Guanxi, overconfidence and corporate fraud in China

Guohua Cao and Jing Zhang
School of Economics and Business Administration, Chongqing University, Chongqing, China

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Abstract

Purpose – This study aims to combine two fraud-related streams of the literature on guanxi and overconfidence into an integrated framework, which is the fraud triangle, to interpret the mechanism of fraud commission and detection.

Design/methodology/approach – A bivariate probit model with Partial Observability (POBi Probit) is applied. Moreover, the POBi Probit model is adjusted to the Chinese context. The China-specific POBi Probit model is constructed using data of Chinese A-share listed companies from 2008 to 2014, with a total of 15,109 firm-year observations.

Findings – Overconfidence induces fraud commission and worsens fraud detection; overconfidence mediates the relationship between fraud and guanxi; the "white side" of guanxi comes from alumni networks, while the "dark side" is derived from relatives-based networks; overconfidence induces fraud commission in accounting and disclosure and benefits the detection of disclosure frauds. Guanxi suppresses fraud commission in management and disclosure, however, it worsens fraud detection given fraud in management and disclosure; overconfidence induces fraud commission in both state-owned enterprises (SOE) and non-SOEs, and benefits fraud detection in SOEs. Guanxi suppresses fraud commission and worsens fraud detection in SOEs and city-owned firms.

Research limitations/implications – There are two drawbacks of the partial observable bivariate probit (POBi-Probit) method that must be mentioned here. On one hand, the ex ante variable selection is one of the most difficult parts of applying the POBi-Probit model and different variables are included in different studies. On the other hand, the POBi-Probit model might not converge if too many variables are included. Thus, many widely accepted factors can be included in the model. Thus, this study initially sets the POBi-Probit model based mainly on Khanna *et al.* (2015) and then adjusts the model for the Chinese context (e. g. considering government ownership) according to Yiu *et al.* (2018) and Zhang (2018) and the local study of Meng *et al.* (2019). Considering the observability of fraud, on one hand, the observability of fraud commission is a widely accepted limitation, especially when accounting opacity comes across with regulatory efficiency (Yiu *et al.* (2018). On the other hand, the observability of relationships is another obstacle to this study. Future studies can go further by revealing the presently unobservable relationships using Big Data technology.

Originality/value – This paper theoretically and practically contributes to the literature on both corporate fraud and corporate governance. Theoretically, by introducing integrated principal-agent resource-reliance theory (IPRT) and upper echelon theory (UET), this paper broadens the framework of fraud triangle theory (FTT) and testifies the availability of the broaden FTT in the transitional and emerging-market context of China. Practically, this paper provides evidence that guanxi and overconfidence are two of the factors affecting corporate fraud. Thus, this paper provides a governance approach opposing corporate fraud in China, which may help the other emerging economies in transition.

Keywords Guanxi, Overconfidence, Corporate fraud, Fraud triangle theory, Bivariate probit model with partial observability

Paper type Research paper

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1. Introduction

Despite being the largest and fastest developing economy in the world, China is often perceived in the international community as a country with weak financial regulations and inefficient law enforcement (Conyon and He, 2016; Kong *et al.*, 2019). Improving corporate governance has become an urgent need for both China and other rapidly growing emerging economies (Hass *et al.*, 2016). Particularly, alternate governance, represented by relational governance, has become a necessary supplement to conventional corporate governance and is highly praised in economies with well-developed legal systems (Yiu *et al.*, 2018).

However, the alternate governance theory (AGT) argued by Yiu *et al.* (2018) ignores not only the moral hazard caused by *guanxi* but also the individuals involved (including their characteristics, psychology and level of rationality). Moreover, AGT fails to satisfy the fraud triangle theory (FTT), and thus, is not enough in interpreting the overall formation mechanism of fraud.

Thus, based on the FTT (Cressey, 1953; Huang *et al.*, 2017; Morales *et al.*, 2014), this research combines two fraud-related streams of the literature on *guanxi* and overconfidence into an integrated framework. By doing so, we construct a comprehensive fraud triangle to interpret the mechanism of fraud commission and detection. On one hand, *guanxi* is considered as the factor of "incentive" and "opportunity," in line with the integrated principal-agency and resource-reliance theory (IPRT) (Dalziel *et al.*, 2011; Tao *et al.*, 2019). On the other hand, overconfidence is applied as the factor of "incentive" and "rationalization," in line with the upper echelon theory (UET) (Hambrick and Mason, 1984; Hambrick, 2007).

To test the comprehensive fraud triangle mentioned above, a bivariate probit model with partial observability (POBi Probit) is applied based on Wang *et al.* (2010), Wang (2013) and Kuang and Lee (2017). The reason for choosing the POBi Probit model is the inherent problem of partial observability in the fraud sample. According to Khanna *et al.* (2015), only detected fraud is observed, instead of the entire population of fraudulent activity. Moreover, the POBi Probit model is adjusted to the Chinese context based on Kong *et al.* (2019), Yiu *et al.* (2018) and Zhang (2018) and the local study of Meng *et al.* (2019). The China-specific POBi Probit model is constructed using data of Chinese A-share listed companies from 2008 to 2014, with a total of 15,109 firm-year observations.

Results show that: overconfidence induces fraud commission and worsens fraud detection; overconfidence mediates the relationship between fraud and *guanxi*; the "white side" of *guanxi* comes from alumni networks, while the "dark side" is derived from relatives-based networks; overconfidence induces fraud commission in accounting and disclosure and benefits the detection of disclosure frauds. *Guanxi* suppresses fraud commission in management and disclosure; however, it worsens fraud detection given fraud in management and disclosure; overconfidence induces fraud commission in both state-owned enterprises (SOE) and non-SOEs and benefits fraud detection in SOEs. *Guanxi* suppresses fraud commission and worsens fraud detection in SOEs and city-owned firms.

This paper theoretically and practically contributes to the literature on both corporate fraud and corporate governance. Theoretically, by introducing IPRT and UET, this paper broadens the framework of FTT and testifies to the availability of the broadened FTT in the transitional and emerging-market context of China. Practically, this paper provides evidence that *guanxi* and overconfidence are two of the factors affecting corporate fraud. Thus, this paper provides a governance approach opposing corporate fraud in China, which may help the other emerging economies in transition.

The rest of this paper is organized as follows. Section 2 provides a review of the relevant literature and develops hypotheses. Section 3 describes the construction of the empirical model and the selection of the data sample. Section 4 outlines the empirical results. Section 5 describes the robustness checks. Section 6 presents the conclusion of this paper.

2. Literature review

2.1 Fraud triangle theory

Fraud damages trust, thus jeopardizing the corporation's own profits and survival. It also destroys the foundations of trading and production (Amiram *et al.*, 2018). On one hand, once a corporation is caught committing fraud, its stock price falls (Gande and Lewis, 2009; Karpoff *et al.*, 2017), the business gets hit badly (Atanasov *et al.*, 2012) and reputation is also hurt (Armour *et al.*, 2017). On the other hand, trust is one of the most important determinants of investors to allocate their assets. A region full of fraud would be removed from the investing list (Giannetti and Wang, 2016).

Considering the significant negative impact of fraud, the FTT has been put forward by Cressey (1953) and applied to many studies (Huang *et al.*, 2017; Lokanan, 2019; Morales *et al.*, 2014; Schuchter and Levi, 2019, 2016). FTT generally divides fraud into three factors (Morales *et al.*, 2014):

(1) "incentive" to commit fraud;

(2) "opportunity" to do so; and

(3) "rationalization" by the fraudster of their commissions.

First, "incentive" is widely accepted as resulting from two major channels. One channel is "capital market incentives," for example, benefitting from stock-based options by raising the stock price (Beneish, 1999; Call *et al.*, 2016), obtaining funding by manipulating financial reports (Dechow *et al.*, 1996; Erickson *et al.*, 2006) and seeking profits via insider trading (Peng and Röell, 2008). The other is "contracting incentives," for instance, obtaining contract income (Dechow *et al.*, 1995) or relieving debt pressure (Burns and Kedia, 2006) through financial manipulation. However, some scholars argue that fraud incentives also result from perceived pressure, such as meeting analysts' forecasts (Huang *et al.*, 2017; Morales *et al.*, 2014).

Second, "opportunity" is often treated as internal monitoring and outside oversight. Internal monitoring factors include financial reports (Agrawal and Chadha, 2005), the structure of the board of directors (Kong *et al.*, 2019; Kuang and Lee, 2017), compensation mechanism (Conyon and He, 2016), the structure of ownership (Chen *et al.*, 2006; Wang *et al.*, 2019; Wu *et al.*, 2016), auditing (Chen *et al.*, 2013), etc. Outside oversight factors include delisting mechanisms (Zhou *et al.*, 2018), public media reporting (Miller, 2006), government campaigns (Zhang, 2018) economic conditions (Povel *et al.*, 2007; Wang *et al.*, 2010), etc.

Finally, "rationalization" is mostly believed to be a result of management characteristics and ethics (Huang *et al.*, 2017). Characteristics-related studies have been conducted by considering factors such as the ancestral culture (Liu, 2016), gender (Adams and Ferreira, 2009) and social networks (Parsons *et al.*, 2018) of the person committing fraud. However, the psychological factor ("fraud-inhibiting inner voice") is considered even more common by Schuchter and Levi (2019, 2016).

2.2 Guanxi and corporate fraud in China

Guanxi is a Chinese phrase, that is also known as connections, connectedness and social networks. *Guanxi* refers to network structures composed of nodes (usually people or institutions) that are connected through various social relationships, ranging from casual to close bonds (Schuchter and Levi, 2019, 2016). In the context of Chinese culture and society, *guanxi* plays an integral (Lin and Lin, 2016).

Recent advances have been made in the area of *guanxi* and fraud (Amiram *et al.*, 2018). The integrated agency-resource dependence theory (Dalziel *et al.*, 2011; Tao *et al.*, 2019) and

several existing studies (Guan *et al.*, 2016) have pointed out that the *guanxi* of top managers and directors profoundly affects corporate decisions. Yiu *et al.* (2018) even put forward a specific term, called "Relational Governance."

However, the effect of *guanxi* is still intensely debated even in developed economies and different conclusions have been drawn from empirical studies with different settings. Although the dual nature of *guanxi* as a mixture of the resource-providing ability and the agency issue, is gaining recognition (El-Khatib *et al.*, 2015), different empirical results continue to generate intense discussion. Generally speaking, the conclusions can be divided into two sides: "*guanxi* benefits" (Cai and Sevilir, 2012; Cohen *et al.*, 2008) and "*guanxi* pays" (Khanna *et al.*, 2015; Kuang and Lee, 2017; Tao *et al.*, 2019).

On one hand, the "*guanxi* benefits" side argues that resources such as capital and information provided by *guanxi* loosen the resource-reliance constraints (Cai and Sevilir, 2012; Cohen *et al.*, 2008). This softens the operating pressure, which is believed to be one of the main causes of fraud by scholars such as Baucus (1994). Moreover, fraud damages the reputation of firms, while *guanxi* is a critical characteristic treasured by entrepreneurs (Allen *et al.*, 2005). A well-connected entrepreneur is under more ethical pressure as a result of his/her high-density network (Jha, 2019), which creates a relational governance structure powered by the network partners (Yiu *et al.*, 2018).

On the other hand, the "*guanxi* pays" side argues that the resource-providing effect of connectedness itself induces the motivations and opportunities to commit fraud. According to IPRT (Dalziel *et al.*, 2011; Tao *et al.*, 2019), more *guanxi* provides more critical resources, provides power and influence to build entrenchment and even becomes a new type of capital called "network capital" (Meyer *et al.*, 2009). However, this resource reliance limits the monitoring ability of internal governance (El-Khatib *et al.*, 2015). Thus, *guanxi*-provided entrenchment and *guanxi*-weakened governance induce managers to seek more private benefits (Tao *et al.*, 2019). Moreover, the psychological gap generated from peer comparison (especially with a very high benchmark) puts pressure on the entrepreneurs to perform and results in fraud (Labianca *et al.*, 2009; Lant, 1992). Thus, a more well-connected firm faces more potential comparison, which means more pressure and a higher likelihood of fraud commission.

What about the effect of *guanxi* on corporate fraud and detection in China? Which kind of *guanxi* plays a more influential role? Which theories concerning *guanxi* are appropriate in the Chinese context? These questions remain unanswered.

This study first considers *guanxi* as one of the determinant factors inducing fraud. Based on IPRT and the comparison pressure (Labianca *et al.*, 2009; Lant, 1992), this study draws the following hypotheses:

H1A. A better-connected firm has a lower fraud commission propensity.

H1B. A better-connected firm has a higher likelihood of fraud detection.

2.3 Overconfidence and corporate fraud in China

In the psychological stream of corporate fraud studies, the impact of overconfidence on fraud has been recognized by scholars such as Ahmed and Duellman (2013), O'Reilly *et al.* (2018) and Schrand and Zechman (2012).

Overconfidence is a general cognitive bias under the assumption of bounded rationality. Overconfidence means individuals tend to overestimate themselves (e.g. the ability to control) (Weinstein, 1980), overestimate the transparency or quality of information (Daniel *et al.*, 2010) and underestimate risk (Malmendier and Tate, 2005).

Entrepreneurs often exhibit a stronger willingness to take risks (namely, risk preference). Thus, entrepreneurs tend to be overconfident (Landier and Thesmar, 2009) and either overestimate the accuracy of their judgments (such as the feasibility of fraud and the profits from a successful fraud) or underestimate the risk of moral failure (such as the probability of being detected and the loss from being detected) (Banerjee *et al.*, 2018). Moreover, overconfident corporate leaders tend to have a stronger optimism bias (Schrand and Zechman, 2012), which rationalizes the fraud commission.

Considering that psychological factors are emphasized as the more general factors in fraud (Schuchter and Levi, 2019, 2016), overconfidence is introduced in this study to construct a comprehensive fraud triangle. Based on UET, this study draws the following hypotheses:

H2A. An overconfident firm has a higher fraud commission propensity.

H2B. An overconfident firm has a lower likelihood of fraud detection.

2.4 Moderation and mediation effects

When facing a decision related to fraud, an overconfident corporation tends to overestimate the commission profit and underestimate the detection risk. How does it work when overconfidence comes across *guanxi*?

FTT suggests that fraud is likely to result from a combination of three factors, which are an incentive, opportunity and rationality (Cressey, 1953; Huang *et al.*, 2017; Morales *et al.*, 2014). However, this question has not been answered adequately with empirical proof. On one hand, as "*guanxi* benefits" suggest, by providing the critical resources which alleviate the operating pressure (Cai and Sevilir, 2012; Cohen *et al.*, 2008) and by creating a reputation pressure between peers (Yiu *et al.*, 2018), *Guanxi* lowers the incentive to commit fraud. On the other hand, as "*guanxi* pays" argues, it is indeed the critical resources provided by *guanxi*, which weaken corporate governance (Tao *et al.*, 2019) and affect how managers react to operating performance (Schumacher *et al.*, 2020).

The question of how overconfidence works with *guanxi* in the field of corporate fraud remains unanswered sufficiently and it boils down to an empirical problem. Thus, this study draws the following hypotheses:

H3A. A better-connected and the overconfident firm has a higher fraud commission propensity.

H3B. A better-connected and the overconfident firm has a higher likelihood of fraud detection.

Besides the moderating effect between *guanxi* and overconfidence, scholars also imply an endogenous relationship between them (Gupta *et al.*, 2018; Schumacher *et al.*, 2020). According to the behavioral-economics theory of value reference point (Wang *et al.*, 2020), overconfidence may be modified during peer comparison (especially with a very high benchmark), which may suppress fraud commission. Moreover, the *guanxi*-provided resources and entrenchment may lead well-connected managers to have an overconfidence bias (Dalziel *et al.*, 2011; Tao *et al.*, 2019). Given that *guanxi* affects overconfidence, which, in turn, affects fraud, the linkage between *guanxi* and fraud is enhanced. That is, due to the resource provided by their connectedness, better-connected corporations may be more biased to be overconfident. Thus, overconfident corporations are more likely to commit fraud and be detected. Thus, the channel between *guanxi* and fraud has been extended.

Besides the direct channel mentioned above (*H1*), an indirect and internal channel is hypothesized as follows (Figure 1):

H4A. A better-connected firm has a lower fraud commission propensity, where overconfidence acts as a mediator.

H4B. A better-connected firm has a higher likelihood of fraud detection, where overconfidence acts as a mediator.

3. Empirical design

3.1 Estimation methodology

A bivariate probit regression with partial observability is applied in this study according to Kuang and Lee (2017), Wang *et al.* (2010) and Wang (2013). Moreover, the POBi Probit model in this study is adjusted to the Chinese context based on Kong *et al.* (2019), Yiu *et al.* (2018) and Zhang (2018), as well as the local study of Meng *et al.* (2019).

The POBi Probit model is applied because of the inherent problem of partial observability in the fraud sample (Khanna *et al.*, 2015). That is, the commission of fraud is unobservable and only the cases of fraud commission being detected can be observed. To be more specific, the process of fraud can be divided into three phrases:

(1) fraud commission, when fraud is committed by a corporation and is unobservable, denoted as $Commit_{it}$;

(2) fraud detection, when the regulator detects a corporate fraud but it is still unobservable, denoted as $Detect_{it}$; and

(3) observed fraud, when the regulator reports the detected fraud commission and it is observable, denoted as $Fraud_{it}$.

During the above process, only the final reported fraud is observed, namely, the detected fraud commission. We denote the detected fraud commission as $Fraud_{it} = Commit_{it}\, Detect_{it}$. $Fraud_{it} = 1$ if firm i has been detected committing a fraud ($Commit_{it} = 1$ and $Detect_{it} = 1$) in year t. $Fraud_{it} = 0$ if it has not committed any fraud or has not been detected even though it has committed fraud ($Commit_{it} = 0$ or $Detect_{it} = 0$) in year t.

For each firm i in year t, $Commit^{*}_{it}$ and $Detect^{*}_{it}$ are used to denote the latent variables determining the propensity of fraud commission $Commit_{it}$ and the likelihood of detection, $Detect_{it}$, respectively, as below:

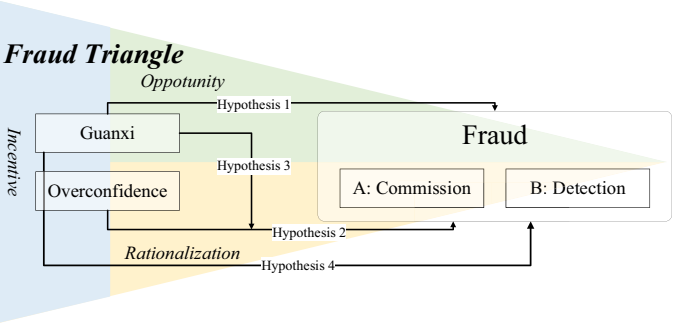

Figure 1.
Theoretical framework

$$Commit_{it}^{*} = \boldsymbol{A} \times \boldsymbol{ExCommit_{it}} + \mu_{it} \tag{1}$$

$$Detect_{it}^{*} = \boldsymbol{B} \times \boldsymbol{ExDetect_{it}} + \vartheta_{it} \tag{2}$$

Here, $\boldsymbol{ExCommit_{it}}$ is a vector of ex ante variables that explains the propensity of fraud commission and $\boldsymbol{ExDetect_{it}}$ is a vector of ex ante variables that explains the possibility of being detected. $\boldsymbol{A}$ and $\boldsymbol{B}$ are the coefficient vectors, respectively. μ_{it} and ϑ_{it} are zero-mean disturbances with a bivariate normal distribution and the correlation between them are denoted as ρ. The rule of defining $Commit_{it}^{*}$ and $Commit_{it}$ is: set $Commit_{it} = 1$ if $Commit_{it}^{*} > 0$ and $Commit_{it} = 0$ if$Commit_{it}^{*} \leq 0$. The rule of defining $Detect_{it}^{*}$ and $Detect_{it}$ is similar:

$$Commit_{it} = \begin{cases} 0, & Commit_{it}^{*} \leq 0 \\ 1, & Commit_{it}^{*} > 0 \end{cases} \text{and} \, Detect_{it} = \begin{cases} 0, & Detect_{it}^{*} \leq 0 \\ 1, & Detect_{it}^{*} > 0 \end{cases} \tag{3}$$

Accordingly, the empirical model for $Fraud_{it}$ can be written as follows:

$$\begin{aligned} P\{Fraud_{it} = 1\} &= P\{Commit_{it} Detect_{it} = 1\} = P\left\{Commit_{it}^{*} > 0, Detect_{it}^{*} > 0\right\} \\ P\{Fraud_{it} = 0\} &= P\{Commit_{it} Detect_{it} = 0\} = 1 - P\left\{Commit_{it}^{*} > 0, Detect_{it}^{*} > 0\right\} \end{aligned} \tag{4}$$

Here, $P\left\{Commit_{it}^{*} > 0, Detect_{it}^{*} > 0\right\} = \phi(\boldsymbol{A} \times \boldsymbol{ExCommit_{it}}, \boldsymbol{B} \times \boldsymbol{ExDetect_{it}}, \rho)$ and ρ denotes the correlation between commission and detection of fraud.

Thus, the log-likelihood function for the POBi Probit model is as follows:

$$L(\boldsymbol{A_{it}}, \boldsymbol{B_{it}}, \rho) = \sum \log(P\{Fraud_{it} = 1\}) + \sum \log(P\{Fraud_{it} = 0\}) \tag{5}$$

As per Khanna *et al.* (2015), maximum likelihood estimation is applied and the industrial clustered robust standard errors are introduced to account for any possibility of industrial correlations.

