that common auditor can significantly reduce supplier's receivables conversion period, which gives evidence that common auditor can increase supplier's bargaining power and thus improve supplier's performance. There's no significant result on supplier's inventory conversion period though.

To test the information intermediary role of common auditor in implementing its effect on supplier's performance, I do cross-sectional tests based on supply chain information environment. I find that the common auditor's positive effect on supplier's performance is more pronounced when the supplier has higher information asymmetry of its customers. The information asymmetry is proxied by corporate uncertainty captured by stock return volatility and bid-ask spread. This finding indicates that common auditor conducts its impact by facilitating information flow along supply chain.

Besides I expect that common auditor's information intermediary role will be more significant when supplier and customer use the same auditor office. As office-level common auditor has a higher probability of personnel overlap of auditing engagements and has a bigger effect on increasing accounting comparability than firm-level common auditor (Chen et al. 2020), it can facilitate more information flow between suppliers and customers. The empirical finding is that the positive effect of common local audit office on supplier's performance is larger and more significant than that of the common auditor from the same audit firm but not the same office. This finding confirms my expectation that the effect of the common auditor is more pronounced if supplier and customer share the same audit office than just the same audit firm.

Finally, I examine whether the enactment of the Sarbanes–Oxley Act (SOX) influences the effect of common auditor. Section 201 of SOX constrains auditors from providing other services than auditing service to their clients, which enhances the independence of auditor role. Thus the common auditor would have less information to transfer and the opportunity of transferring information would also be reduced. And accordingly the impact of common auditor might be reduced after the enactment of SOX. The empirical result shows that the positive impact of common auditor on supplier's performance is no longer significant after SOX. In further exploration, I find that the common auditor effect is more pronounced when the common auditor provides non-audit services to the supplier, which supports the influence of SOX and gives insight that common auditor might transfer information through non-audit services. The results of both the office-level common auditor and the SOX tests further confirm that common auditor conduct its effect by facilitating information flow along supply chain and also give some evidence that common auditor can transfer information through discussion with firm managers.

Overall, the findings of this study show that supplier can benefit from the presence of common auditor and the result is robust by using alternative measure of common auditor and addressing potential endogeneity concerns.

This study has several contributions. Firstly this is the first study to investigate the impact of common auditor on suppliers' performance. This research contributes to the stream of the extant literature of the impact of common auditor in supply chain. Previous literature mainly study the impact of common auditor in supply chain on improving auditing quality (Johnstone et al. 2014; Chen et al. 2012; Huang et al. 2014). Besides, Dhaliwal et al. (2017) study common auditor effect on increasing relationship

specific investments in supply chain. This study adds the impact of the common auditor's information intermediary role on improving supplier's operating performance.

Secondly, this research contributes to the stream of the extant literature of the impact of the information intermediary role of auditors on their clients' corporate behavior and performance. Extant studies mainly investigate the impact of auditors' information intermediary role on corporate investment performance and financing performance. Common auditor can influence firms' investment activities such as mergers and acquisitions (Cai et al. 2016), relationship-specific investment along supply chains (Dhaliwal et al. 2017). Common auditor can also influence firms' financing performance, such as firm's bank loan interest rate (Francis and Wang 2021). Except for the investment and financing performance, this study adds evidence of the impact of auditors' information intermediary role on corporate operating performance by examining the effect of common auditor in supply chain on supplier's operating performance.

Thirdly, responding to Cai et al. (2016)'s call for studies of what information contents that common auditor could transfer, this research tries to recognize the potential information contents that common auditor could transfer along the supply chain relationship. Many studies have examined the information intermediary role of common auditor in many different relationships such as mergers and acquisitions (Cai et al. 2016; Dhaliwal et al. 2016), industry peers (Francis et al. 2014), and supply chains (Dhaliwal et al. 2017), but what information contents that common auditor could transfer along these relationships have not been explored. This study tries to fill this gap by giving some evidence that common auditor might transfer customer's

demand information to supplier.

2. Literature Review

2.1 Auditor's Information Intermediary Role

By conducting auditing services, auditors knows very well of their clients' financial situation and operating performance. Thus, auditors have the opportunity to transfer information among their clients. In previous literature, auditors have been found to play an information intermediary role among their clients. Bianchi et al. (2014) and Lim et al. (2018) find that auditors can gather and spread information about tax savings strategies among their client firms, and Bae et al. (2017) find that auditors can give their clients information advantages which can improve clients' investment efficiency. In mergers and acquisitions, Cai et al. (2016) find that the auditor who audits both the acquirer firm and the target firm can improve information transfer between acquirer and target firms and thus increase the quality and stock market performance of the merger deal. Also, Dhaliwal et al. (2016) find that common auditor in mergers and acquisitions might transfer more information of target firm to acquirer firm than vice versa, which could benefit the acquirer but at the expense of the target firm. In supply chain, Dhaliwal et al. (2017) find that the common auditor who audits both the supplier firm and the customer firm can reduce information asymmetry by increasing financial statements comparability between the supplier and the customer, leading to more relationship specific investment in supply chain. These literatures give evidence that auditor could foster information flow among its clients.

2.2 Common Auditor and Information Asymmetry in Supply Chain

As auditor can play an information intermediary role among its clients, the common auditor in supply chain could reduce information asymmetry between suppliers and

customers by playing this role. There are three potential channels through which common auditor in supply chain could foster information transfer between the supplier and the customer: (1) improving accounting comparability; (2) improving accounting quality; (3) discussing with the management.

The first channel is improving accounting comparability between the supplier and the customer. By conducting auditing services, auditor can increase accounting comparability among its clients. Because different audit firms have different auditing styles, such as different interpretation and implementation of accounting rules, the financial statements audited by the same audit firm should be more comparable (Francis et al. 2014). What's more, even in the same auditor firm, different individual auditors may have different styles in implementing the accounting rules. Thus, client firms with a common individual signing auditor exhibit even higher accounting comparability than when they are audited by the same audit firm but different offices or the same auditor office but different individual auditor (Jiu et al. 2020; Chen et al. 2020). Specifically in supply chain, Dhaliwal et al. (2017) find that common auditor can increase accounting comparability between the supplier and the customer by measuring the similarity of business description sections of financial statements. High accounting comparability can let connected client firms have a better understanding of each other's financial and operating performance and get more useful information. Chircop et al. (2020) find that higher accounting comparability with industry peers can help a firm to learn R&D investment experience from its industry peers, which can increase that firm's innovative efficiency. In the same way, suppliers and customers can learn more information of each other from higher accounting comparability. For example, through higher accounting comparability, suppliers could learn the financial health of its customers, so that it can select better financial situation customers and

thus reduce its account receivables conversion period. Besides, through better interpretation of each other's sales and inventory data in accounting reports, a supplier can learn more information of its customer's demand and a customer can learn more information of its supplier's supply and capacity. What's more, through better understanding of customers' procurement, a supplier can learn more information of its customers' production cost. Also, through better understanding of suppliers' customer service cost, a customer can learn more information of its suppliers' product quality.

The second channel is improving accounting quality of the supplier and the customer. By auditing both the supplier and the customer, common auditor can get better supply chain knowledge. This knowledge is valuable in helping the common auditor to detect questionable accounting practices of the supplier and customer, leading to higher audit quality. Many literatures have found that common auditor in supply chain is associated with higher audit quality. Chen et al. (2012) find that sharing a common auditor with customers can reduce the probability of supplier's accounting restatements. And auditor's supply chain knowledge is associated with higher audit quality (Johnstone et al. 2014). Higher audit quality leads to higher accounting quality. And higher accounting quality increases the transparency and credibility of the accounting financial information which can help to reduce information asymmetry. For instance, higher accounting quality could reduce the possibility of firms to fancy their operating numbers, such as sales and earnings, by constraining earnings management. With more accurate information of customers' earnings, a supplier can have better understanding of its customers' operating performance, so that it can select better performed customers as supply chain partners and improve its own performance. Besides, with more accurate information of customers' sales, a supplier can have better forecast of its customers' demand, so that it can make better production planning. In turn, with

more accurate information of suppliers' sales, a customer can have better understanding of its suppliers' capacity.

The third channel is discussing with the management of both the supplier and the customer. Auditor always has discussions with firm managers in the preparation of financial statements and in non-audit services. In these soft talks, common auditor might transfer extra information of other clients or expertise of other industries to that firm, whether intentional or otherwise. For instance, by auditing a supplier's customers, the common auditor would have certain understanding of the demand of the customers and the customers' industry. So the common auditor could transfer its knowledge of customers' demand to the supplier when discussing with supplier's managers about its sales situation, so that the supplier could get more demand information of its customers through this discussion. In the same way, common auditor could transfer any other information related to supply chain when it checks the accounting information of supply chain transactions with the firm managers. Although there is no direct evidence proving this behavior of common auditor in supply chain, there is some indirect evidence in mergers and acquisitions. Dhaliwal et al. (2016) find that in mergers and acquisitions, common auditor could transfer more information of target firm to acquirer firm which will benefit the acquirer but at the expense of the target firm. In addition, Cai et al. (2016) find that the effect of common auditor is more pronounced when the target and acquirer companies share the same audit office than just the same audit firm, as there is higher probability of personnel overlap and information sharing between the two engagement teams. The evidence in mergers and acquisition also gives potential for common auditor in supply chain to transfer information through this channel. And I'll give some indirect evidence in supply chain in my empirical tests.

2.3 Information Asymmetry in Supply Chain and Supplier's Performance

It is well known that information asymmetry in supply chain is negatively associated with the performance of the supply chain and the supply chain partners. The information asymmetry in supply chain studied by previous literature mainly includes customer's demand and cost information asymmetry, and supplier's supply and quality information asymmetry (Shen et al. 2019).

Thus, reducing information asymmetry could improve supply chain performance. Schloetzer (2012) show that more information sharing between the manufacturer and its distributors can increase sales growth, sales productivity and profitability. Inderfurth et al. (2013) find that information sharing between supplier and customer has positive effects on supply chain coordination. Better supply chain coordination can increase supply chain efficiency and reduce cost.

The reduction of different kinds of information asymmetry could benefit the supplier and even the supply chain. Getting more cost structure information of the customer is valuable for supplier (Corbett et al. 2004). Cao et al. (2013) show that the manufacturer's profit will always increase when the retailer's cost information is shared with him in the dual-channel supply chain. Besides, Lee et al. (2000) find that the demand information sharing in a two-level supply chain consisting a manufacturer and a retailer can reduce the manufacturer's inventory holding and shortage cost. And Yan and Pei (2011) show that sharing demand information with each other between a manufacturer and retailers will always benefit the multi-channel manufacturer. In addition, Wang et al. (2006) find that reducing quality information asymmetry can increase supplier's profit. And Terlaak and King (2006) show that quality information certified by ISO 9000 Quality Management Standard can reduce information

asymmetry and increase supplier's sales growth. What's more, Jain and Moinzadeh (2005) demonstrate that the retailer's order rate might increase if the supply information is updated in the supply chain. And Budde and Minner (2015) show that the supply chain performance can be improved if the supplier could update its supply information in the supply chain, such as capacity information.