However, the POBi Probit model might not converge if it includes too many variables (Yiu *et al.*, 2018; Zhang, 2018) Thus, the selection of ex ante variables becomes one of the most difficult parts of applying the POBi Probit model and different variables are included in different studies. This study initially sets the POBi Probit model based mainly on Khanna *et al.* (2015) and then adjusts the model for Chinese features (e.g. political connection and government ownership) according to recent studies related to Chinese corporate fraud by Kong *et al.* (2019), Yiu *et al.* (2018) and Zhang (2018), as well as the local study of Meng *et al.* (2019).

3.2 Model Specification

3.2.1 Dependent variable: observed fraud. Considering that corporate fraud includes several definitions, as Amiram *et al.* (2018) suggest, a comprehensive database is needed to alleviate sample selection bias. Thus, we introduce the local corporate fraud recorded by the China Regulatory Enforcement Research (CRSR) database into the China Stock Market and Accounting Research (CSMAR) database. This is according to the existing studies of fraud in China, such as Yiu *et al.* (2018) and Zhang (2018). The fraud data collected by CRSR is

based on each corporate fraud announcement officially released by the regulators of Chinese securities and exchanges (China Securities Regulatory Commission (CSRC), Shanghai Stock Exchange (CSHSE) and Shenzhen Stock Exchange (CSZSE)).

According to existing empirical studies on corporate fraud (Khanna *et al.*, 2015; Yiu *et al.*, 2018; Zhang, 2018), the fraud occurrence of Chinese listed corporations is applied as a proxy of observed fraud ($Fraud_{it}$) in this study. The observed fraud ($Fraud_{it}$) is only the detected part ($Detect_{it}$) of the unobservable whole population of fraud commission ($Commit_{it}$), namely, $Fraud_{it} = Detect_{it}Commit_{it}$ as mentioned before. As for the observed fraud ($Fraud_{it}$) variable, if listed corporate i is announced committing fraud in the year t, $Fraud_{it}$ is denoted as 1. Otherwise, $Fraud_{it}$ is denoted as 0 (Table 1).

Furthermore, subdivisions of fraud are considered according to Khanna *et al.* (2015) and Kong *et al.* (2019). In the view of 16 types of fraud being specified by the CSRC, the more China-specific subdividing method of Kong *et al.* (2019) is applied. Thus, five major types of fraud are subdivided: =accounting fraud, including profit fabrication (P2501, the CSRC fraud-type ID, similarly hereinafter), assets fabrication (P2502) and general accounting misconducting (P2515). Management fraud, including listing fraud (P2507), capital contribution fraud (P2508), the unauthorized fund uses changes (P2509), embezzlement (P2510), insider trading (P2511) and illegal guarantees (P2514). Finance fraud, including illegal stock trading (P2512) and stock price manipulation (P2513). Disclosure fraud, including misleading statement (P2503), disclosure postponements (P2504), major information omission (P2505) and false disclosure and others (P2506). All other frauds (P2599).

3.2.2 Control variables for estimating latent variables. The POBi Probit model requires two sets of variables, one each for the fraud commission and fraud detection equations. According to Khanna *et al.* (2015), Yiu *et al.* (2018) and Zhang (2018) and the local study of Meng *et al.* (2019), three sets of control variables are divided into: ex ante factors of fraud commission propensity, ex ante factors of fraud detection likelihood and ex ante factors of

Major Tytpe	CSRC type	CSRC type ID
Accounting	Profit fabrication	P2501
	Assets fabrication	P2502
	General accounting misconducting	P2515
Management	Listing fraud	P2507
	Capital contribution fraud	P2508
	Unauthorized fund uses changes	P2509
	Embezzlement	P2510
	Insider trading	P2511
	Illegal guarantees	P2514
Finance	Illegal stock trading	P2512
	Stock price manipulation	P2513
Disclosure	Misleading statement	P2503
	Disclosure postponements	P2504
	Major information omission	P2505
	False disclosure and others	P2506
Other	All other fraud	P2599

Table 1.
Fraud type subdivision method

Notes: [1] The major type is subdivided based on Kong *et al.* (2019). [2] CSRC type and ID comes from CSRC and CSMAR

both commission and detection. In total, the first set of commission variables considers private information related to the internal characteristics of firms, such as tenure, age and gender of the Chief Executive Officer (CEO). The second set of detection variables considers monitoring factors, such as the size and independence of the director board. The third set of sharing variables considers financial information that is open for both the insider and the public, such as stock price volatility and turnover.

3.2.2.1 Ex ante factors of fraud detection likelihood. Referring to Khanna *et al.* (2015) and Meng *et al.* (2019), monitoring factors are mainly considered among the detecting control variables; these include five control variables related to internal monitoring and two control variables related to external monitoring.

The size of the director board (*lnDrct*), which is measured by the logarithmic form of director board size, is believed to influence fraud detection (Hass *et al.*, 2016; Wu *et al.*, 2016; Zhang, 2018). Independence of the director board (*IndDrctRatio*), which is measured by the ratio of independent directors, is widely accepted to detect fraud (Yiu *et al.*, 2018; Zhou *et al.*, 2018). The frequency of meetings held by the director board (*DBM*), which is measured by the number of director board meetings held in a year, is considered to reflect the internal monitoring effectiveness (Wang *et al.*, 2019). The number of auditors (*AuditNo*), which is measured by the number of auditors, is believed to have a significant effect on corporate fraud detection (Zhang, 2018). Qualification of auditors (*BigFour*), which is measured by whether the auditor is one of the Big Four internationally known accounting firms (PwC, DTT, KPMG and EY); if the auditor is one of the Big Four, denote *BigFour* = 1, otherwise, denotes, *BigFour* = 0. *BigFour* is included as external auditing is believed to benefit detecting corporate fraud (Zhou *et al.*, 2018). Analyst coverage (*Analyst*), which is measured by the number of following analysts, is considered because security analysts scrutinize a firm's financial disclosure (Zhang, 2018) and thus help detect corporate fraud. Institutional ownership (*InstOwn*), which is measured by the ratio of institutional shareholding, is believed to effectively monitor a firm's management (Wu *et al.*, 2016).

3.2.2.2 Ex ante factors of the fraud commission propensity. Referring to the local study of Meng *et al.* (2019), the characteristics of the CEO constitute this part of the fraud-commission propensity control variables. This study applies CEO characteristics as the ex ante factor of fraud commission propensity because these characteristics are more private information than financial reports and capital market indexes. When considering fraud commission and detection, private information plays a bigger role, while financial information can be observed by monitors and investors.

Tenure of CEO (*CEOTenure*) is included based on O'Reilly *et al.* (2018), who show that CEO tenure is related to the number and duration of lawsuits. The age of the CEO (*CEOAge*) is considered according to Conyon and He (2016). Gender of CEO (*CEOMale*), which is measured by a dummy variable (equals 1 if the CEO is a male and 0 otherwise) is introduced based on Zhou *et al.* (2018). Shareholding of CEO (*ln CEOShare*), which is measured by the logarithmic form of CEO shareholdings, is considered an important equity-based incentive to commit fraud (Kong *et al.*, 2019; Yiu *et al.*, 2018). CEO duality, in which the CEO is also the chairman of the board (*Duality*), which is measured by a dummy variable (equal to 1 if the CEO is the board chairman at the same time and equals 0 otherwise), is widely accepted as enhancing the CEO's controlling power in his firm, allowing more managerial discretion and impeding effective monitoring (Zhang, 2018). Shareholding centrality (*Shrcr*1), which is measured by the percentage of shares held by the largest shareholder, is considered based on Conyon and He (2016) and Zhou *et al.* (2018).

3.2.2.3 Ex ante factors of both the commission and the detection. Referring to Meng *et al.* (2019), public information on the corporation's finances and the capital market are

considered in the set of sharing variables. For the corporation, the pressure from internal finances and outside capital is one of the main reasons for committing fraud. For the monitors, information accessibility comes first and then abnormal information draws attention. This assumption of information accessibility is the main difference between this paper and Khanna *et al.* (2015).

Firm size (*ln Asset*), which is measured by the asset in the logarithmic form, is considered negatively related to a firm's incentives as larger firms face heightened monitoring and public attention (Kong *et al.*, 2019; Yiu *et al.*, 2018; Zhang, 2018). Firm performance (*ROA*), which is measured by the return on asset and its effect is still unclear as to whether it has a positive or a negative effect due to the contrary results of Dechow *et al.* (2011) and (Khanna *et al.*, 2015). Firm leverage (*Leverage*), which is measured by debt on assets, is believed to be an important fraud-inducing factor (Zhang, 2018). Firm growth (*Growth*), which is measured by sales growth, is a controlling variable because higher-growth firms can attract more attention from regulators and investors (Wang *et al.*, 2019). State-ownership (*SOE*), which is a dummy variable that equals 1 if a firm is controlled by the state and 0 otherwise. SOE draws a lot of research attention and is concluded to have weakened monitoring (Wang *et al.*, 2019; Yiu *et al.*, 2018) and have a lower enforcement incidence (Hou and Moore, 2010). Tobin's Q (*TobinQ*), which is measured by the famous firm value index Tobin's Q (Yiu *et al.*, 2018; Zhang, 2018). Stock return (*EPS*), which is measured by earnings per share, is included as regulators may trigger investigations once a manager manipulates financial statements to mislead investors (Wang *et al.*, 2019). Stock price volatility (*Volatility*), which is measured by the annually-averaged standard deviation of stock price changes, is introduced because firms with higher stock return volatility have a greater probability of being complained of by investors. After all, the likelihood of a big investment loss is higher (Wang *et al.*, 2019). Stock turnover (*Turnover*), which is measured by the annual stock turnover, is considered because a firm with a higher turnover tends to draw more publicity, which may raise their litigation risk (Zhou *et al.*, 2018).

Considering the Chinese context, political connections are included in this paper, as several studies have pointed out that it is a representative Chinese characteristic that influences corporate fraud and detection. According to a recent study by Kong *et al.* (2019), the political connection is a considerable factor that suppresses the incidence of fraud commission. Thus, a political connection is included as a dummy variable in this study, denoted as *PC* and is set to 1 if there is any political connection and is set to 0 otherwise.

Industry average performance (*EPSIndAve*) is included for controlling fixed effects instead of the other 19 and 7 yearly industrial dummy variables because too many variables may prevent the POBi probit model estimation from converging (Yiu *et al.*, 2018; Zhang, 2018). *EPSIndAve* is measured by the annually-averaged EPS per industry.

3.2.3 Independent variable: Guanxi. Referring to the thorough study of Khanna *et al.* (2015), connectedness based on kinship, working experience, alumni relationship and the political connection is considered in this study. As more and more scholars have recognized strength as a critical and considerable factor of relationships (El-Khatib *et al.*, 2015; Kuang and Lee, 2017; Tao *et al.*, 2019), the strength of connectedness is considered in this study and accordingly measured as network centrality including four dimensions, which are betweenness, closeness, degree and eigenvector.

To construct a comprehensive connectedness strength index, the recently and widely used three-step process is applied according to El-Khatib *et al.* (2015) and Tao *et al.* (2019):

(1) 16 raw centrality indexes are generated by calculating 4 dimensions of centrality based on the 4 different social networks of each entrepreneur in each year. Moreover, it is assumed that once formed, connections persist until one party of the

pair dies according to El-Khatib *et al.* (2015). This means that the network grows monotonically larger over time. Considering the limited calculation ability facing the ever-growing educational network, the leaf nodes who are neither top officers nor mediators between two top officers are cut from the educational network. However, the leaf nodes in the other networks are kept owing to the computable size of the other networks.

(2) 16 annual percentile centrality indexes are generated based on each of the 16 raw indexes. These 16 percentile indexes are denoted as 1 being the least central and 100 being the most central. This percentile transformation preserves the rank order of the network importance of each entrepreneur, making the size of the network irrelevant and thus comparable across different years (El-Khatib *et al.*, 2015).

(3) A comprehensive firm-level centrality index is generated by averaging the 16 annual percentile indexes of all CEO and directors in each year (Tao *et al.*, 2019). Moreover, the maximizing method is applied as a robustness check (Table 2).

3.2.4 Independent variable: overconfidence. The prevailing measurement of overconfidence can be divided into four main streams, which are

(1) stock-based ones (Banerjee *et al.*, 2018; Hirshleifer *et al.*, 2012);

(2) operation-based ones (Ahmed and Duellman, 2013);

(3) news-based ones (Hirshleifer *et al.*, 2012; Hribar and Yang, 2016); and

(4) subjective-scoring ones (O'Reilly *et al.*, 2018).

The stock-based measurement considering a stock purchase and stock-based option reveals the characteristics of the CEO and director (Banerjee *et al.*, 2018; Hirshleifer *et al.*, 2012). The operation-based measurement often applies abnormal corporate operation behaviors as a proxy, such as investment (Ahmed and Duellman, 2013) and debt issuance (Huang and Kisgen, 2013). The news-based measurement counts the words describing a CEO or director as "overconfident" (Hirshleifer *et al.*, 2012; Hribar and Yang, 2016). The subjective-scoring measurement is relatively rare, which might induce subjective bias and limit the sample size (O'Reilly *et al.*, 2018).

The measurement of overconfidence applied in this study is mainly based on the stock-based measurement of Hirshleifer *et al.* (2012) and (Banerjee *et al.*, 2018) and is adjusted to the Chinese context based on domestic studies (Wang and Wang, 2017; Wang *et al.*, 2017).

Although option-based measurement is more widely used in recent studies, the stock-based measurement is applied in this study because of the rarity and informational unavailability of stock option compensation in the Chinese context (Conyon and He, 2016;

Guanxi	Definition
PerScoreMean	Averaged percentile centrality indexes of all relationship-based network
PerScoreMax	Maximum percentile centrality indexes of all relationship-based network
CenMean	Averaged raw centrality indexes of all relationship-based network
CenMax	Maximum raw centrality indexes of all relationship-based network
PoSAMean	Averaged percentile centrality indexes of all alumni-based network
PoSCMean	Averaged percentile centrality indexes of all colleague-based network
PoSFGOMean	Averaged percentile centrality indexes of all government-based network
PoSRMean	Averaged percentile centrality indexes of all relative-based network

Table 2. *Guanxi* variable definition

Hass *et al.*, 2016; Zhou *et al.*, 2018). Operation-based measurement is less appropriate for this study than the stock-based one because of its reliance upon historical operation: abnormal operations are defined compared to the historical behavior (by average or regression) (Ahmed and Duellman, 2013). Also, either method will use up at least two-sevenths of our sample, thus expending too much information. The critical obstacle of applying news-based measurements to the Chinese context is the complexity of the Chinese language and literature. Subjective scoring is abandoned mainly because of the difficulty in avoiding subjective bias.

Based on local studies (Wang *et al.*, 2017), an adjusted measurement of overconfidence is applied in this study. The idea behind is similar to that of the stock-based one applied by Banerjee *et al.* (2018) and Hirshleifer *et al.* (2012). That is to say, overconfident CEOs and directors tend to hold their stocks for an extended period, even if the return is less than that of their peers' holding because they overoptimistically believe in themselves. Thus, the following CEOs and directors are assumed to be overconfident and we denote $OC_{i,t} = 1$ for those who did not sell their shares even if the EPS is less than the industrial average. Otherwise, CEOs and directors are treated as non-overconfidence and we denote $OC_{i,t} = 0$:

$$\forall \begin{cases} EPS_{it} < IndustryAverageEPS_{it} \\ ShareHolding_{jt} \geq ShareHolding_{jt} \end{cases}, \quad OC_{i,t} = 1 \tag{1}$$

Here, $EPS_{i,t}$ denotes the earnings per share, $IndustryAverageEPS_{i,t}$ denotes the average EPS in industry and $ShareHolding_{jt}$ denotes the shareholding of the CEO or director. i denotes firm, j denotes CEO or director and t denotes the year.

3.3 Sample selection and data resource

The primary data comes from the CSMAR database, which has been the same resource of several relevant existing studies (Conyon and He, 2016; Kong *et al.*, 2019; Tao *et al.*, 2019; Yiu *et al.*, 2018; Zhang, 2018; Zhou *et al.*, 2018). The data used in this study are on A-share corporations listed on the CSHSE and CSZSE during the period from 2008 to 2014. After the removal of data-missing observations and winsorization with 1% at both tails, a sample of 15,109 firm-year observations is obtained. Descriptive statistics (whole sample, SOEs and non-SOEs) are shown in Appendix Table A1.

The sample starts from 2008 for two main reasons: the Chinese share structure reform around 2006 significantly changed the reporting of some accounting data. Thus, some financial indicators are not easily comparable with those prior to the reform (Zhou *et al.*, 2018); the Chinese property law reform around 2007 also significantly influenced corporate fraud (Kong *et al.*, 2019). Additionally, the 2008 global crisis is another considerably profound event that caused structural changes.

4. Results and analysis

4.1 Results of the baseline model

Table 3 presents the results of the baseline POBi Probit model, where model (1) corresponds to the fraud commission equation and model (2) corresponds to the detection equation. The independent variables of commission and detection reflect the measurement of detected fraud. *Guanxi* is reflected by the aggregated average percentile network centrality index as the measurement. The other variables are defined in Section 3.2 and Appendix Table A1.

The results of interest are not all statistically significant but are interesting.

Model Dependent variable	(1) Commit	(2) Detect | Commit
Main effect		
Overconfidence	0.2823** (2.17)	−0.4680** (−2.04)
Guanxi	−0.0038 (−0.76)	0.0043 (0.48)
Control variables: commit		
Tenure of CEO	0.0026 (0.21)	
Age of CEO	−0.006 (−0.31)	
Gender of CEO	0.0072 (0.15)	
Shareholding of CEO	0.0011 (0.56)	
Duality of CEO and Director	0.0839*** (2.74)	
Share centrality	−0.0052*** (−4.80)	
Control variables: detect		
Size of Director Board		0.1973** (2.42)
Independence of Directors		0.0527 (0.16)
Number of Directors Meeting		0.0378*** (2.61)
Number of Auditors		−0.0295 (−0.41)
Qualification of Auditors		−0.4295** (−2.52)
Number of analysts		−0.0008 (−1.55)
Institutional ownership		−0.0120*** (−2.66)
Control variables		
Firm size	−0.1909*** (−5.51)	0.2275*** (3.77)
Performance	−0.4307 (−0.70)	−1.2190* (−1.75)
Leverage	0.8950*** (5.00)	−0.5313* (−1.83)
Sales growth	0.0275 (0.66)	0.0136 (0.20)
State ownership	−0.0867 (−0.85)	−0.2381 (−1.44)
Tobin's Q	0.0106 (0.41)	0.0203 (0.69)
Earning per share	−0.0109 (−0.20)	0.0302 (0.77)
Annual stock price volatility	0.0548 (0.13)	0.7590 (1.42)
Annual stock turnover	−3.9794*** (−3.86)	8.3877*** (3.47)
Industry average EPS	−0.2133 (−1.07)	0.2804 (0.82)
Chinese feature		
Political connection	−0.0676 (−0.77)	0.3191** (2.26)
Model specific		
Constant	3.6527*** (4.36)	−4.5199*** (−3.44)
Log pseudolikelihood (Wald χ^2)	−7151.5188*** (396.22)	
rho (Wald χ^2)	−0.6886* (3.67)	
N	15,109	

Notes: [1] *, ** and *** denote significance at the 10, 5 and 1% confidence levels. [2] Probit coefficients and their robust standard errors (in parentheses) are reported

Table 3.
Results of Baseline POBi Probit model

On one hand, *H1* is supported. Overconfidence is associated with a greater fraud incidence and a lower detection likelihood, consistent with the existing studies. Overconfident firms tend to issue an overly optimistic expectation because of the effects of over-optimism and miscalibration (Hribar and Yang, 2016) Thus, they are more likely to start down a slippery slope with growing intentional misbehavior led by this optimistic bias (Schrand and Zechman, 2012). What's worse, even external monitoring seems to be ineffective in moderating this overconfidence (Ahmed and Duellman, 2013), which may be caused by the false information delivered by the optimistic impression of overconfidence.

On the other hand, *H2* is rejected. *Guanxi* is associated with lower fraud incidence and a greater likelihood of detection. However, these relationships are not statistically significant for the whole sample. Thus, no proof is found, neither for nor against the influence of *guanxi* on corporate fraud. This result is partly consistent with that of Kuang and Lee (2017), indicating the coexistence of two plausible effects between *guanxi* and fraud. While improved resource and information accessibility may induce CEOs' fraud incentive and monitors' detection ability (Intintoli *et al.*, 2017; Omer *et al.*, 2018), too many commitments caused by widespread connections distract their focus to do so (Cashman *et al.*, 2012). A further study of different relationship-based *guanxi* is conducted and reported in Section 5.1.

The majority of the control variables are consistent with the conjectures and mostly consistent with prior studies (Khanna *et al.*, 2015; Wang, 2013; Wang *et al.*, 2010; Wang *et al.*, 2019; Zhang, 2018).

First, we examine the set of fraud commission factors. CEO duality is positively related to the incidence of fraud, while shareholding centrality is negatively related. On the one hand, duality induces fraud commission by giving CEOs more internal power, which is consistent with Wang *et al.* (2019) and Zhang (2019). On the other hand, a higher shareholding centrality means a more related shareholder, who would endeavor to have better corporate monitoring for their own sake. Thus, the decentralized responsibility problem [1] is avoided and better governance is brought about by this more central party.