Except the supply chain related information, the transfer of other information, such as proprietary information and industry expertise, could also benefit the supply chain. Hong et al. (2014) show that complete sharing and proper and secure use of the proprietary information are important to supply chain collaboration which would create significant savings and financial benefits. Dass et al. (2014) show that directors from the industries of the firm's suppliers or customers have an economically significant positive effect on firm value (Tobin's Q) and performance (ROA) by sharing industry information and expertise.

3. Hypothesis Development

The above literatures give evidence and potential mechanism that common auditor in supply chain could play an information intermediary role between suppliers and customers, and this role could influence the supply chain performance. As far as I know, no extant study has examined the impact of common auditor on corporate operating performance. This study is going to find evidence of this association by examining the impact of common auditor on supply chain partners' performance. As listed firms are only required to report their major customers but not their major suppliers, there is a data limitation to study customers' supply chain performance. Therefore, in this study, from suppliers' perspective, I examine the impact of common auditor on supplier's performance.

As common auditor could play an information intermediary role in supply chain, it can transfer information between the supplier and customer, which would improve supplier's performance[1]. For instance. If common auditor can transfer customer's demand information to the supplier, such as customer's capacity planning, the supplier could have better sales forecast and better capacity planning, leading to less production cost (Lee et al. 2000). Besides, if common auditor can transfer customer's cost information to the supplier, such as customer's procurement cost, the supplier could set its price more appropriately and thus get higher sales and more profit (Cao et al. 2013). What's more, if the common auditor can transfer supplier's supply and quality information to the customer, such as supplier's capacity planning and customer service cost, it might increase the customer's order rate and increase the supplier's sales (Jain and Moinzadeh 2005; Terlaak and King 2006).

As it is well known that information asymmetry is negatively associated with supply chain performance, the reduction of information asymmetry by common auditor could benefit the supply chain and thus the supplier's performance. As information sharing plays an important role in supply chain management (Zhou and Benton 2007) and in the collaboration and coordination (Inderfurth et al. 2013) between suppliers and customers, the information transfer by common auditor could improve supply chain efficiency and then increase supplier's sales and reduce supplier's cost, leading to better supplier's performance. So, I expect that there is a positive association between common auditor and supplier's performance. Thus, my first hypothesis is that:

[1] There is possibility that common auditor might transfer some information which would hurt supplier's performance. For instance, if common auditor transfers supplier's confidential information, such as R&D investment information, which is used opportunistically by the customer, the supplier's benefit would be hurt. As this kind of behavior would let the common auditor face high litigation risk or reputation risk, the common auditor would be less likely to behave this way.

H1: Common auditor in supply chain has a positive effect on supplier's performance.

To further investigate the sources of the positive effect of common auditor on supplier's performance, I examine which components of supplier's performance will be influenced by common auditor. As information sharing in supply chain can increase supplier's sales (Schloetzer 2012), and improve supply chain coordination and thus reduce supplier's cost, the information transfer by common auditor could also improve supplier's performance by increasing supplier's sales and reducing supplier's cost.

The transfer of different information contents may have different effects on supplier's sales and cost. As discussed above, the transfer of customer's cost information, supplier's supply and quality information could improve supplier's sales by raising supplier's price, increasing customer's order rate and increasing the credibility of supplier's product, respectively. And the transfer of customer's demand information could reduce supplier's distortion of demand forecast, improve supplier's production planning and thus reduce supplier's production cost. But as far as I know, there is no evidence of the information contents transferred by common auditor and no evidence of whether the information transfer is bidirectional or unidirectional between suppliers and customers. Thus the positive effect of common auditor on supplier's operating performance could come from supplier's sales increase or cost reduction or both. So my second hypothesis is that:

H2a: The positive effect of common auditor on supplier's performance comes from supplier's sales increase.

H2b: The positive effect of common auditor on supplier's performance comes from supplier's cost reduction.

As getting more information of the counterparty in a transaction can increase the focal party's bargaining power in negotiations, the information transfer by common auditor in supply chain could influence supplier's bargaining power, which might contribute to the positive effect of common auditor on supplier's performance. For instance, if common auditor can transfer customer's cost information to supplier, the supplier could gain more bargaining power on setting higher price and thus increase sales and profit. And if common auditor can transfer customer's demand information to supplier, the supplier could gain more bargaining power on holding less inventory, which could increase supplier's inventory turnover and reduce supplier's inventory holding cost.

Although common auditor could also transfer supplier's information to customer and increase customer's bargaining power, the supplier might gain more bargaining power from common auditor than customer does. As listed firms are only asked to report their major customers, thus in my sample, the average size of customer firms is much larger than the average size of supplier firms. Therefore it is reasonable to consider the customer as the more powerful party in supply chain transactions in my sample. And as the more powerful party, customers can ask their suppliers to share more information. Thus the customers will face less information asymmetry of their suppliers. On the contrary, suppliers might face much information asymmetry of their customers. Then the information transfer fostered by common auditor would give more valuable customer information to the supplier than vice versa. That is to say the marginal effect of the common auditor presence would be larger to the supplier than to the customer, which could give the supplier more bargaining power.

If the supplier gains more bargaining power from common auditor, it can ask for more benefits, such as carrying less inventory, increasing prices, and reducing trade credit,

which would improve supplier's performance (Porter 1974). So my third hypothesis is that:

H3: Common auditor can increase supplier's bargaining power that might contribute to the positive effect of common auditor on supplier's performance.

As the impact of common auditor on supplier's performance is mainly caused by the effect of information sharing, the marginal effect of common auditor presence should be larger in higher information asymmetry environment. So the association between common auditor presence and supplier's performance is expected to be more pronounced in the environment where there is more information asymmetry between suppliers and customers. Thus the fourth hypothesis is that:

H4: The positive effect of common auditor on supplier's performance is more pronounced in high information asymmetry environment.

4. Sample and Descriptive Analysis

According to FASB and SEC's requirements, listed firms in the US are required to disclose their major customers. This customer information can be found in the Compustat Segments-Customer database. I use the major customer data collected from this database as the supplier-customer relationship sample[2]. I incorporate into the sample the suppliers and customers' financial information from Compustat Fundamentals Files, and the stock transaction data from the CRSP database.

[2] Thank Dr. ZHANG Yue for providing the supplier-customer relationship data matched with customer *Gvkey*.

In my sample, I require the supplier-customer relationships to have data of the supplier's sales generated from the customer. As this study examines the impact of common auditor's information intermediary role between suppliers and customers, I also require the suppliers in my sample to have auditor information. For customers without auditor information, I regard these customers as not having common auditor with their suppliers. I remove the observations without suppliers' or customers' financial information, including total assets, leverage, sales growth and ROA. For firms missing information of R&D investments and advertisement expenses, I regard them as having no expenditure on R&D and advertisement. I require my sample to have available data of all variables in the baseline test, but I allow for different sample sizes in other tests based on data availability. Finally, my sample for the base-line test includes 68,887 supplier-customer-year relationships, for a total of 40,399 supplier-year observations. The sample period is from 1977 to 2016. I use the supplier-year observations as my testing sample. As most suppliers have more than one customers, I follow Dhaliwal et al. (2017) and measure the supplier's customer-base common auditor presence by using the percentage of supplier's sales accounted for by the customers who use the same auditor as the supplier. The calculation is shown below,

$$Pct\_Common\_Auditor = \sum_{j=1}^{J} \left(\frac{Sales_{ijt}}{Sales_{it}} \times Common\_Auditor \right)$$

Where $Sales_{ijt}$ is supplier *i*'s sales to customer *j* in year *t*, and $Sales_{it}$ is supplier *i*'s total sales in year *t*. The variable *Common_Auditor* is a dummy which equals to 1 if the supplier *i* uses the same auditor as the customer *j* in year *t*. The sales-weighted average of common auditor presence measures the percentage of supplier's sales generated from the business with its common-auditor customers. This measure captures the significance of common auditor presence to the supplier.

Following Patatoukas (2012), as suppliers only disclose their major customers, I measure the financial characteristics of supplier's customer base by constructing an index of the *J* major customers of supplier *i* in year *t* as below,

$$C\_Varibale_{it} = \sum_{j=1}^{J} \left(w_{ijt} \times C\_Varibale_{ijt} \right)$$

The weight w_{ijt} is defined as[3],

$$Sales_{ijt} / \sum_{j=1}^{J} Sales_{ijt}$$

The definition of all variables used in this study is listed in the Appendix. Table 1 gives the summary statistics of the main variables. Some variables' summary statistics are noteworthy. First, the mean value of *Pct_Common_Auditor* is 0.049 which is very low. This is because that suppliers are only required to disclose their major customers and the average supplier has 1.7 major customers. Thus more than 75 percent of the supplier-year observations have no common-auditor customer. Second, the firm size of the supplier is much smaller than the average size of its customers. Thus the supplier's dependence on its customers might be higher than the customer's dependence on suppliers and the customers might have more bargaining power in the supply chain relationships in my sample. Besides, the suppliers are younger than their major customers. And the suppliers have higher sales growth. The average duration of suppliers with their major customers is 4.4 years. Around 78 percent of the supplier-year observations employ Big-N auditors.

[3] I tried alternative measure of weight ($\frac{Sales_{ijt}}{Sales_{it}}$) to calculate customer-characteristic variables, and the empirical results are still there.

Table 1: Descriptive Statistics

Variable	n	Mean	Std. Dev.	5th	25th	50th	75th	95th
ROA	40,397	-0.071	0.326	-0.653	-0.081	0.026	0.073	0.169
Pct_Common_Auditor	40,397	0.049	0.121	0.000	0.000	0.000	0.000	0.300
Dum_Common_Auditor	40,397	0.234	0.423	0.000	0.000	0.000	0.000	1.000
Pct_Common_Auditor_Office	17,384	0.009	0.048	0.000	0.000	0.000	0.000	0.000
Pct_Common_Auditor_Different_Office	17,384	0.050	0.117	0.000	0.000	0.000	0.000	0.300
Dum_Common_Auditor_Office	17,384	0.048	0.213	0.000	0.000	0.000	0.000	0.000
Dum_Common_Auditor_Different_Office	17,384	0.236	0.425	0.000	0.000	0.000	0.000	1.000
SIZE	40,397	18.613	2.265	15.020	16.989	18.464	20.209	22.542
LEV	40,397	0.530	0.365	0.111	0.288	0.488	0.671	1.082
Lag_ROA	40,397	-0.064	0.315	-0.643	-0.074	0.028	0.075	0.178
AGE	40,397	12.647	11.179	1.000	4.000	9.000	18.000	36.000
SG	40,397	0.244	0.726	-0.366	-0.045	0.093	0.294	1.222
RD_Intensity	40,397	0.067	0.127	0.000	0.000	0.007	0.083	0.316
AD_Intensity	40,397	0.010	0.029	0.000	0.000	0.000	0.002	0.058
BigN	40,397	0.785	0.411	0.000	1.000	1.000	1.000	1.000
CSIZE	40,397	23.159	3.134	19.233	22.259	23.739	24.770	26.109
CAGE	40,397	24.671	12.884	2.000	16.000	25.000	34.000	46.180
CSG	40,397	0.099	0.201	-0.149	0.000	0.071	0.152	0.439
LINKAGE	40,397	4.363	3.748	1.000	2.000	3.000	5.976	12.022
CC	40,397	0.112	0.178	0.003	0.017	0.043	0.118	0.494
ATO	40,397	1.100	0.804	0.132	0.501	0.972	1.490	2.572
PM	40,397	-0.280	1.222	-1.722	-0.098	0.024	0.078	0.248
OM	39,639	-0.116	1.014	-1.334	0.003	0.093	0.176	0.476
NOM	39,639	-0.158	0.321	-0.620	-0.165	-0.082	-0.042	0.049
SGA	40,397	0.327	0.456	0.000	0.093	0.204	0.381	1.025
GM	40,397	0.253	0.739	-0.175	0.204	0.334	0.510	0.795
Days of Receivables	40,148	68.836	50.192	17.995	42.408	58.576	80.206	146.831
Days of Inventory	40,019	73.977	80.262	0.000	9.167	55.534	107.564	224.308
Days of Payables	40,267	76.690	119.664	10.522	27.284	44.166	74.165	239.107
Bullwhip_Effect	32,129	1.344	1.036	0.440	0.889	1.000	1.429	3.354
Lag_Bullwhip_Effect	24,443	1.336	1.010	0.432	0.880	1.000	1.440	3.342
SEASONALITY	32,129	-0.779	4.044	-5.034	-0.361	0.209	0.580	0.913
AR1RHO	32,182	-0.296	0.555	-1.118	-0.595	-0.320	-0.025	0.616

Notes: This table presents descriptive statistics for variables used in all regressions for the full sample, audit office subsample, and bullwhip effect subsample. All variables are defined in the Appendix.