Second, we look at the set of fraud detection factors. Director board size and director meeting frequency are associated with a higher likelihood of detection, while auditor qualification and institutional ownership are associated with a lower likelihood of detection. First, although existing scholars argue that larger boards tend to be less effective monitors, this study suggests that larger boards are effective in detecting fraud, which is consistent with Khanna *et al.* (2015). Second, more frequent director meetings tend to benefit fraud detection, as indicated by the statistically significant positive coefficient. That is, although more frequent meetings may be costly, they are helpful in better detecting corporate fraud. Third, auditor qualification, measured by the dummy variable of whether a firm uses any of the four biggest auditor companies, is negatively related to the likelihood of detection, which brings to mind the shocking incident of Enron and indicates skepticism toward the biggest auditor companies. Finally, higher institutional ownership is negatively associated with the likelihood of detection because the majority of institutions (such as foreign investors, securities firms, trust firms and financial firms) are rather passive investors (Wang *et al.*, 2019).

Third, we examine the set of sharing factors. Firm size and annual stock turnover are negatively associated with the incidence of fraud and positively associated with the likelihood of detection. Leverage and performance are negatively associated with fraud detection. First, larger firms tend not to commit fraud because they are often more mature, diversified and operating with less profit volatility. Thus, larger firm size suppresses fraud incentives (Zhang, 2018) and attract more public attention, including that of regulators (Wang *et al.*, 2019). Second, stock turnover is negatively associated with fraud and positively associated with detection because of the ease of identifying a plaintiff class of investors as regulators. This is consistent with Khanna *et al.* (2015), Wang *et al.* (2010), Wang (2013), Khanna *et al.* (2015) and Wang *et al.* (2019). Third, leverage is positively related to fraud while negatively related to detection, which means that firms with easier access to funds are more likely to commit fraud (Zhang, 2018). Finally, firm performance, measured by return on asset (ROA), is associated with a lower likelihood of detection, consistent with Wang *et al.* (2019) and Yiu *et al.* (2018). This result indicates a lower incentive for fraud detection when subjects are a better performing firm that may be a considerably important taxpayer and employer.

Finally, the political connection is associated with a greater likelihood of detection, which is in contrast with the "regulatory privilege" result of Wu *et al.* (2016), while consisting with the "regulatory schooling" theory argued by Kong *et al.* (2019). The main cause of this contradiction may be due to the model setting and estimation method. Wu *et al.* (2016) ignore the difference between fraud commission and fraud detection, thus applying a simple probit model. However, this study and Kong *et al.* (2019) divide fraud announcement into the propensity of commission and the likelihood of detection and apply a bivariate probit model with partial observability.

4.2 Moderation effect

To test *H3*, which considers the moderation effect between *guanxi* and overconfidence, a product term $OC_{it} \times Guanxi_{it}$ is introduced to the baseline model. The main results are shown in Table 4, indicating that no moderation effect can be proved. Thus, *H3* is rejected. That is, *guanxi* and overconfidence can influence fraud commission and detection separately.

4.3 Mediation effect of overconfidence

Does better connectedness lead to a bias in overconfidence? To answer this question, the mediation effect of overconfidence is considered separately in this section. To do so, we follow (Mackinnon and Fairchild, 2009). The results are shown in Table 5. We observe a partial mediation effect of overconfidence on the relationship between *guanxi* and fraud (both commission and detection). *H4A* is supported, while *H4B* is rejected.

More specifically, at first, better connectedness lowers both the propensity to commit fraud and the likelihood of being detected. Second, better connectedness suppresses overconfidence and encourages modesty. Third, overconfidence heightens both the propensity to commit fraud and the likelihood of being detected. Finally, overconfidence partially mediates the process by which *guanxi* affects the commission and detection of fraud. After considering the partial mediation effect of overconfidence, the net effects of better connectedness on fraud commission and fraud detection are both statistically significant and negative.

These results provide supporting evidence to both the direct and indirect channels from *guanxi* to fraud, where overconfidence serves as a mediator for the indirect channel. However, it is noteworthy that the relationship between *guanxi* and fraud is rather complex. On one hand, better connectedness suppresses fraud commission, which benefits the society and economy. On the other hand, better connectedness conceals fraud commission by lowering the likelihood of fraud detection and may cause the problem of adverse choice: a better-connected corporation is less likely to be caught, which may induce the better-connected corporation to commit even more fraud.

5. Robustness test

5.1 Different relationship-based guanxi

Which relationship-based *guanxi* (kinsfolk-based, colleague-based, alumni-based or political) is more influential? This question has also not been settled definitively. Cohen *et al.* (2008) point out that education-based *guanxi* is longer-lasting, stronger, more interactive, more effective and more beneficial. El-Khatib *et al.* (2015) state that appointment-based *guanxi* is more powerful than that based on past employment, education and social organization memberships. A different conclusion is found by Kuang and Lee (2017), namely, that social connections through employment and social activities play a more significant role, while educational ties do not.

Table 4.
Results of moderating effect test based on POBi Probit model

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Relationship	Aggregation		Alumni		Colleagues		FGORelation		Relatives	
Dependent	Commit	Detect	Commit	Detect	Commit	Detect	Commit	Detect	Commit	Detect
OC	0.1355 (0.71)	−0.0309 (−0.17)	0.1467 (1.18)	−0.0925 (−0.85)	0.4572** (2.24)	−0.6524 (−1.62)	0.0087 (0.04)	0.1866 (1.54)	0.2413** (2.37)	−0.1802* (−1.69)
Guanxi	0.0006 (0.05)	−0.0034 (−0.35)	0.0016 (0.26)	−0.0027 (−0.66)	0.0036 (0.55)	−0.0048 (−0.33)	−0.0497 (−1.37)	0.0337 (1.59)	0.0418** (1.97)	−0.0236 (−1.50)
OC × *Guanxi*	0.0042 (0.31)	−0.0019 (−0.18)	0.0027** (2.02)	0.0019 (0.55)	−0.0071 (−0.94)	0.0068 (0.43)	0.0568 (2.35)	−0.0780*** (−2.66)	−0.0115 (−0.50)	0.0254* (1.67)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cons	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
rho	0.5210		0.4868		−0.7327		0.6415		0.5808	
(Wald χ^2)	(0.47)		(0.33)		(2.69)		(0.98)		(1.28)	
N	15,109		15,109		15,109		15,109		15,109	

Notes: [1] *, ** and *** denote significance at the 10, 5 and 1% confidence levels. [2] Probit coefficients and their robust standard errors (in parentheses) are reported. [3] Control variables and constants are the same as the base model

Table 5. Results of mediation effect test based on Logit model

Model	(1)	(2)	(3)	(4)	(5)	(6)
Fraud		Fraud commission			Fraud detection	
Explained	Commission	OC	Commission	Detection	OC	Detection
OC			0.1879*** (3.115)			0.1220** (2.120)
Guanxi	−0.0061** (−2.383)	−0.0073** (−1.985)	−0.0059** (−2.282)	−0.0060** (−2.329)	−0.0083** (−2.266)	−0.0058** (−2.260)
Controls						
Commission	Yes	Yes	Yes	No	No	No
Detection	No	No	No	Yes	Yes	Yes
Sharing	Yes	Yes	Yes	Yes	Yes	Yes
Cons	Yes	Yes	Yes	Yes	Yes	Yes
N	15,109	15,109	15,109	15,334	15,334	15,334

Notes: [1] *, ** and *** denote significance at the 10, 5 and 1% confidence levels. [2] The logit coefficients in ratio form and their robust standard errors (in parentheses) are reported. [3] Control variables and constants are the same as the base model

Networks based on different relationships are separately considered in this section, as prior studies have shown that different relationship-based networks may act differently. Cai and Sevilir (2012) apply shared directors, while Cohen *et al.* (2008) and El-Khatib *et al.* (2015) use shared education. Kuang and Lee (2017) and Zhang (2019) introduce shared working experience, while Khanna *et al.* (2015) and Tao *et al.* (2019) thoroughly consider colleagues, educational relationships and other relationships.

Thus, alumni, colleagues, governmental relationships and relatives are used to measure different networks and the average of these four types is used as well. The model setting (control variables, centrality calculation method and aggregation method) and estimation remain the same as those in the baseline model. The results of centrality based on subdivided relationships are shown in Table 6.

The major results remain the same as those of the baseline model. Overconfidence is associated with a higher propensity of fraud commission when separately related to each type of network and is associated with a lower likelihood of fraud detection when separately relating to alumni-based and governmental-relationship-based networks. Alumni-based networks are related to a lower propensity for fraud commission and a higher likelihood of fraud detection. They play a monitoring role by facilitating information flows (Cohen *et al.*, 2008), with loyalty between alumni too weak to become accomplices (Khanna *et al.*, 2015). Thus, private information of fraud commission is hard to conceal. A relatives-based network is related to a higher propensity of fraud commission, while no statistically significant influence on fraud detection is found. The main difference between a relatives-based network and the other networks is loyalty, which is believed to be one of the reasons causing this result.

Moreover, it is worth noting that several mechanisms are reversed in the entire model. Generally speaking, there is a substitution effect between different types of relationship-based *guanxi*, while only relatives-based *guanxi* remains the most effective. *Guanxi* based on relatives has a consistently significant association with higher fraud commission.

5.2 Different types of fraud

Fraud can be defined variously (Amiram *et al.*, 2018). Different types of fraud may be influenced by different factors (Conyon and He, 2016; Kong *et al.*, 2019; Zhang, 2018). Thus, different types of fraud are considered separately in this section, according to the division method shown in Table 1. The two-step Logit model is applied instead of the POBi Probit model set above because the latter is unable to move to convergence, as mentioned previously (Yiu *et al.*, 2018; Zhang, 2018). The Logit model is applied instead of a Probit model because they are similar in most cases. However, it is easier to interpret the coefficient of logit regression as the odds ratios. The results of the two-step Logit models are shown in Table 7.

Overconfidence is associated with a higher propensity of fraud commission in accounting, disclosure and other types of fraud and with a higher likelihood of fraud detection in the disclosure fraud. These results are consistent with Ahmed and Duellman (2013), Hribar and Yang (2016) and Schrand and Zechman (2012) of overconfidence affecting financial reporting behavior. On one hand, accounting, disclosure and other types of fraud are mainly concerned with expectation. Overconfident firms tend to believe they can fill the gap between the false accounting (or disclosure) information and the real conditions before being detected and thus risk the danger of accounting (or disclosure) manipulation. On the other hand, due to the ease of manipulating disclosure information, overconfident firms tend to exaggerate more overtly, thus being more likely to be detected.

Table 6. Results of subdivided *Guanxi* based on POBi Probit model

Model	(1)	(2)	(3)	(4)	(5)
Relationship	Alumni		Colleagues		FGORelation
Explained	Commit	Detect	Commit	Detect	Commit
OC	0.2658*** (2.71)	−0.4255** (−2.31)	0.2123* (1.77)	−0.0636 (−0.85)	0.3257** (2.06)
Alumni	−0.0047** (−2.22)	0.0101** (2.42)			
Colleagues			0.0035 (0.49)	−0.0037 (−1.10)	
FGORelation					−0.0067 (−0.32)
Relative					
Controls	Yes	Yes	Yes	Yes	Yes
Cons	Yes	Yes	Yes	Yes	Yes
Rho	−0.6595**		0.4099		−0.7303*
(Wald χ^2)	(4.56)		(0.18)		(3.43)
N	15,109		15,109		15,109

Notes: [1] *, ** and *** denote significance at the 10, 5 and 1% confidence levels. [2] Probit coefficients and their robust standard errors (in parentheses) are reported. [3] Control variables and constants are the same as the base model

(*continued*)

Table 6.

Model	(6)	(7)		(8)	(9)		(10)
Relationship	FGORelation		Relatives			All	
Explained	Detect	Commit		Detect	Commit		Detect
OC	−0.5282** (−2.13)	0.1758** (1.97)		−0.0519 (−0.69)	0.1323 (1.01)		−0.0256 (−0.24)
Alumni					0.0046 (1.04)		−0.0021 (−0.51)
Colleagues					0.0036 (0.62)		−0.0035 (−0.75)
FGORelation	−0.0136 (−0.41)				−0.0468** (−1.98)		0.0081 (0.31)
Relative		0.0373** (2.08)		−0.0103 (−0.80)	0.0443** (2.17)		−0.0174 (−1.11)
Controls	Yes	Yes		Yes	Yes		Yes
Cons	Yes	Yes		Yes	Yes		Yes
Rho	−0.7303*		0.5661			0.3762	
(Wald χ^2)	(3.43)		(1.18)			(0.63)	
N	15,109		15,109			15,109	

Table 7.
Results of different type of fraud based on two step Logit model

Model	(1)	(2)	(3)	(4)
FraudType	Accounting		Management	
Explained	Commit	Detect	Commit	Detect
OC	0.2310** (2.410)	0.0855 (0.920)	0.0921 (0.718)	−0.0087 (−0.070)
Guanxi	−0.0043 (−0.961)	−0.0025 (−0.551)	−0.0209*** (−3.569)	−0.0205*** (−3.516)
Controls	Yes	Yes	Yes	Yes
Fix & cons	Yes	Yes	Yes	Yes
N	15,109	15,334	15,109	15,334

Notes: [1] *, ** and *** denote significance at the 10, 5 and 1% confidence levels. [2] Logit coefficients in the odds ratio form and their robust standard errors (in parentheses) are reported. [3] Control variables and constants are the same as the base model

(*continued*)

Table 7.

Model	(5)	(6)	(7)	(8)	(9)	(10)
FraudType	Finance		Disclosure		Other	
Explained	Commit	Detect	Commit	Detect	Commit	Detect
OC	0.0040 (0.035)	−0.0038 (−0.033)	0.2298*** (3.196)	0.1436** (2.171)	0.1332** (1.979)	0.0520 (0.773)
Guanxi	0.0079 (1.439)	0.0070 (1.283)	−0.0091*** (−3.042)	−0.0088*** (−2.965)	−0.0018 (−0.585)	−0.0012 (−0.397)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fix & cons	Yes	Yes	Yes	Yes	Yes	Yes
N	15,109	15,334	15,109	15,334	15,109	15,334

Guanxi becomes statistically significant relating to the fraud of management and disclosure when looking at different types of fraud. *Guanxi* is associated with a lower fraud commission incidence and a lower likelihood of fraud detection, both in management fraud and disclosure fraud. On one hand, a more well-connected firm has a lower incentive to commit fraud (of management and disclosure). This is because wider connections require a more altruistic norm, including keeping promises (Jha, 2019). This result is consistent with Jha (2019) of more social capital suppressing financial reporting misconduct. On the other hand, a more well-connected firm has a lower likelihood of being detected, indicating a focus distraction effect of monitors' oversight quality (Cashman *et al.*, 2012). The results above are generally consistent with the connections' "dark side" concept of Kuang and Lee (2017).

5.3 Different ownership of firm

Chinese firms can be generally classified into two types based on their ownership: SOEs and non-SOEs. SOEs and non-SOEs are significantly different, including differences in operating objectives and business status (Tao *et al.*, 2019; Wang *et al.*, 2019).

The two-step Logit model is applied in this section owing to the inability of the Probit model to converge. The results of the two-step Logit model are shown in Table 8.

Overconfidence is associated with a higher propensity of fraud commission in both SOEs and non-SOEs, while it is associated with a higher likelihood of fraud detection only in SOEs. On one hand, the fraud-inducing effect of overconfidence is found regardless of ownership, supporting the theories of Schrand and Zechman (2012) and Ahmed and Duellman (2013), broadening their observations to a context like China. On the other hand, the positive coefficient of fraud detection indicates better governance due to overconfidence, even given the widely accepted fact that "monitoring is reduced as the SOEs answer more to the state than to the stock market" (Tao *et al.*, 2019; Wang *et al.*, 2019).

Guanxi is related to a lower propensity for fraud commission and a lower likelihood of fraud detection in both state-owned and non-state-owned firms. That is, instead of no statistically significant influence being found in the baseline model, *guanxi* plays a role in state-owned firms, suppressing fraud incentives and concealing fraud detection. On one hand, *guanxi* suppresses fraud incentives of well-connected SOEs because of the "altruistic norm" channel and "dense network" channel (Jha, 2019). On the other hand, firms tend to conceal committed fraud, as public exposure of fraud will damage their reputation and bring them huge losses (Cowen and Marcel, 2011). In addition, better-connected SOEs suffer more from fraud (Kuang and Lee, 2017).

5.4 Different measurement and estimation methods

A robustness test is applied to the results by several alternate measurements of *guanxi* (Kuang and Lee, 2017). The measurements include the maximizing percentile centrality, the averaging raw centrality and the maximizing raw centrality.

In addition, considering that the POBi Probit model may have a model setting error (Yiu *et al.*, 2018; Zhang, 2018), the Logit model and Probit model are used as alternate empirical methods. Every measurement of *guanxi* and sub-relationship-based *guanxi* are considered in the Logit and Probit models.

The results of the robustness tests are shown from Appendix Table A2 to Table 12. Generally speaking, the major findings remain robust.

6. Conclusion

By introducing the FTT to China's context of transition and an emerging economy, this study constructs a comprehensive fraud triangle with *guanxi* and overconfidence. *Guanxi*

Table 8.
Results of ownership-dividing sub-samples based on two-step Logit model

Model	(1)		(2)	(3)		(4)
Ownership	Non-state-owned			State-owned		
Explained	Commit		Detect	Commit		Detect
OC	0.1755** (2.085)		0.1045 (1.333)	0.1957** (2.000)		0.1614* (1.686)
Guanxi	−0.0042 (−1.270)		−0.0049 (−1.470)	−0.0073* (−1.780)		−0.0078* (−1.913)
Controls	Yes		Yes	Yes		Yes
Fix & cons	Yes		Yes	Yes		Yes
N		8,128			6,981	
Ratio		53.8%			46.2%	

Notes: [1] *, ** and *** denote significance at the 10%, 5%and 1% confidence levels. [2] Logit coefficients in the odds ratio form and their robust standard errors (in parentheses) are reported. [3] Control variables and constants are the same as the base model. [4] Ratio = sub-sample obs. ÷ total obs. × 100%

(*continued*)

Model	(5)	(6)	(7)	(8)	(9)	(10)
Ownership	Nation-owned		Province-owned		City-owned	
Explained	Commit	Detect	Commit	Detect	Commit	Detect
OC	0.2788 (1.575)	0.2553 (1.450)	0.0892 (0.572)	0.1077 (0.683)	0.0574 (0.371)	0.0046 (0.029)
Guanxi	−0.0102 (−1.338)	−0.0076 (−1.007)	0.0033 (0.419)	0.0027 (0.344)	−0.0123* (−1.856)	−0.0122* (−1.861)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Fix & cons	Yes	Yes	Yes	Yes	Yes	Yes
N	2,363		1,628		2,980	
Ratio	15.6%		10.8%		19.7%	

Table 8.

consists of "incentive" and "opportunity" according to integrated agency and resource dependence theory (Dalziel *et al.*, 2011; Tao *et al.*, 2019), while overconfidence consists of "incentive" and "rationalization" according to UET (Hambrick and Mason, 1984; Hambrick, 2007). To test this fraud triangle, a bivariate probit model with partial observability (POBi Probit) is applied according to Kuang and Lee (2017), Wang (2013) and Wang *et al.* (2010). In addition, the POBi Probit model is adjusted to the Chinese context based on Yiu *et al.* (2018) and Zhang (2018) and the local study of Meng *et al.* (2019). Estimation is done on a data set of the Chinese A-share listed corporations from 2008 to 2014, with a total of 15,109 firm-year observations.

The major results of the study are as follows:

- Overconfidence is positively related to the propensity of fraud commission and negatively related to the likelihood of detection, given fraud is committed. These relationships are statistically significant and robust to different relationship-based *guanxi*. These relationships are also robust to alternate measurements of *guanxi*. Thus, *H1A* and *H1B* are supported.
- The effect of aggregated *guanxi* on aggregated fraud is not supported in this study, while the effect of sub-relationship-based *guanxi* is found in this study. Alumni-based networks suppress fraud commission and benefit fraud detection, while relative-based networks induce fraud commission and deteriorate fraud detection. Thus, *H2A* and *H2B* are rejected.
- The moderation effect of *guanxi* and overconfidence is not supported in this study. Thus, *H3A* and *H3B* are rejected. However, there is a partial mediation effect of overconfidence between *guanxi* and fraud (both commission and detection). Hence, *H4A* is supported, while *H4B* is rejected.
- When considering the sub-types of fraud, on one hand, overconfidence is positively related to the propensity of fraud commission in accounting and disclosure and positively related to the likelihood of fraud detection in disclosure. On the other hand, *guanxi* suppresses fraud commission in management and disclosure but impedes detection given fraud in management and disclosure. That is, in a more specific situation, *H1A*, *H1B*, *H2A* and *H2B* are supported.
- When considering sub-samples divided by ownership, on one hand, overconfidence is positively related to the propensity of fraud commission in both non-SOEs and SOEs and positively related to the likelihood of fraud detection in SOEs. On the other hand, *guanxi* is negatively related to the propensity of fraud commission and the likelihood of fraud detection in SOEs and non-SOEs, respectively. These findings suggest that *H1A*, *H1B*, *H2A* and *H2B* can be supported in some more specific situations.

From the empirical results above, it is found that:

(1) An incentive factor in terms of overconfidence matters more in fraud than an opportunity factor in terms of *guanxi*. Moreover, overconfidence is found to be the mediator between *guanxi* and fraud. On one hand, this result reveals the motility of incentives in fraud, which is to say that opportunity may be created by the fraudster given the incentive, without initial opportunity. Thus, the incentive for fraud is worth more monitoring attention. On the other hand, the dark side of overconfidence is supported by this result, which is largely consistent with Banerjee *et al.* (2018), O'Reilly *et al.* (2018) and Schrand and Zechman (2012).

(2) Alumni-based *guanxi* suppresses fraud commission and benefits detection given fraud. This result supports the "white side" of *guanxi* and is consistent with Khanna *et al.* (2015). However, relative-based *guanxi* induces fraud commission and deteriorates fraud detection. This result supports the "dark side" of *guanxi* and is consistent with Kuang and Lee (2017) and Tao *et al.* (2019). Furthermore, this result reveals that the source of the "dark side" is derived from political networks and relational networks and thus provides a social network governance approach against corporate fraud.

(3) When considering fraud types, the fraud-inducing effect of overconfidence is mainly in fraud of accounting and disclosure. The detection deteriorating effect of overconfidence is mainly in fraud of disclosure. These results show that fraud in accounting and disclosure is susceptible to overconfidence (i.e. fraud incentives) and thus reveal the preferential targets for governance against corporate fraud.

(4) When considering state ownership, on one hand, overconfidence induces fraud commission in both SOEs and non-SOEs, while benefits fraud detection only in SOEs. This result shows that SOEs are more modest and more overconfidence-adverse than non-SOEs and thus pay more attention to detect overconfidence-induced fraud. On the other hand, *guanxi* suppresses fraud commission in SOEs and non-SOEs while deteriorating detection in SOEs and non-SOEs at the same time. That is to say, given fraud in SOEs and non-SOEs, SOEs and non-SOEs are less efficient in detecting fraud. This result may be related to the reputation of state-owned capital.

This paper theoretically and empirically contributes to the literature on both corporate fraud and corporate governance in three ways:

- This study combines the integrated agency and resource-dependence theory and UET together with the FTT, constructing a comprehensive fraud triangle, which is rare in the existing research related to corporate fraud. Thus, the theoretical framework of FTT has been broadened and a different theoretical application of IART and UET has been introduced in this paper.
- This study introduces *guanxi* and overconfidence into FTT and empirically examines their effects on the commission and detection of fraud. By doing so, this study provides evidence that *guanxi* and overconfidence are the two factors affecting corporate fraud, while prior studies focus on either *guanxi* as external monitoring or overconfidence as an internal incentive.
- By empirically inquiring commission and detection of corporate fraud with Chinese characteristics (*guanxi*, political connection, state ownership, etc.), this study provides governance approaches opposing corporate fraud by revealing the mechanism of these characteristics. Moreover, considering China as one of the typical transitional and emerging economies, these governance approaches may be worth promoting in the other emerging economies in transition.

However, some work can be done in future studies:

- There are two drawbacks of the partial observable bivariate probit (POBi-Probit) method that must be mentioned here. On one hand, the ex ante variable selection is one of the most difficult parts of applying the POBi-Probit model and different variables are included in different studies. On the other hand, the POBi-Probit model might not converge if too many variables are included. Thus, many widely accepted

factors can be included in the model. Thus, this study initially sets the POBi-Probit model based mainly on Khanna *et al.* (2015) and then adjusts the model for the Chinese context (e. g. considering government ownership) according to Yiu *et al.* (2018) and Zhang (2018) and the local study of Meng *et al.* (2019).

- Considering the observability of fraud, on one hand, the observability of fraud commission is a widely accepted limitation, especially when accounting opacity comes across with regulatory efficiency (Yiu *et al.*, 2018). On the other hand, the observability of relationships is another obstacle to this study. Future studies can go further by revealing the presently unobservable relationships using Big Data technology.

Note

1. Also named Bystander Apathy, a social psychological claim that individuals are less likely to offer help to a victim when other people are present. The greater the number of bystanders, the less likely it is that one of them will help. In economic terms, it is similar to the Free-rider Problem.

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Corresponding author
Jing Zhang can be contacted at: zhangjing215@cqu.edu.cn

Variable	Definition	Whole sample N	Mean	SD	Min	Max	SOE N	Mean	SD	Min	Max	Non-SOE N	Mean	SD	Min	Max
Fraud	Fraud	15,109	0.1965	0.3974	0	1	6,981	0.1600	0.3670	0	1	8,128	0.2280	0.4190	0	1
OC	Overconfidence	15,109	0.5687	0.4953	0	1	6,981	0.5990	0.4900	0	1	8,128	0.5430	0.4980	0	1
PerScoreMean	Guanxi	15,109	13.6676	8.6313	0	38.5698	6,981	13.1900	8.9070	0	36.3700	8,128	14.0800	8.3660	0	38.5700
PerScoreMax		15,109	34.7105	19.8561	0	65.4563	6,981	33.4500	20.2900	0	65.4600	8,128	35.7900	19.4100	0	65.4600
CenMean		15,109	0.0260	0.0197	0	0.0971	6,981	0.0275	0.0203	0	0.0971	8,128	0.0247	0.0191	0	0.0922
CenMax		15,109	0.2237	0.1510	0	0.4729	6,981	0.2150	0.1470	0	0.4580	8,128	0.2310	0.1540	0	0.4730
PoSAMean		15,109	17.6285	19.0570	0	64.5899	6,981	16.0400	18.7600	0	64.5900	8,128	18.9900	19.2100	0	64.5700
PoSCMean		15,109	19.3711	13.2580	0	43.3767	6,981	20.2200	13.6200	0	43.3800	8,128	18.6400	12.9000	0	43.300
PoSFGOMean		15,109	3.2226	2.4253	0	8.8373	6,981	3.5170	2.2780	0	8.8370	8,128	2.9700	2.5180	0	8.7500
PoSRMean		15,109	2.4089	3.8718	0	16.6752	6,981	0.1070	0.7830	0	14.4900	8,128	4.3860	4.3460	0	16.6800
PC	Political connection	15,109	0.4113	0.4921	0	1	6,981	0.3680	0.4820	0	1	8,128	0.4480	0.4970	0	1
CEOTensure	Tensure of CEO	15,109	0.5099	1.0314	0	19	6,981	0.5390	1.0500	0	12	8,128	0.4850	1.0140	0	19
CEOAge	Age of CEO	15,109	48.0017	6.5956	0	77	6,981	48.8400	5.8480	0	75	8,128	47.2800	7.0980	0	77
CEOMale	Gender of CEO	15,109	0.9385	0.2402	0	1	6,981	0.9610	0.1940	0	1	8,128	0.9190	0.2720	0	1
lnCEOShare	Shareholding of CEO	15,109	5.6435	7.3281	0	20.8229	6,981	2.6870	4.9820	0	18.8800	8,128	8.1830	8.0340	0	20.8200
Duality	Duality of CEO and board chairman	15,109	0.2258	0.4181	0	1	6,981	0.0940	0.2920	0	1	8,128	0.3390	0.4730	0	1
Shrcr1	Shareholding centrality	15,109	36.0697	15.6173	2.1969	89.4086	6,981	39.4100	15.8400	3.621	86.4200	8,128	33.2000	14.8300	2.1970	89.4100
lnDrct	Number of directors	15,109	2.1600	0.2688	0	3.0910	6,981	2.2160	0.2890	0	2.9440	8,128	2.1120	0.2400	0	3.0910
IndDrctRatio	Ratio of independent directors	15,109	0.3667	0.0612	0	0.8000	6,981	0.3620	0.0639	0	0.8000	8,128	0.3710	0.0584	0	0.6670
DBM	Number of the meeting held by directors	15,109	9.1918	3.7196	0	57	6,981	9.1360	3.8620	0	57	8,128	9.2400	3.5920	0	49
AuditNo	Number of auditors	15,109	1.9824	0.3418	0	3	6,981	1.9860	0.3330	0	3	8,128	1.9800	0.3490	0	3
BigFour	Whether auditor is the Big Four	15,109	0.0633	0.2435	0	1	6,981	0.1020	0.3030	0	1	8,128	0.0298	0.1700	0	1
Analyst	Number of analysts following	15,109	58.3391	86.3235	0	1001	6,981	57.6100	87.0700	0	1001	8,128	58.9600	85.6700	0	954

(*continued*)

Table A1. Definition and descriptive statistics of variables

Table A1.

Variable	Sample Definition	Whole sample N	Mean	SD	Min	Max	SOE N	Mean	SD	Min	Max	Non-SOE N	Mean	SD	Min	Max
InstOwn	Proportion of institution-held shares	15,109	6.6017	8.7351	0	75.4950	6,981	6.9310	9.1930	0	75.5000	8,128	6.3190	8.3120	0	67.9000
lnAsset	Firm size	15,109	21.8209	1.4238	0	26.7706	6,981	22.3400	1.4980	0	26.7700	8,128	21.3700	1.1850	0	26.7700
ROA	Return on asset	15,109	0.0382	0.0643	−0.2299	0.2576	6,981	0.0324	0.0619	−0.230	0.2580	8,128	0.0432	0.0658	−0.2300	0.2580
Leverage	Debt-to-assets ratio	15,109	0.4652	0.2476	0	1.3963	6,981	0.5390	0.2170	0	1.3960	8,128	0.4020	0.2550	0	1.3960
RevGrowth	Growth of revenue	15,109	0.1915	0.5721	−0.6588	4.4643	6,981	0.1790	0.5490	−0.659	4.4640	8,128	0.2030	0.5910	−0.6590	4.4640
SOE	Whether owned by the state	15,109	0.4620	0.4986	0	1	6,981	1	0	1	1	8,128	0	0	0	0
TobinQ	Tobin's Q	15,109	1.9030	1.3025	0	8.9891	6,981	1.7700	1.1250	0	8.9890	8,128	2.0180	1.4280	0	8.9890
EPS	Earnings per share	15,109	0.3722	0.6685	−22.4125	17.5343	6,981	0.3480	0.6960	−6.860	15.3800	8,128	0.3930	0.6430	−22.410	17.5300
Volatility	Volatility of share price	15,109	0.0316	0.0261	0	1.6084	6,981	0.0303	0.0208	0	0.9800	8,128	0.0327	0.0299	0	1.6080
Turnover	Turnover of share	15,109	0.0307	0.0372	0	0.8634	6,981	0.0222	0.0233	0	0.5620	8,128	0.0380	0.0446	0	0.8630
EPSIndAve	Industrial-average EPS	15,109	0.3790	0.2064	−0.6251	2.4587	6,981	0.3730	0.2360	−0.625	2.4590	8,128	0.3840	0.1760	−0.3520	2.4590

Note: SD = Standard deviation

Table A2.
Results of mediation effect test based on two step Logit model

Model	(1)	(2)	(3)	(4)	(5)	(6)
Estimation			Logit			
Explained	Fraud	OC	Fraud	Fraud	OC	Fraud
OC			0.1879*** (3.115)			0.1220** (2.120)
PerScoreMean	−0.0061** (−2.383)	−0.0073** (−1.985)	−0.0059** (−2.282)	−0.0060** (−2.329)	−0.0083** (−2.266)	−0.0058** (−2.260)
PC	0.2059*** (4.768)	−0.0104 (−0.173)	0.2061*** (4.771)	0.2039*** (4.748)	−0.0302 (−0.510)	0.2039*** (4.747)
CEOTensure	0.0266 (1.242)	0.0528** (2.011)	0.0265 (1.238)			
CEOAge	−0.0043 (−1.317)	0.0053 (1.114)	−0.0045 (−1.360)			
CEOMale	−0.0051 (−0.059)	0.1464 (1.188)	−0.0034 (−0.039)			
lnCEOShare	−0.0007 (−0.198)	−0.0206*** (−4.077)	0.0003 (0.091)			
Duality	0.1320** (2.454)	−0.1040 (−1.265)	0.1359** (2.530)			
Shrcr1	−0.0101*** (−6.735)	0.0020 (1.039)	−0.0098*** (−6.565)			
lnDrct				0.2542*** (2.913)	−0.1261 (−1.124)	0.2552*** (2.927)
IndDrctRatio				0.1414 (0.388)	−0.3387 (−0.697)	0.1369 (0.375)
DBM				0.0360*** (6.576)	0.0031 (0.377)	0.0357*** (6.518)
AuditNo				−0.0462 (−0.771)	−0.0108 (−0.157)	−0.0452 (−0.755)
BigFour				−0.4965*** (−3.968)	0.0897 (0.691)	−0.4960*** (−3.966)
Analyst				−0.0017*** (−4.365)	−0.0001 (−0.284)	−0.0016*** (−3.989)
InstOwn				−0.0043 (−1.384)	−0.0071* (−1.851)	−0.0037 (−1.211)
lnAsset	−0.1288*** (−5.888)	−0.0029 (−0.100)	−0.1202*** (−5.745)	−0.1133*** (−4.953)	0.0275 (0.881)	−0.1111*** (−4.892)
ROA	−1.7054*** (−2.934)	4.7824*** (4.076)	−1.5228*** (−3.052)	−1.7330*** (−3.467)	4.7975*** (4.121)	−1.6021*** (−3.432)
Leverage	0.8306*** (8.490)	0.2193 (1.251)	0.8279*** (8.502)	0.7571*** (7.999)	0.2767 (1.613)	0.7570*** (8.011)
RevGrowth	0.0876** (2.379)	−0.1130* (−1.801)	0.0895** (2.448)	0.0560 (1.555)	−0.1091* (−1.754)	0.0581 (1.618)
SOE	−0.3303*** (−6.516)	0.0938 (1.278)	−0.3367*** (−6.657)	−0.4335*** (−8.969)	0.2334*** (3.536)	−0.4376*** (−9.062)
TobinQ	−0.0129 (−0.732)	−0.1045*** (−3.020)	−0.0120 (−0.688)	0.0204 (1.159)	−0.0735** (−2.121)	0.0185 (1.056)
EPS	−0.1328 (−1.419)	−22.6771*** (−18.278)	−0.0597 (−0.743)	−0.0612 (−0.849)	−22.7260*** (−18.174)	−0.0250 (−0.380)
Volatility	1.9167** (2.187)	0.6327 (0.613)	1.8376** (2.116)	1.4012* (1.775)	0.5049 (0.530)	1.3537* (1.721)
Turnover	−1.1392* (−1.826)	0.8313 (1.029)	−0.9371 (−1.559)	−1.4575** (−2.318)	0.4536 (0.577)	−1.2665** (−2.056)
EPSIndAve	−0.2276* (−1.925)	21.9270*** (17.816)	−0.3653*** (−2.853)	−0.1284 (−1.101)	21.9909*** (17.839)	−0.2207* (−1.747)
YearDummy	0.0781*** (6.369)	−0.0325** (−2.002)	0.0765*** (6.270)	0.0718*** (6.151)	−0.0475*** (−2.991)	0.0711*** (6.101)
IndDummy	−0.0214*** (−3.454)	−0.0049 (−0.653)	−0.0212*** (−3.424)	−0.0226*** (−3.699)	−0.0032 (−0.432)	−0.0225*** (−3.689)
_cons	1.5850*** (3.366)	−0.0958 (−0.153)	1.2970*** (2.848)	0.0366 (0.072)	−0.0385 (−0.057)	−0.0743 (−0.146)
N	15,109	15,109	15,109	15,334	15,334	15,334

Notes: [1] *, ** and *** denote significant at a confidence level of 10, 5 and 1%. [2] Logit coefficients in ratio form and their robust standard errors in parentheses are reported

(*continued*)

Table A2.

Model	(7)	(8)	(9)	(10)	(11)	(12)
Estimation				Probit		
Explained	Fraud	OC	Fraud	Fraud	OC	Fraud
OC			0.1061*** (3.306)			0.0701** (2.195)
PerScoreMean	−0.0037** (−2.499)	−0.0044** (−2.069)	−0.0035** (−2.375)	−0.0036** (−2.453)	−0.0050** (−2.389)	−0.0034** (−2.366)
PC	0.1180*** (4.803)	0.0171 (0.499)	0.1175*** (4.781)	0.1161*** (4.754)	0.0057 (0.170)	0.1159*** (4.742)
CEOTensure	0.0144 (1.189)	0.0374*** (2.720)	0.0145 (1.198)			
CEOAge	−0.0024 (−1.289)	0.0041 (1.573)	−0.0025 (−1.329)			
CEOMale	0.0004 (0.008)	0.0548 (0.884)	0.0001 (0.001)			
lnCEOShare	−0.0004 (−0.217)	−0.0133*** (−4.581)	0.0002 (0.093)			
Duality	0.0743** (2.414)	−0.0769* (−1.666)	0.0765** (2.486)			
Shrcr1	−0.0057*** (−6.744)	0.0007 (0.624)	−0.0055*** (−6.569)			
lnDrct				0.1484*** (3.046)	−0.0130 (−0.214)	0.1493*** (3.065)
IndDrctRatio				0.0584 (0.288)	−0.5965** (−2.147)	0.0576 (0.283)
DBM				0.0206*** (6.466)	0.0022 (0.466)	0.0204*** (6.400)
AuditNo				−0.0258 (−0.746)	−0.0279 (−0.767)	−0.0247 (−0.715)
BigFour				−0.2566*** (−3.944)	0.0230 (0.297)	−0.2558*** (−3.937)
Analyst				−0.0009*** (−4.135)	−0.0006** (−2.189)	−0.0008*** (−3.769)
InstOwn				−0.0026 (−1.502)	−0.0056** (−2.527)	−0.0022 (−1.278)
lnAsset	−0.0798*** (−6.707)	−0.0138 (−0.867)	−0.0739*** (−6.287)	−0.0695*** (−5.286)	0.0203 (1.126)	−0.0682*** (−5.192)
ROA	−1.0798*** (−3.766)	3.7236*** (5.489)	−0.9024*** (−3.331)	−1.0452*** (−3.862)	3.8055*** (5.664)	−0.9453*** (−3.573)
Leverage	0.5021*** (8.799)	0.1205 (1.280)	0.4992*** (8.774)	0.4623*** (8.346)	0.1334 (1.450)	0.4612*** (8.334)
RevGrowth	0.0507** (2.391)	−0.0661* (−1.924)	0.0518** (2.453)	0.0327 (1.568)	−0.0683** (−2.009)	0.0339 (1.629)
SOE	−0.1859*** (−6.483)	0.1011** (2.450)	−0.1902*** (−6.628)	−0.2452*** (−8.955)	0.1727*** (4.809)	−0.2479*** (−9.054)
TobinQ	−0.0065 (−0.645)	−0.0580*** (−3.327)	−0.0061 (−0.611)	0.0139 (1.364)	−0.0305* (−1.714)	0.0125 (1.233)
EPS	−0.0507 (−1.353)	−8.7222*** (−31.916)	−0.0225 (−0.635)	−0.0206 (−0.620)	−8.6729*** (−31.973)	−0.0037 (−0.111)
Volatility	1.1462** (2.382)	0.5543 (0.858)	1.0919** (2.287)	0.8590* (1.897)	0.4677 (0.783)	0.8284* (1.835)
Turnover	−0.7058** (−2.013)	0.6031 (1.465)	−0.5722* (−1.659)	−0.8723** (−2.462)	0.3521 (0.889)	−0.7598** (−2.165)
EPSIndAve	−0.1270* (−1.947)	8.2097*** (26.812)	−0.1997*** (−2.855)	−0.0752 (−1.158)	8.2080*** (27.320)	−0.1264* (−1.805)
YearDummy	0.0457*** (6.595)	−0.0159* (−1.805)	0.0446*** (6.439)	0.0421*** (6.308)	−0.0252*** (−2.900)	0.0416*** (6.238)
IndDummy	−0.0126*** (−3.650)	−0.0039 (−0.824)	−0.0124*** (−3.607)	−0.0133*** (−3.914)	−0.0023 (−0.500)	−0.0133*** (−3.900)
_cons	0.9659*** (3.772)	0.1784 (0.523)	0.7834*** (3.056)	0.0553 (0.190)	−0.0778 (−0.201)	−0.0130 (−0.045)
N	15,109	15,109	15,109	15,334	15,334	15,334

Table A3. Robust test of maximizing percentile centrality on sub-type fraud via two step Logit model

Model	(1)	(2)	(3)	(4)	(5)
Fraud type	Accounting		Management		Finance
OC	0.2359** (2.466)	0.1099 (1.177)	0.0950 (0.742)	0.0079 (0.063)	0.0091 (0.080)
PerScoreMax	0.0012 (0.595)	0.0017 (0.859)	−0.0064*** (−2.643)	−0.0066*** (−2.713)	0.0066*** (2.611)
CEOTensure	−0.0869** (−2.243)		−0.0473 (−0.877)		0.0483 (1.214)
CEOAge	−0.0074 (−1.419)		−0.0110 (−1.577)		−0.0011 (−0.157)
CEOMale	−0.0209 (−0.138)		−0.0087 (−0.043)		−0.1460 (−0.855)
lnCEOShare	0.0043 (0.720)		−0.0103 (−1.323)		0.0185*** (2.621)
Duality	0.0594 (0.635)		0.4671*** (3.930)		−0.1190 (−1.039)
Shrcr1	−0.0024 (−0.948)		−0.0071** (−2.140)		−0.0163*** (−5.195)
lnDrct		0.2095 (1.389)		0.5536*** (3.357)	
IndDrctRatio		1.2601** (1.987)		0.2025 (0.244)	
DBM		0.0451*** (4.991)		0.0427*** (3.868)	
AuditNo		0.0797 (0.778)		−0.1134 (−0.857)	
BigFour		−0.8068*** (−2.980)		−1.1193*** (−2.632)	
Analyst		−0.0030*** (−3.758)		−0.0031*** (−3.102)	
InstOwn		−0.0055 (−1.037)		0.0068 (1.057)	
lnAsset	−0.1380*** (−4.815)	−0.0895*** (−2.750)	−0.0846** (−2.357)	−0.0847** (−1.980)	−0.0058 (−0.144)
ROA	−1.7648** (−2.372)	−1.5491** (−2.186)	−2.8666*** (−3.029)	−2.9992*** (−3.260)	0.3326 (0.415)
Leverage	0.3804** (2.436)	0.2587* (1.669)	0.3788* (1.918)	0.3165 (1.583)	0.3097* (1.697)
RevGrowth	0.1016* (1.713)	0.0734 (1.254)	0.1230 (1.508)	0.1065 (1.326)	0.1234** (1.961)
SOE	−0.2300*** (−2.645)	−0.2907*** (−3.511)	−0.2836** (−2.574)	−0.4296*** (−4.043)	−0.6483*** (−5.435)
TobinQ	−0.0969*** (−3.145)	−0.0674** (−2.198)	−0.0501 (−1.354)	−0.0267 (−0.690)	0.0668** (2.179)
EPS	−0.1513 (−1.561)	−0.1297* (−1.776)	−0.1294 (−1.084)	−0.1255 (−1.348)	−0.1011 (−1.503)
Volatility	0.9740 (1.217)	0.7470 (0.926)	1.0420* (1.845)	0.7554 (1.283)	2.2162*** (2.798)
Turnover	0.0158 (0.018)	−0.1314 (−0.146)	0.3546 (0.334)	0.1555 (0.139)	−1.3705 (−1.021)
EPSIndAve	−0.1999 (−0.994)	−0.0240 (−0.119)	−0.6418** (−2.210)	−0.5211* (−1.796)	−0.4039 (−1.629)
PC	0.0932 (1.232)	0.0884 (1.169)	0.0343 (0.341)	0.0004 (0.004)	0.1657* (1.794)
Fix & cons	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109

Notes: [1] *, ** and *** denote significant at a confidence level of 10, 5 and 1%. [2] Logit coefficients in ratio form and their robust standard errors (in parentheses) are reported

(*continued*)

Table A3.