Table 2 shows the pairwise correlations between the main variables. The correlations between supplier characteristics and *Pct_Common_Auditor* indicate that suppliers with larger firm size, Big-N auditors and higher customer concentration are more likely to have higher percentage of sales generated from common-auditor customers. Importantly, the correlation between supplier's ROA and *Pct_Common_Auditor* gives preliminary evidence that there could be a positive relationship between common auditor presence and supplier's performance.

Table 2: Pairwise Pearson Correlations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) *ROA*	1.000														
(2) *Pct_Common_Auditor*	0.010*	1.000													
(3) *SIZE*	0.308***	0.115***	1.000												
(4) *LEV*	-0.381***	-0.026***	-0.018***	1.000											
(5) *Lag_ROA*	0.576***	-0.009*	0.296***	-0.297***	1.000										
(6) *AGE*	0.139***	-0.031***	0.367***	0.054***	0.143***	1.000									
(7) *SG*	-0.001	0.021***	-0.064***	-0.079***	-0.186***	-0.185***	1.000								
(8) *RD_Intensity*	-0.513***	0.063***	-0.228***	0.070***	-0.435***	-0.149***	0.087***	1.000							
(9) *AD_Intensity*	-0.044***	-0.022***	-0.019***	0.066***	-0.013***	0.014***	-0.016***	0.012**	1.000						
(10) *BigN*	0.112***	0.205***	0.354***	-0.070***	0.112***	-0.007	0.013***	0.020***	-0.015***	1.000					
(11) *CSIZE*	0.040***	0.062***	0.230***	0.018***	0.046***	0.156***	-0.040***	-0.014***	-0.019***	0.049***	1.000				
(12) *CAGE*	0.045***	0.002	0.215***	0.045***	0.050***	0.250***	-0.072***	-0.038***	-0.006	-0.015***	0.431***	1.000			
(13) *CSG*	0.028***	0.007	-0.066***	-0.043***	-0.005	-0.097***	0.148***	0.024***	0.023***	0.017***	-0.076***	-0.210***	1.000		
(14) *LINKAGE*	0.129***	0.031***	0.260***	0.021***	0.139***	0.431***	-0.168***	-0.107***	0.030***	0.010**	0.189***	0.302***	-0.135***	1.000	
(15) *CC*	-0.164***	0.215***	-0.196***	0.004	-0.185***	-0.128***	0.125***	0.231***	-0.070***	-0.080***	0.005	-0.023***	0.010*	-0.021***	1.000

Notes: This table presents pairwise Pearson correlations between the main variables in the base-line test. All variables are defined in the Appendix. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels respectively.

5. Empirical Results

I investigate the empirical association between common auditor presence in supply chain and supplier's performance in this section. First I examine whether common auditor can improve supplier's performance. Then I further explore which components of supplier's performance (sales or cost) are actually influenced by common auditor. And based on the influenced components, I conduct analysis to find the potential information contents that common auditor could transfer along supply chain. Besides, I also examine whether common auditor could impact supplier's performance by influencing supplier's bargaining power. Finally, I conduct cross-sectional tests to explore the information intermediary role played by common auditor in implementing its impact on supplier's performance.

5.1 Base-Line Test

I examine the empirical association between common auditor presence and supplier's performance by using the following panel data regression:

$$Performance_{it} = \beta_0 + \beta_1 Common\_Auditor\_Presence_{it} + \gamma Controls_{it} + \epsilon_{it} \quad (1)$$

The dependent variable is supplier's return on assets (*ROA*) which stands for supplier's operating performance. The primary explanatory variable is the common auditor presence in the supplier's customer base, proxied by the sales-weighted percentage of customers who employ the same audit firm as the supplier (*Pct_Common_Auditor*). I also use a dummy variable (*Dum_Common_Auditor*), which equals one if at least one of the supplier's customers uses the same auditor firm as the supplier, as an alternative measure of common auditor presence in supply chain.

Following Patatoukas (2012), I use the vector of control variables including variables that are correlated with supplier's accounting rates of return (*ROA*) and customer-base common auditor presence (*Pct_Common_Auditor, Dum_Common_Auditor*), including supplier's firm size (*SIZE*), sales growth (*SG*), firm age (*AGE*), leverage (*LEV*), previous-year ROA (*Lag_ROA*), research and development intensity (*RD_Intensity*), advertisement intensity (*AD_Intensity*) and Big-N auditor indicator (*BigN*). And I also include industry and year fixed effects and the regression data is clustered by supplier firms.

Given that the customers' choices of external auditors are not random, the customer-base common auditor presence might be associated with the characteristics of a supplier's customers. Thus I also run the regression by controlling the variables of the supplier's customer-base characteristics, including customer-base firm size (*CSIZE*), sales growth (*CSG*), age (*CAGE*), and the relationship duration with the supplier (LINKAGE). The measure of customer-base characteristics is the sales-weighted average of the major customers of the supplier, which is shown in previous section. As customer concentration has a positive effect on supplier's performance (Patatoukas 2012), and it might be correlated with the common auditor presence, I also include supplier's customer concentration (CC) as another control variable.

Table 3 shows the regression results. Consistent with H1, The coefficients of both *Pct_Common_Auditor* and *Dum_Common_Auditor* are positive and significant which shows a positive relationship between the common auditor presence and supplier's ROA. This means that common auditor in supply chain can help to improve supplier's profitability. As for economic significance, according to Table 3 Column 1, an increase of one standard deviation of *Pct_Common_Auditor* (i.e., 12.1%) would lead to an

increase of the supplier's ROA by 0.48% (0.121×0.0396), which stands for a 18.5% increase of the sample median of supplier's ROA (i.e., 2.6%). And Table 3 Column 2 shows that the presence of common auditor could increase the supplier's ROA by 0.63%, which stands for a 24.2% increase of the sample median of supplier's ROA.

Table 3: Common Auditor and Supplier's Profitability

	1	2
VARIABLES	*ROA*	*ROA*
Pct_Common_Auditor	0.038***	
	(3.35)	
Dum_Common_Auditor		0.006**
		(2.14)
SIZE	0.023***	0.023***
	(19.31)	(19.30)
LEV	-0.222***	-0.222***
	(-24.66)	(-24.67)
Lag_ROA	0.318***	0.318***
	(26.53)	(26.53)
AGE	0.001***	0.001***
	(4.09)	(4.04)
SG	0.035***	0.035***
	(12.86)	(12.84)
RD_Intensity	-0.868***	-0.869***
	(-30.46)	(-30.47)
AD_Intensity	-0.259***	-0.258***
	(-3.41)	(-3.40)
BigN	0.002	0.003
	(0.42)	(0.56)
CSIZE	-0.000	-0.000
	(-0.87)	(-0.84)
CAGE	0.000**	0.000*
	(1.99)	(1.95)
CSG	0.039***	0.039***
	(5.34)	(5.35)
LINKAGE	0.002***	0.002***
	(5.83)	(5.90)
CC	-0.008	-0.002
	(-0.67)	(-0.18)
Constant	-0.329***	-0.331***
	(-14.80)	(-14.82)
Observations	40,397	40,397
R-squared	0.517	0.517
Industry FE and Year FE	YES	YES
Firm Cluster	YES	YES

Notes: This table shows the empirical results of the association between common auditor and supplier's operating performance. The dependent variable is supplier's ROA. *Pct_Common_Auditor* is the percentage of supplier's sales accounted for by the key customers that use a common audit firm with the supplier. *Dum_Common_Auditor* is an indicator that is equal to one if at least one of the key customers use a common audit firm with the supplier, and zero otherwise. The Appendix shows the definition of all other variables. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively and t-statistics are shown in parentheses.

5.2 DuPont Profitability Analysis

To examine why common auditor can help to improve supplier's profitability, I follow Patatoukas (2012) to conduct the DuPont Profitability analysis to investigate the associations between the common auditor presence and the components of supplier's performance.

According to the DuPont analysis which can provide market participants with much valuable information (Soliman 2008), I decompose the overall supplier's performance (ROA) into two multiplicative components:

$$ROA = \frac{Net\ Income}{Net\ Sales} \times \frac{Net\ Sales}{Total\ Assets} \quad (2)$$

The left multiplicative component stands for profit margin (*PM*) which is measured as net income divided by net sales, and the right multiplicative component stands for asset turnover (*ATO*) which is measured as net sales divided by total assets. DuPont decomposition indicates that the performance difference of suppliers with more or less common auditor presence in their customer base could be traced to differences in asset turnovers and profit margins. Table 4 Panel A Columns 1 and 2 show the empirical results. After controlling for the characteristics of the supplier firm and its customer base, I find a significant and positive relationship between *Pct_Common_Auditor* and supplier's profit margin. But, I find no significant relationship between *Pct_Common_Auditor* and supplier's asset turnover. The main findings of Columns 1 and 2 in Table 4 Panel A are twofold. First, the positive impact of common auditor on supplier's profitability is mainly driven by the common auditor's positive impact on supplier's profit margin. Second, the common auditor presence in supply chain has no

significant impact on supplier's firm-size-adjusted sales to its customers.