Model	(6)	(7)	(8)	(9)	(10)
Fraud type	Finance	Disclosure		Other	
OC	−0.0110 (−0.095)	0.2316*** (3.220)	0.1500** (2.235)	0.1355** (2.011)	0.0593 (0.873)
PerScoreMax	0.0066*** (2.583)	−0.0025* (−1.915)	−0.0025* (−1.942)	0.0007 (0.551)	0.0008 (0.635)
CEOTensure		0.0287 (1.155)		0.0216 (0.853)	
CEOAge		−0.0036 (−0.939)		−0.0076** (−1.985)	
CEOMale		−0.0108 (−0.108)		0.2016* (1.842)	
lnCEOShare		−0.0078** (−1.999)		0.0024 (0.595)	
Duality		0.1534** (2.470)		0.1162* (1.835)	
Shrcr1		−0.0097*** (−5.520)		−0.0050*** (−2.875)	
lnDrct	0.2569 (1.045)		0.1743* (1.829)		0.2471** (2.300)
IndDrctRatio	0.0968 (0.110)		0.0126 (0.030)		1.0149** (2.278)
DBM	0.0316*** (3.022)		0.0325*** (5.227)		0.0348*** (5.533)
AuditNo	0.0788 (0.528)		−0.0306 (−0.446)		−0.0405 (−0.622)
BigFour	−0.8260*** (−2.647)		−0.6664*** (−4.049)		−0.3248** (−2.299)
Analyst	−0.0010 (−1.395)		−0.0026*** (−5.076)		−0.0018*** (−3.534)
InstOwn	0.0068 (1.193)		−0.0047 (−1.244)		−0.0036 (−0.964)
lnAsset	−0.0046 (−0.094)	−0.1498*** (−6.301)	−0.1142*** (−4.619)	−0.1195*** (−5.177)	−0.1037*** (−4.106)
ROA	0.1591 (0.192)	−1.5596*** (−2.630)	−1.5968*** (−2.943)	−1.3734** (−2.499)	−1.2953** (−2.358)
Leverage	0.2146 (1.177)	0.9396*** (8.734)	0.8961*** (8.435)	0.7385*** (6.813)	0.6567*** (6.095)
RevGrowth	0.0899 (1.431)	0.0902** (2.175)	0.0626 (1.542)	0.0366 (0.826)	0.0132 (0.303)
SOE	−0.7913*** (−6.888)	−0.2602*** (−4.497)	−0.3334*** (−6.050)	−0.2450*** (−4.093)	−0.3147*** (−5.498)
TobinQ	0.0810** (2.529)	−0.0413** (−2.107)	−0.0004 (−0.023)	−0.0748*** (−3.592)	−0.0490** (−2.342)
EPS	−0.0924 (−1.363)	−0.1336 (−1.281)	−0.0862 (−1.065)	−0.0524 (−0.670)	−0.0293 (−0.384)
Volatility	1.7276** (2.218)	1.1495* (1.723)	0.7362 (1.139)	0.9638 (1.347)	0.6456 (0.911)
Turnover	−1.1335 (−0.882)	−0.7978 (−1.150)	−1.3902* (−1.887)	−0.7049 (−1.061)	−0.7975 (−1.176)
EPSIndAve	−0.2467 (−0.954)	−0.4536*** (−3.005)	−0.2759* (−1.837)	−0.2291 (−1.543)	−0.0964 (−0.642)
PC	0.1855** (2.037)	0.1850*** (3.682)	0.1792*** (3.565)	0.1470*** (2.873)	0.1419*** (2.766)
Fix & cons	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109

Table A4. Robust test of maximizing percentile centrality on sub-ownership via two-step Logit model

Model	(1)	(2)	(3)	(4)	(5)
Ownership	Non-SOEs		SOEs		Nation
OC	0.1816** (2.149)	0.1102 (1.404)	0.1954** (1.994)	0.1619* (1.690)	0.2849 (1.608)
PerScoreMax	0.0015 (1.036)	0.0013 (0.875)	−0.0030* (−1.667)	−0.0031* (−1.737)	−0.0048 (−1.384)
CEOTensure	0.0154 (0.550)		0.0332 (1.005)		0.0956* (1.703)
CEOAge	−0.0044 (−1.100)		−0.0025 (−0.421)		−0.0252** (−2.077)
CEOMale	−0.0514 (−0.516)		0.0705 (0.401)		0.5724 (1.024)
lnCEOShare	0.0043 (1.114)		−0.0106 (−1.438)		0.0114 (0.904)
Duality	0.0566 (0.919)		0.3778*** (3.583)		0.6516*** (2.850)
Shrcr1	−0.0108*** (−5.436)		−0.0076*** (−3.254)		−0.0039 (−0.827)
lnDrct		0.1857 (1.504)		0.3657*** (2.731)	
IndDrctRatio		0.1329 (0.262)		0.1503 (0.264)	
DBM		0.0517*** (6.817)		0.0169* (1.947)	
AuditNo		−0.0398 (−0.529)		−0.0406 (−0.400)	
BigFour		−0.2238 (−1.133)		−0.6480*** (−3.811)	
Analyst		−0.0017*** (−3.477)		−0.0012* (−1.752)	
InstOwn		−0.0028 (−0.654)		−0.0081* (−1.715)	
lnAsset	−0.0787*** (−2.730)	−0.0880*** (−2.758)	−0.1871*** (−5.296)	−0.1602*** (−4.305)	−0.2140*** (−3.558)
ROA	−2.2975*** (−3.490)	−2.2916*** (−3.708)	−0.0480 (−0.050)	−0.1983 (−0.213)	4.4491** (2.432)
Leverage	0.5171*** (4.312)	0.4307*** (3.610)	1.4201*** (7.826)	1.4154*** (7.874)	0.9134*** (2.859)
RevGrowth	0.1195*** (2.581)	0.0900* (1.955)	0.0293 (0.468)	−0.0011 (−0.018)	0.1461 (1.338)
TobinQ	0.0098 (0.477)	0.0377* (1.786)	−0.0667* (−1.876)	−0.0319 (−0.899)	−0.1993*** (−2.753)
EPS	−0.1090 (−0.774)	−0.0846 (−0.725)	−0.0048 (−0.038)	0.0580 (0.510)	−0.4122** (−2.334)
Volatility	1.0681 (1.381)	0.4591 (0.614)	5.4059** (2.224)	4.5376** (2.462)	4.5782 (1.305)
Turnover	−3.0828*** (−3.879)	−3.2555*** (−4.056)	5.0204*** (3.640)	4.7102*** (3.698)	2.4484 (1.044)
EPSIndAve	−0.2299 (−1.230)	−0.0658 (−0.357)	−0.5080*** (−2.690)	−0.4097** (−2.174)	−1.0120*** (−3.103)
PC	0.1346** (2.436)	0.1373** (2.485)	0.3147*** (4.435)	0.3152*** (4.440)	0.3176** (2.194)
Fix & cons	Yes	Yes	Yes	Yes	Yes
N	8128	8128	6981	6981	2363

Notes: [1] *, ** and *** denote significant at a confidence level of 10, 5 and 1%. [2] Logit coefficients in ratio form and their robust standard errors (in parentheses) are reported

(*continued*)

Table A4.

Model	(6)	(7)	(8)	(9)	(10)
Ownership	Nation	Province		City	
OC	0.2601 (1.477)	0.0861 (0.552)	0.1041 (0.660)	0.0521 (0.336)	0.0008 (0.005)
PerScoreMax	−0.0036 (−1.063)	−0.0004 (−0.111)	−0.0004 (−0.117)	−0.0041 (−1.458)	−0.0038 (−1.350)
CEOTensure		−0.0058 (−0.094)		0.0221 (0.389)	
CEOAge		0.0106 (0.773)		0.0055 (0.649)	
CEOMale		0.3223 (0.720)		−0.1822 (−0.871)	
lnCEOShare		−0.0168 (−1.114)		−0.0192 (−1.644)	
Duality		−0.0937 (−0.351)		0.4976*** (3.522)	
Shrcr1		−0.0152*** (−3.842)		−0.0042 (−1.152)	
lnDrct	1.0927*** (3.471)		0.4608* (1.892)		−0.0700 (−0.364)
IndDrctRatio	1.2541 (1.060)		1.7694 (1.554)		−0.7909 (−0.906)
DBM	−0.0201 (−0.772)		0.0440*** (2.822)		0.0186 (1.531)
AuditNo	−0.3608** (−2.350)		0.0880 (0.430)		0.0139 (0.091)
BigFour	−0.8633*** (−2.939)		−0.0333 (−0.113)		−0.6699** (−2.224)
Analyst	0.0006 (0.482)		−0.0017 (−1.360)		−0.0024* (−1.720)
InstOwn	−0.0229** (−2.224)		0.0035 (0.505)		−0.0047 (−0.543)
lnAsset	−0.2121*** (−2.986)	−0.0632 (−1.297)	−0.0993* (−1.897)	−0.2800*** (−4.605)	−0.2204*** (−3.446)
ROA	4.2698** (2.471)	−1.2291 (−0.776)	−1.5458 (−0.990)	0.4401 (0.311)	−0.1651 (−0.112)
Leverage	0.8893*** (2.891)	1.4451*** (3.828)	1.4304*** (3.770)	1.7164*** (6.022)	1.6687*** (5.939)
RevGrowth	0.1389 (1.293)	0.0278 (0.288)	0.0030 (0.030)	−0.1138 (−0.973)	−0.1430 (−1.228)
TobinQ	−0.1539** (−2.140)	−0.0523 (−0.857)	−0.0503 (−0.809)	−0.0512 (−0.896)	−0.0138 (−0.241)
EPS	−0.3484** (−2.251)	0.1405 (1.555)	0.2137** (2.069)	−0.2971 (−1.384)	−0.1845 (−0.821)
Volatility	4.8461 (1.527)	3.1255** (2.244)	3.3036** (2.523)	17.4093*** (2.766)	14.0887** (2.262)
Turnover	2.4916 (1.073)	7.2202*** (3.040)	6.7162*** (2.758)	3.6517* (1.669)	4.0214** (2.022)
EPSIndAve	−0.9595*** (−3.062)	−0.1963 (−0.650)	−0.1405 (−0.475)	−0.1330 (−0.399)	0.0441 (0.129)
PC	0.2420* (1.664)	0.0282 (0.207)	0.0638 (0.463)	0.5061*** (4.678)	0.4697*** (4.386)
Fix & cons	Yes	Yes	Yes	Yes	Yes
N	2363	1628	1628	2980	2980

Table A5. Robust test of averaging raw centrality on sub-type fraud via two-step Logit model

Model	(1)	(2)	(3)	(4)	(5)
Fraud type	Accounting		Management		Finance
OC	0.2320** (2.419)	0.1066 (1.140)	0.0982 (0.764)	0.0139 (0.110)	0.0021 (0.019)
CenMean	−2.0241 (−1.060)	−1.3716 (−0.714)	−9.8859*** (−3.733)	−9.8182*** (−3.671)	3.4127 (1.455)
CEOTensure	−0.0880** (−2.275)		−0.0512 (−0.950)		0.0492 (1.235)
CEOAge	−0.0075 (−1.430)		−0.0107 (−1.522)		−0.0015 (−0.223)
CEOMale	−0.0143 (−0.095)		−0.0046 (−0.023)		−0.1421 (−0.831)
lnCEOShare	0.0050 (0.836)		−0.0099 (−1.283)		0.0194*** (2.739)
Duality	0.0605 (0.647)		0.4666*** (3.935)		−0.1186 (−1.036)
Shrcr1	−0.0022 (−0.872)		−0.0073** (−2.186)		−0.0159*** (−5.076)
lnDrct		0.2268 (1.477)		0.5636*** (3.368)	
IndDrctRatio		1.3017** (2.033)		0.2950 (0.353)	
DBM		0.0454*** (5.017)		0.0433*** (3.918)	
AuditNo		0.0777 (0.756)		−0.1140 (−0.863)	
BigFour		−0.7889*** (−2.919)		−1.0866** (−2.558)	
Analyst		−0.0029*** (−3.698)		−0.0030*** (−3.062)	
InstOwn		−0.0054 (−1.015)		0.0071 (1.097)	
lnAsset	−0.1313*** (−4.615)	−0.0853*** (−2.614)	−0.0764** (−2.050)	−0.0810* (−1.853)	0.0006 (0.015)
ROA	−1.7668** (−2.369)	−1.5523** (−2.189)	−2.8628*** (−3.004)	−2.9979*** (−3.249)	0.3369 (0.421)
Leverage	0.3723** (2.393)	0.2460 (1.593)	0.3872* (1.950)	0.3238 (1.612)	0.2934 (1.621)
RevGrowth	0.1012* (1.708)	0.0733 (1.254)	0.1253 (1.533)	0.1088 (1.352)	0.1221* (1.947)
SOE	−0.2279*** (−2.614)	−0.2929*** (−3.525)	−0.2553** (−2.307)	−0.4005*** (−3.755)	−0.6643*** (−5.561)
TobinQ	−0.0945*** (−3.069)	−0.0664** (−2.165)	−0.0435 (−1.173)	−0.0217 (−0.561)	0.0672** (2.189)
EPS	−0.1513 (−1.544)	−0.1300* (−1.765)	−0.1323 (−1.082)	−0.1295 (−1.352)	−0.0989 (−1.476)
Volatility	1.0010 (1.255)	0.7811 (0.976)	1.0430* (1.833)	0.7557 (1.275)	2.2461*** (2.827)
Turnover	0.0486 (0.056)	−0.0650 (−0.073)	0.3054 (0.277)	0.0602 (0.052)	−1.2101 (−0.915)
EPSIndAve	−0.1910 (−0.947)	−0.0239 (−0.118)	−0.6067** (−2.077)	−0.4907* (−1.685)	−0.4176* (−1.688)
PC	0.1003 (1.331)	0.0973 (1.290)	0.0193 (0.192)	−0.0156 (−0.155)	0.1873** (2.040)
Fix & cons	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109

Notes: [1] *, ** and ***denote significant at a confidence level of 10, 5 and 1%. [2] Logit coefficients in ratio form and their robust standard errors (in parentheses) are reported

(*continued*)

Table A5.

Model	(6)	(7)	(8)	(9)	(10)
Fraud type	Finance	Disclosure		Other	
OC	−0.0191 (−0.166)	0.2324*** (3.230)	0.1519** (2.262)	0.1326** (1.968)	0.0567 (0.836)
CenMean	3.6604 (1.554)	−3.4235*** (−2.652)	−3.1247** (−2.413)	−2.0756 (−1.585)	−1.8946 (−1.438)
CEOTensure		0.0272 (1.094)		0.0203 (0.804)	
CEOAge		−0.0034 (−0.899)		−0.0077** (−1.995)	
CEOMale		−0.0089 (−0.089)		0.2075* (1.895)	
lnCEOShare		−0.0077** (−1.971)		0.0030 (0.744)	
Duality		0.1534** (2.471)		0.1171* (1.850)	
Shrcr1		−0.0097*** (−5.557)		−0.0049*** (−2.804)	
lnDrct	0.2787 (1.121)		0.1732* (1.811)		0.2614** (2.403)
IndDrctRatio	0.1150 (0.130)		0.0320 (0.076)		1.0510** (2.340)
DBM	0.0316*** (3.032)		0.0327*** (5.243)		0.0351*** (5.573)
AuditNo	0.0767 (0.510)		−0.0305 (−0.445)		−0.0419 (−0.642)
BigFour	−0.8208*** (−2.629)		−0.6571*** (−3.992)		−0.3084** (−2.186)
Analyst	−0.0010 (−1.372)		−0.0026*** (−5.051)		−0.0018*** (−3.476)
InstOwn	0.0068 (1.191)		−0.0047 (−1.231)		−0.0035 (−0.937)
lnAsset	−0.0007 (−0.014)	−0.1471*** (−6.186)	−0.1135*** (−4.575)	−0.1126*** (−4.886)	−0.0994*** (−3.942)
ROA	0.1779 (0.216)	−1.5616*** (−2.631)	−1.5986*** (−2.941)	−1.3782** (−2.508)	−1.2980** (−2.365)
Leverage	0.1950 (1.080)	0.9425*** (8.775)	0.8993*** (8.478)	0.7314*** (6.762)	0.6465*** (6.016)
RevGrowth	0.0891 (1.426)	0.0912** (2.202)	0.0636 (1.566)	0.0369 (0.833)	0.0137 (0.314)
SOE	−0.8112*** (−7.049)	−0.2504*** (−4.323)	−0.3235*** (−5.857)	−0.2424*** (−4.049)	−0.3142*** (−5.492)
TobinQ	0.0797** (2.490)	−0.0390** (−1.988)	0.0013 (0.067)	−0.0721*** (−3.461)	−0.0474** (−2.269)
EPS	−0.0909 (−1.348)	−0.1349 (−1.289)	−0.0875 (−1.074)	−0.0530 (−0.678)	−0.0307 (−0.403)
Volatility	1.7583** (2.242)	1.1461* (1.721)	0.7298 (1.130)	0.9869 (1.373)	0.6742 (0.949)
Turnover	−0.9439 (−0.752)	−0.8506 (−1.214)	−1.4566** (−1.960)	−0.6808 (−1.022)	−0.7523 (−1.111)
EPSIndAve	−0.2644 (−1.027)	−0.4386*** (−2.896)	−0.2639* (−1.753)	−0.2193 (−1.474)	−0.0917 (−0.611)
PC	0.2065** (2.282)	0.1780*** (3.557)	0.1719*** (3.433)	0.1520*** (2.979)	0.1473*** (2.879)
Fix & cons	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109

Table A6. Robust test of averaging raw centrality on sub-ownership via two-step Logit model

Model	(1)	(2)	(3)	(4)	(5)
Ownership	Non-SOEs		SOEs		Nation
OC	0.1773** (2.100)	0.1072 (1.366)	0.1959** (2.008)	0.1611* (1.689)	0.2798 (1.579)
CenMean	−1.1492 (−0.793)	−1.0788 (−0.742)	−5.1419*** (−2.896)	−5.2096*** (−2.941)	−5.4261* (−1.703)
CEOTensure	0.0150 (0.532)		0.0308 (0.935)		0.0933* (1.672)
CEOAge	−0.0045 (−1.127)		−0.0024 (−0.399)		−0.0253** (−2.077)
CEOMale	−0.0441 (−0.441)		0.0661 (0.377)		0.5553 (0.991)
lnCEOShare	0.0048 (1.260)		−0.0096 (−1.301)		0.0124 (0.982)
Duality	0.0573 (0.931)		0.3748*** (3.551)		0.6660*** (2.905)
Shrcr1	−0.0106*** (−5.352)		−0.0075*** (−3.232)		−0.0037 (−0.779)
lnDrct		0.1977 (1.585)		0.3697*** (2.759)	
IndDrctRatio		0.1589 (0.312)		0.1776 (0.312)	
DBM		0.0519*** (6.853)		0.0173** (1.990)	
AuditNo		−0.0410 (−0.543)		−0.0413 (−0.407)	
BigFour		−0.2118 (−1.074)		−0.6303*** (−3.715)	
Analyst		−0.0017*** (−3.424)		−0.0012* (−1.728)	
InstOwn		−0.0026 (−0.617)		−0.0082* (−1.735)	
lnAsset	−0.0750*** (−2.597)	−0.0867*** (−2.718)	−0.1795*** (−5.098)	−0.1548*** (−4.178)	−0.2141*** (−3.556)
ROA	−2.3064*** (−3.507)	−2.2958*** (−3.714)	−0.0575 (−0.060)	−0.1964 (−0.213)	4.3955** (2.439)
Leverage	0.5069*** (4.235)	0.4189*** (3.519)	1.4327*** (7.902)	1.4251*** (7.927)	0.9071*** (2.855)
RevGrowth	0.1201*** (2.595)	0.0907** (1.969)	0.0310 (0.496)	0.0006 (0.009)	0.1483 (1.353)
TobinQ	0.0117 (0.570)	0.0384* (1.819)	−0.0635* (−1.789)	−0.0290 (−0.821)	−0.2034*** (−2.807)
EPS	−0.1080 (−0.768)	−0.0848 (−0.724)	−0.0045 (−0.037)	0.0568 (0.513)	−0.4080** (−2.344)
Volatility	1.1088 (1.426)	0.4992 (0.668)	5.2817** (2.199)	4.4391** (2.431)	4.4672 (1.243)
Turnover	−3.0487*** (−3.837)	−3.1994*** (−3.997)	4.9397*** (3.644)	4.6240*** (3.663)	2.3396 (0.981)
EPSIndAve	−0.2244 (−1.198)	−0.0650 (−0.352)	−0.4844** (−2.576)	−0.3865** (−2.059)	−0.9895*** (−3.023)
PC	0.1400** (2.540)	0.1422*** (2.580)	0.3038*** (4.327)	0.3042*** (4.326)	0.3079** (2.146)
Fix & cons	Yes	Yes	Yes	Yes	Yes
N	8128	8128	6981	6981	2363

Notes: [1] *, ** and *** denote significant at a confidence level of 10, 5 and 1%. [2] Logit coefficients in ratio form and their robust standard errors (in parentheses) are reported

(*continued*)

Table A6.