Table 4: Common Auditor and Decomposed Supplier's Performance

Panel A: Common Auditor Measured by *Pct_Common_Auditor*

	1	2	3	4	5	6
VARIABLES	*ATO*	*PM*	*OM*	*NOM*	*SGA*	*GM*
Pct_Common_Auditor	0.030	0.281***	0.245***	0.033*	-0.025	0.188***
	(0.59)	(3.26)	(3.31)	(1.74)	(-0.77)	(2.88)
SIZE	-0.105***	0.013***	0.025***	-0.013***	-0.034***	-0.007**
	(-19.29)	(2.61)	(6.12)	(-9.11)	(-16.93)	(-2.01)
LEV	0.539***	0.047	0.184***	-0.126***	-0.102***	0.033
	(24.33)	(1.31)	(6.53)	(-12.37)	(-7.66)	(1.40)
Lag_ROA	0.369***	1.124***	0.957***	0.145***	-0.425***	0.367***
	(18.81)	(22.44)	(24.57)	(10.56)	(-20.37)	(13.23)
AGE	0.004***	0.003***	0.001**	0.002***	-0.001**	0.001
	(4.76)	(4.74)	(2.09)	(9.41)	(-2.20)	(1.25)
SG	-0.003	0.093***	0.077***	0.015***	-0.003	0.062***
	(-0.51)	(5.64)	(5.77)	(3.86)	(-0.42)	(6.41)
RD_Intensity	-0.475***	-2.487***	-2.130***	-0.234***	0.568***	-1.165***
	(-6.91)	(-17.10)	(-17.67)	(-6.97)	(9.70)	(-10.79)
AD_Intensity	2.201***	1.093***	0.825***	0.273***	1.581***	2.278***
	(8.16)	(4.30)	(3.93)	(4.07)	(13.77)	(12.83)
BigN	0.001	-0.049**	-0.037**	-0.003	-0.007	-0.051***
	(0.07)	(-2.38)	(-2.17)	(-0.56)	(-0.80)	(-3.47)
CSIZE	0.005**	0.003	0.003	0.001	-0.002*	-0.001
	(2.28)	(1.45)	(1.32)	(1.15)	(-1.96)	(-0.56)
CAGE	0.001	-0.001	-0.001	0.000	-0.000	-0.001*
	(1.50)	(-0.78)	(-1.32)	(0.88)	(-1.34)	(-1.90)
CSG	0.055***	0.112***	0.073**	0.022**	-0.023	0.036
	(2.74)	(3.22)	(2.46)	(2.13)	(-1.61)	(1.56)
LINKAGE	0.013***	0.013***	0.010***	0.002***	-0.004***	0.005***
	(5.82)	(7.62)	(7.07)	(4.02)	(-5.53)	(3.51)
CC	-0.157***	-0.903***	-0.826***	-0.040**	-0.112***	-0.783***
	(-3.47)	(-10.45)	(-11.05)	(-2.14)	(-3.60)	(-12.44)
Constant	2.562***	-0.380***	-0.490***	0.115***	1.036***	0.567***
	(24.97)	(-3.96)	(-6.13)	(4.22)	(25.09)	(8.32)
Observations	40,397	40,397	39,639	39,639	40,397	40,397
R-squared	0.396	0.325	0.360	0.157	0.282	0.237
Industry FE and Year FE	YES	YES	YES	YES	YES	YES
Firm Cluster	YES	YES	YES	YES	YES	YES

(continued on next page)

Table 4 (continued)

Panel B: Common Auditor Measured by Dum_Common_Auditor

	1	2	3	4	5	6
VARIABLES	*ATO*	*PM*	*OM*	*NOM*	*SGA*	*GM*
Dum_Common_Auditor	0.010	0.061***	0.052***	0.007	-0.008	0.034***
	(0.69)	(3.70)	(3.60)	(1.49)	(-1.20)	(2.73)
SIZE	-0.105***	0.012**	0.025***	-0.013***	-0.034***	-0.007**
	(-19.28)	(2.55)	(6.07)	(-9.09)	(-16.84)	(-2.00)
LEV	0.539***	0.046	0.183***	-0.126***	-0.102***	0.032
	(24.34)	(1.28)	(6.49)	(-12.39)	(-7.65)	(1.37)
Lag_ROA	0.369***	1.124***	0.957***	0.145***	-0.425***	0.367***
	(18.81)	(22.44)	(24.56)	(10.56)	(-20.37)	(13.23)
AGE	0.004***	0.003***	0.001**	0.002***	-0.001**	0.001
	(4.77)	(4.67)	(2.01)	(9.39)	(-2.21)	(1.18)
SG	-0.003	0.092***	0.076***	0.015***	-0.003	0.062***
	(-0.51)	(5.63)	(5.75)	(3.85)	(-0.42)	(6.39)
RD_Intensity	-0.475***	-2.488***	-2.131***	-0.234***	0.569***	-1.165***
	(-6.91)	(-17.09)	(-17.66)	(-6.97)	(9.71)	(-10.78)
AD_Intensity	2.202***	1.100***	0.829***	0.273***	1.580***	2.282***
	(8.17)	(4.34)	(3.95)	(4.08)	(13.77)	(12.86)
BigN	0.001	-0.048**	-0.035**	-0.003	-0.007	-0.049***
	(0.04)	(-2.33)	(-2.07)	(-0.51)	(-0.73)	(-3.29)
CSIZE	0.005**	0.004	0.003	0.001	-0.002*	-0.001
	(2.27)	(1.46)	(1.35)	(1.16)	(-1.94)	(-0.51)
CAGE	0.001	-0.001	-0.001	0.000	-0.000	-0.001*
	(1.50)	(-0.82)	(-1.35)	(0.87)	(-1.34)	(-1.95)
CSG	0.055***	0.113***	0.074**	0.022**	-0.023	0.037
	(2.75)	(3.25)	(2.49)	(2.15)	(-1.62)	(1.59)
LINKAGE	0.013***	0.013***	0.011***	0.002***	-0.004***	0.005***
	(5.83)	(7.72)	(7.16)	(4.07)	(-5.54)	(3.60)
CC	-0.153***	-0.861***	-0.790***	-0.035*	-0.116***	-0.755***
	(-3.49)	(-10.38)	(-11.01)	(-1.95)	(-3.87)	(-12.47)
Constant	2.563***	-0.382***	-0.494***	0.115***	1.035***	0.562***
	(24.93)	(-3.96)	(-6.16)	(4.19)	(24.99)	(8.20)
Observations	40,397	40,397	39,639	39,639	40,397	40,397
R-squared	0.396	0.325	0.360	0.157	0.282	0.237
Industry FE and Year FE	YES	YES	YES	YES	YES	YES
Firm Cluster	YES	YES	YES	YES	YES	YES

Notes: This table shows the empirical results of the Dupont Profitability Analysis of decomposed supplier's ROA. Panel A shows the results of using *Pct_Common_Auditor* as the measure of common auditor presence and Panel B shows the results of using *Dum_Common_Auditor* as the alternative measure of common auditor presence. The Appendix shows the definition of all other variables. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively and t-statistics are shown in parentheses.

To provide further insights, I decompose profit margin (*PM*) into non-operating margin (*NOM*) and operating margin (*OM*). Specifically I decompose net income, which is the numerator of the profit margin, into "operating income before depreciation" and "other items". The regression results are shown in Table 4 Panel A Columns 3 and 4. I find a significant and positive relationship between *Pct_Common_Auditor* and supplier's

operating margin and a slightly significant relationship between *Pct_Common_Auditor* and supplier's non-operating margin. Besides, the coefficient of *Pct_Common_Auditor* on non-operating margins (*NOM*) is much smaller than that on operating margins (*OM*). This finding shows that it is the operating margin that drives the positive association between *Pct_Common_Auditor* and supplier's profit margin.

Next, I further decompose Operating margin (*OM*) into gross margin (*GM*) minus SG&A ratio (*SGA*) which is the ratio of SG&A expenses to sales. Table 4 Panel A Column 5 shows that there is no significant association between *Pct_Common_Auditor* and supplier's SG&A expenses. This means that the common auditor presence might not influence supplier's transaction cost, as SG&A expenses stand for much of the transaction cost. Column 6 of Table 4 Panel A shows a significant and positive relationship between *Pct_Common_Auditor* and supplier's gross margin, which indicates that the positive impact of common auditor on supplier's gross margin drives the positive association between common auditor presence and supplier's operating margin. Besides, as the common auditor has no significant effect on supplier's sales based on the finding from Table 4 Panel A Column 1, the improved gross margin should mainly come from the reduction of cost of goods sold. The underlying mechanism could be that common auditor helps the supplier have a better understanding of the customers' demand and reduce the supplier's distortion of demand forecast, so that the supplier can have a more efficient production plan and reduce production cost (e.g. cost of goods sold), leading higher gross margin (Radhakrishnan et al. 2014). Thus this finding implies that common auditor could transfer information between supplier and customer to reduce supplier's production cost. The empirical results of *Dum_Common_Auditor* as an alternative measure of

common auditor presence are shown in Table 4 Panel B. The empirical results for the two measures of common auditor presence (*Pct_Common_Auditor* and *Dum_Common_Auditor*) are similar.

To summarize the DuPont Profitability Analysis, the positive impact of common auditor on supplier's profitability is mainly because that the common auditor can help to improve supplier's gross margin by reducing production cost. The common auditor has no significant effect on supplier's sales and transaction cost. Thus H2b is proved.

5.3 Impact of Common Auditor on Supplier's Bullwhip Effect

According to the finding of DuPont Profitability Analysis in the previous section, the common auditor's effect on supplier's ROA should be driven by the decreased production cost. One of the possible reasons why common auditor can reduce supplier's production cost is that common auditor might transfer customers' demand information to the supplier and reduce supplier's information distortion of demand so that the supplier can make better capacity planning. As overestimation or underestimation of capacity could cause idle time or shortage cost, the better capacity planning of supplier can reduce its production cost. So this section further tests whether common auditor could transfer customers' demand information to the supplier so that the supplier can reduce production cost and have a higher profitability.

To test the demand information transfer by common auditor and the reduction of supplier's information distortion of demand, I use the test of bullwhip effect within the supplier firm. Bullwhip effect is defined as the amplification of demand variability when one moves up along a supply chain. It means that under the bullwhip effect, upstream suppliers will face higher demand variability than downstream

manufacturers or distributers (customers in this study's setting). The bullwhip effect can create some inefficiencies to the upstream suppliers such as distortion of demand forecasting, high inventory and capacity planning issues (Metters, 1997), which can increase suppliers' production cost. Supplier's bullwhip effect can be reduced if the supplier can get more demand information of its customers. So if common auditor in supply chain can transfer customers' demand information to the supplier, the supplier's bullwhip effect will be reduced and thus the supplier can reduce its production cost. Therefore, to test the effect of common auditor on transferring demand information from customers to suppliers and improving supplier's production efficiency, I examine the effect of common auditor on supplier's bullwhip effect.

According to the definition of bullwhip effect, the measure of bullwhip effect should capture the amplification of upstream suppliers' demand variability to downstream customers' demand variability. Cachon et al. (2007) measure the bullwhip effect at the industry level. They construct a ratio of the demand variability of upstream suppliers which is measured by the variance of production to the demand variability of downstream customers which is measured by the variance of cost of goods sold that is the margin-adjusted sales. Shan et al. (2014) and Bray and Mendelson (2012) measure the bullwhip effect at the firm level. They also employ similar ratio to measure the bullwhip effect. Following Zhao et al. (2019), I measure the supplier's bullwhip effect as follows:

$$Bullwhip\_Effect = \frac{\sigma(PRODUCTION)}{\sigma(DEMAND)} \quad (3)$$

Where $\sigma(PRODUCTION)$ is quarterly *PRODUCTION*'s standard deviation and

$\sigma(DEMAND)$ is quarterly *DEMAND*'s standard deviation in a fiscal year. Following Shan et al. (2014) and Bray and Mendelson (2012), I measure the demand of customers by using supplier's cost of goods sold, and I measure the production of the supplier by using supplier's cost of goods sold plus inventory changes. In equation (3), also following Shan et al. (2014), I first take the logarithm of supplier's production and then take its first difference to form *PRODUCTION*. In the same way, I first take the logarithm of customers' demand and then take its first difference to form *DEMAND.* As I use firm quarterly data to measure bullwhip effect, I require my sample to have all four quarterly financial data of each year.

To test the effect of common auditor on supplier's bullwhip effect, I use the following panel data model:

$$Bullwhip\_Effect_{it} = \beta_0 + \beta_1 Common\_Auditor\_Presence_{it} + \gamma Controls_{it} + \epsilon_{it} \quad (4)$$

The dependent variable *Bullwhip_Effect* is measured as above. And the independent variable of common auditor presence is measured by using both *Pct_Common_Auditor* and *Dum_Common_Auditor*.

Following Shan et al. (2014), I control variables that are associated with the supplier's bullwhip effect, which includes supplier's firm size (*SIZE*), gross margin (*GM*), inventory days (*Days of Inventory*), account payable days (*Days of Payables*), seasonality in demand (*SEASONALITY*) and correlation in demand (*AR1RHO*). The definition of these control variables are shown in the Appendix. In addition to those variables, I also control for supplier and customer characteristics that may affect the

supplier's bullwhip effect and the presence of common auditor, including supplier's firm age (*AGE*), advertisement intensity (*AD_Intensity*), Big-N auditor indicator (*BigN*), relationship duration with customers (*LINKAGE*) and customer concentration (*CC*).

Table 5: Common Auditor and Supplier's Bullwhip Effect

	1	2
VARIABLES	*Bullwhip_Effect*	*Bullwhip_Effect*
Pct_Common_Auditor	-0.103*	
	(-1.72)	
Dum_Common_Auditor		-0.051***
		(-3.05)
Lag_Bullwhip_Effect	0.230***	0.230***
	(19.05)	(19.04)
GM	0.054***	0.054***
	(6.73)	(6.74)
Days of Inventory	0.002***	0.002***
	(11.72)	(11.71)
Days of Payables	-0.000	-0.000
	(-0.87)	(-0.91)
SEASONALITY	-0.052***	-0.052***
	(-12.66)	(-12.69)
AR1RHO	0.079***	0.079***
	(6.97)	(6.97)
SIZE	0.002	0.003
	(0.47)	(0.60)
AGE	-0.003***	-0.003***
	(-3.82)	(-3.88)
AD_Intensity	-0.977***	-0.980***
	(-4.21)	(-4.23)
BigN	0.075***	0.082***
	(3.55)	(3.86)
LINKAGE	0.004*	0.004*
	(1.72)	(1.72)
CC	-0.094**	-0.109***
	(-2.23)	(-2.66)
Constant	0.826***	0.819***
	(9.99)	(9.92)
Observations	23,302	23,302
R-squared	0.153	0.154
Industry FE and Year FE	YES	YES
Firm Cluster	YES	YES

Notes: This table shows the empirical results of the association between common auditor and supplier's bullwhip effect. *Bullwhip_Effect* is the dependent variable. It is measured as the ratio of quarterly PRODUCTION's standard deviation to quarterly DEMAND's standard deviation in a fiscal year. PRODUCTION is the first difference of the logarithm of supplier's production which is measured by using cost of goods sold plus inventory changes in every quarter. DEMAND is the first difference of the logarithm of customers' demand which is measured by using cost of goods sold in every quarter. As quarterly financial data is used to measure bullwhip effect, the supplier-year observations are required to have all four quarterly financial data. The Appendix shows the definition of all other variables. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively and t-statistics are shown in parentheses.

The regression result is shown in Table 5. The coefficient of *Dum_Common_Auditor* is negative and significant which means that the presence of common auditor can mitigate supplier's bullwhip effect. The coefficient of *Pct_Common_Auditor* is less significant but is still negative. This finding indicates that common auditor in supply chain could transfer customers' demand information to suppliers and reduce supplier's information distortion of demand so that the supplier can have better capacity planning and reduce production variability, leading to less production cost and higher profit. So, this finding further proves the finding of previous section that common auditor could improve supplier's performance by reducing supplier's the production cost.

5.4 Impact of Common Auditor on Supplier's Bargaining Power

Besides transferring customer's demand information to supplier and improving supplier's production efficiency, influencing bargaining powers between suppliers and customers could also be one of the sources that common auditor exerts its impact on supplier's performance. Common auditor could increase supplier's bargaining power by transferring customer's information to supplier, which might contribute to the positive effect of common auditor on supplier's performance. For instance, if common auditor can transfer customer's demand information to supplier, the supplier could gain more bargaining power in asking for holding less inventory so that the supplier can reduce its inventory holding cost. Also, if common auditor can transfer customer's cost structure information to supplier, the supplier could gain more bargaining in asking for higher price of its selling products.

Although common auditor could also transfer supplier's information to customer and increase customer's bargaining power, the supplier might gain more bargaining power

from common auditor than customer does. As only supplier's major customers are included in my testing sample, the average size of customers is much bigger than the average size of suppliers, which indicates that the major customers are the more powerful party in the supply chain relationships. Thus the major customers could use their power to ask the supplier to give more information, but the supplier doesn't have that power to ask the major customers to sharing more information. So the supplier will face much more information asymmetry of their customers than vice versa. Thus the information transfer by common auditor could be more valuable to the supplier than to the customers so that the common auditor could increase more bargaining power of the supplier.

If the supplier could gain more bargaining power from common auditor, the supplier could ask for more benefits in the supply chain relationship, such as carrying less inventory, increasing prices, and reducing trade credit (Porter 1974). Thus to test whether common auditor could improve supplier's performance by increasing supplier's bargaining power, I examine whether common auditor could reduce supplier's trade credit to its customers and let the supplier carry less inventory. As there is no data of supplier's product prices to its customers, I don't test the impact of common auditor on supplier's product price. If the supplier can carry less inventory, it will have shorter inventory holding days. And if the supplier reduces its trade credit to its customers, it can have shorted receivables conversion periods. Thus in this section, to test H3, I test the impact of common auditor on supplier's receivables conversion periods (*Days of Receivables*) and inventory conversion periods (*Days of Inventory*) to explore whether common auditor could increase supplier's bargaining power and thus improve supplier's performance.

Table 6: Common Auditor and Supplier's Bargaining Power

VARIABLES	1 *Days of Receivables*	2 *Days of Receivables*	3 *Days of Inventory*	4 *Days of Inventory*
Pct_Common_Auditor	-10.333**		11.206	
	(-2.58)		(1.48)	
Dum_Common_Auditor		-2.903***		-0.210
		(-3.14)		(-0.13)
SIZE	1.119***	1.138***	-0.773	-0.731
	(3.12)	(3.17)	(-1.47)	(-1.37)
LEV	-4.956***	-4.908***	-11.700***	-11.716***
	(-3.77)	(-3.73)	(-6.47)	(-6.48)
Lag_ROA	-6.708***	-6.715***	-0.803	-0.804
	(-4.75)	(-4.76)	(-0.38)	(-0.38)
AGE	-0.154***	-0.153***	0.133	0.126
	(-3.12)	(-3.12)	(1.61)	(1.53)
SG	3.112***	3.115***	0.245	0.223
	(5.62)	(5.63)	(0.33)	(0.30)
RD_Intensity	-14.523***	-14.490***	-15.412**	-15.406**
	(-3.65)	(-3.65)	(-2.26)	(-2.26)
AD_Intensity	-65.139***	-65.439***	177.927***	178.024***
	(-5.13)	(-5.16)	(6.29)	(6.30)
BigN	-3.660***	-3.536***	-10.364***	-9.631***
	(-2.90)	(-2.80)	(-4.90)	(-4.60)
CSIZE	0.016	0.019	-1.238***	-1.221***
	(0.12)	(0.13)	(-4.67)	(-4.61)
CAGE	-0.094**	-0.094**	0.131**	0.127**
	(-2.30)	(-2.30)	(2.22)	(2.14)
CSG	0.514	0.475	8.013***	8.039***
	(0.35)	(0.32)	(3.45)	(3.46)
LINKAGE	-0.332***	-0.336***	-0.374*	-0.361*
	(-2.93)	(-2.98)	(-1.80)	(-1.73)
CC	0.193	-1.320	-43.625***	-41.894***
	(0.05)	(-0.37)	(-10.20)	(-9.98)
Constant	59.703***	59.529***	130.780***	129.572***
	(8.54)	(8.50)	(12.04)	(11.81)
Observations	40,148	40,148	40,019	40,019
R-squared	0.107	0.107	0.261	0.261
Industry FE and Year FE	YES	YES	YES	YES
Firm Cluster	YES	YES	YES	YES

Notes: This table presents the results of estimating the effect of common auditor on supplier's operating performance through increasing supplier's bargaining power. The dependent variable *Days of Receivables* is supplier's receivables conversion period measured by dividing accounts receivable by sales and multiplying 365 days. And *Days of Inventory* is supplier's inventory conversion period measured by dividing inventory by cost of goods sold and multiplying 365 days. The Appendix shows the definition of all other variables. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively and t-statistics are shown in parentheses.

Table 6 shows the regression results. In Columns 1 and 2 of Table 6 where supplier's *Days of Receivables* is the dependent variable, the coefficients of both *Pct_Common_Auditor* and *Dum_Common_Auditor* are negative and significant. This means that common auditor can help the supplier collect receivables more quickly

from their customers and indicates that supplier can gain more bargaining power against customers. The reduction of supplier's receivable conversion period can reduce supplier's financing cost and increase supplier's profit. Columns 3 and 4 of Table 6 show that there is no significant association between common auditor presence and supplier's inventory conversion period.

Therefore, the finding of this section shows that common auditor can significantly reduce supplier's receivables conversion period which gives evidence that common auditor could help suppler gain more bargaining power and thus increase performance.

5.5 Cross-Sectional Tests

I also investigate the impact of common auditor on supplier's performance under different information asymmetry environments. As the common auditor implements its effect mainly by promoting information sharing between supplier and customer, the impact of common auditor on supplier's performance is supposed to be more pronounced in high information asymmetry environment.

I use cross-sectional tests to investigate the information intermediary role played by common auditor in supply chain. Firms with more uncertainty are likely to have high information asymmetry with their investors and supply chain partners. Thus, following Cai et al. (2016), I measure firms' uncertainty by using their stock return volatility and bid-ask spread in stock market. Higher firm uncertainty will be related to higher stock return volatility and bid-ask spread. Because the bid or ask prices of many firms in NASDAQ were not reported before 1983, I use the data sample from 1983 to 2016 in this section. And because of different data availability of stock return volatility and bid-ask spread, I allow for different sample sizes when using different measures of

firms' uncertainty. As the previous finding shows that the common auditor's positive effect on supplier's performance is mainly from decreasing supplier's production cost. And this production cost reduction could be because that common auditor can transfer customers' demand information to the supplier. Thus I predict that the common auditor effect is more pronounced in high customer information asymmetry environment.

I test the impact of common auditor on supplier's performance in different customer information environments measured by the customers' uncertainty. If a customer has high uncertainty, its supplier will have difficulty to get the accurate demand information of the customer, which could lead to the supplier's bullwhip effect. Thus based on inaccurate demand information to prepare the capacity and production, the supplier might produce much more or much less products than needed, leading to high production cost of the supplier. So if common auditor can transfer customers' information to supplier, it could benefit supplier's performance, and this effect should be more pronounced in high customer uncertainty environment.