Model	(6)	(7)	(8)	(9)	(10)
Ownership	Nation	Province		City	
OC	0.2567 (1.457)	0.0884 (0.567)	0.1062 (0.673)	0.0623 (0.402)	0.0073 (0.047)
CenMean	−3.8541 (−1.219)	1.1570 (0.335)	0.6648 (0.194)	−8.2153*** (−2.759)	−8.4503*** (−2.859)
CEOTensure		−0.0057 (−0.093)		0.0187 (0.328)	
CEOAge		0.0102 (0.745)		0.0055 (0.639)	
CEOMale		0.3197 (0.715)		−0.1896 (−0.909)	
lnCEOShare		−0.0168 (−1.111)		−0.0177 (−1.505)	
Duality		−0.0973 (−0.366)		0.4808*** (3.394)	
Shrcr1		−0.0151*** (−3.809)		−0.0039 (−1.058)	
lnDrct	1.0733*** (3.445)		0.4540* (1.871)		−0.0463 (−0.240)
IndDrctRatio	1.2841 (1.088)		1.7609 (1.552)		−0.8165 (−0.930)
DBM	−0.0201 (−0.775)		0.0438*** (2.803)		0.0187 (1.534)
AuditNo	−0.3568** (−2.336)		0.0872 (0.427)		0.0054 (0.035)
BigFour	−0.8623*** (−2.934)		−0.0341 (−0.116)		−0.6237** (−2.081)
Analyst	0.0006 (0.527)		−0.0017 (−1.350)		−0.0024* (−1.758)
InstOwn	−0.0231** (−2.239)		0.0035 (0.511)		−0.0053 (−0.616)
lnAsset	−0.2139*** (−3.015)	−0.0664 (−1.358)	−0.1012* (−1.929)	−0.2666*** (−4.355)	−0.2060*** (−3.188)
ROA	4.2439** (2.481)	−1.2211 (−0.769)	−1.5368 (−0.983)	0.4117 (0.292)	−0.1563 (−0.106)
Leverage	0.8861*** (2.885)	1.4501*** (3.854)	1.4355*** (3.805)	1.7658*** (6.168)	1.7096*** (6.068)
RevGrowth	0.1409 (1.309)	0.0290 (0.301)	0.0039 (0.040)	−0.1069 (−0.921)	−0.1359 (−1.172)
TobinQ	−0.1580** (−2.194)	−0.0527 (−0.865)	−0.0508 (−0.819)	−0.0437 (−0.769)	−0.0055 (−0.097)
EPS	−0.3473** (−2.274)	0.1438 (1.585)	0.2154** (2.076)	−0.2898 (−1.360)	−0.1754 (−0.789)
Volatility	4.7700 (1.497)	3.1415** (2.261)	3.3140** (2.533)	16.6754*** (2.631)	13.4937** (2.146)
Turnover	2.3860 (1.015)	7.2114*** (3.036)	6.7134*** (2.757)	3.5201* (1.675)	3.8507** (1.973)
EPSIndAve	−0.9466*** (−3.016)	−0.2075 (−0.685)	−0.1475 (−0.498)	−0.1086 (−0.326)	0.0750 (0.220)
PC	0.2338 (1.623)	0.0243 (0.181)	0.0604 (0.443)	0.4928*** (4.587)	0.4613*** (4.338)
Fix & cons	Yes	Yes	Yes	Yes	Yes
N	2363	1628	1628	2980	2980

Table A7. Robust test of maximizing raw centrality on subtype fraud via two-step Logit model

Model	(1)	(2)	(3)	(4)	(5)
Fraud type	Accounting		Management		Finance
OC	0.2357** (2.461)	0.1096 (1.173)	0.0976 (0.764)	0.0107 (0.086)	0.0064 (0.057)
CenMax	0.1506 (0.568)	0.2266 (0.854)	−0.7641** (−2.321)	−0.7497** (−2.257)	0.6179* (1.931)
CEOTensure	−0.0867** (−2.239)		−0.0483 (−0.893)		0.0487 (1.224)
CEOAge	−0.0074 (−1.415)		−0.0111 (−1.594)		−0.0011 (−0.160)
CEOMale	−0.0204 (−0.135)		−0.0116 (−0.058)		−0.1402 (−0.820)
lnCEOShare	0.0043 (0.719)		−0.0104 (−1.342)		0.0189*** (2.672)
Duality	0.0588 (0.629)		0.4707*** (3.959)		−0.1216 (−1.061)
Shrcr1	−0.0024 (−0.935)		−0.0074** (−2.215)		−0.0161*** (−5.137)
lnDrct		0.2106 (1.394)		0.5413*** (3.302)	
IndDrctRatio		1.2581** (1.982)		0.1970 (0.238)	
DBM		0.0450*** (4.977)		0.0430*** (3.888)	
AuditNo		0.0792 (0.772)		−0.1101 (−0.834)	
BigFour		−0.8072*** (−2.986)		−1.1211*** (−2.634)	
Analyst		−0.0030*** (−3.756)		−0.0031*** (−3.110)	
InstOwn		−0.0054 (−1.031)		0.0067 (1.040)	
lnAsset	−0.1379*** (−4.817)	−0.0893*** (−2.747)	−0.0861** (−2.398)	−0.0868** (−2.033)	−0.0015 (−0.037)
ROA	−1.7653** (−2.371)	−1.5503** (−2.187)	−2.8622*** (−3.039)	−2.9915*** (−3.262)	0.3319 (0.414)
Leverage	0.3797** (2.436)	0.2581* (1.667)	0.3855* (1.950)	0.3237 (1.617)	0.3017* (1.656)
RevGrowth	0.1014* (1.709)	0.0731 (1.249)	0.1243 (1.525)	0.1078 (1.342)	0.1226* (1.948)
SOE	−0.2307*** (−2.654)	−0.2913*** (−3.519)	−0.2782** (−2.522)	−0.4239*** (−3.982)	−0.6522*** (−5.469)
TobinQ	−0.0969*** (−3.146)	−0.0675** (−2.201)	−0.0501 (−1.356)	−0.0266 (−0.689)	0.0682** (2.225)
EPS	−0.1510 (−1.555)	−0.1293* (−1.766)	−0.1306 (−1.109)	−0.1269 (−1.376)	−0.0989 (−1.472)
Volatility	0.9785 (1.228)	0.7535 (0.939)	1.0171* (1.796)	0.7195 (1.218)	2.2474*** (2.825)
Turnover	0.0181 (0.021)	−0.1283 (−0.143)	0.3316 (0.313)	0.1157 (0.104)	−1.3130 (−0.982)
EPSIndAve	−0.2022 (−1.004)	−0.0276 (−0.136)	−0.6309** (−2.169)	−0.5087* (−1.747)	−0.4136* (−1.671)
PC	0.0944 (1.250)	0.0898 (1.189)	0.0262 (0.261)	−0.0086 (−0.085)	0.1758* (1.904)
Fix & cons	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109

Notes: [1] *, ** and *** denote significant at a confidence level of 10, 5 and 1%. [2] Logit coefficients in ratio form and their robust standard errors (in parentheses) are reported)

(*continued*)

Table A7.

Model	(6)	(7)	(8)	(9)	(10)
Fraud type	Finance	Disclosure		Other	
OC	−0.0136 (−0.118)	0.2331*** (3.244)	0.1517** (2.263)	0.1349** (2.002)	0.0587 (0.865)
CenMax	0.6244* (1.953)	−0.2240 (−1.313)	−0.2098 (−1.231)	0.0489 (0.279)	0.0702 (0.401)
CEOTensure		0.0285 (1.146)		0.0216 (0.853)	
CEOAge		−0.0035 (−0.938)		−0.0077** (−1.988)	
CEOMale		−0.0132 (−0.132)		0.2025* (1.850)	
lnCEOShare		−0.0079** (−2.042)		0.0024 (0.614)	
Duality		0.1541** (2.482)		0.1161* (1.834)	
Shrcr1		−0.0097*** (−5.576)		−0.0050*** (−2.858)	
lnDrct	0.2690 (1.085)		0.1689* (1.776)		0.2492** (2.316)
IndDrctRatio	0.1076 (0.122)		0.0098 (0.024)		1.0174** (2.281)
DBM	0.0315*** (3.017)		0.0326*** (5.224)		0.0348*** (5.530)
AuditNo	0.0758 (0.505)		−0.0295 (−0.431)		−0.0409 (−0.627)
BigFour	−0.8190*** (−2.626)		−0.6696*** (−4.067)		−0.3237** (−2.292)
Analyst	−0.0010 (−1.380)		−0.0026*** (−5.088)		−0.0018*** (−3.526)
InstOwn	0.0069 (1.211)		−0.0048 (−1.260)		−0.0036 (−0.960)
lnAsset	−0.0018 (−0.036)	−0.1516*** (−6.352)	−0.1159*** (−4.680)	−0.1187*** (−5.146)	−0.1032*** (−4.089)
ROA	0.1636 (0.198)	−1.5591*** (−2.631)	−1.5976*** (−2.948)	−1.3737** (−2.500)	−1.2950** (−2.358)
Leverage	0.2056 (1.128)	0.9429*** (8.768)	0.9006*** (8.479)	0.7370*** (6.803)	0.6549*** (6.082)
RevGrowth	0.0890 (1.418)	0.0907** (2.189)	0.0630 (1.552)	0.0364 (0.823)	0.0131 (0.300)
SOE	−0.7955*** (−6.928)	−0.2580*** (−4.457)	−0.3308*** (−5.997)	−0.2458*** (−4.108)	−0.3157*** (−5.515)
TobinQ	0.0812** (2.538)	−0.0418** (−2.127)	−0.0006 (−0.029)	−0.0746*** (−3.584)	−0.0490** (−2.341)
EPS	−0.0909 (−1.343)	−0.1338 (−1.284)	−0.0860 (−1.068)	−0.0523 (−0.669)	−0.0294 (−0.385)
Volatility	1.7572** (2.229)	1.1347* (1.701)	0.7173 (1.110)	0.9693 (1.357)	0.6521 (0.921)
Turnover	−1.0618 (−0.832)	−0.8214 (−1.183)	−1.4283* (−1.935)	−0.6960 (−1.048)	−0.7865 (−1.161)
EPSIndAve	−0.2599 (−1.009)	−0.4505*** (−2.982)	−0.2717* (−1.807)	−0.2297 (−1.546)	−0.0977 (−0.651)
PC	0.1952** (2.146)	0.1803*** (3.596)	0.1740*** (3.468)	0.1488*** (2.913)	0.1436*** (2.802)
Fix & cons	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109

Table A8. Robust test of maximizing raw centrality on sub-ownership via two-step Logit model

Model	(1)	(2)	(3)	(4)	(5)
Ownership	Non-SOEs		SOEs		Nation
OC	0.1811** (2.146)	0.1099 (1.401)	0.1959** (2.000)	0.1622* (1.696)	0.2898 (1.631)
CenMax	0.1660 (0.890)	0.1496 (0.806)	−0.4976** (−2.015)	−0.5000** (−2.028)	−0.8558* (−1.774)
CEOTensure	0.0157 (0.559)		0.0324 (0.980)		0.0956* (1.696)
CEOAge	−0.0044 (−1.097)		−0.0026 (−0.434)		−0.0251** (−2.059)
CEOMale	−0.0501 (−0.503)		0.0724 (0.412)		0.5725 (1.020)
lnCEOShare	0.0043 (1.126)		−0.0105 (−1.429)		0.0120 (0.954)
Duality	0.0558 (0.906)		0.3781*** (3.584)		0.6731*** (2.934)
Shrcr1	−0.0108*** (−5.413)		−0.0076*** (−3.283)		−0.0039 (−0.832)
lnDrct		0.1866 (1.511)		0.3682*** (2.747)	
IndDrctRatvio		0.1304 (0.257)		0.1475 (0.259)	
DBM		0.0516*** (6.811)		0.0172** (1.975)	
AuditNo		−0.0406 (−0.540)		−0.0404 (−0.398)	
BigFour		−0.2237 (−1.132)		−0.6430*** (−3.785)	
Analyst		−0.0017*** (−3.471)		−0.0012* (−1.741)	
InstOwn		−0.0028 (−0.656)		−0.0083* (−1.746)	
lnAsset	−0.0784*** (−2.720)	−0.0878*** (−2.753)	−0.1845*** (−5.220)	−0.1589*** (−4.277)	−0.2084*** (−3.431)
ROA	−2.2986*** (−3.495)	−2.2910*** (−3.709)	−0.0429 (−0.044)	−0.1899 (−0.204)	4.4080** (2.407)
Leverage	0.5163*** (4.304)	0.4303*** (3.604)	1.4254*** (7.860)	1.4215*** (7.912)	0.9120*** (2.845)
RevGrowth	0.1193** (2.576)	0.0898* (1.950)	0.0298 (0.476)	−0.0007 (−0.012)	0.1473 (1.351)
TobinQ	0.0098 (0.479)	0.0376* (1.782)	−0.0663* (−1.863)	−0.0314 (−0.886)	−0.1992*** (−2.738)
EPS	−0.1082 (−0.770)	−0.0841 (−0.722)	−0.0046 (−0.037)	0.0584 (0.519)	−0.4037** (−2.266)
Volatility	1.0687 (1.384)	0.4594 (0.616)	5.3620** (2.209)	4.4941** (2.436)	4.7107 (1.329)
Turnover	−3.0742*** (−3.872)	−3.2479*** (−4.053)	5.0476*** (3.655)	4.7321*** (3.703)	2.4242 (1.030)
EPSIndAve	−0.2340 (−1.250)	−0.0696 (−0.378)	−0.5068*** (−2.685)	−0.4086** (−2.171)	−1.0058*** (−3.076)
PC	0.1361** (2.465)	0.1384** (2.507)	0.3161*** (4.476)	0.3161*** (4.469)	0.3211** (2.226)
Fix & cons	Yes	Yes	Yes	Yes	Yes
N	8128	8128	6981	6981	2363

Notes: [1] *, ** and *** denote significant at a confidence level of 10, 5 and 1%. [2] Logit coefficients in ratio form and their robust standard errors (in parentheses) are reported

(*continued*)

Table A8.

Model	(6)	(7)	(8)	(9)	(10)
Ownership	Nation	Province		City	
OC	0.2621 (1.487)	0.0848 (0.543)	0.1034 (0.655)	0.0517 (0.334)	−0.0005 (−0.003)
CenMax	−0.6579 (−1.358)	−0.1816 (−0.407)	−0.1398 (−0.316)	−0.5863 (−1.480)	−0.5790 (−1.470)
CEOTensure		−0.0057 (−0.093)		0.0210 (0.368)	
CEOAge		0.0107 (0.780)		0.0053 (0.625)	
CEOMale		0.3294 (0.736)		−0.1845 (−0.886)	
lnCEOShare		−0.0171 (−1.131)		−0.0191 (−1.634)	
Duality		−0.0912 (−0.342)		0.4957*** (3.506)	
Shrcr1		−0.0153*** (−3.865)		−0.0042 (−1.153)	
lnDrct	1.0993*** (3.471)		0.4660* (1.910)		−0.0707 (−0.368)
IndDrctRatvio	1.2870 (1.085)		1.7737 (1.555)		−0.8168 (−0.935)
DBM	−0.0196 (−0.753)		0.0441*** (2.829)		0.0189 (1.561)
AuditNo	−0.3581** (−2.337)		0.0885 (0.433)		0.0110 (0.072)
BigFour	−0.8594*** (−2.926)		−0.0310 (−0.105)		−0.6648** (−2.211)
Analyst	0.0006 (0.502)		−0.0017 (−1.368)		−0.0024* (−1.713)
InstOwn	−0.0231** (−2.232)		0.0034 (0.498)		−0.0050 (−0.575)
lnAsset	−0.2097*** (−2.954)	−0.0605 (−1.232)	−0.0980* (−1.867)	−0.2800*** (−4.591)	−0.2199*** (−3.429)
ROA	4.2429** (2.458)	−1.2254 (−0.775)	−1.5416 (−0.989)	0.4442 (0.314)	−0.1560 (−0.106)
Leverage	0.8906*** (2.895)	1.4394*** (3.822)	1.4274*** (3.778)	1.7303*** (6.062)	1.6807*** (5.976)
RevGrowth	0.1393 (1.298)	0.0268 (0.279)	0.0023 (0.024)	−0.1124 (−0.964)	−0.1419 (−1.221)
TobinQ	−0.1537** (−2.131)	−0.0527 (−0.861)	−0.0504 (−0.812)	−0.0504 (−0.881)	−0.0126 (−0.220)
EPS	−0.3414** (−2.204)	0.1383 (1.535)	0.2126** (2.060)	−0.2990 (−1.388)	−0.1866 (−0.828)
Volatility	4.9511 (1.556)	3.1040** (2.223)	3.2875** (2.506)	16.9478*** (2.676)	13.6563** (2.178)
Turnover	2.4824 (1.066)	7.2533*** (3.053)	6.7361*** (2.767)	3.7010* (1.678)	4.0636** (2.028)
EPSIndAve	−0.9555*** (−3.046)	−0.1940 (−0.643)	−0.1387 (−0.470)	−0.1333 (−0.399)	0.0440 (0.129)
PC	0.2459* (1.695)	0.0347 (0.256)	0.0679 (0.495)	0.5046*** (4.669)	0.4701*** (4.395)
Fix & cons	Yes	Yes	Yes	Yes	Yes
N	2363	1628	1628	2980	2980