Using measures of supplier's customer-base return volatility and bid-ask spread, I divide the total sample into subsamples of high and low customer information asymmetry. In the first test, supplier-year observations whose customer-base return volatility are higher than the sample median are assigned into the high customer information asymmetry subsample and the rest observations are assigned into the low customer information asymmetry subsample. In the same way, in the second test, supplier-year observations whose customer-base bid-ask spread are higher than the sample median are assigned into the high customer information asymmetry subsample and the other observations are assigned into the low customer information asymmetry subsample.

Table 7: Common Auditor in Different Customer Information Environments

Panel A: Common Auditor Measured by *Pct_Common_Auditor*

VARIABLES	1	2	3	4
	ROA			
SUBSAMPLES	*ret_volatility_high*	*ret_volatility_low*	*bid_ask_spread_high*	*bid_ask_spread_low*
Pct_Common_Auditor	0.057***	0.032**	0.069***	0.018
	(3.52)	(2.09)	(3.30)	(1.19)
SIZE	0.026***	0.025***	0.028***	0.019***
	(14.16)	(16.30)	(13.41)	(9.94)
LEV	-0.259***	-0.219***	-0.272***	-0.184***
	(-17.78)	(-16.38)	(-16.88)	(-11.93)
Lag_ROA	0.313***	0.343***	0.324***	0.350***
	(19.66)	(18.66)	(17.89)	(16.92)
AGE	0.001***	0.000**	0.001***	0.000**
	(3.73)	(2.10)	(4.98)	(2.47)
SG	0.029***	0.037***	0.027***	0.038***
	(6.30)	(9.25)	(5.73)	(7.24)
RD_Intensity	-0.987***	-0.814***	-1.022***	-0.796***
	(-26.11)	(-20.93)	(-24.08)	(-18.98)
AD_Intensity	-0.291***	-0.097	-0.144	-0.111
	(-2.93)	(-0.95)	(-1.38)	(-0.98)
BigN	0.010	0.007	0.022**	0.013**
	(1.63)	(1.29)	(2.54)	(2.31)
CSIZE	0.000	0.001	0.001	-0.001
	(0.43)	(0.57)	(0.89)	(-0.96)
CAGE	0.001***	-0.000	0.001***	0.000
	(3.86)	(-1.60)	(2.59)	(0.58)
CSG	0.050***	0.028**	0.038***	0.056***
	(5.18)	(2.36)	(3.51)	(4.81)
LINKAGE	0.002***	0.001***	0.001*	0.001***
	(4.18)	(2.64)	(1.94)	(3.36)
CC	-0.001	0.014	0.009	0.007
	(-0.06)	(0.99)	(0.45)	(0.46)
Constant	-0.424***	-0.379***	-0.475***	-0.272***
	(-11.59)	(-10.59)	(-11.06)	(-5.88)
Observations	15,251	15,268	12,067	12,167
R-squared	0.504	0.513	0.522	0.538
Industry FE and Year FE	YES	YES	YES	YES
Firm Cluster	YES	YES	YES	YES

(continued on next page)

Table 7 (continued)

Panel B: Common Auditor Measured by *Dum_Common_Auditor*

VARIABLES	1	2	3	4
	ROA			
SUBSAMPLES	*ret_volatility* _high	*ret_volatility* _low	*bid_ask_spread* _high	*bid_ask_spread* _low
Dum_Common_Auditor	0.010**	0.005	0.012**	0.002
	(2.17)	(1.35)	(2.30)	(0.53)
SIZE	0.026***	0.025***	0.028***	0.019***
	(14.19)	(16.28)	(13.35)	(9.96)
LEV	-0.259***	-0.219***	-0.272***	-0.184***
	(-17.79)	(-16.39)	(-16.89)	(-11.94)
Lag_ROA	0.313***	0.343***	0.324***	0.350***
	(19.67)	(18.68)	(17.90)	(16.92)
AGE	0.001***	0.000**	0.001***	0.000**
	(3.67)	(2.08)	(4.97)	(2.45)
SG	0.029***	0.037***	0.027***	0.038***
	(6.28)	(9.24)	(5.69)	(7.24)
RD_Intensity	-0.988***	-0.813***	-1.022***	-0.796***
	(-26.11)	(-20.90)	(-24.02)	(-18.99)
AD_Intensity	-0.289***	-0.096	-0.141	-0.110
	(-2.92)	(-0.95)	(-1.36)	(-0.98)
BigN	0.011*	0.008	0.023***	0.014**
	(1.74)	(1.38)	(2.62)	(2.38)
CSIZE	0.001	0.001	0.001	-0.001
	(0.46)	(0.59)	(0.98)	(-0.96)
CAGE	0.001***	-0.000	0.001**	0.000
	(3.81)	(-1.64)	(2.53)	(0.55)
CSG	0.050***	0.028**	0.038***	0.057***
	(5.22)	(2.38)	(3.54)	(4.82)
LINKAGE	0.002***	0.001***	0.001**	0.001***
	(4.22)	(2.72)	(1.98)	(3.42)
CC	0.010	0.019	0.020	0.011
	(0.58)	(1.36)	(1.06)	(0.71)
Constant	-0.426***	-0.381***	-0.477***	-0.273***
	(-11.65)	(-10.59)	(-11.08)	(-5.89)
Observations	15,251	15,268	12,067	12,167
R-squared	0.504	0.513	0.522	0.538
Industry FE and Year FE	YES	YES	YES	YES
Firm Cluster	YES	YES	YES	YES

Notes: This table presents the results of cross-sectional tests based on different customer information environments, which is measured by the supplier's customer-base stock return volatility and bid-ask spread. Stock return volatility is measured by the daily stock return volatility over the fiscal year. And bid-ask spread is measured by the mean of daily bid–ask spreads over the fiscal year. In Columns 1 and 2, the sample is divided into high customer information asymmetry subsample (*ret_volatility_high*) and low customer information asymmetry subsample (*ret_volatility_low*) based on the sample median of customer-base stock return volatility. And in Columns 3 and 4, the sample is divided into high customer information asymmetry subsample (*bid_ask_spread_high*) and low customer information asymmetry subsample (*bid_ask_spread_low*) based on the sample median of customer-base bid-ask spread. Panel A presents the results of using *Pct_Common_Auditor* as the measure of common auditor presence and Panel B presents the results of using *Dum_Common_Auditor* as the alternative measure of common auditor presence. The total testing sample period is from 1983 to 2016. The Appendix shows the definition of all other variables. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively and t-statistics are shown in parentheses.

Table 7 shows the regression results of equation (1) in different subsamples. Consistent

with H4, Columns 1 and 2 of Panel A demonstrate that the impact of common auditor on supplier's performance is bigger and more significant in subsample of high customer return volatility. And Columns 3 and 4 of Panel A demonstrate that the impact of common auditor is larger and more significant in subsample of high customer bid-ask spread, while the common auditor effect is no longer significant in subsample of low customer bid-ask spread. The empirical results of using *Dum_Common_Auditor* as an alternative measure of common auditor in Panel B of Table 7 are similar to the results in Panel A of Table 7. The main finding of Table 7 is that the impact of common auditor on supplier's performance is more pronounced in high customer uncertainty environments, which indicates that common auditor can improve supplier's performance by transferring customers' information to the supplier.

6. Additional Tests

6.1 Office-Level Common Auditor

I also investigate whether the common audit office has more significant effect on supplier's performance than just the common audit firm. One reason is that if the supplier and customer use the same common audit office, there will be a higher probability of overlap of audit personnel on client engagement teams and increased informal contact between audit teams of the supplier and customer (Dhaliwal et al. 2016). It is easier for the auditors of the same office to share information. Besides, the common audit office has a larger effect on increasing accounting comparability between the clients than the common audit firm (Chen et al. 2020). Thus the common audit office is expected to have a bigger effect on supplier's performance than the common audit firm between supplier and its customers. Following Dhaliwal et al. (2016) and Cai et al. (2016), I use the office-level common auditor test as another examination of the information intermediary role of common auditor along supply

chain.

The auditor office data is collected from the Audit Analytics database. As the auditor office data is only available from 2000, the testing sample period is from 2000 to 2016. Suppliers with no audit office data is deleted from the testing sample and customers with no audit office data is regarded as having different auditor office with the supplier if they use the same auditor firm with the supplier.

I divide *Pct_Common_Auditor* in equation (1) into *Pct_Common_Auditor_Same_Office* which measures the sales-weighted percentage of a supplier's customers that share audit office with the supplier, and *Pct_Common_Auditor_Different_Office* which measures the sales-weighted percentage of a supplier's customers that share audit firm but not share audit office with the supplier. As an alternative measure, I also divide *Dum_Common_Auditor* in equation (1) into *Dum_Common_Auditor_Same_Office* which is the dummy variable that equals 1 if at least one of the supplier's customers uses the same audit office with the supplier, and 0 otherwise, and *Dum_Common_Auditor_Different_Office* which is the dummy variable that equals 1 if at least one of the supplier's customers uses the same audit firm with the supplier but no customer use the same audit office with the supplier, and 0 otherwise. Table 8 Column 1 shows that the coefficient of *Pct_Common_Auditor_Same_Office* is larger and more significant than the coefficient of *Pct_Common_Auditor_Different_Office*. And Table 8 Column 2 shows that the coefficient of *Dum_Common_Auditor_Same_Office* is larger and more significant than the coefficient of *Dum_Common_Auditor_Different_Office* which is no longer significant. The finding of Table 8 indicates that the office-level common auditor transfers more information between supplier and customer than firm-level common

auditor, and has a bigger impact on improving supplier's performance.

Table 8: Common Audit Office and Supplier's Performance

	1	2
VARIABLES	*ROA*	*ROA*
Pct_Common_Auditor_Same_Office	0.080**	
	(2.15)	
Pct_Common_Auditor_Different_Office	0.032*	
	(1.83)	
Dum_Common_Auditor_Same_Office		0.024***
		(3.30)
Dum_Common_Auditor_Different_Office		0.000
		(0.09)
SIZE	0.020***	0.020***
	(10.85)	(10.85)
LEV	-0.187***	-0.187***
	(-14.53)	(-14.55)
Lag_ROA	0.364***	0.364***
	(20.41)	(20.40)
AGE	0.001***	0.001***
	(3.62)	(3.64)
SG	0.031***	0.031***
	(6.86)	(6.86)
RD_Intensity	-0.811***	-0.812***
	(-20.28)	(-20.29)
AD_Intensity	-0.174	-0.172
	(-1.47)	(-1.46)
Big4	0.004	0.006
	(0.69)	(0.95)
CSIZE	-0.001	-0.001
	(-0.99)	(-0.93)
CAGE	0.000*	0.000*
	(1.89)	(1.88)
CSG	0.046***	0.046***
	(3.67)	(3.66)
LINKAGE	0.002***	0.002***
	(5.15)	(5.28)
CC	-0.003	0.002
	(-0.17)	(0.13)
Constant	-0.321***	-0.323***
	(-8.61)	(-8.65)
Observations	17,384	17,384
R-squared	0.543	0.543
Industry FE and Year FE	YES	YES
Firm Cluster	YES	YES

Notes: This table shows the empirical results of the association between common audit office and supplier's operating performance. Independent variable *Pct_Common_Auditor_Same_Office* is the percentage of supplier's sales accounted for by the key customers that use a common audit office with the supplier. Independent variable *Pct_Common_Auditor_Different_Office* is the percentage of supplier's sales accounted for by the key customers that use a common audit firm but not common office with the supplier. Independent variable *Dum_Common_Auditor_Same_Office* is an indicator that is equal to one if at least one of the key customers use a common audit office with the supplier, and zero otherwise. Independent variable *Dum_Common_Auditor_Different_Office* is an indicator that is equal to one if at least one of the key customers use a common audit firm with the supplier but no customer uses the same audit office with the supplier, and zero otherwise. As the audit office data is only available from 2000 in Audit Analytics database, the testing sample period is from 2000 to 2016. The Appendix shows the definition of all other variables. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively and t-statistics are shown in parentheses.