Model	(1)	(2)	(3)	(4)	(5)	(6)
Estimation				Logit		
Dependent	Fraud	Fraud	Fraud	Fraud	Fraud	Fraud
OC	0.1148** (1.965)	0.1184** (2.028)	0.1159** (1.985)	0.1156** (1.979)	0.1177** (2.015)	0.1183** (2.026)
PerScoreMean	−0.0054** (−2.087)					
PoSAMean		0.0012 (1.049)				0.0028** (2.205)
PoSCMean			−0.0027 (−1.626)			−0.0015 (−0.757)
PoSFGOMean				−0.0264*** (−3.006)		−0.0300*** (−2.872)
PoSRMean					0.0085 (1.272)	0.0082 (1.203)
PC	0.2042*** (4.709)	0.1979*** (4.563)	0.2058*** (4.735)	0.2086*** (4.805)	0.1925*** (4.396)	0.2005*** (4.567)
CEO_Tensure	0.0318 (1.480)	0.0323 (1.504)	0.0320 (1.493)	0.0308 (1.436)	0.0319 (1.489)	0.0316 (1.473)
CEO_Age	−0.0043 (−1.300)	−0.0040 (−1.214)	−0.0042 (−1.260)	−0.0041 (−1.226)	−0.0040 (−1.203)	−0.0036 (−1.084)
CEO_Male	−0.0162 (−0.187)	−0.0232 (−0.268)	−0.0175 (−0.202)	−0.0122 (−0.140)	−0.0195 (−0.224)	−0.0101 (−0.116)
ln_CEOShare	0.0015 (0.447)	0.0007 (0.194)	0.0012 (0.358)	0.0012 (0.353)	0.0003 (0.088)	0.0001 (0.026)
Duality	0.1522*** (2.818)	0.1499*** (2.775)	0.1507*** (2.791)	0.1484*** (2.746)	0.1498*** (2.773)	0.1414*** (2.613)
Shrcr1	−0.0098*** (−6.416)	−0.0101*** (−6.651)	−0.0098*** (−6.481)	−0.0099*** (−6.518)	−0.0103*** (−6.736)	−0.0102*** (−6.643)
ln_Drct	0.2464*** (2.783)	0.2340*** (2.661)	0.2479*** (2.798)	0.2568*** (2.875)	0.2360*** (2.677)	0.2574*** (2.882)
IndDrct_Ratio	0.1660 (0.450)	0.1494 (0.407)	0.1633 (0.442)	0.1608 (0.434)	0.1645 (0.447)	0.1518 (0.409)
DBM	0.0352*** (6.375)	0.0351*** (6.350)	0.0351*** (6.354)	0.0352*** (6.368)	0.0353*** (6.390)	0.0352*** (6.360)
AuditNo	−0.0438 (−0.724)	−0.0419 (−0.695)	−0.0429 (−0.710)	−0.0427 (−0.707)	−0.0430 (−0.714)	−0.0425 (−0.704)
BigFour	−0.5067*** (−3.985)	−0.5207*** (−4.088)	−0.5105*** (−4.012)	−0.5060*** (−3.978)	−0.5121*** (−4.024)	−0.5109*** (−4.004)
Analyst	−0.0015*** (−3.788)	−0.0016*** (−3.843)	−0.0015*** (−3.833)	−0.0015*** (−3.818)	−0.0016*** (−3.877)	−0.0016*** (−3.900)
InstOwn	−0.0072** (−2.281)	−0.0074** (−2.338)	−0.0073** (−2.293)	−0.0072** (−2.276)	−0.0073** (−2.302)	−0.0072** (−2.270)
ln_Asset	−0.0772*** (−3.331)	−0.0821*** (−3.546)	−0.0774*** (−3.345)	−0.0750*** (−3.234)	−0.0801*** (−3.468)	−0.0743*** (−3.198)
ROA	−1.3686*** (−2.885)	−1.3670*** (−2.884)	−1.3631*** (−2.875)	−1.3796*** (−2.911)	−1.3627*** (−2.874)	−1.3648*** (−2.883)
Leverage	0.7426*** (7.635)	0.7506*** (7.705)	0.7449*** (7.662)	0.7419*** (7.618)	0.7542*** (7.749)	0.7543*** (7.729)
Rev_Growth	0.0701* (1.923)	0.0707* (1.942)	0.0703* (1.929)	0.0703* (1.919)	0.0698* (1.917)	0.0696* (1.895)
SOE	−0.3454*** (−6.770)	−0.3400*** (−6.660)	−0.3407*** (−6.675)	−0.3363*** (−6.581)	−0.3136*** (−5.661)	−0.3018*** (−5.436)
TobinQ	0.0168 (0.944)	0.0149 (0.837)	0.0160 (0.901)	0.0168 (0.947)	0.0166 (0.933)	0.0186 (1.046)
EPS	−0.0313 (−0.466)	−0.0306 (−0.459)	−0.0309 (−0.462)	−0.0314 (−0.470)	−0.0305 (−0.456)	−0.0310 (−0.466)
Volatility	1.5585* (1.838)	1.5259* (1.817)	1.5426* (1.837)	1.5484* (1.831)	1.5383* (1.841)	1.5451* (1.857)
Turnover	−1.2362** (−1.961)	−1.3200** (−2.086)	−1.3009** (−2.057)	−1.3218** (−2.083)	−1.3410** (−2.112)	−1.4469** (−2.247)
EPS_Ind_Ave	−0.2317* (−1.800)	−0.2289* (−1.777)	−0.2239* (−1.741)	−0.2177* (−1.689)	−0.2233* (−1.734)	−0.2097 (−1.626)
Fix & cons	Yes	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109	15109

Notes: [1] *, ** and *** denote significant at a confidence level of 10, 5 and 1%. [2] Logit coefficients in ratio form, Probit coefficients and their robust standard errors (in parentheses) are reported

(*continued*)

Table A9. Robustness test of averaging percentile centrality via Logit and Probit regression

Table A9.

Model	(7)	(8)	(9)	(10)	(11)	(12)
Estimation				Probit		
Dependent	Fraud	Fraud	Fraud	Fraud	Fraud	Fraud
OC	0.0663** (2.041)	0.0688** (2.115)	0.0672** (2.069)	0.0668** (2.054)	0.0685** (2.106)	0.0680** (2.091)
PerScoreMean	−0.0033** (−2.230)					
PoSAMean		0.0006 (0.872)				0.0015** (2.036)
PoSCMean			−0.0015 (−1.611)			−0.0007 (−0.618)
PoSFGOMean				−0.0153*** (−3.046)		−0.0175*** (−2.900)
PoSRMean					0.0044 (1.135)	0.0042 (1.077)
PC	0.1162*** (4.709)	0.1125*** (4.559)	0.1169*** (4.725)	0.1188*** (4.807)	0.1098*** (4.409)	0.1146*** (4.588)
CEO_Tensure	0.0180 (1.477)	0.0182 (1.492)	0.0180 (1.482)	0.0173 (1.423)	0.0180 (1.475)	0.0176 (1.444)
CEO_Age	−0.0024 (−1.267)	−0.0022 (−1.187)	−0.0023 (−1.223)	−0.0022 (−1.186)	−0.0022 (−1.175)	−0.0020 (−1.057)
CEO_Male	−0.0077 (−0.154)	−0.0112 (−0.225)	−0.0088 (−0.178)	−0.0052 (−0.105)	−0.0097 (−0.195)	−0.0042 (−0.084)
ln_CEOShare	0.0009 (0.455)	0.0004 (0.202)	0.0007 (0.355)	0.0007 (0.351)	0.0002 (0.106)	0.0001 (0.058)
Duality	0.0858*** (2.768)	0.0844*** (2.723)	0.0848*** (2.738)	0.0833*** (2.687)	0.0841*** (2.714)	0.0795** (2.561)
Shrcr1	−0.0055*** (−6.481)	−0.0057*** (−6.702)	−0.0056*** (−6.552)	−0.0056*** (−6.583)	−0.0058*** (−6.776)	−0.0058*** (−6.693)
ln_Drct	0.1453*** (2.922)	0.1377*** (2.779)	0.1457*** (2.929)	0.1507*** (3.010)	0.1388*** (2.797)	0.1508*** (3.013)
IndDrct_Ratio	0.0823 (0.398)	0.0730 (0.354)	0.0810 (0.392)	0.0772 (0.372)	0.0798 (0.386)	0.0719 (0.346)
DBM	0.0202*** (6.273)	0.0202*** (6.254)	0.0201*** (6.248)	0.0202*** (6.266)	0.0202*** (6.280)	0.0202*** (6.264)
AuditNo	−0.0250 (−0.717)	−0.0237 (−0.681)	−0.0243 (−0.698)	−0.0241 (−0.692)	−0.0244 (−0.702)	−0.0238 (−0.685)
BigFour	−0.2646*** (−4.007)	−0.2725*** (−4.119)	−0.2670*** (−4.041)	−0.2648*** (−4.006)	−0.2681*** (−4.058)	−0.2670*** (−4.030)
Analyst	−0.0008*** (−3.562)	−0.0008*** (−3.582)	−0.0008*** (−3.589)	−0.0008*** (−3.574)	−0.0008*** (−3.614)	−0.0008*** (−3.617)
InstOwn	−0.0042** (−2.396)	−0.0043** (−2.453)	−0.0042** (−2.408)	−0.0042** (−2.390)	−0.0043** (−2.423)	−0.0042** (−2.392)
ln_Asset	−0.0489*** (−3.629)	−0.0518*** (−3.849)	−0.0492*** (−3.650)	−0.0477*** (−3.536)	−0.0509*** (−3.782)	−0.0474*** (−3.505)
ROA	−0.8099*** (−3.000)	−0.8107*** (−2.999)	−0.8063*** (−2.988)	−0.8177*** (−3.027)	−0.8064*** (−2.983)	−0.8112*** (−3.003)
Leverage	0.4490*** (7.870)	0.4530*** (7.933)	0.4507*** (7.901)	0.4487*** (7.858)	0.4553*** (7.973)	0.4548*** (7.950)
Rev_Growth	0.0409* (1.940)	0.0411* (1.949)	0.0411* (1.945)	0.0411* (1.943)	0.0406* (1.925)	0.0408* (1.924)
SOE	−0.1941*** (−6.679)	−0.1910*** (−6.566)	−0.1914*** (−6.583)	−0.1891*** (−6.501)	−0.1771*** (−5.579)	−0.1707*** (−5.365)
TobinQ	0.0114 (1.103)	0.0105 (1.011)	0.0110 (1.064)	0.0115 (1.110)	0.0114 (1.096)	0.0126 (1.210)
EPS	−0.0075 (−0.223)	−0.0066 (−0.195)	−0.0072 (−0.213)	−0.0074 (−0.218)	−0.0067 (−0.198)	−0.0072 (−0.211)
Volatility	0.9356** (1.992)	0.9161** (1.961)	0.9258** (1.983)	0.9299** (1.985)	0.9233** (1.982)	0.9275** (1.995)
Turnover	−0.7314** (−2.040)	−0.7763** (−2.159)	−0.7688** (−2.139)	−0.7841** (−2.175)	−0.7859** (−2.179)	−0.8466** (−2.324)
EPS_Ind_Ave	−0.1284* (−1.799)	−0.1274* (−1.782)	−0.1244* (−1.743)	−0.1208* (−1.688)	−0.1248* (−1.745)	−0.1161 (−1.621)
Fix & cons	Yes	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109	15109

Table A10. Robustness test of maximizing percentile centrality via Logit and Probit regression

Model	(1)	(2)	(3)	(4)	(5)	(6)
Estimation			Logit			
Dependent	Fraud	Fraud	Fraud	Fraud	Fraud	Fraud
OC	0.1169** (2.002)	0.1174** (2.010)	0.1158** (1.982)	0.1168** (2.000)	0.1175** (2.011)	0.1176** (2.013)
PerScoreMax	−0.0002 (−0.203)					
PoSAMax		0.0002 (0.235)				0.0012 (1.135)
PoSCMax			−0.0017 (−1.288)			−0.0012 (−0.711)
PoSFGOMax				−0.0132** (−2.008)		−0.0134* (−1.661)
PoSRMax					0.0047 (0.881)	0.0051 (0.923)
PC	0.2011*** (4.617)	0.1995*** (4.598)	0.2061*** (4.736)	0.2098*** (4.816)	0.1950*** (4.460)	0.2055*** (4.676)
CEO_Tensure	0.0319 (1.487)	0.0320 (1.490)	0.0324 (1.510)	0.0314 (1.466)	0.0319 (1.489)	0.0321 (1.499)
CEO_Age	−0.0042 (−1.259)	−0.0041 (−1.245)	−0.0042 (−1.268)	−0.0040 (−1.215)	−0.0041 (−1.223)	−0.0038 (−1.143)
CEO_Male	−0.0212 (−0.244)	−0.0220 (−0.253)	−0.0191 (−0.219)	−0.0158 (−0.181)	−0.0203 (−0.234)	−0.0139 (−0.160)
ln_CEOShare	0.0010 (0.294)	0.0009 (0.260)	0.0011 (0.326)	0.0010 (0.305)	0.0004 (0.130)	0.0003 (0.075)
Duality	0.1518*** (2.812)	0.1513*** (2.801)	0.1513*** (2.800)	0.1497*** (2.770)	0.1505*** (2.786)	0.1459*** (2.697)
Shrcr1	−0.0100*** (−6.586)	−0.0100*** (−6.618)	−0.0099*** (−6.511)	−0.0100*** (−6.566)	−0.0102*** (−6.680)	−0.0101*** (−6.622)
ln_Drct	0.2384*** (2.702)	0.2362*** (2.683)	0.2460*** (2.779)	0.2536*** (2.839)	0.2368*** (2.686)	0.2552*** (2.857)
IndDrct_Ratio	0.1590 (0.432)	0.1554 (0.423)	0.1584 (0.429)	0.1653 (0.447)	0.1615 (0.439)	0.1585 (0.427)
DBM	0.0352*** (6.364)	0.0351*** (6.353)	0.0351*** (6.362)	0.0353*** (6.386)	0.0352*** (6.377)	0.0352*** (6.366)
AuditNo	−0.0425 (−0.705)	−0.0422 (−0.700)	−0.0430 (−0.712)	−0.0425 (−0.703)	−0.0427 (−0.709)	−0.0423 (−0.700)
BigFour	−0.5143*** (−4.037)	−0.5174*** (−4.057)	−0.5117*** (−4.023)	−0.5101*** (−4.008)	−0.5133*** (−4.034)	−0.5155*** (−4.035)
Analyst	−0.0015*** (−3.824)	−0.0015*** (−3.829)	−0.0015*** (−3.838)	−0.0015*** (−3.838)	−0.0016*** (−3.859)	−0.0016*** (−3.900)
InstOwn	−0.0073** (−2.318)	−0.0074** (−2.323)	−0.0073** (−2.300)	−0.0073** (−2.287)	−0.0073** (−2.313)	−0.0072** (−2.271)
ln_Asset	−0.0805*** (−3.479)	−0.0812*** (−3.507)	−0.0782*** (−3.379)	−0.0767*** (−3.310)	−0.0801*** (−3.465)	−0.0757*** (−3.258)
ROA	−1.3696*** (−2.888)	−1.3692*** (−2.888)	−1.3626*** (−2.874)	−1.3721*** (−2.894)	−1.3681*** (−2.885)	−1.3631*** (−2.879)
Leverage	0.7465*** (7.663)	0.7480*** (7.680)	0.7451*** (7.661)	0.7456*** (7.662)	0.7519*** (7.727)	0.7536*** (7.729)
Rev_Growth	0.0706* (1.938)	0.0706* (1.940)	0.0704* (1.930)	0.0704* (1.925)	0.0699* (1.918)	0.0696* (1.901)
SOE	−0.3427*** (−6.719)	−0.3417*** (−6.697)	−0.3425*** (−6.713)	−0.3344*** (−6.520)	−0.3210*** (−5.734)	−0.3083*** (−5.478)
TobinQ	0.0152 (0.853)	0.0150 (0.843)	0.0159 (0.893)	0.0163 (0.914)	0.0161 (0.904)	0.0175 (0.981)
EPS	−0.0308 (−0.461)	−0.0307 (−0.460)	−0.0309 (−0.463)	−0.0306 (−0.459)	−0.0303 (−0.454)	−0.0300 (−0.452)
Volatility	1.5359* (1.821)	1.5302* (1.818)	1.5515* (1.831)	1.5537* (1.839)	1.5335* (1.834)	1.5526* (1.856)
Turnover	−1.2852** (−2.037)	−1.2998** (−2.059)	−1.2725** (−2.017)	−1.3162** (−2.078)	−1.3300** (−2.096)	−1.3891** (−2.172)
EPS_Ind_Ave	−0.2288* (−1.777)	−0.2283* (−1.774)	−0.2290* (−1.780)	−0.2219* (−1.722)	−0.2245* (−1.743)	−0.2169* (−1.684)
Fix & cons	Yes	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109	15109

Notes: [1] *, ** and *** denote significant at a confidence level of 10, 5 and 1%. [2] Logit coefficients in ratio form, Probit coefficients and their robust standard errors (in parentheses) are reported

(*continued*)

Table A10.

Model	(7)	(8)	(9)	(10)	(11)	(12)
Estimation				Probit		
Dependent	Fraud	Fraud	Fraud	Fraud	Fraud	Fraud
OC	0.0679** (2.088)	0.0682** (2.098)	0.0672** (2.068)	0.0679** (2.086)	0.0683** (2.101)	0.0681** (2.094)
PerScoreMax	−0.0002 (−0.346)					
PoSAMax		0.0000 (0.068)				0.0006 (0.972)
PoSCMax			−0.0010 (−1.311)			−0.0006 (−0.635)
PoSFGOMax				−0.0075** (−1.998)		−0.0075 (−1.613)
PoSRMax					0.0022 (0.725)	0.0025 (0.780)
PC	0.1146*** (4.621)	0.1135*** (4.596)	0.1173*** (4.732)	0.1194*** (4.813)	0.1113*** (4.472)	0.1175*** (4.693)
CEO_Tensure	0.0180 (1.480)	0.0180 (1.481)	0.0183 (1.503)	0.0177 (1.452)	0.0180 (1.478)	0.0180 (1.475)
CEO_Age	−0.0023 (−1.227)	−0.0023 (−1.217)	−0.0023 (−1.231)	−0.0022 (−1.177)	−0.0023 (−1.194)	−0.0021 (−1.116)
CEO_Male	−0.0103 (−0.207)	−0.0107 (−0.214)	−0.0095 (−0.191)	−0.0076 (−0.152)	−0.0101 (−0.203)	−0.0067 (−0.134)
ln_CEOShare	0.0006 (0.299)	0.0005 (0.267)	0.0006 (0.322)	0.0006 (0.297)	0.0003 (0.152)	0.0002 (0.106)
Duality	0.0854*** (2.757)	0.0852*** (2.749)	0.0851*** (2.747)	0.0842*** (2.717)	0.0846*** (2.730)	0.0823*** (2.653)
Shrcr1	−0.0057*** (−6.638)	−0.0057*** (−6.673)	−0.0056*** (−6.577)	−0.0057*** (−6.632)	−0.0058*** (−6.718)	−0.0057*** (−6.667)
ln_Drct	0.1406*** (2.830)	0.1391*** (2.805)	0.1447*** (2.907)	0.1484*** (2.961)	0.1391*** (2.806)	0.1492*** (2.979)
IndDrct_Ratio	0.0783 (0.379)	0.0765 (0.371)	0.0781 (0.378)	0.0804 (0.388)	0.0781 (0.378)	0.0769 (0.371)
DBM	0.0202*** (6.263)	0.0202*** (6.257)	0.0202*** (6.257)	0.0202*** (6.283)	0.0202*** (6.269)	0.0202*** (6.269)
AuditNo	−0.0242 (−0.695)	−0.0240 (−0.689)	−0.0244 (−0.700)	−0.0241 (−0.692)	−0.0242 (−0.696)	−0.0240 (−0.690)
BigFour	−0.2690*** (−4.067)	−0.2704*** (−4.082)	−0.2678*** (−4.054)	−0.2670*** (−4.041)	−0.2688*** (−4.069)	−0.2692*** (−4.059)
Analyst	−0.0008*** (−3.576)	−0.0008*** (−3.577)	−0.0008*** (−3.596)	−0.0008*** (−3.583)	−0.0008*** (−3.599)	−0.0008*** (−3.624)
InstOwn	−0.0043** (−2.433)	−0.0043** (−2.439)	−0.0043** (−2.416)	−0.0042** (−2.406)	−0.0043** (−2.432)	−0.0042** (−2.394)
ln_Asset	−0.0509*** (−3.778)	−0.0513*** (−3.809)	−0.0496*** (−3.681)	−0.0488*** (−3.615)	−0.0509*** (−3.783)	−0.0483*** (−3.569)
ROA	−0.8108*** (−3.001)	−0.8110*** (−3.001)	−0.8057*** (−2.984)	−0.8128*** (−3.007)	−0.8096*** (−2.996)	−0.8077*** (−2.990)
Leverage	0.4510*** (7.897)	0.4518*** (7.911)	0.4506*** (7.898)	0.4509*** (7.901)	0.4540*** (7.950)	0.4547*** (7.953)
Rev_Growth	0.0411* (1.948)	0.0411* (1.948)	0.0410* (1.944)	0.0411* (1.944)	0.0407* (1.928)	0.0407* (1.922)
SOE	−0.1927*** (−6.628)	−0.1921*** (−6.605)	−0.1924*** (−6.622)	−0.1880*** (−6.441)	−0.1819*** (−5.662)	−0.1750*** (−5.419)
TobinQ	0.0106 (1.023)	0.0105 (1.014)	0.0110 (1.060)	0.0112 (1.079)	0.0110 (1.064)	0.0118 (1.141)
EPS	−0.0069 (−0.203)	−0.0068 (−0.199)	−0.0071 (−0.211)	−0.0067 (−0.197)	−0.0067 (−0.196)	−0.0065 (−0.190)
Volatility	0.9226** (1.970)	0.9194** (1.966)	0.9297** (1.982)	0.9317** (1.990)	0.9207** (1.975)	0.9310** (1.997)
Turnover	−0.7569** (−2.109)	−0.7645** (−2.129)	−0.7525** (−2.097)	−0.7780** (−2.161)	−0.7798** (−2.164)	−0.8116** (−2.239)
EPS_Ind_Ave	−0.1276* (−1.786)	−0.1273* (−1.782)	−0.1274* (−1.784)	−0.1239* (−1.733)	−0.1255* (−1.755)	−0.1213* (−1.696)
Fix & cons	Yes	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109	15109

Table A11. Robustness test of averaging raw centrality via Logit and Probit regression