6.2 Impact of the Enactment of Sarbanes-Oxley Act

In 2002, the enactment of Sarbanes-Oxley Act (SOX) enhances the independence of auditor role. Section 201 of SOX constrains auditors from providing other services than auditing service to their clients. For instance, auditors cannot provide consulting service to their clients any more after SOX. This enactment may have several impacts on common auditor's information intermediary role in supply chain. First, without the constrained non-audit services, the common auditor may have less understanding about the supplier and the customer. Thus it may have less information to transfer between the supplier and the customer. Second, if common auditor could transfer information through the constrained non-audit services, after SOX the common auditor would lose the opportunity and chance to transfer information through the constrained non-audit services. For instance, the common auditor might transfer customers' information to the supplier through its consulting service to the supplier. But after SOX, the common auditor can no longer provide consulting service to the supplier and thus cannot transfer customers' information through the consulting service. Therefore, the enactment of SOX might reduce the importance of the common auditor's information intermediary role in supply chain and I predict that the positive effect of common auditor on supplier's performance is smaller after SOX.

Thus I examine whether the effect of common auditor on supplier's performance is mitigated after SOX as another measure of the information intermediary role of common auditor in supply chain. I use subsamples of before-SOX and after-SOX supplier-year observations to test the influence of SOX on the common auditor effect. I define before-SOX period from 1977 to 2002 and the after-SOX period from 2003 to 2016. The subsample regression results of equation (1) are shown in Table 9. The coefficients of *Pct_Common_Auditor* and *Dum_Common_Auditor* are larger and

significant in the before-SOX subsample, while they are no longer significant in the after-SOX subsample. This result indicates that the positive effect of common auditor on supplier's performance is mitigated after SOX as the common auditor might transfer less information along the supply chain after SOX.

Table 9: Common Auditor and Supplier's Performance under SOX

	1	2	3	4
VARIABLES	*ROA*			
SUBSAMPLES	Before-SOX		After-SOX	
Pct_Common_Auditor	0.057***		0.015	
	(3.63)		(1.01)	
Dum_Common_Auditor		0.011***		-0.000
		(2.78)		(-0.12)
SIZE	0.025***	0.025***	0.020***	0.020***
	(17.30)	(17.19)	(10.61)	(10.64)
LEV	-0.253***	-0.253***	-0.184***	-0.184***
	(-22.97)	(-23.00)	(-12.73)	(-12.73)
Lag_ROA	0.282***	0.282***	0.380***	0.380***
	(19.88)	(19.88)	(18.11)	(18.12)
AGE	0.001***	0.001***	0.001***	0.001***
	(3.97)	(3.96)	(3.18)	(3.14)
SG	0.033***	0.033***	0.038***	0.038***
	(10.10)	(10.09)	(8.00)	(7.99)
RD_Intensity	-0.994***	-0.993***	-0.694***	-0.694***
	(-27.03)	(-27.02)	(-16.24)	(-16.25)
AD_Intensity	-0.290***	-0.289***	-0.185	-0.184
	(-3.22)	(-3.22)	(-1.60)	(-1.60)
BigN	-0.002	-0.001	0.007	0.008
	(-0.26)	(-0.17)	(1.13)	(1.33)
CSIZE	-0.000	-0.000	-0.001	-0.001
	(-0.24)	(-0.21)	(-1.64)	(-1.59)
CAGE	0.001**	0.001**	0.000	0.000
	(2.40)	(2.39)	(0.29)	(0.26)
CSG	0.041***	0.042***	0.040***	0.040***
	(4.76)	(4.79)	(3.05)	(3.06)
LINKAGE	0.002***	0.002***	0.002***	0.002***
	(4.45)	(4.47)	(4.41)	(4.48)
CC	-0.011	-0.003	-0.013	-0.010
	(-0.75)	(-0.23)	(-0.79)	(-0.65)
Constant	-0.346***	-0.346***	-0.298***	-0.299***
	(-13.05)	(-13.01)	(-7.95)	(-8.00)
Observations	25,671	25,671	14,726	14,726
R-squared	0.500	0.500	0.565	0.565
Industry FE and Year FE	YES	YES	YES	YES
Firm Cluster	YES	YES	YES	YES

Notes: This table presents the results of the impact of SOX on the common auditor effect. The Before-SOX subsample includes observations before and on 2002 and After-SOX subsample includes observations after 2002. The Appendix shows the definition of all other variables. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively and t-statistics are shown in parentheses.

According to previous finding, it seems that common auditor could transfer information between suppliers and customers through non-audit services. This means that the information intermediary role of common auditor would be higher when the common auditor provides non-audit services to the supplier. So, I expect that the common auditor effect would be more pronounced when the common auditor provides non-audit services to the supplier.

I use cross-sectional test to examine whether common auditor could transfer information through non-audit services. I use the non-audit fees data from the Audit Analytics database to define whether auditors provide non-audit services to suppliers. If a supplier receives non-audit services from its auditor, the non-audit fees should be larger than 0. The non-audit fees data is only available from 2000, so in this cross-sectional test, the sample period is from 2000 to 2016. The observations with missing data of non-audit fees are removed from the sample. I partition the sample into *With Non-Audit Services* subsample if the non-audit fees that the supplier gives to its auditor are larger than 0, and *Without Non-Audit Services* subsample if the non-audit fees are equal to 0. I run equation (1) in each subsample.

The regression result is shown in Table 10. The coefficient of *Pct_Common_Auditor* is significant in *With Non-Audit Services* subsample, but it is not significant in *Without Non-Audit Services* subsample, which indicates that common auditor might mainly transfer information through non-audit services. The coefficient of *Dum_Common_Auditor* is not significant in both subsamples.

So, this regression result gives some evidence that common auditor could transfer information and improve supplier's performance through non-audit services. As in the

non-audit services, such as consulting services, the main way that common auditor could transfer information is through discussion with managers of suppliers, this regression result also gives further evidence that discussion with firm managers might be an important channel for common auditor to transfer information.

Table 10: Common Auditor Effect through Non-Audit Services

	1	2	3	4
VARIABLES	*ROA*			
SUBSAMPLES	With Non-Audit Services		Without Non-Audit Services	
Pct_Common_Auditor	0.036**		0.010	
	(2.17)		(0.24)	
Dum_Common_Auditor		0.005		-0.006
		(1.04)		(-0.46)
SIZE	0.019***	0.020***	0.030***	0.030***
	(11.06)	(11.09)	(4.35)	(4.37)
LEV	-0.161***	-0.161***	-0.220***	-0.220***
	(-11.89)	(-11.90)	(-5.73)	(-5.74)
Lag_ROA	0.361***	0.361***	0.381***	0.381***
	(19.84)	(19.84)	(6.80)	(6.80)
AGE	0.000***	0.000***	0.001**	0.001**
	(2.76)	(2.70)	(2.11)	(2.09)
SG	0.030***	0.030***	0.038***	0.038***
	(5.97)	(5.94)	(3.12)	(3.12)
RD_Intensity	-0.777***	-0.777***	-0.748***	-0.748***
	(-17.87)	(-17.87)	(-6.68)	(-6.68)
AD_Intensity	-0.175	-0.173	-0.123	-0.121
	(-1.35)	(-1.34)	(-0.33)	(-0.33)
BigN	0.006	0.007	0.004	0.007
	(0.80)	(0.95)	(0.23)	(0.42)
CSIZE	-0.001	-0.001	0.000	0.000
	(-0.75)	(-0.73)	(0.03)	(0.08)
CAGE	0.000**	0.000*	0.000	0.000
	(1.98)	(1.93)	(0.75)	(0.73)
CSG	0.059***	0.059***	0.032	0.032
	(4.43)	(4.46)	(0.78)	(0.78)
LINKAGE	0.002***	0.002***	0.004**	0.004**
	(4.71)	(4.84)	(2.51)	(2.51)
CC	-0.000	0.006	-0.028	-0.026
	(-0.01)	(0.37)	(-0.67)	(-0.66)
Constant	-0.316***	-0.318***	-0.526***	-0.531***
	(-8.61)	(-8.66)	(-3.81)	(-3.85)
Observations	14,367	14,367	2,156	2,156
R-squared	0.523	0.523	0.585	0.585
Industry FE and Year FE	YES	YES	YES	YES
Firm Cluster	YES	YES	YES	YES

Notes: This table presents the results of the impact of non-audit services on the common auditor effect. The sample period is from 2000 to 2016. The *With Non-Audit Services* subsample includes observations with non-audit fees higher than 0 and *Without Non-Audit Services* subsample includes observations equal to 0. The Appendix shows the definition of all other variables. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively and t-statistics are shown in parentheses.

To summarize this section, the more pronounced common auditor effect in common audit office and before SOX further proves that common auditor improves supplier's performance by playing an information intermediary role in supply chain. Besides, the two findings also give more evidence that common auditor could transfer information through discussion with firm managers, as there is more opportunity of discussion with firm managers and more information could be transferred through the discussion in common auditor office and before SOX through non-audit services.

7. Robustness Test

Addressing Potential Endogeneity Problem – DID Test

There might be endogeneity concerns of reverse causality problems. As common auditor might transfer information of supplier's operating and financial situation to the customers and help the customers to select better performed suppliers, suppliers with higher performance are more likely to be selected as customers' supply chain partners. Thus the higher performance of a supplier might lead to higher percentage of its customers who use the same auditor. Besides, there might be omitted unobservable variable that influences both the common auditor presence and supplier's performance.