Model	(1)	(2)	(3)	(4)	(5)	(6)
Estimation			Logit			
Dependent	Fraud	Fraud	Fraud	Fraud	Fraud	Fraud
OC	0.1163** (1.987)	0.1184** (2.029)	0.1169** (2.000)	0.1156** (1.977)	0.1172** (2.006)	0.1183** (2.027)
CenMean	−2.7361** (−2.437)					
AlumniMean		0.6113 (1.282)				1.4744*** (2.809)
ColleaguesMean			−3.1346** (−2.093)			−2.3236 (−1.338)
FGORelationMean				−3.4081*** (−3.423)		−3.7877*** (−3.345)
RelativesMean					−0.6723 (−0.067)	−0.3357 (−0.034)
PC	0.2029*** (4.678)	0.1967*** (4.534)	0.2047*** (4.719)	0.2070*** (4.770)	0.2001*** (4.618)	0.2027*** (4.666)
CEO_Tensure	0.0306 (1.428)	0.0323 (1.506)	0.0324 (1.516)	0.0303 (1.415)	0.0319 (1.488)	0.0315 (1.471)
CEO_Age	−0.0042 (−1.253)	−0.0040 (−1.212)	−0.0042 (−1.280)	−0.0041 (−1.224)	−0.0042 (−1.255)	−0.0038 (−1.138)
CEO_Male	−0.0152 (−0.175)	−0.0233 (−0.269)	−0.0163 (−0.188)	−0.0102 (−0.117)	−0.0218 (−0.251)	−0.0089 (−0.102)
ln_CEOShare	0.0015 (0.435)	0.0006 (0.181)	0.0013 (0.382)	0.0012 (0.360)	0.0009 (0.282)	0.0007 (0.207)
Duality	0.1526*** (2.825)	0.1496*** (2.768)	0.1508*** (2.795)	0.1480*** (2.738)	0.1517*** (2.808)	0.1417*** (2.621)
Shrcr1	−0.0099*** (−6.524)	−0.0101*** (−6.663)	−0.0099*** (−6.538)	−0.0099*** (−6.522)	−0.0100*** (−6.614)	−0.0100*** (−6.590)
ln_Drct	0.2483*** (2.792)	0.2322*** (2.642)	0.2468*** (2.786)	0.2564*** (2.873)	0.2372*** (2.691)	0.2537*** (2.844)
IndDrct_Ratio	0.1884 (0.509)	0.1448 (0.394)	0.1701 (0.460)	0.1504 (0.406)	0.1573 (0.428)	0.1275 (0.344)
DBM	0.0354*** (6.403)	0.0351*** (6.343)	0.0350*** (6.336)	0.0354*** (6.398)	0.0352*** (6.364)	0.0352*** (6.337)
AuditNo	−0.0437 (−0.723)	−0.0421 (−0.698)	−0.0435 (−0.719)	−0.0445 (−0.736)	−0.0424 (−0.702)	−0.0448 (−0.740)
BigFour	−0.4958*** (−3.895)	−0.5227*** (−4.106)	−0.5084*** (−3.995)	−0.5020*** (−3.945)	−0.5155*** (−4.053)	−0.5126*** (−4.022)
Analyst	−0.0015*** (−3.773)	−0.0016*** (−3.853)	−0.0015*** (−3.832)	−0.0015*** (−3.810)	−0.0015*** (−3.830)	−0.0016*** (−3.873)
InstOwn	−0.0072** (−2.279)	−0.0074** (−2.322)	−0.0072** (−2.270)	−0.0072** (−2.257)	−0.0074** (−2.322)	−0.0070** (−2.209)
ln_Asset	−0.0767*** (−3.310)	−0.0823*** (−3.555)	−0.0763*** (−3.294)	−0.0743*** (−3.201)	−0.0808*** (−3.499)	−0.0736*** (−3.165)
ROA	−1.3745*** (−2.893)	−1.3683*** (−2.888)	−1.3658*** (−2.881)	−1.3791*** (−2.908)	−1.3697*** (−2.889)	−1.3746*** (−2.906)
Leverage	0.7426*** (7.631)	0.7519*** (7.716)	0.7447*** (7.661)	0.7406*** (7.598)	0.7472*** (7.684)	0.7492*** (7.670)
Rev_Growth	0.0714* (1.959)	0.0704* (1.931)	0.0710* (1.946)	0.0703* (1.920)	0.0706* (1.939)	0.0700* (1.904)
SOE	−0.3375*** (−6.608)	−0.3390*** (−6.640)	−0.3372*** (−6.602)	−0.3386*** (−6.632)	−0.3425*** (−6.698)	−0.3265*** (−6.367)
TobinQ	0.0175 (0.980)	0.0149 (0.834)	0.0167 (0.938)	0.0176 (0.987)	0.0151 (0.848)	0.0185 (1.037)
EPS	−0.0322 (−0.476)	−0.0305 (−0.458)	−0.0306 (−0.458)	−0.0328 (−0.490)	−0.0308 (−0.460)	−0.0323 (−0.488)
Volatility	1.5555* (1.836)	1.5258* (1.817)	1.5362* (1.833)	1.5408* (1.808)	1.5330* (1.820)	1.5273* (1.809)
Turnover	−1.2771** (−2.018)	−1.3141** (−2.080)	−1.3042** (−2.058)	−1.2931** (−2.040)	−1.2917** (−2.048)	−1.3607** (−2.130)
EPS_Ind_Ave	−0.2207* (−1.711)	−0.2295* (−1.782)	−0.2166* (−1.684)	−0.2177* (−1.688)	−0.2286* (−1.775)	−0.2104 (−1.631)
Fix & cons	Yes	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109	15109

Notes: [1] *, ** and *** denote significant at a confidence level of 10, 5 and 1%. [2] Logit coefficients in ratio form, Probit coefficients and their robust standard errors (in parentheses) are reported

(*continued*)

Table A11.

Model	(7)	(8)	(9)	(10)	(11)	(12)
Estimation			Probit			
Dependent	Fraud	Fraud	Fraud	Fraud	Fraud	Fraud
OC	0.0672** (2.068)	0.0688** (2.117)	0.0678** (2.086)	0.0667** (2.052)	0.0682** (2.097)	0.0679** (2.091)
CenMean	−1.6520*** (−2.609)					
AlumniMean		0.3080 (1.142)				0.7961*** (2.683)
ColleaguesMean			−1.7740** (−2.084)			−1.2150 (−1.231)
FGORelationMean				−1.9869*** (−3.505)		−2.2048*** (−3.409)
RelativesMean					−0.4991 (−0.082)	−0.3291 (−0.055)
PC	0.1153*** (4.673)	0.1118*** (4.527)	0.1162*** (4.708)	0.1177*** (4.769)	0.1136*** (4.608)	0.1153*** (4.661)
CEO_Tensure	0.0173 (1.418)	0.0182 (1.496)	0.0183 (1.505)	0.0170 (1.400)	0.0180 (1.480)	0.0177 (1.451)
CEO_Age	−0.0023 (−1.217)	−0.0022 (−1.183)	−0.0024 (−1.247)	−0.0023 (−1.190)	−0.0023 (−1.221)	−0.0021 (−1.115)
CEO_Male	−0.0073 (−0.146)	−0.0111 (−0.224)	−0.0082 (−0.166)	−0.0040 (−0.080)	−0.0107 (−0.215)	−0.0030 (−0.060)
ln_CEOShare	0.0008 (0.440)	0.0004 (0.185)	0.0007 (0.380)	0.0007 (0.360)	0.0005 (0.276)	0.0004 (0.218)
Duality	0.0856*** (2.763)	0.0842*** (2.716)	0.0848*** (2.737)	0.0829*** (2.676)	0.0852*** (2.751)	0.0795** (2.564)
Shrcr1	−0.0056*** (−6.592)	−0.0057*** (−6.715)	−0.0056*** (−6.610)	−0.0056*** (−6.584)	−0.0057*** (−6.672)	−0.0057*** (−6.648)
ln_Drct	0.1464*** (2.934)	0.1366*** (2.757)	0.1452*** (2.920)	0.1507*** (3.013)	0.1393*** (2.809)	0.1491*** (2.984)
IndDrct_Ratio	0.0959 (0.463)	0.0704 (0.341)	0.0858 (0.415)	0.0708 (0.342)	0.0767 (0.371)	0.0593 (0.286)
DBM	0.0203*** (6.303)	0.0201*** (6.252)	0.0201*** (6.232)	0.0203*** (6.302)	0.0202*** (6.261)	0.0202*** (6.267)
AuditNo	−0.0249 (−0.714)	−0.0238 (−0.685)	−0.0245 (−0.704)	−0.0252 (−0.723)	−0.0240 (−0.689)	−0.0252 (−0.724)
BigFour	−0.2585*** (−3.910)	−0.2738*** (−4.142)	−0.2659*** (−4.023)	−0.2627*** (−3.976)	−0.2701*** (−4.089)	−0.2689*** (−4.063)
Analyst	−0.0008*** (−3.544)	−0.0008*** (−3.589)	−0.0008*** (−3.588)	−0.0008*** (−3.571)	−0.0008*** (−3.580)	−0.0008*** (−3.604)
InstOwn	−0.0042** (−2.394)	−0.0043** (−2.440)	−0.0042** (−2.386)	−0.0042** (−2.366)	−0.0043** (−2.439)	−0.0041** (−2.326)
ln_Asset	−0.0486*** (−3.604)	−0.0520*** (−3.863)	−0.0485*** (−3.597)	−0.0474*** (−3.507)	−0.0512*** (−3.812)	−0.0470*** (−3.477)
ROA	−0.8138*** (−3.013)	−0.8113*** (−3.002)	−0.8079*** (−2.994)	−0.8172*** (−3.027)	−0.8112*** (−3.002)	−0.8165*** (−3.027)
Leverage	0.4490*** (7.868)	0.4538*** (7.943)	0.4506*** (7.901)	0.4479*** (7.841)	0.4516*** (7.917)	0.4522*** (7.904)
Rev_Growth	0.0418** (1.979)	0.0409* (1.940)	0.0415** (1.967)	0.0412* (1.947)	0.0411* (1.947)	0.0411* (1.940)
SOE	−0.1896*** (−6.520)	−0.1903*** (−6.540)	−0.1893*** (−6.508)	−0.1903*** (−6.547)	−0.1924*** (−6.602)	−0.1833*** (−6.270)
TobinQ	0.0118 (1.139)	0.0105 (1.010)	0.0114 (1.100)	0.0119 (1.147)	0.0105 (1.015)	0.0125 (1.204)
EPS	−0.0080 (−0.236)	−0.0065 (−0.192)	−0.0071 (−0.210)	−0.0085 (−0.252)	−0.0068 (−0.200)	−0.0082 (−0.243)
Volatility	0.9343** (1.990)	0.9156** (1.961)	0.9215** (1.976)	0.9252** (1.965)	0.9199** (1.967)	0.9159* (1.955)
Turnover	−0.7534** (−2.094)	−0.7753** (−2.158)	−0.7682** (−2.134)	−0.7664** (−2.128)	−0.7630** (−2.126)	−0.8030** (−2.217)
EPS_Ind_Ave	−0.1224* (−1.711)	−0.1276* (−1.785)	−0.1203* (−1.685)	−0.1207* (−1.686)	−0.1274* (−1.783)	−0.1159 (−1.617)
Fix & cons	Yes	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109	15109

Model	(1)	(2)	(3)	(4)	(5)	(6)
Estimation			Logit			
Dependent	Fraud	Fraud	Fraud	Fraud	Fraud	Fraud
OC	0.1167** (1.997)	0.1179** (2.019)	0.1162** (1.988)	0.1165** (1.993)	0.1173** (2.008)	0.1184** (2.029)
CenMax	−0.0662 (−0.445)					
AlumniMax		0.0790 (0.643)				0.3008** (2.151)
ColleaguesMax			−0.7477** (−2.109)			−0.6515 (−1.489)
FGORelationMax				−0.6516** (−2.548)		−0.6586** (−2.155)
RelativesMax					−0.7785 (−0.273)	−0.6143 (−0.216)
	PC	0.2018*** (4.643)	0.1984*** (4.571)	0.2081*** (4.787)	0.2108*** (4.843)	0.2001*** (4.617)
CEO_Tensure	0.0318 (1.482)	0.0321 (1.495)	0.0332 (1.550)	0.0313 (1.459)	0.0319 (1.487)	0.0330 (1.539)
CEO_Age	−0.0042 (−1.267)	−0.0041 (−1.232)	−0.0043 (−1.309)	−0.0040 (−1.214)	−0.0042 (−1.258)	−0.0039 (−1.178)
CEO_Male	−0.0208 (−0.239)	−0.0223 (−0.257)	−0.0174 (−0.200)	−0.0128 (−0.147)	−0.0222 (−0.255)	−0.0120 (−0.138)
ln_CEOShare	0.0011 (0.314)	0.0008 (0.229)	0.0012 (0.364)	0.0010 (0.308)	0.0010 (0.290)	0.0007 (0.198)
Duality	0.1522*** (2.819)	0.1506*** (2.787)	0.1506*** (2.789)	0.1492*** (2.761)	0.1515*** (2.805)	0.1438*** (2.657)
Shrcr1	−0.0100*** (−6.583)	−0.0101*** (−6.634)	−0.0099*** (−6.518)	−0.0100*** (−6.577)	−0.0100*** (−6.610)	−0.0100*** (−6.589)
ln_Drct	0.2398*** (2.715)	0.2344*** (2.664)	0.2504*** (2.820)	0.2580*** (2.880)	0.2374*** (2.694)	0.2597*** (2.898)
IndDrct_Ratio	0.1612 (0.438)	0.1519 (0.413)	0.1615 (0.437)	0.1573 (0.424)	0.1565 (0.426)	0.1385 (0.373)
DBM	0.0352*** (6.368)	0.0351*** (6.345)	0.0351*** (6.353)	0.0354*** (6.410)	0.0352*** (6.364)	0.0351*** (6.344)
AuditNo	−0.0425 (−0.705)	−0.0421 (−0.698)	−0.0435 (−0.720)	−0.0434 (−0.718)	−0.0422 (−0.700)	−0.0431 (−0.712)
BigFour	−0.5126*** (−4.026)	−0.5204*** (−4.084)	−0.5090*** (−4.001)	−0.5053*** (−3.970)	−0.5156*** (−4.054)	−0.5186*** (−4.064)
Analyst	−0.0015*** (−3.819)	−0.0016*** (−3.838)	−0.0015*** (−3.848)	−0.0015*** (−3.829)	−0.0015*** (−3.831)	−0.0016*** (−3.891)
InstOwn	−0.0073** (−2.318)	−0.0074** (−2.322)	−0.0072** (−2.267)	−0.0072** (−2.287)	−0.0074** (−2.323)	−0.0071** (−2.241)
ln_Asset	−0.0801*** (−3.461)	−0.0817*** (−3.531)	−0.0759*** (−3.280)	−0.0750*** (−3.231)	−0.0808*** (−3.497)	−0.0738*** (−3.182)
ROA	−1.3697*** (−2.888)	−1.3690*** (−2.888)	−1.3596*** (−2.866)	−1.3711*** (−2.891)	−1.3700*** (−2.889)	−1.3605*** (−2.873)
Leverage	0.7457*** (7.658)	0.7496*** (7.693)	0.7456*** (7.670)	0.7420*** (7.617)	0.7471*** (7.683)	0.7497*** (7.682)
Rev_Growth	0.0707* (1.941)	0.0705* (1.937)	0.0708* (1.939)	0.0705* (1.926)	0.0706* (1.938)	0.0704* (1.916)
SOE	−0.3430*** (−6.725)	−0.3407*** (−6.676)	−0.3386*** (−6.632)	−0.3345*** (−6.540)	−0.3430*** (−6.714)	−0.3256*** (−6.348)
TobinQ	0.0153 (0.860)	0.0149 (0.834)	0.0169 (0.951)	0.0169 (0.952)	0.0151 (0.848)	0.0177 (0.991)
EPS	−0.0309 (−0.462)	−0.0306 (−0.459)	−0.0306 (−0.457)	−0.0325 (−0.485)	−0.0308 (−0.461)	−0.0318 (−0.479)
Volatility	1.5378* (1.821)	1.5278* (1.818)	1.5516* (1.830)	1.5491* (1.829)	1.5331* (1.819)	1.5463* (1.832)
Turnover	−1.2788** (−2.029)	−1.3097** (−2.074)	−1.2610** (−2.000)	−1.3056** (−2.062)	−1.2922** (−2.048)	−1.3496** (−2.121)
EPS_Ind_Ave	−0.2282* (−1.772)	−0.2287* (−1.776)	−0.2236* (−1.739)	−0.2201* (−1.708)	−0.2286* (−1.776)	−0.2168* (−1.685)
Fix & cons	Yes	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109	15109

Notes: [1] *, ** and *** denote significant at a confidence level of 10, 5 and 1%. [2] Logit coefficients in ratio form, Probit coefficients and their robust standard errors in parentheses are reported

(*continued*)

Table A12. Robustness test of maximizing raw centrality via Logit and Probit regression

Table A12.

Model	(7)	(8)	(9)	(10)	(11)	(12)
Estimation			Probit			
Dependent	Fraud	Fraud	Fraud	Fraud	Fraud	Fraud
OC	0.0678** (2.084)	0.0685** (2.106)	0.0674** (2.076)	0.0676** (2.080)	0.0682** (2.098)	0.0685** (2.108)
CenMax	−0.0479 (−0.572)					
AlumniMax		0.0344 (0.495)				0.1589** (2.009)
ColleaguesMax			−0.4286** (−2.120)			−0.3553 (−1.421)
FGORelationMax				−0.3766*** (−2.576)		−0.3769** (−2.142)
RelativesMax					−0.4755 (−0.285)	−0.3827 (−0.230)
	0.2111*** (4.848)	0.1149*** (4.644)	0.1128*** (4.568)	0.1184*** (4.784)	0.1200*** (4.844)	0.1136*** (4.607)
CEO_Tensure	0.0179 (1.474)	0.0181 (1.486)	0.0188 (1.542)	0.0176 (1.445)	0.0180 (1.480)	0.0185 (1.520)
CEO_Age	−0.0023 (−1.234)	−0.0023 (−1.203)	−0.0024 (−1.276)	−0.0022 (−1.177)	−0.0023 (−1.223)	−0.0022 (−1.150)
CEO_Male	−0.0102 (−0.204)	−0.0108 (−0.217)	−0.0089 (−0.178)	−0.0058 (−0.117)	−0.0109 (−0.218)	−0.0053 (−0.106)
ln_CEOShare	0.0006 (0.318)	0.0004 (0.235)	0.0007 (0.363)	0.0006 (0.300)	0.0005 (0.284)	0.0004 (0.207)
Duality	0.0857*** (2.765)	0.0848*** (2.735)	0.0848*** (2.735)	0.0840*** (2.709)	0.0851*** (2.747)	0.0812*** (2.615)
Shrcr1	−0.0057*** (−6.639)	−0.0057*** (−6.686)	−0.0056*** (−6.588)	−0.0057*** (−6.641)	−0.0057*** (−6.668)	−0.0057*** (−6.648)
ln_Drct	0.1413*** (2.843)	0.1380*** (2.784)	0.1473*** (2.952)	0.1511*** (3.009)	0.1395*** (2.812)	0.1521*** (3.027)
IndDrct_Ratio	0.0797 (0.386)	0.0744 (0.360)	0.0801 (0.387)	0.0759 (0.366)	0.0762 (0.369)	0.0666 (0.320)
DBM	0.0202*** (6.267)	0.0201*** (6.251)	0.0201*** (6.247)	0.0203*** (6.307)	0.0202*** (6.261)	0.0202*** (6.261)
AuditNo	−0.0241 (−0.694)	−0.0239 (−0.686)	−0.0245 (−0.705)	−0.0247 (−0.710)	−0.0238 (−0.685)	−0.0245 (−0.702)
BigFour	−0.2681*** (−4.054)	−0.2722*** (−4.114)	−0.2664*** (−4.032)	−0.2646*** (−4.004)	−0.2701*** (−4.090)	−0.2717*** (−4.101)
Analyst	−0.0008*** (−3.574)	−0.0008*** (−3.581)	−0.0008*** (−3.611)	−0.0008*** (−3.581)	−0.0008*** (−3.581)	−0.0008*** (−3.624)
InstOwn	−0.0043** (−2.432)	−0.0043** (−2.439)	−0.0042** (−2.384)	−0.0042** (−2.399)	−0.0043** (−2.440)	−0.0042** (−2.359)
ln_Asset	−0.0507*** (−3.762)	−0.0517*** (−3.836)	−0.0482*** (−3.575)	−0.0477*** (−3.530)	−0.0512*** (−3.811)	−0.0471*** (−3.482)
ROA	−0.8107*** (−3.000)	−0.8112*** (−3.001)	−0.8031*** (−2.975)	−0.8119*** (−3.007)	−0.8117*** (−3.003)	−0.8063*** (−2.989)
Leverage	0.4508*** (7.894)	0.4526*** (7.923)	0.4511*** (7.909)	0.4489*** (7.861)	0.4516*** (7.917)	0.4528*** (7.917)
Rev_Growth	0.0412* (1.952)	0.0410* (1.945)	0.0414* (1.960)	0.0412* (1.948)	0.0411* (1.947)	0.0412* (1.944)
SOE	−0.1928*** (−6.635)	−0.1914*** (−6.580)	−0.1901*** (−6.539)	−0.1879*** (−6.450)	−0.1926*** (−6.619)	−0.1827*** (−6.250)
TobinQ	0.0106 (1.028)	0.0104 (1.007)	0.0116 (1.117)	0.0115 (1.113)	0.0105 (1.016)	0.0120 (1.160)
EPS	−0.0070 (−0.207)	−0.0066 (−0.196)	−0.0071 (−0.211)	−0.0081 (−0.238)	−0.0068 (−0.201)	−0.0077 (−0.228)
Volatility	0.9234** (1.971)	0.9174** (1.964)	0.9291** (1.980)	0.9297** (1.982)	0.9200** (1.967)	0.9262** (1.978)
Turnover	−0.7532** (−2.100)	−0.7714** (−2.148)	−0.7447** (−2.076)	−0.7707** (−2.142)	−0.7633** (−2.127)	−0.7943** (−2.199)
EPS_Ind_Ave	−0.1272* (−1.780)	−0.1274* (−1.782)	−0.1242* (−1.741)	−0.1226* (−1.714)	−0.1274* (−1.783)	−0.1201* (−1.682)
Fix & cons	Yes	Yes	Yes	Yes	Yes	Yes
N	15109	15109	15109	15109	15109	15109