To address these endogeneity concerns, I conduct a DID test based on auditor mergers and acquisitions. For a supplier, if its auditor is merged or acquired, the common auditor presence situation of this supplier might be changed. This auditor merger is exogenous as it is not controlled by the supplier or its customers. Thus the auditor merger and acquisition is suitable to be used as an exogenous shock to conduct DID test. In my DID design. I use the the two Big-Eight accounting firm mergers in 1989 as the exogenous shock. In 1989, Touche Ross is merged by Deloitte, Haskins & Sells

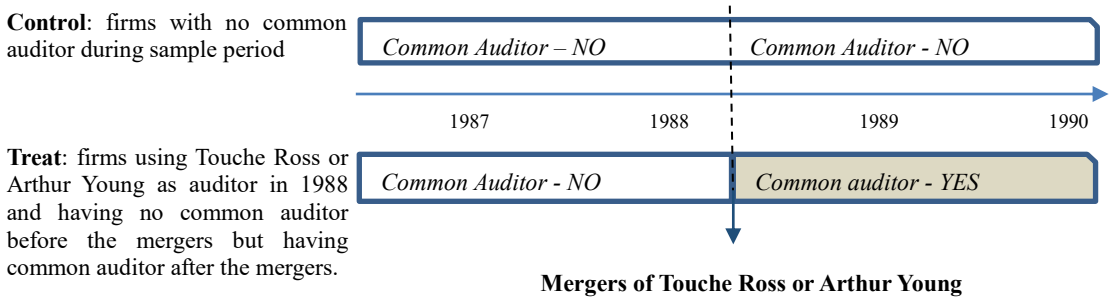
to form Deloitte & Touche, and Arthur Young was merged by Ernst & Whinney to form Ernst & Young. I use the lead and lag two years of the merger time (i.e. from 1987 to 1990) as the DID sample period. The treatment group includes supplier-year observations that the supplier used Touche Ross or Arthur Young as external auditor in the year before the merger (i.e. in 1988) and there was no common auditor before the merger (i.e. in 1987 and 1988) but there was common auditor after the merger (i.e. in 1989 and 1990). The control group includes supplier-year observations that the supplier had no common auditor with its customers all the time during the sample period (i.e. from 1987 to 1990). The DID test regression is shown as below:

$$Performance_{it} = \beta_0 + \beta_1 Treat_{it} + \beta_2 Post_{it} + \beta_3 Treat_{it} \times Post_{it} + \gamma Controls_{it} + \epsilon_{it} \quad (5)$$

Treat is an indicator variable that equals 1 if the observation is in treatment group, and 0 otherwise. *Post* is also an indicator variable that equals 1 if the observation is after the mergers of Touche Ross and Arthur Young (i.e. in 1989 and 1990), and 0 otherwise. The variable of most interest is the interaction term of *Treat* and *Post*, *Treat* × *Post*. The coefficient of *Treat* × *Post* is expected to be positive and significant if the common auditor effect on supplier's performance is not caused by endogeneity concerns. The DID design is shown in Figure 1.

Before the DID test, I use propensity-score matching (PSM) to address the potential sample selection concerns. I conduct the PSM by using Kernel matching and Logit model. Then I use the matched control group to conduct the DID test.

Figure 1: DID Sample Design



Notes: This figure shows the DID design for addressing potential endogeneity concerns. The treatment group includes firms using Touche Ross or Arthur Young as auditor in 1988 and having no common auditor before the mergers but having common auditor after the mergers in the testing sample period. The control group includes firms with no common auditor during sample period. The testing sample period is the lead and lag two years of the merger time (i.e. from 1987 to 1990). The post-merger time period is from 1989 to 1990 and the pre-merger time period is from 1987 to 1988.

The regression result of equation (5) is shown in Table 11. The coefficient of *Treat* × *Post* is positive and significant, which means that the common auditor presence caused by mergers of Touche Ross and Arthur Young has a significant effect on improving supplier's ROA. This finding indicates that the positive effect of common auditor on supplier's performance is not caused by endogeneity concerns. There are some limitations of this DID design. First, the merger of auditor might influence the supplier's auditing quality and thus could influence supplier's reporting ROA. Another concern is that at the year when supplier's auditor is merged, the supplier's may also change its customers, which might influence supplier's performance. But I have controlled the Big-N auditor indicator and the supplier's customer-base characteristics, these two limitations should not be a big problem.

Table 11: Common Auditor and Supplier's Performance – DID Test

VARIABLES	*ROA*
Treat	-0.028
	(-0.48)
Treat × *Post*	0.083***
	(2.61)
SIZE	0.016***
	(3.58)
LEV	-0.212***
	(-5.25)
Lag_ROA	0.128
	(1.48)
AGE	0.001
	(1.46)
SG	0.057**
	(2.26)
RD_Intensity	-0.518
	(-1.41)
AD_Intensity	0.093
	(0.38)
Big4	-0.002
	(-0.11)
CSIZE	-0.003
	(-1.35)
CAGE	0.002**
	(2.12)
CSG	0.039
	(1.23)
LINKAGE	0.002
	(1.49)
CC	-0.031
	(-0.44)
Constant	-0.155**
	(-2.07)
Observations	1,069
R-squared	0.309
Industry FE and Year FE	YES
Firm Cluster	YES

Notes: This table presents the results of the DID test based on the two Big-Eight auditor mergers of Touche Ross and Arthur Young in 1989. *Treat* is an indicator variable that is equal to 1 if the observations are in treatment group, and 0 otherwise. The treatment group includes supplier firms using Touche Ross or Arthur Young as auditor in 1988 and having no common auditor before the mergers but having common auditor after the mergers in the testing sample period. *Post* is also an indicator variable that is equal to 1 if the observations are after the mergers of Touche Ross and Arthur Young (i.e. in 1989 and 1990), and 0 otherwise. The testing sample period is from 1987 to 1990. The Appendix shows the definition of all other variables. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively and t-statistics are shown in parentheses.

8. Conclusion

As an auditor could play an information intermediary role among its clients, the common auditor in supply chain could transfer information between the supplier and the customer and influence the supplier's performance. Using suppliers' major

customer data, I find that common auditor in supply chain can improve supplier's performance. Common auditor has a positive and significant effect on supplier's ROA, which is mainly driven by the reduction of supplier's production cost, while there's no significant association between common auditor and supplier's sales and transaction cost. The finding of the negative association between common auditor and supplier's bullwhip effect further proves that common auditor could reduce supplier's production cost and gives evidence that common auditor might transfer customers' demand information to the supplier. I also find that common auditor can give supplier more bargaining power which significantly reduces supplier's receivable conversion period. I use cross-sectional tests to examine the information intermediary role of common auditor in supply chain and find that the impact of common auditor on supplier's operating performance is more pronounced when the supplier face higher information asymmetry of its customers which is measured by corporate uncertainty. I also find that the impact of common auditor on supplier's operating performance is more significant if supplier and customer use the same audit office than just the same audit firm. Finally I investigate the impact of Sarbanes–Oxley Act (SOX) on the common auditor effect and find that the impact of common auditor on supplier's operating performance is mitigated after SOX. These empirical findings indicate that common auditor can improve supplier's performance by facilitating information flow along supply chain, and the result is robust by using alternative measure of common auditor and addressing potential endogeneity concerns.

There are several limitations of this study. First, the data sample only includes suppliers' major customers but not vice versa, so the average size of customers is much larger than that of suppliers. Thus the research findings of this study might not be suitable to be generated to all supply chain relationships. Second, as there is no data

of customers' major suppliers, this study doesn't examine the effect of common auditor on customer's performance, which is left for future studies.

For more future studies, as I find some hint that common auditor might transfer information through discussion with firm managers in supply chain, researchers can try to find more strong evidence to prove this finding. And as I also find evidence that common auditor might transfer customer's demand information to supplier, future studies could find more evidence of this demand information transfer by common auditor and could also explore what other information contents that common auditor could transfer along supply chain. What's more, my analyses mainly focus on common auditor at the firm level. As Dhaliwal et al. (2016) and others show that common auditor at the office level has stronger effects in their respective settings, future study could explore the possibility of defining common auditor at the audit office level. Finally, although I mentioned three potential channels that common auditor could transfer information between suppliers and customers, what exact channels that common auditor could transfer information, what information content that common auditor could transfer through each channel, and how each transferred information content improves supplier's performance are not the focus of this study, which are left for future exploration.

Appendix

Variable Definitions

Variable	Definition
ROA	Supplier's ROA measured as the ratio of net income to total assets.
Pct_Common_Auditor	The percentage of supplier's sales accounted for by the key customers that use a common audit firm with the supplier.
Dum_Common_Auditor	Dummy variable equals one if at least one of the key customers use a common audit firm with the supplier, and zero otherwise.
Pct_Common_Auditor_ Same_Office	The percentage of supplier's sales accounted for by the key customers that use a common audit office with the supplier.
Pct_Common_Auditor_ Different_Office	The percentage of supplier's sales accounted for by the key customers that use a common audit firm but not common office with the supplier.
Dum_Common_Auditor_ Same_Office	Dummy variable equals one if at least one of the key customers use a common audit office with the supplier, and zero otherwise.
Dum_Common_Auditor_ Different_Office	Dummy variable equals one if at least one of the key customers use a common audit firm with the supplier but no customer uses the same audit office with the supplier, and zero otherwise.
SIZE	Supplier's firm size measured as the natural logarithm of total assets.
Lag_ROA	Supplier's prior-year ROA.
LEV	Supplier's leverage calculated as total liabilities divided by total assets.
AGE	Supplier's firm age measured as the difference between fiscal data year and corporate IPO year.
SG	Supplier's sales growth calculated as the difference of current-year sales and previous-year sales, divided by previous-year sales.
RD_Intensity	Supplier's R&D intensity measured as the ratio of R&D expenses to total assets (zero if missing).
AD_Intensity	Supplier's Advertising intensity measured as the ratio of advertising expenses to total assets (zero if missing).
BigN	Dummy variable equals one if supplier's auditor is one of the big N auditor firms and zero otherwise.
CAGE	Sales-weighted average of major customers' firm age.
CSG	Sales-weighted average of annual percentage sales growth for identifiable customers.
CSIZE	Sales-weighted average of major customers' firm size.
LINKAGE	Sales-weighted average of supplier-customer relationship duration for identifiable customers.
CC	Customer concentration measured as the sum of the squares of sales share accounted for by each identifiable customer.

PM	Supplier's profit margin calculated as net income divided by sales.
ATO	Supplier's assets turnover calculated as sales divided by total assets.
NOM	Supplier's non-operating margin calculated as the difference between profit margin and operating margin.
OM	Supplier's operating margin calculated as operating income before depreciation divided by sales.
SGA	Supplier's SG&A ratio calculated as SG&A expenses divided by sales.
GM	Supplier's gross margin calculated as the ratio of the difference between sales and COGS to sales.
Days of Receivables	Supplier's receivables conversion period measured by dividing accounts receivable by sales and multiplying 365 days.
Days of Inventory	Supplier's inventory conversion period measured by dividing inventory by cost of goods sold and multiplying 365 days.
Days of Payables	Supplier's payables conversion period measured by dividing accounts payable by cost of goods sold and multiplying 365 days.
Bullwhip_Effect	Supplier's bullwhip effect, measured as the ratio of quarterly *PRODUCTION*'s standard deviation to quarterly *DEMAND*'s standard deviation in a fiscal year. *PRODUCTION* is the first difference of the logarithm of supplier's production which is measured by using cost of goods sold plus inventory changes in every quarter. *DEMAND* is the first difference of the logarithm of customers' demand which is measured by using cost of goods sold in every quarter.
Lag_Bullwhip_Effect	Supplier's prior-year *Bullwhip_Effect*.
SEASONALITY	The seasonality of customers' demand measured by dividing the variance difference of customers' *DEMAND* and customers' deseasonalized *DEMAND* by using the variance of customers' *DEMAND*. Quarterly data is used to measure variances for each year.
AR1RHO	The autoregressive coefficient of deseasonalized *DEMAND*, which is estimated by using quarterly data in each year.

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